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THE LICHENS OF BRITISH COLUMBIA

Illustrated Keys

Part 2 — Fruticose Species

by Trevor Goward

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(Illustrations by Trevor Goward)



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Prepared by

Trevor Goward

Herbarium, Department of Botany

University of British Columbia

Vancouver, BC V6T 1Z4

Mailing Address:

Edgewood Blue, Box 131

Clearwater, BC V0E 1N0

for

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INTRODUCTION

Our knowledge of lichen floristics in British Columbia has advanced rapidly in recent years. Only three decades ago, the known British Columbia lichen flora stood at 569 species (Otto and Ahti 1967). Today, by contrast, it stands at approximately 1300 species (Noble et al. 1987; Goward, unpublished). Notwithstanding this impressive figure, a comprehensive inventory of the province's lichen flora is still a long way off. In support of this claim, consider that more than 20 lichen species, on average, are added to the provincial lichen flora each year!

A significant number of lichen species warrant formal designation as "rare" or "infrequent" in British Columbia. To date, four such species carry official endangerment status in Canada (Goward et al. 1998), while one species appears on the International Union for Conservation

of Nature and Natural Resources (IUCN) "global redlist of lichens" (Thor 1996: www.dha.slu.se/guest/global.htm). Several other species may already be at risk of extirpation in the province (Goward 1996). Reflecting these concerns, the British Columbia Conservation Data Centre has recently initiated a preliminary tracking list of the province's "red-listed" and "blue-listed" lichens.

Few portions of the province have received serious attention from lichenologists. To date, comprehensive lichen studies have been carried out only on southeast Vancouver Island (Noble 1982) and the Queen Charlotte Islands (Brodo 1995; Brodo and Ahti 1996; Brodo and Santesson 1997; Brodo and Wirth 1998). The lichen flora of Wells Gray Park is also relatively well documented (Goward and Ahti 1992; Goward, unpublished).

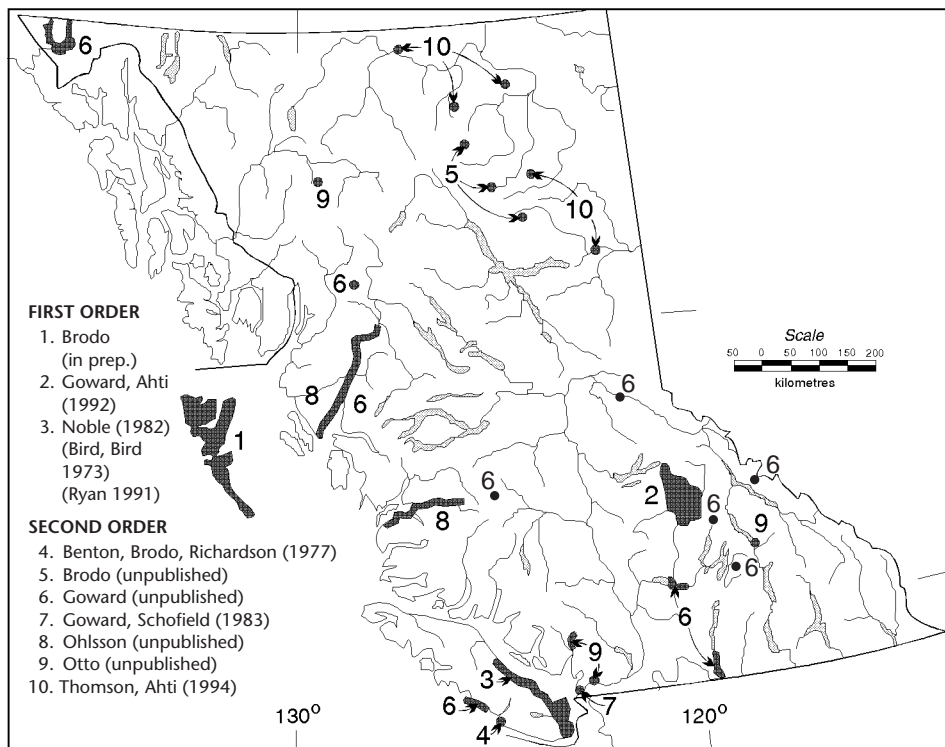


FIGURE 1 First- and second-order lichen floristic studies in British Columbia to 1998.

Important collections from other regions do exist (Figure 1), but have not been published, and are widely scattered.

Lichen study in British Columbia has traditionally been hampered by a lack of comprehensive keys to the species. Recently, however, Goward et al. (1994) published illustrated keys to 327 species of foliose and squamulose lichens. The present manual is a companion volume to that work; it provides illustrated keys to 309 species of fruticose lichens (and allied fungi) that are known from or expected to occur in British Columbia.

This manual adopts a broad interpretation of the fruticose life form. Included here are all lichen genera—both macrolichens and microlichens—in which a majority of species bear stalks or branches that are roughly circular in cross-section. Although fruticose microlichens are traditionally regarded as crustose, they are included here owing to their dominant stalked sexual or asexual reproductive structures. Examples of fruticose microlichens include *Calicium*, *Chaenotheca*, *Gyalideopsis*, and *Microlychnus*.

Two primary objectives have guided the preparation of this manual:

1. to briefly summarize the ecology, distribution, and frequency status of all fruticose lichens known to occur in British Columbia.
2. to stimulate lichenological research by making these lichens accessible to a broad audience.

In keeping with the presumed needs and resources of ecologists, biologists, naturalists, teachers, and other beginning students of lichens, this manual emphasizes morphological characters over chemical and spore characters; it also avoids technical terms as far as possible.¹ It must be acknowledged, however, that some species cannot be reliably identified without recourse to thin-layer chromatography or

examination under a light microscope; fortunately, most such species are small and inconspicuous, and are unlikely to be encountered by the beginner.

The genus and species concepts adopted here are often pragmatic. As a rule, they give priority to “intuitive” morphological groupings that do not always accord with the latest findings of anatomical and molecular research. This approach proceeds from the assumption that laboratory research will continue to uncover evolutionary relationships not readily perceived in the field. Looking ahead, two parallel approaches to lichen taxonomy can be expected to evolve: one that emphasizes taxonomic stability, and is suited to the requirements of lichen floristics and field ecology; and one that emphasizes phylogenetic relatedness, and is suited to continuing molecular, chemical, and ultrastructural studies. Although this manual follows the first of these approaches, alternative genus and species concepts are given in the synonymy under the accepted species.

Accompanying the keys are 320 line drawings intended to convey species concepts based on typical material. The drawings emphasize specific characters expressed in the adjacent key, and are not intended to depict the entire lichen. Illustrations of whole lichens can be found in various popular and semi-popular references, including Hale (1979), Kershaw et al. (1998), McCune and Geiser (1997), McCune and Goward (1995), MacKinnon et al. (1992), Parish et al. (1996), Pojar and MacKinnon (1994), Thomson (1984, 1997), and Vitt et al. (1988).

It is beyond the scope of this manual to provide a comprehensive summary of lichen biology (see instead: Hale 1983; Hawksworth and Hill 1984; Lawrey 1984; Nash 1996). Effective identification does, however, require a basic understanding of lichen morphology and chemistry.

¹ Technical terms are discussed in “Identifying Lichens” (page 10) and appear there in bold type. Additional terms are defined in the keys, as well as in the Glossary (page 295).

Interpreting the Genus and Species Accounts

Accordingly, the reader is invited to consult “Identifying Lichens” (page 10) prior to using the keys.

This manual represents a first attempt to provide comprehensive keys to the fruticose lichens of British Columbia. Though

For convenience, lichens can be arranged in several different growth forms, including crustose, squamulose, foliose, and fruticose (see “Identifying Lichens,” page 10). Because, however, these growth forms are units of convenience, not biology, they do not always offer a perfect “fit” with the genera they are supposed to circumscribe. For example, while all species of *Bryoria* are fruticose, the genus *Cladonia* contains both squamulose species and fruticose species. For convenience, this manual incorporates all lichen genera known to occur in British Columbia in which a majority of species can be described as fruticose. In a few instances, fruticose species belonging to essentially nonfruticose genera are also included (in parentheses) in the keys, but are not discussed in the species accounts. Species appearing in square brackets [...] are expected to occur in British Columbia, but have yet to be reliably recorded.

The body of the manual is arranged alphabetically, first by genus and then by species within each genus.

The genus accounts include:

1. the scientific name,
2. a common name,
3. a short description of the genus, with diagnostic characters placed in bold italic type,
4. pertinent references,
5. the derivation of the common name,
6. notes on global status, distribution, taxonomy, chemistry, and points of distinction with similar genera.

The species accounts are more complex, and are organized under the following headings:

every effort has been made to make the keys as usable as possible, numerous errors and oversights doubtless remain. The reader is invited to bring these to the author’s attention for the benefit of future students of British Columbia’s lichens.²

Species and Author Citation: Except in cases of recent taxonomic or nomenclatural revision, species names and author citations follow Esslinger and Egan (1995).

Synonyms: As a rule, only synonyms in recent or widespread use are given.

Distribution Maps: The map number appearing to the right of some species is keyed to Appendix 1, in which distribution maps are provided for species judged to be rare or infrequent in the province.

Common Names: Common names are adopted, adapted, or introduced for all lichen species included in this manual. Alternative common names are given in parentheses (...). See also “A Note on Common Names,” page 21.

Habitat/Range: Information is provided on lichen frequency status, common substrates, site characteristics, provincial “life zone” distribution, distribution in the northern hemisphere, and cordilleran distribution.

1. **Frequency status** is given using the following terms: rare, infrequent, frequent, common.
2. **Substrates** include acid/base-rich/mossy/seasonally inundated rock, coniferous/deciduous trees or shrubs, and soil, moss, duff, bark, or wood.
3. **Site characteristics** are expressed as: exposed/open/ sheltered/shady/old-growth forests, steppe, depressions, or outcrops, at lower/middle/upper/alpine elevations.
4. **Provincial “life zone” distributions** are given according to the terms listed in columns I and II of Table 1; see also Figure 2. Biogeoclimatic units (column III of Table 1) are occasionally used,

² Please direct comments to Trevor Goward, Edgewood Blue, Box 131, Clearwater, BC V0E 1N0.

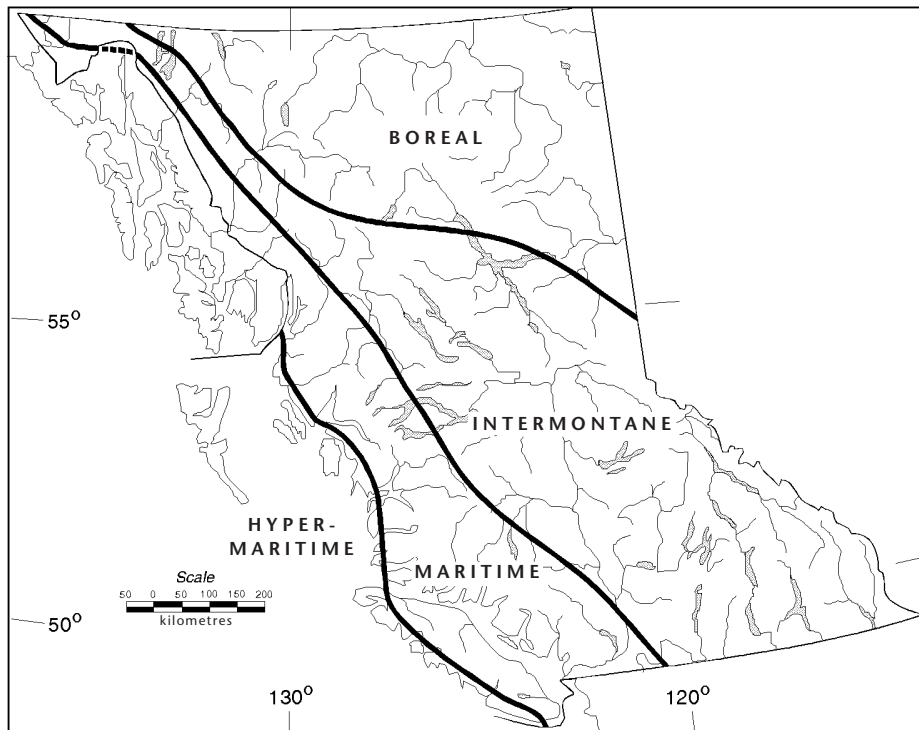


FIGURE 2 "Life zones" of British Columbia.

TABLE 1 *Distributional units and their definition*

General Range (I)	Life Zone (II)	Biogeoclimatic Equivalent ^a (III)	Conrad's Index of Continentality (IV)
COAST	Hypermaritime	CWH wh and vh ^b	< 8
	Maritime		9 - 29
	-dry	CDF	
	-wet	CWH (not wh and vh)	
INLAND	-subalpine	MH	
	Intermontane		30 - 39
	-semi-arid	BG, PP	
	-dry (lowland)	IDF	
	-dry (upland)	SBPS	
	-moist (lowland)	SBS	
	-moist (upland)	MS	
	-humid (lowland)	ICH	
	-subalpine	ESSF	
	Boreal	BWBS, SWB	> 40
SUBALPINE	Throughout	MH, ESSF	various
ALPINE	Throughout	AT	various
WIDESPREAD	Throughout	"throughout"	various

a See Table 2 or the Glossary for definitions of these biogeoclimatic zone codes.

b Only the Wet Hypermaritime (wh) and Very Wet Hypermaritime (vh) subzones of the Coastal Western Hemlock Zone (CWH) are included here.

and are mapped in Figure 3; see also “Understanding Biogeoclimatic Zonation” (below). The continentality units in column IV are based on Conrad’s Index of Continentality (Conrad 1946), and are included to enable ecoclimatic comparisons with other regions of the world (for further details, see Goward and Ahti 1992).

5. *Distribution in the northern hemisphere* is expressed relative to western North America. The following distributional units are used:

- western N Am
- western N Am - eastern N Am
- western N Am - western Eurasia
- western N Am - eastern Eurasia
- incompletely circumpolar (= any three of the above distributional units)
- circumpolar

6. *Cordilleran distribution* is summarized using the following geographic units: N to sAK (Alaska: Pacific coast only), AK (Alaska: boreal and arctic regions only), YU (Yukon), or wNT (Northwest Territories: west of the Mackenzie River only); and S to AZ (Arizona), CA (California), CO (Colorado), ID (Idaho), MT (Montana), MX (Mexico), NM (New Mexico), NV (Nevada), OR (Oregon),

UT (Utah), WA (Washington), or WY (Wyoming); and AB (Alberta). While most state records appearing in this manual are based on published reports, a few unpublished records are also given; these appear in parentheses.

Reactions: In most cases, only positive reactions are given, based on commonly used chemical reagents and ultraviolet light; negative reactions are generally omitted. For further details see “Making Use of Lichen Chemistry,” page 20.

Contents: In most cases, only dominant lichen substances are listed. Substances given in parentheses are “accessory,” that is, they do not occur in all specimens.

Variability: Some lichen species vary greatly with habitat, whereas others are more uniform. To assist in identification, each species has been assigned a variability rating of “low,” “medium,” or “high.” Species rated as “high” do not necessarily conform with all characters given in the keys.

Notes: Included here are comments on taxonomic problems, points of distinction with similar species, chemistry, and keys to subspecies and varieties. In general, detailed notes are reserved for taxonomically difficult genera.

Understanding Biogeoclimatic Zonation

British Columbia is a highly diverse province in which hundreds of ecosystems can be recognized. Maintaining these in the face of increasing pressure for resource development represents an enormous challenge—and involves, as a first step, classifying the province’s ecosystems in detail.

In recent years, researchers with the B.C. Ministry of Forests have described medium-scale ecosystems according to the principles of biogeoclimatic ecosystem classification (Pojar et al. 1987). They have also arranged these ecosystems into a hierarchical system of biogeoclimatic zones, subzones, and variants.

Collectively, the zones, subzones, and

variants of the biogeoclimatic system are referred to as biogeoclimatic units. Each unit is characterized by a unique set of climatic variables, and supports—and is for practical purposes defined by—a unique vegetation. In biogeoclimatic ecosystem classification, the defining vegetation for each unit occurs on moderately well-drained sites. Such sites are said to be “zonal.”

The most encompassing of the biogeoclimatic units is the biogeoclimatic zone. Fourteen biogeoclimatic zones are recognized for British Columbia and many of these are used here to describe lichen distribution. They are briefly characterized in Table 2 and mapped in Figure 3. For a

more detailed summary, see *Ecosystems of British Columbia* (Meidinger and Pojar 1991).

Lichen distribution may also be expressed using more generalized classification systems such as the “life zone system” (see Figure 2) and “general range system” adopted here. These systems are compared with their biogeoclimatic counterparts in Table 1. The comparison is

made mostly at the zonal level, though two biogeoclimatic subzones have also been used: the Wet Hypermaritime (wh) and Very Wet Hypermaritime (vh) subzones of the Coastal Western Hemlock Zone (CWH). These subzones occur in the hypermaritime or outer coastal areas of British Columbia (see Figure 2). See Table 2 for the full names of other biogeoclimatic zones.

TABLE 2 Summary information on the biogeoclimatic zones of British Columbia (Source: Lavender et al. 1990)

Zone	Code	Zonal vegetation	Zonal soils	Selected climatic characteristics ^a				
				Monthly temp. range	°days >5°C	°days <0°C	May–Sept. ppt (mm)	Oct.–April ppt (mm)
Alpine Tundra	AT	<i>Cassiope</i> spp., <i>Phyllodoce</i> spp., <i>Luetkea pectinata</i> , <i>Loiseleuria procumbens</i> , <i>Dryas</i> spp., <i>Salix</i> spp., <i>Silene acaulis</i> , <i>Poa</i> spp., <i>Festuca</i> spp., <i>Carex</i> spp., <i>Cetraria</i> spp., <i>Stereocaulon</i> spp., <i>Polytrichum piliferum</i>	Regosols, Humic Regosols, Brunisols, Humo-Ferri Podzols	-11.1–9.5	427	1763	287	469
Boreal White and Black Spruce	BWBS	White spruce, lodgepole pine, black spruce, <i>Rosa acicularis</i> , <i>Viburnum edule</i> , <i>Mertensia paniculata</i> , <i>Pyrola asarifolia</i> , <i>Cornus canadensis</i> , <i>Vaccinium vitis-idaea</i> , <i>Ptilium crista-castrensis</i> , <i>Pleurozium schreberi</i>	Gray Luvisols, Dystric and Brunisols	-24.5–16.6	709–1268	1692–2742	145–305	182–198
Bunch-grass	BG	<i>Agropyron spicatum</i> , <i>Artemisia tridentata</i> , <i>Artemisia frigida</i> , <i>Poa sandbergii</i> , <i>Koeleria macrantha</i> , <i>Festuca scabrella</i> , <i>Festuca idahoensis</i> , <i>Chrysothamnus nauseosus</i>	Brown and Dark Brown Chernozems	-10.8–22.4	1771–2516	230–878	98–175	108–208
Coastal Douglas-fir	CDF	Douglas-fir, grand fir, bigleaf maple, western flowering dogwood, <i>Holodiscus discolor</i> , <i>Gaultheria shallon</i> , <i>Mahonia nervosa</i> , <i>Rosa gymnocarpa</i> , <i>Symphoricarpos albus</i> , <i>Trientalis latifolia</i> , <i>Rubus ursinus</i> , <i>Pteridium aquilinum</i> , <i>Kindbergia oregana</i> , <i>Rhytidia-delpheus triquetrus</i>	Dystric Brunisols	1.8–18.0	1794–2121	9–43	107–238	540–1107

TABLE 2 *Continued*

Zone	Code	Zonal vegetation	Zonal soils	Selected climatic characteristics ^a				
				Monthly temp. range	°days >5°C	°days <0°C	May–Sept. ppt (mm)	Oct.–April ppt (mm)
Coastal Western Hemlock	CWH	Western hemlock, amabilis fir, Sitka spruce, yellow-cedar, <i>Vaccinium alaskaense</i> , <i>Vaccinium parvifolium</i> , <i>Menziesia ferruginea</i> , <i>Gaultheria shallon</i> , <i>Polystichum munitum</i> , <i>Pteridium aquilinum</i> , <i>Blechnum spicant</i> , <i>Clintonia uniflora</i> , <i>Rhytidiadelphus loreus</i> , <i>Hylocomium splendens</i>	Ferro-Humic and Humo-Ferric Podzols	-6.6–18.7	1059–2205	5–493	159–1162	695–3225
Engelmann Spruce–Subalpine Fir	ESSF	Subalpine fir, Engelmann spruce, <i>Rhododendron albiflorum</i> , <i>Menziesia ferruginea</i> , <i>Vaccinium (membranaceum, ovalifolium, scoparium)</i> , <i>Rubus pedatus</i> , <i>Gymnocarpium dryopteris</i> , <i>Tiarella unifoliata</i> , <i>Valeriana sitchensis</i> , <i>Orthilia secunda</i> , <i>Streptopus roseus</i> , <i>Veratrum viride</i> , <i>Barbilophozia lycopodioides</i> , <i>Pleurozium schreberi</i> , <i>Rhytidiopsis robusta</i>	Humo-Ferric Podzols	-10.9–13.3	629–801	879–1189	205–425	271–1597
Interior Cedar–Hemlock	ICH	Western hemlock, western red-cedar, hybrid white spruce, Douglas-fir, subalpine fir, <i>Vaccinium ovalifolium</i> , <i>Oplopanax horridus</i> , <i>Vaccinium membranaceum</i> , <i>Rubus parviflorous</i> , <i>Paxistima myrsinites</i> , <i>Smilacina racemosa</i> , <i>Streptopus (amplexifolius, roseus)</i> , <i>Chimaphila umbellata</i> , <i>Goodyera oblongifolia</i> , <i>Gymnocarpium dryopteris</i> , <i>Ptilium crista-castrensis</i> , <i>Pleurozium schreberi</i> , <i>Hylocomium splendens</i> , <i>Rhytidiadelphus triquetrus</i>	Humo-Ferric Podzols, Gray Luvisols, and Dystric Brunisols	-10.7–20.8	1267–2140	238–820	200–439	294–1098
Interior Douglas-fir	IDF	Douglas-fir, lodgepole pine, ponderosa pine, <i>Spiraea betulifolia</i> , <i>Amelanchier alnifolia</i> , <i>Juniperus communis</i> , <i>Symphoricarpos albus</i> , <i>Mahonia aquifolium</i> , <i>Paxistima myrsinites</i> , <i>Calamagrostis rubescens</i> , <i>Arctostaphylos uva-ursi</i> , <i>Agropyron spicatum</i> , <i>Pleurozium schreberi</i>	Gray Luvisols, Eutric and Dystric Brunisols	-13.1–21.3	903–2366	235–1260	107–291	149–1022

TABLE 2 *Continued*

Zone	Code	Zonal vegetation	Zonal soils	Selected climatic characteristics ^a				
				Monthly temp. range	°days >5°C	°days <0°C	May–Sept. ppt (mm)	Oct.–April ppt (mm)
Montane Spruce	MS	Hybrid white spruce, sub-alpine fir, lodgepole pine, Douglas-fir, <i>Vaccinium scoparium</i> , <i>Lonicera utahensis</i> , <i>Shepherdia canadensis</i> , <i>Paxistima myrsinites</i> , <i>Vaccinium membranaceum</i> , <i>Alnus viridis</i> , <i>Linnaea borealis</i> , <i>Empetrum nigrum</i> , <i>Calamagrostis rubescens</i> , <i>Pleurozium schreberi</i>	Dystric Brunisols and Humo-Ferric Podzols	-12.5–17.4	891–1310	847–890	158–252	223–469
Mountain Hemlock	MH	Mountain hemlock, amabilis fir, yellow-cedar, <i>Vaccinium (ovalifolium, membranaceum, alaskaense)</i> , <i>Menziesia ferruginea</i> , <i>Rhododendron albiflorum</i> , <i>Rubus pedatus</i> , <i>Phyllodoce empetriformis</i> , <i>Rhytidiopsis robusta</i> , <i>Rhytidiadelphus loreus</i> , <i>Hylocomium splendens</i>	Ferro-Humic Podzols and Folisols	-2.3–13.2	919–933	307–352	694–707	1857–2260
Ponderosa Pine	PP	Ponderosa pine, <i>Agropyron spicatum</i> , <i>Balsamorhiza sagittata</i> , <i>Festuca (saximontana, idahoensis)</i> , <i>Koeleria macrantha</i> , <i>Lithospermum ruderales</i> , <i>Achillea millefolium</i>	Eutric and Dystric Brunisols	-8.6–21.6	1505–2442	258–861	86–270	170–334
Spruce–Willow–Birch	SWB	White spruce, subalpine fir, <i>Salix glauca</i> , <i>Betula glandulosa</i> , <i>Potentilla fruticosa</i> , <i>Shepherdia canadensis</i> , <i>Festuca altaica</i> , <i>Lupinus arcticus</i> , <i>Pedicularis labradorica</i> , <i>Epilobium angustifolium</i> , <i>Empetrum nigrum</i> , <i>Vaccinium (vitis-idaea, caespitosum)</i> , <i>Hylocomium splendens</i> , <i>Cladina</i> spp., <i>Nephroma arcticum</i>	Eutric or Dystric Brunisols, Humo-Ferric Podzols	-19.2–14.0	534–933	2036–2298	275–280	179–424
Sub-Boreal Pine–Spruce	SBPS	Lodgepole pine, white spruce, <i>Shepherdia canadensis</i> , <i>Spiraea betulifolia</i> , <i>Rosa acicularis</i> , <i>Calamagrostis rubescens</i> , <i>Arctostaphylos uva-ursi</i> , <i>Vaccinium caespitosum</i> , <i>Linnaea borealis</i> , <i>Pleurozium schreberi</i> , <i>Peltigera</i> spp., <i>Cladina</i> spp.	Gray Luvisols and Dystric Brunisols	-13.8–14.3	697–1044	1140–1405	243–300	218–222

TABLE 2 *Concluded*

Zone	Code	Zonal vegetation	Zonal soils	Selected climatic characteristics ^a				
				Monthly temp. range	°days >5°C	°days <0°C	May–Sept. ppt (mm)	Oct.–April ppt (mm)
Sub-Boreal Spruce	SBS	Hybrid white spruce, sub-alpine fir, lodgepole pine, <i>Vaccinium membranaceum</i> , <i>Rubus parviflorus</i> , <i>Viburnum edule</i> , <i>Lonicera involucrata</i> , <i>Spiraea betulifolia</i> , <i>Rosa acicularis</i> , <i>Aralia nudicaulis</i> , <i>Cornus canadensis</i> , <i>Linnaea borealis</i> , <i>Arnica cordifolia</i> , <i>Clintonia uniflora</i> , <i>Aster conspicuus</i> , <i>Osmorhiza chilensis</i> , <i>Oryzopsis asperifolia</i> , <i>Smilacina racemosa</i> , <i>Gymnocarpium dryopteris</i> , <i>Pleurozium schreberi</i> , <i>Ptilium crista-castrensis</i> , <i>Hylocomium splendens</i> , <i>Dicranum polysetum</i> , <i>Rhytidiadelphus triquetrus</i> , <i>Peltigera</i> spp.	Gray Luvisols and Dystric Brunisols, Humo-Ferri Podzols	-14.6–16.9	884–1510	792–1369	189–353	250–1383

a Selected climatic characteristics summarized from Atmospheric Environment Service (AES) long-term stations. Prepared by D. Meidinger.

Identifying Lichens

The vast majority of lichens are classified as *Ascomycetes* (cup fungi), and hence are related to morels and elf saddles. While most fungi, however, draw their nourishment from sources external to themselves (e.g., decaying leaves or logs), lichen fungi “cultivate” their foodstuff among the fungal threads of which they themselves are composed. This foodstuff consists of tiny, photosynthesizing algal or cyanobacterial cells, or both. Lichens can therefore be viewed as living greenhouses supported largely by carbohydrates derived from the photosynthetic “crops” growing within them. This in part accounts for the exposed lifestyle adopted by most lichens: whereas a majority of fungi pass their lives (except when fruiting) within the things they feed on, lichens colonize the surfaces of rocks, trees, logs, duff, and soil.

When a fungus enters into a stable, enduring relationship with a microscopic alga or cyanobacterium, both partners are said to be **lichenized**. In general appearance, most lichenized fungi, algae, and cyanobacteria do not closely resemble

their **unlichenized** relatives. Rather, they form a composite “plant,” or **thallus** (Figures 4–5). Under the microscope, a typical lichen thallus resembles a kind of sandwich in which the fungal partner (**mycobiont**) and the “algal” partner (**photobiont**) are **stratified** in distinct layers (Figure 4). In many conspicuous lichen species, four such layers can be discerned: a protective rind or **upper cortex** (Figure 4a); an “algal” or **photobiont layer** (Figure 4b); a pale, usually whitish region of loosely interwoven fungal threads, called the **medulla** (Figure 4c); and another protective covering or **lower cortex** (Figure 4d).

As already mentioned, the photobionts in nearly all lichens consist of **green algae** or **cyanobacteria**. When exposed by a razor blade and viewed under a dissecting microscope, most algae are easily recognized by their characteristic single-celled habit, as well as by their bright grass-green colour (but yellowish green in *Trentepohlia*). Cyanobacteria are much more variable in form—single-celled, cluster-

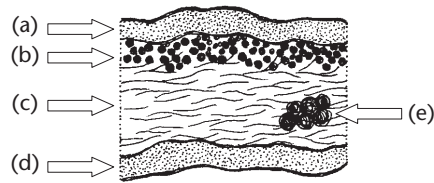


FIGURE 4 *Thallus stratified/heteromorous* (cross-section): (a) upper cortex; (b) algal or cyanobacterial layer / photobiont layer; (c) medulla; (d) lower cortex; and (e) a cephalodium.

celled, or strandlike—but they are never grass-green, although at least one genus can be yellowish green. In some species dominated by a green algal photobiont, cyanobacteria are also present as scattered, localized colonies called **cephalodia** (Figure 4e). These can occur internally or over the upper or lower surface (Figures 10d, 11l).

In some groups having a cyanobacterial photobiont, the photobiont cells are intermingled throughout with fungal threads, and the thallus is uniformly dark both inside and out. Such lichens are said to be **nonstratified** (Figure 5); viewed from the outside, they are typically brownish, blackish, or bluish grey. They can assume a **gelatinous** consistency when wet, and are then popularly referred to as “gel lichens.” Most nonstratified lichens lack a cortex (Figure 5a), though a primitive cellular cortex is present in *Leptogium* and

Polychidium (Figure 5b). Strandlike **rhizoids** (Figure 5c) can also occur in some cyanobacterial species.

Many different groups of algae and cyanobacteria have entered into association with lichen fungi. Common cyanobacterial groups include the Chroococcales (Figure 6a), *Nostoc* (Figure 6b), the Rivulariaceae (Figure 6c), *Scytonema* (Figure 6d), and *Stigonema* (Figure 6e). The most common algal groups include *Stichococcus* (Figure 6f), *Trebouxia* and related genera (Figure 6g), and *Trentepohlia* (Figure 6h). For keys to these and other photobiont genera, see page 23.

Specialized **holdfasts**, or **rhizines** (Figure 7a–e), occur in many species having a lower cortex. Rhizines anchor the lichen to the colonized surface or **substrate**, and can be **simple** (Figure 7a), **forking** (Figure 7b), **squarrose** (Figure 7c), **tufted** (Figure 7d), or **flocculent**

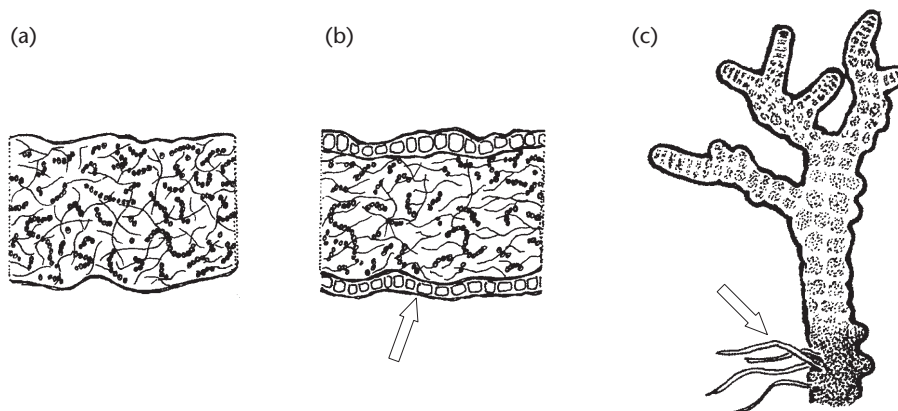


FIGURE 5 *Thallus nonstratified/homoiomorous* (cross-section, in part): (a) noncorticate, (b) corticate(←), (c) bearing rhizoids(←).

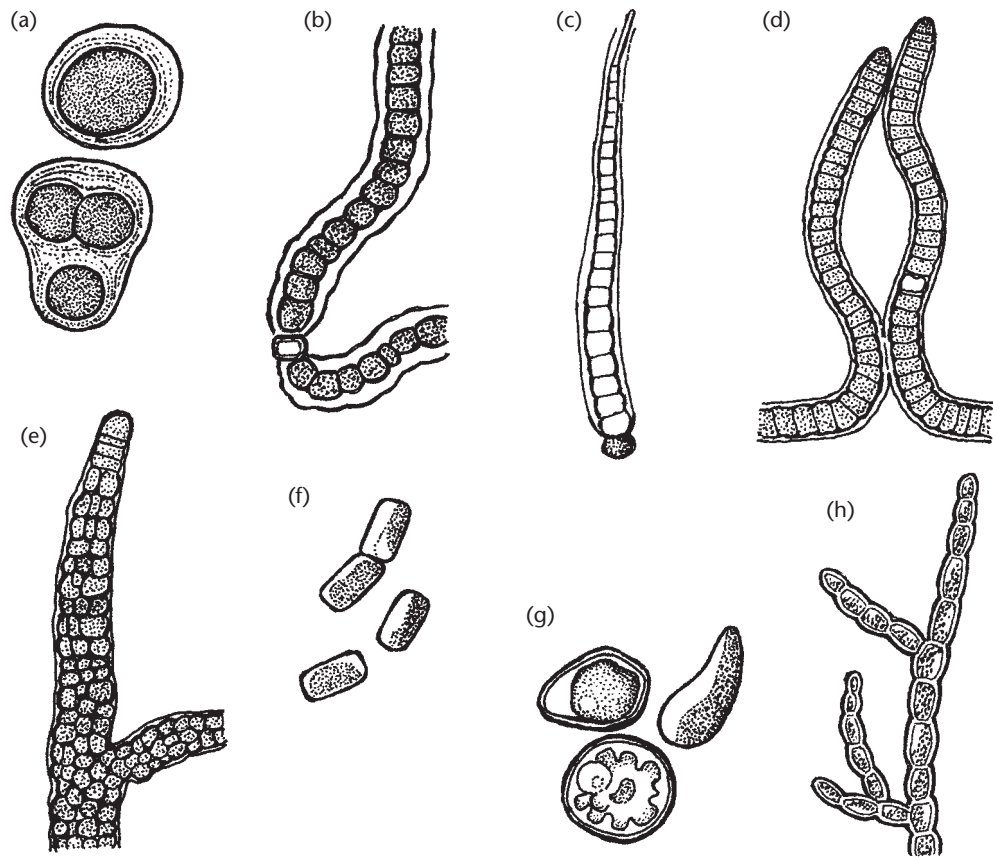


FIGURE 6 Common photobionts (free-growing/unlichenized forms; for lichenized forms, see the key on page 23), a–e = cyanobacteria; f–h = algae: (a) Chroococcales; (b) Nostoc; (c) Rivulariaceae; (d) Scytonema; (e) Stigonema; (f) Stichococcus; (g) trebouxioid; and (h) Trentepohlia.

(Figure 7e). In some foliose species (see below), rhizines are replaced by a single thickened point of attachment, or **umbilicus** (Figure 7f). In others, the rhizines are replaced by a dark, woolly **hypothallus** (Figure 7g) that can sometimes extend beyond the margins of the lichen. Rhizine-like structures that occur along the margins of leaflike lobes are called **cilia** (Figure 10i).

Two broad categories of branching are recognized in this manual. Branching is said to be **even** when the arms of each branch pair are predominantly equal (Figure 8a), and **uneven** when they are not equal (Figure 8b). Similarly, five degrees of attachment can be distinguished: **appressed** (Figure 8c), **decumbent**

(Figure 8d), **semi-erect** (Figure 8e), **erect** (Figure 8f), and **pendent** (Figure 8g).

Lichens have traditionally been divided into three growth forms (**crustose**, **foliose**, and **fruticose**: see below), though other classifications are possible. The one adopted here recognizes seven growth forms:

1. **Dust/leprose** lichens (Figure 9a) lack both an upper and lower cortex, the lower surface being attached directly to the substrate, and the upper surface bearing a continuous covering of powdery or granular soredia.

2. **Crust/crustose** lichens (Figure 9b) are also attached directly to the substrate, but have a hard, protective upper cortex; viewed from above, they often resemble paint stains. Some crust

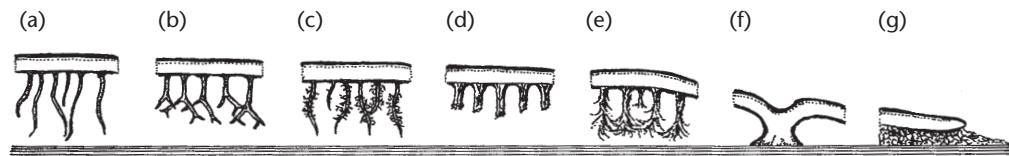


FIGURE 7 *Organs of attachment (cross-section): (a) rhizines (simple); (b) rhizines (forking); (c) rhizines (squarrose); (d) rhizines (tufted); (e) rhizines (flocculent, confluent); (f) holdfast (umbilicus); and (g) hypothallus.*

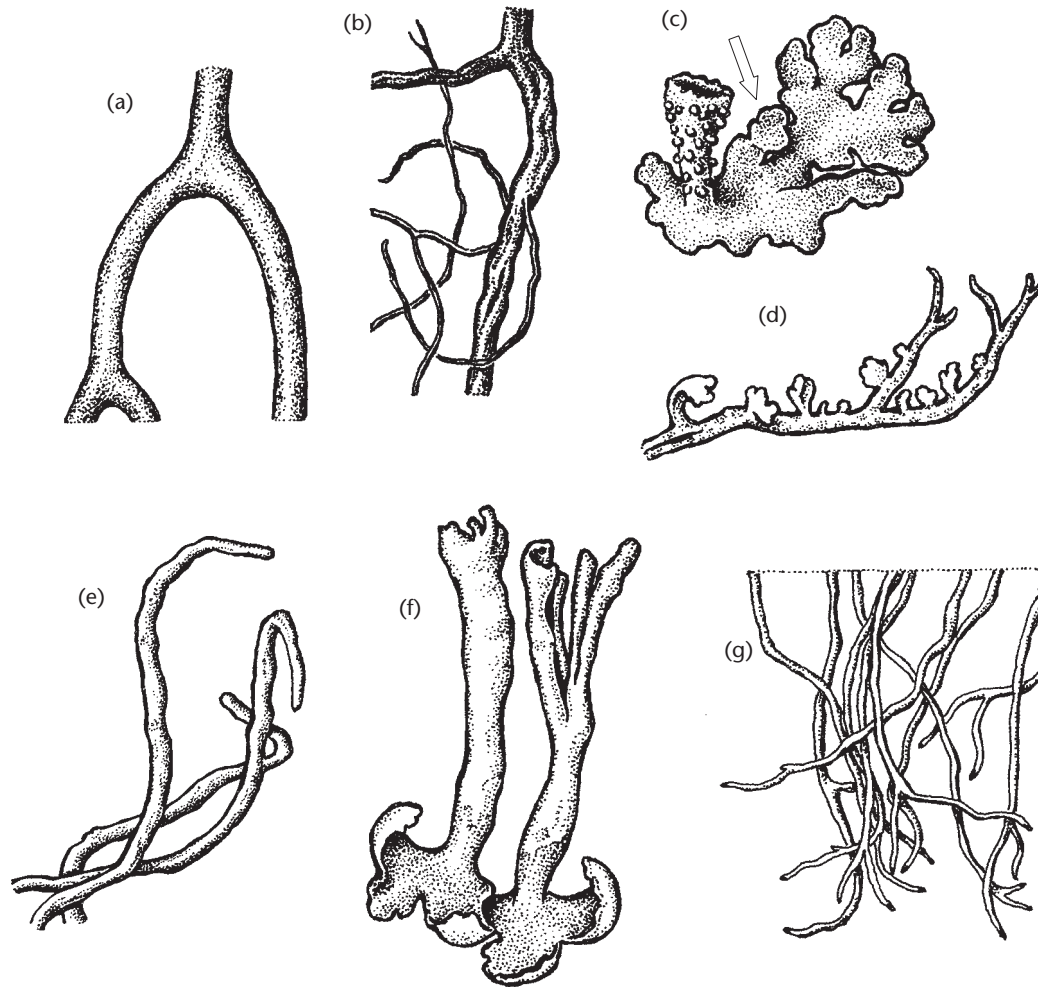


FIGURE 8 *Branching and degrees of attachment: (a) even/isotomic branching; (b) uneven/anisotomic branching; (c) appressed(\leftarrow); (d) decumbent; (e) semi-erect; (f) erect; and (g) pendent.*

lichens give rise to elongate **isidia** (see below), while others bear stalked fruiting structures termed **podetia** and **pseudopodetia**; such species can be classified as club lichens or shrub lichens (see below). Other crust lichens intergrade with scale and leaf lichens (see below).

3. **Scale/squamulose** lichens (Figure 9c) are similar to dust and crust lichens in lacking a lower cortex (and rhizines). The thallus, however, consists of small, often partly raised, and usually overlapping/**imbricate** scales/**squamules** (Figure 9c), the lower surface of which is often white and cottony (check under hand lens). In *Cladonia*, the squamules often give rise to hollow, stalked fruiting structures called **podetia**; see also club and shrub lichens, below.
4. **Leaf/foliose** lichens (Figure 9d) more or less resemble leaves—at least in the sense that their thalli consist of flattened **lobes** that typically have an upper and lower cortex. The lobes can be narrow or broad, and short or elongate. The degree of attachment to the substrate varies from appressed through semi-erect or even unattached. This is the only growth form in which well-developed **rhizines** occur.
5. **Club/fruticose** lichens (Figure 9e) are at least partly round in cross-section; they have no “true” lower surface and therefore no lower cortex and rhizines. Most club lichens consist of thickened, up-

right, unbranched, or sometimes sparsely branched stems; when hollow, they are usually referred to as **podetia**; when solid, they are called **pseudopodetia**.

6. **Shrub/fruticose** lichens (Figure 9f) resemble club lichens in having somewhat thickened stems that are more or less circular in cross-section. Here, however, the stems are strongly branched. Occasionally the stems arise from a basal crust or basal scales. When hollow, they are generally termed **podetia**; whereas, when solid, they are again called **pseudopodetia**. Shrub lichens vary from decumbent to semi-erect or erect.
7. **Hair/fruticose** lichens (Figure 9g) differ from shrub lichens in having much finer, and proportionately much longer, branches. In habit, hair lichens are semi-erect or pendent.

The upper cortex of most lichens is smooth and naked. However, in some species it can be minutely roughened (i.e., **scabrid**), or covered in **pustules** (Figure 10a) or a fine network of ridges (a **reticulum**: Figure 10b). Other species bear a thin whitish frosting (or **pruina**), while others still have a fine nap of tiny, erect, or appressed glasslike hairs (or **tomentum**: Figure 10c). A woolly tomentum is also sometimes present over the lower surface.

The lower surface of most lichens is also smooth, though raised **veins** (Figure 10h) occur in some foliose species. In others, the lower surface can be sparsely

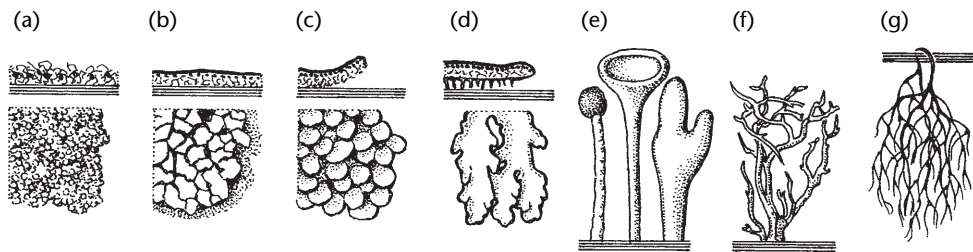


FIGURE 9 Growth forms (cross-section and surface view, in part): (a) dust/leprose; (b) crust/crustose; (c) scale/squamulose (with squamules); (d) leaf/foliose (with lobes); (e) club/fruticose; (f) shrub/fruticose; and (g) hair/fruticose.

speckled with tiny pits through which the medulla is exposed. When rimmed and craterlike, these pits are termed **cyphellae** (Figure 10f); otherwise they are called **pseudocyphellae** (Figure 10g). In some lichens, pseudocyphellae occur over the upper cortex, and must then be carefully distinguished from **maculae** (Figure 10e): pale areas of the upper surface in which the cortex is unbroken. Fruticose lichens can also produce pseudocyphellae.

Surface details can provide important

clues to identification. In some species, for example, the cortex is pocked by broad depressions (or **foveoles**: Figure 11a), while in others it bears conspicuous longitudinal **striations** (Figure 11b). Yet other species carry numerous tile-like **areoles** (Figure 11c) which may or may not be **peltate** (i.e., attached by a short central stalk: Figure 11d). The presence of tiny, scale-like **microsquamules** (Figure 11f) is diagnostic for some *Cladonia* species, whereas some species of *Usnea* bear

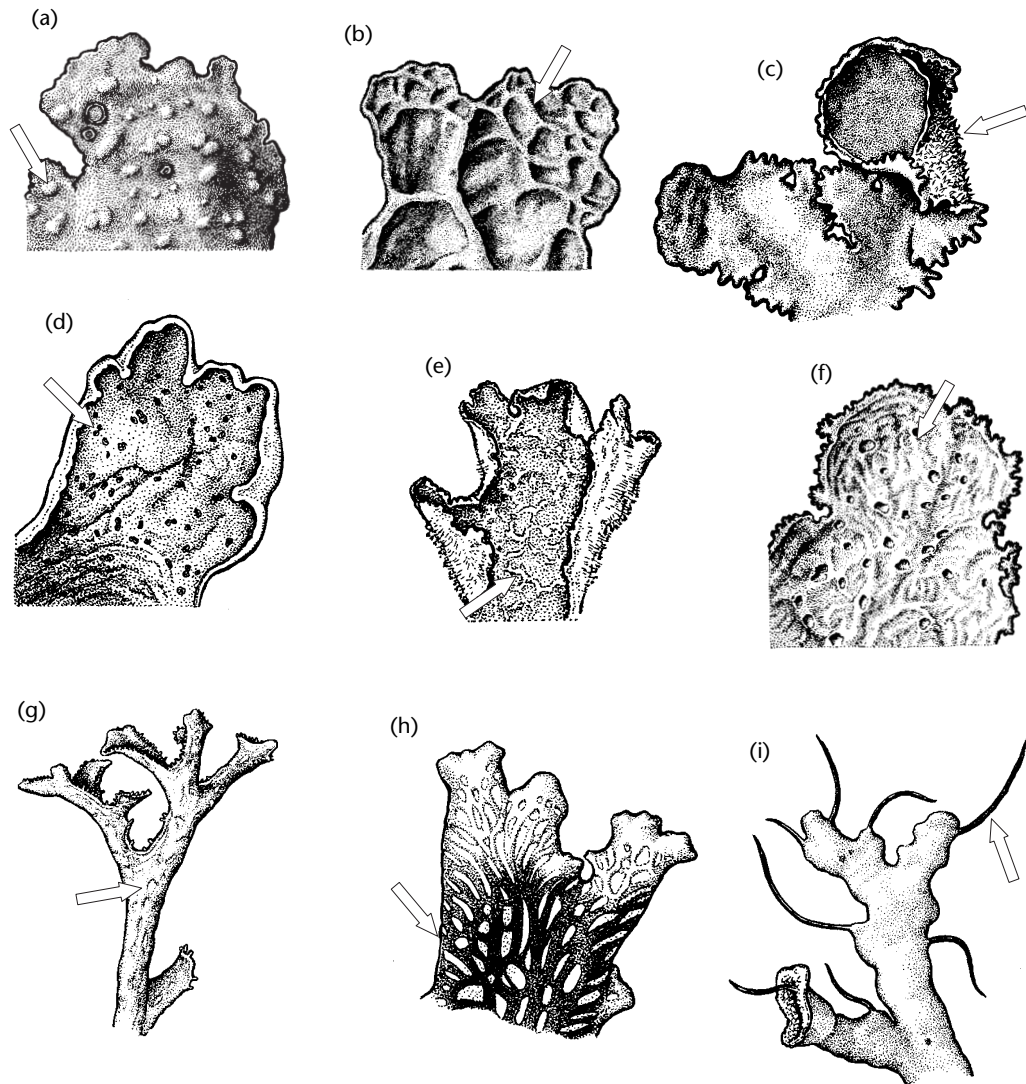


FIGURE 10 Surface (and other) details: foliose: (a) pustules(←); (b) reticulum(←); (c) tomentum(←); (d) cephalodia(←); (e) maculae(←); (f) cyphellae(←) (lower); (g) pseudocyphellae(←); (h) veins(←) (lower); and (i) cilia(←).

numerous goosefleshlike **papillae** (Figure 11g), or copious short side branches (or **fibrils**: Figure 11h). Similarly, most *Stereocaulon* species support a dense “foliage” of **phyllocladia** (Figure 11j), while small spine-like **spinules** (Figure 11i) occur in some species of *Bryoria*.

As a group, lichens reproduce both

vegetatively (in which case the fungus and alga/cyanobacterium are dispersed together, as a functional unit), and by sexual means (in which case only the spores of the fungus are dispersed: see below).

Vegetative reproduction sometimes occurs as a result of mechanical fragmentation (wear and tear), but more often it involves

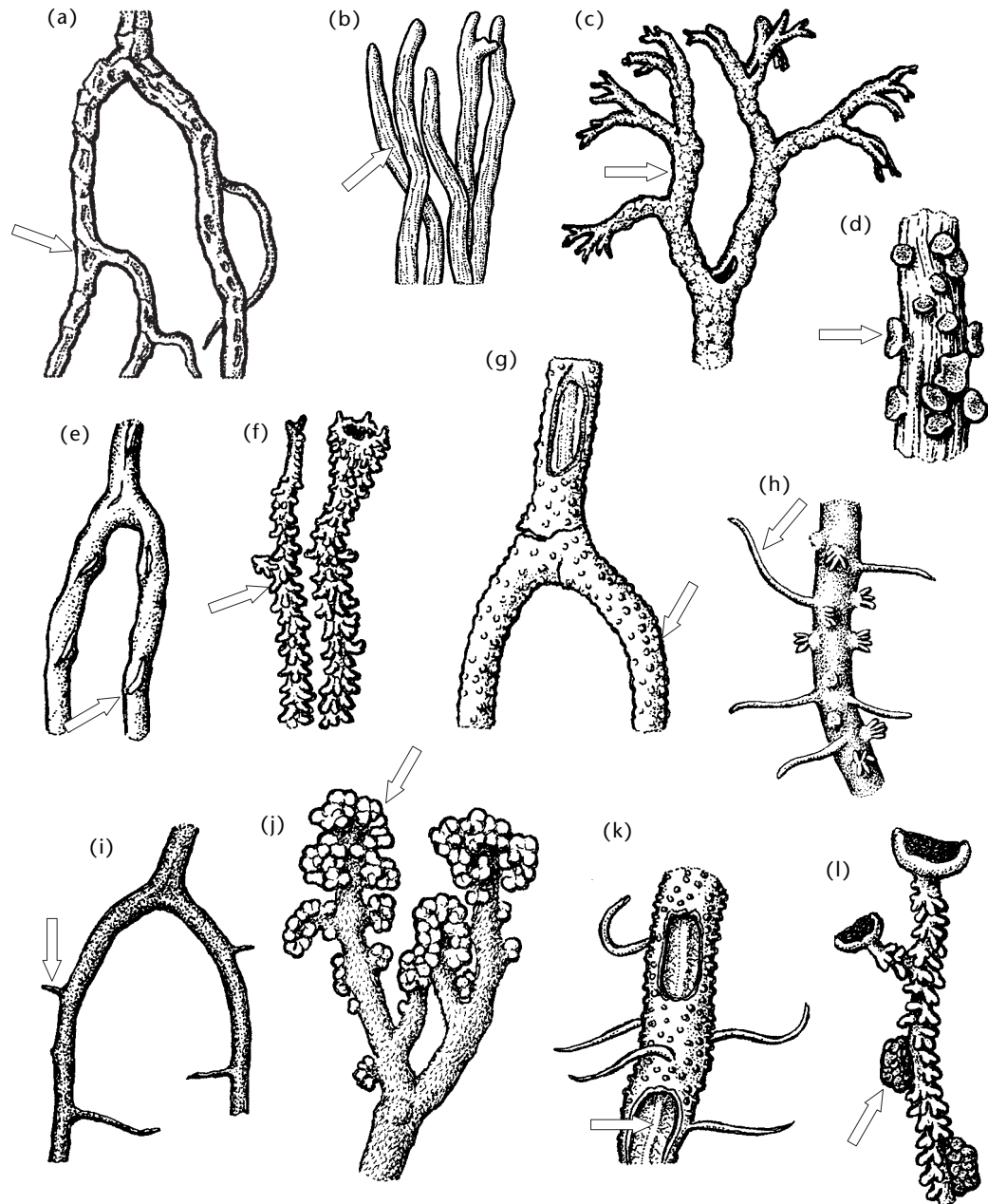


FIGURE 11 Surface (and other) details: fruticose: (a) foveoles(←); (b) striations(←); (c) plates/areoles(←); (d) peltate areoles(←); (e) pseudocyphellae(←); (f) microsquamules(←); (g) papillae(←); (h) fibrils(←); (i) spinules(←); (j) phyllocladia(←); (k) central cord(←); and (l) cephalodia(←).

transport (as by birds) of specialized outgrowths called soredia and isidia. **Soredia** (Figure 14a–d) are masses of soft, powdery granules that have erupted through cracks and other areas of weakness in the cortex. When very fine (i.e., resembling talcum powder), they are said to be powdery/farinose (Figure 14b); otherwise they can be described as more or less granular (Figure 14c). Though commonly borne in well-delimited **soralia** (Figure 14a), soredia can also be broadcast over the surface; they are then said to be **diffuse** (Figure 14d). By contrast, **isidia** (Figure 14e–i) are tiny outgrowths of the upper cortex; their hardened outer surface is usually readily distinguished from the powdery appearance of soredia. Similar to soredia, isidia

contain both a fungus and an alga/cyanobacterium. They can be **granular/globose** (Figure 14e), **barrel-shaped** (Figure 14f), **fingerlike/cylindrical** (Figure 14g), **coralloid** (Figure 14h), or **scale-like** (Figure 14i).

The primary function of sexual fruiting bodies is to produce sexual **spores** (Figure 12a–l). Sexual spores come in many shapes, and can be **threadlike/filiform** (Figure 12a), **spindle-shaped/fusiform** (Figure 12b), **ellipsoid** (Figure 12c), **clublike/clavate** (Figure 12d), **globose** (Figure 12e), or **peanut-shell-like** (Figure 12f). They can also be **1-celled** (Figure 12g), or divided by a narrow cross-wall or **septum** (Figure 12h, i) into **2-celled** (Figure 12h) or **multi-celled** spores (Figure 12i). When the septum is very broad, the spores are

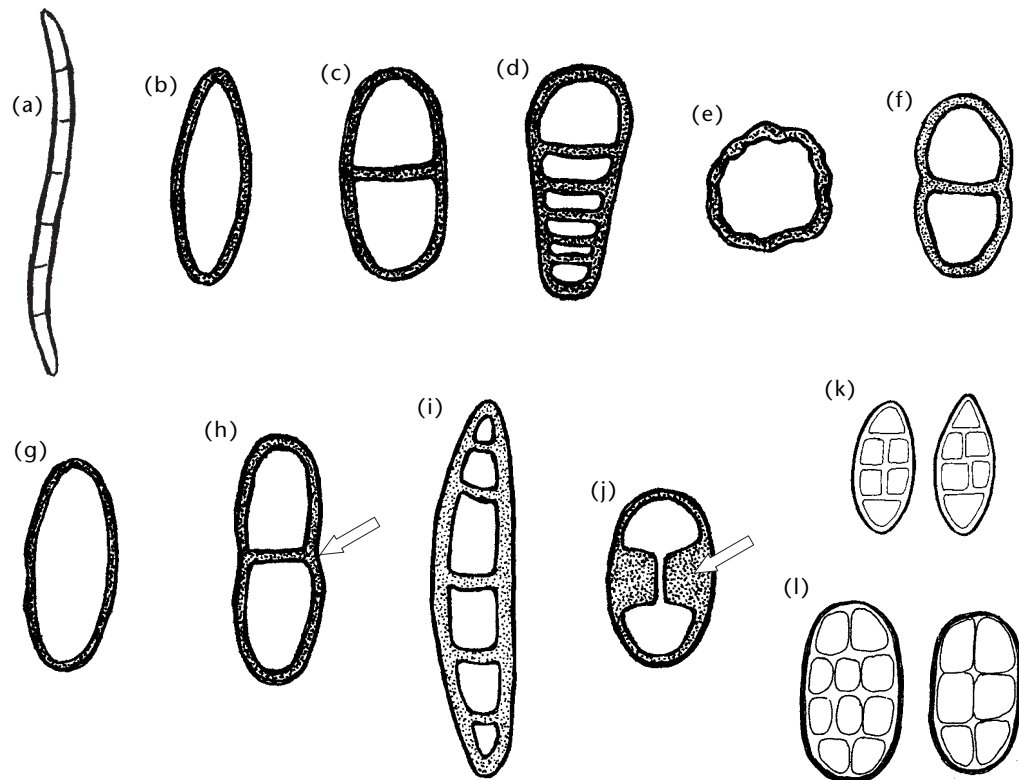


FIGURE 12 *Spores and conidia: (a) threadlike/filiform; (b) spindle-shaped/fusiform; (c) ellipsoid; (d) clublike/clavate; (e) globose; (f) peanut-shell-shaped; (g) 1-celled/simple; (h) 2-celled (with narrow septum(←)); (i) many-celled/multi-septate; (j) polarilocular (with broad septum(←)); (k) submuriform; and (l) muriform.*

termed **polarilocular** (Figure 12j). Spores having both crosswise and lengthwise septa are called **submuriform** (Figure 12k) or, when well developed, **muriform** (Figure 12l).

For most species covered in this manual, sexual fruiting bodies take the form of **apothecia** (Figure 13a–g). These are small saucerlike, buttonlike, or hemispherical structures usually readily observed over the thallus surface. Apothecia are gen-

erally **unstalked** (Figure 13a–e), but in a few genera they are borne at the ends of long, brittle stalks as expanded “heads,” or **capitula** (Figure 13f, g).

Apothecia contain both fertile and sterile tissues. The former comprise the **central disc**: a compact cluster of tiny vial-like **asci**, each bearing its complement of one to several spores (Figure 13a–e). Surrounding the disc is a sterile rim, or **excipulum** (Figure 13a, d, e). When photobiont cells

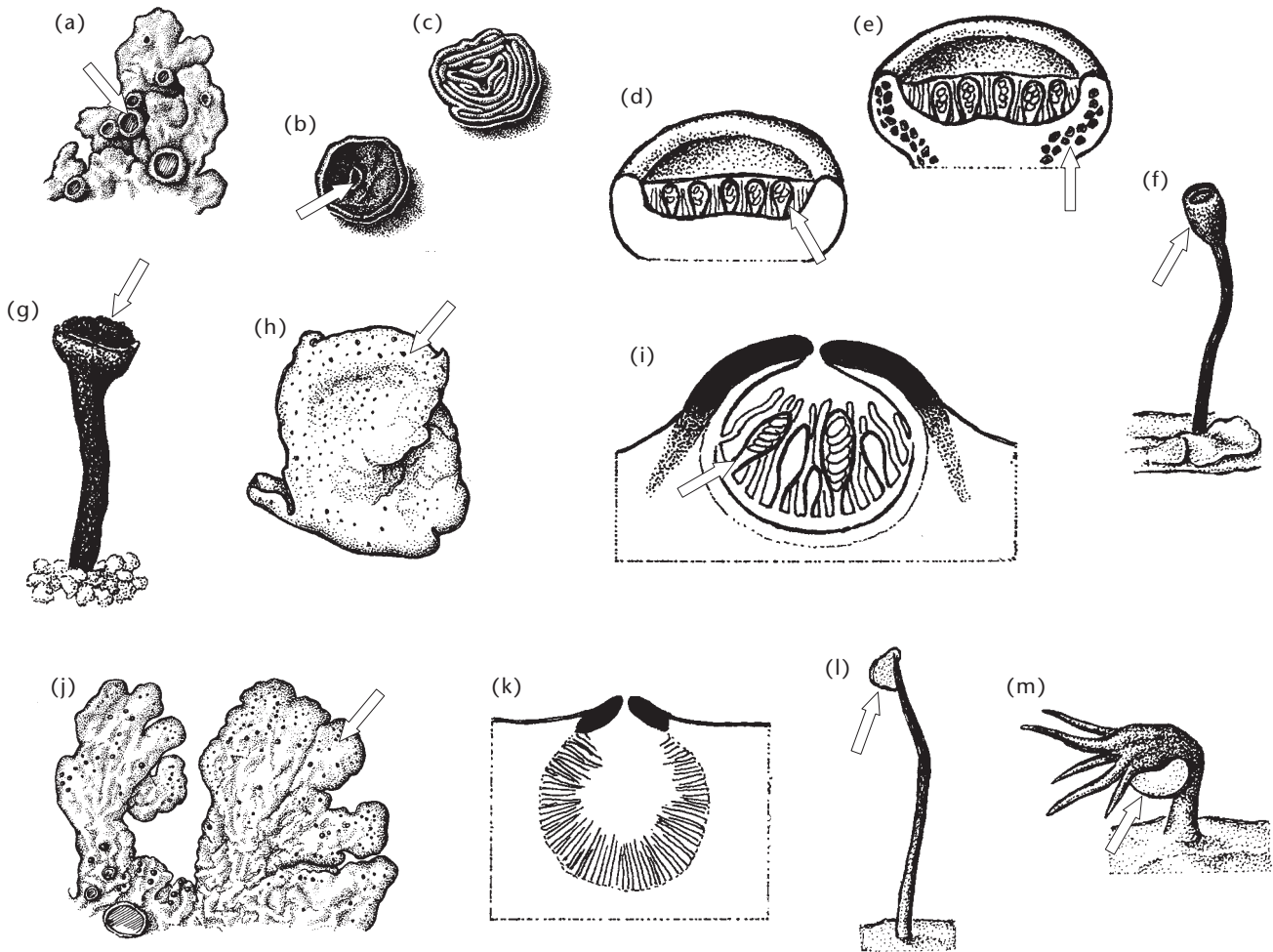


FIGURE 13 Sexual and asexual reproductive structures (surface view unless indicated): (a) unstalked apothecia (showing discs and well-developed apothecial rims/excipula(←)); (b) unstalked apothecium (with a buttoned disc/omphalodisc(←)); (c) unstalked apothecium (with fissured disc/gyrodisc); (d) unstalked apothecium (cross-section: with nonthalline rim/excypulum and spore-containing asci(←)); (e) unstalked apothecium (cross-section: with thalline rim/excypulum: note presence of algae(←)); (f) stalked apothecium (with excipulum and disc [i.e., capitulum(←)]); (g) stalked apothecium (showing mazaedium(←)); (h) perithecia; (i) perithecia (cross-section: note spore-containing asci); (j) pycnidia; (k) pycnidia (cross-section): note absence of asci; (l and m) hyphophores (showing stalks and conidial heads(←)).

are present in the excipulum, it is said to be **thalline** (Figure 13e); when they are lacking, it is **nonthalline** (Figure 13d). In *Calicium*, *Sphaerophorus*, and related genera, the disc is replaced by a distinctly powdery **mazaedium** (Figure 13g) that readily smudges when rubbed. In other lichens, sexual fruiting bodies take the form of **perithecia** (Figure 13h, i): minute flask-like, ascus-bearing structures that are immersed in the thallus, and are visible from above as blackish or brownish dots.

Perithecia must be carefully distinguished from some forms of **pycnidia**

(Figure 13j, k) which, though also dotlike, bear reproductive cells called **conidia**. Conidia come in many shapes but, unlike sexual spores, they never develop in vial-like asci. They are also usually much smaller than sexual spores, often measuring less than 4–5 μm long. In some genera, conidia are produced at the tips of stalked fruiting bodies called **hyphophores** (Figure 13l, m), while in others they are borne directly over the cortex in well-demarcated, black, sooty patches; these are termed **thalloconidia**.

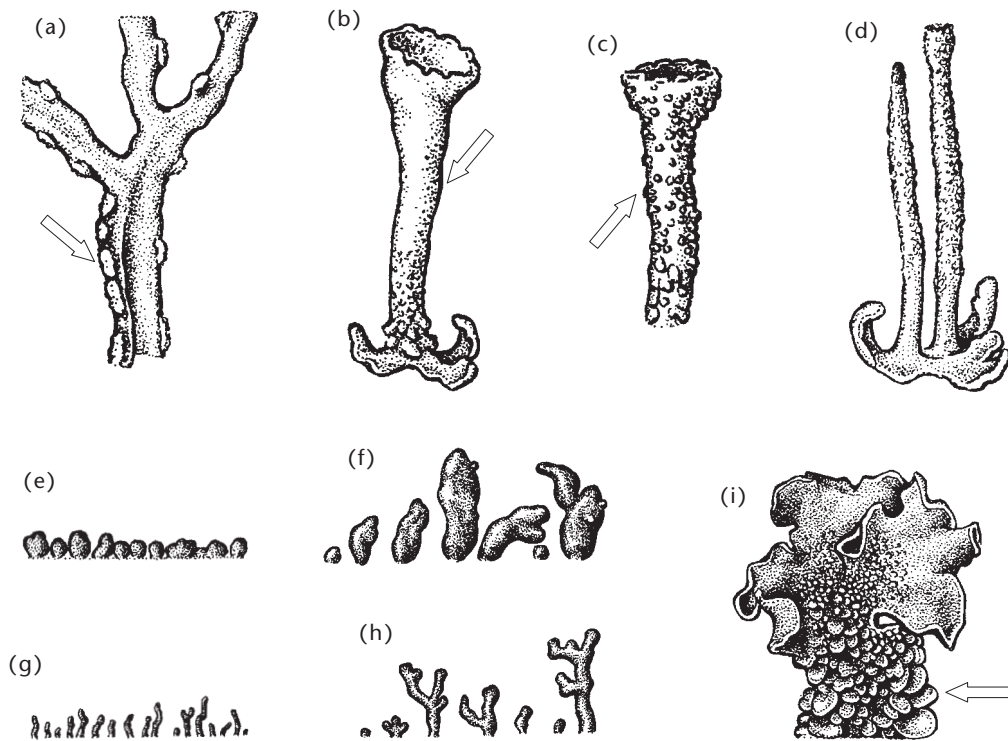


FIGURE 14 Vegetative reproductive structures: (a) soredia in a sororium(←); (b) soredia (powdery/farinose(←)); (c) soredia (granular(←)); (d) soredia (diffuse); (e) isidia (granular/globose); (f) isidia (barrel-shaped); (g) isidia (fingerlike/cylindrical); (h) isidia (coralloid); and (i) isidia (scale-like(←)).

Making Use of Lichen Chemistry

Lichens produce a diverse array of chemical substances. Reflecting this, lichen chemistry provides a useful tool for the identification of many species. The presence of specific chemical substances can be established through the use of spot tests, ultraviolet lamps, and thin-layer chromatography.

1. Spot Tests A spot test is performed when a small quantity of liquid reagent is applied to one or more lichen tissues. This can be done using a fine brush or capillary pipette that has been drawn to a point over a flame. The resulting colour change (or lack of it) is often diagnostic for one or more of several chemical substances present in the lichen. Five reagents are called for in this manual: calcium hypochlorite (C),³ nitric acid (H), potassium iodide (I), potassium hydroxide (K), and paraphenyldiamine (PD). Of these, only C, K, and PD are used routinely. All of the reagents are toxic and should be carefully stored in small, tightly sealed glass bottles. Chemical reactions can be observed using a hand lens (10x or stronger), but a dissecting microscope allows more detailed observation. Work the lichen using a stiff, single-edged razor blade and a pair of fine forceps or tweezers. Never apply a reagent directly to an herbarium specimen; instead, break off a tiny fragment that can later be discarded. Carefully record all colour changes, taking care to record both positive and negative reactions (e.g., Cortex K+ yellow, C-, PD-; medulla K-, C-, PD+ yellow becoming orange).

Calcium hypochlorite (C): This reagent, chlorine bleach (e.g., Javex), can be purchased from most grocery outlets. The reaction (a reddish or pinkish coloration) is often fleeting, and must be observed carefully. In some cases, a more vivid reaction can be obtained by using a “KC” test, in which K is followed by C. Calcium hypochlorite is unstable and

should be discarded (usually after two or three months) when it no longer smells strongly of chlorine.

Nitric acid (H): This reagent is rarely used, but is helpful in distinguishing between the foliose genera *Neofuscelia* and *Melanelia*. The expected reaction (in *Neofuscelia*) is a rapid darkening of the upper cortex, with a blue-green tinge. It is also used to discriminate among certain species of *Chaenothecopsis*. Use at 50% concentration.

Potassium iodide (I): Iodine solutions react with a variety of starches. For example, when applied to the spore-producing apothecial layer (or hymenium) in the foliose genera *Fuscopannaria* and *Pannaria*, the tissues become blue, violet, or even bluish black (check under a light microscope). This reagent also gives a bluish or purplish reaction when applied to the medulla of some *Sphaerophorus* species. The preferred formula is Lugol's iodine solution: 0.5 g iodine, 1.5 g potassium iodide, and 100 ml distilled water.

Potassium hydroxide (K): This is a 10–35% solution of potassium hydroxide in water. The reagent can be purchased (in pellet form) from most drugstores. The usual colour reactions are: yellow, yellow changing to orange or red, and red. If tightly stoppered, a solution of K will often remain active for up to six months.

Potassium hydroxide / calcium hypochlorite (KC): In this test, K is applied first, and then C. A positive reaction yields instantaneous pinks or reds that often fade quickly. Useful in the identification of a wide range of lichens.

Calcium hypochlorite / potassium hydroxide (CK): This is a seldom-used test, in which C is applied first, followed by K. A positive reaction gives a deep yellow or orangish colour, and is useful primarily in the recognition of barbatic acid (diagnostic, for example, in *Usnea ceratina*), although salazinic acid also yields a

³ The abbreviations used here for calcium hypochlorite (C), nitric acid (H), potassium iodide (I), and potassium hydroxide (K) should not be confused with the standard symbols for the chemical elements carbon, hydrogen, iodine, and potassium. Alternative abbreviations include HNO₃ for H, and KOH for K.

CK+ yellowish to orangish reaction.

Paraphenylenediamine (PD): This reagent is most safely used as Steiner's Stable PD Solution: 1 g PD crystals, 10 g sodium sulphite, 5 ml detergent (e.g., Photo-flo), 100 ml distilled water. An alternative solution (preferred for *Stereocaulon*) can also be prepared by dissolving a few crystals of PD in two or three drops of 70% ethyl alcohol (note: rubbing alcohol works well, but avoid the use of isopropyl alcohol). The resulting solution is highly unstable, and deteriorates after only a few minutes. By contrast, Steiner's Solution lasts a month or more, especially if stored in a dark bottle; it should be discarded when it turns a dark pink. PD is suspected of being carcinogenic; it must be handled carefully, as it is absorbed through the skin, and stains cloth, books, and specimens. Reactions often develop slowly (e.g., 30–60 seconds), and result in a yellow, orange, or red coloration. The crystals can be difficult to obtain.

2. Ultraviolet (UV) Lamps Ultraviolet fluorescence provides an effective means

of detecting many lichen substances. Long-wave UV is preferred (i.e., 365 µm). The technique involves exposing the medulla of the specimen with a razor blade, and then examining it with a UV lamp in a darkened room. A positive UV reaction yields a distinct bluish, yellowish, or whitish incandescence. Because UV light is damaging to the eyes, protective goggles should be worn when conducting these tests. Avoid using UV lamps for extended periods, and never look directly into the lamp. Ultraviolet lamps can be obtained from scientific and geological supply outlets.

3. Thin-layer Chromatography (TLC)

Thin-layer chromatography is more expensive and time consuming than spot tests or UV tests, but is also more discriminating. In fact, many chemical substances can be detected in no other way (i.e., without the use of even more sophisticated techniques). The technique is not difficult to learn, but instruction in the method is beyond the scope of this manual. White and James (1985) provide a good introduction.

A Note on Common Names

In this manual, common names are proposed for all fruticose macrolichens and microlichens known to occur in British Columbia.

Some of these names have been adopted from *Lichens of North America* (Brodo et al. [2001]), though most are original with this publication. Names in parentheses have been used by earlier authors—for example, Alvin (1977), Benton and Underhill (1977), Bland (1971), Bolton (1960), Brodo (1988), Casselman (1993), Hawksworth et al. (1995), Johnson et al. (1995), Kershaw et al. (1998), McCune and Geiser (1997), McGrath (1977), MacKinnon et al. (1992), Nearing (1947), Parish et al. (1996), Perez-Llano (1944), Pojar and MacKinnon (1994), Richardson (1975), Smith (1921), and Vitt et al. (1988)—but for various reasons are not accepted here.

Most of the accepted common names

record observable attributes of the species and genera to which they apply, though other names are intentionally fanciful. In most cases, the same “root” name applies to all members of a given genus (e.g., all species of *Bryoria* bear the name “horse-hair”), but in some cases this name is applied also to the species of other similar genera.

Common names are perhaps most satisfactorily viewed as vehicles of communication for those who are unwilling to use scientific names. Scientific names are intended to be universal and stable; common names are by nature regional and highly plastic. The common names introduced here are intended primarily for use by the naturalist community of British Columbia. While some may gain currency elsewhere in North America, alternative names will probably be coined for many species.

**Making Use
of the Keys**

The keys in this manual consist of sequential pairs of parallel, but opposing, statements that can be compared against any fruticose species known to occur in British Columbia. To identify a lichen, begin with the first statement, or “lead,” in the “Key to Lichen Growth Forms” (page 27), and select the statement (i.e., 1a or 1b) that more accurately describes the specimen in hand. Next, proceed to the couplet indicated at the end of the appropriate statement, and repeat the process. Eventually you will be directed to one of the genus keys (i.e., Keys A, B, or C), and then, following the same process, to one of the species keys (i.e., the keys appearing within the genus accounts, which begin on page 45). The end point in the keying process is reached when the selected lead yields a species name. If the illustration accompanying that name matches the specimen, then the identification is probably correct. If it does not, then the process must be repeated to determine at what point a wrong turn was taken. Jotting down the identification sequence will help to more effectively retrace the steps.

Because some lichens vary considerably in appearance, depending on habitat, it has often proved necessary to key out a

species under more than one lead. Where a specimen seems well described by both leads of a pair, it can usually be looked for under both leads. *Cladonia umbricola*, for example, appears in the key to *Cladonia* in ten different places!

Unless otherwise indicated, the colour values given in the keys are based on dry material; moist specimens are often considerably darker than indicated. Thallus measurements are also based on dry material. Spores, however, can only be accurately measured when mounted in water (or other liquid) on a glass slide, and covered with a cover slip. Spores are measured in microns (μm) and should be examined under a light microscope (LM), usually at 400x or 1000x. Measurements emphasize the **larger** spores—an observation that applies also to lobes, isidia, pseudocyphellae, and other structures.

The line drawings accompanying the keys are tied to the keys by a lead number (e.g., 23a). They are often also tied by pointer arrows (\leftarrow), which call attention to specific statements in the keys and are intended to identify salient features of the species. Magnification is indicated by the symbol “x” (e.g., “x2” indicates that the lichen is shown at twice life size).

**Lichen
Photobionts: Algae
and Cyanobacteria**

In some groups of lichens, reliable identification requires knowing the identity of the photosynthetic partner, or photobiont. Unfortunately, not all lichen photobionts can be reliably identified in their lichenized state. In some cases, identification is possible only after the photobiont has been extracted from the lichen, and grown in culture under laboratory conditions. (Ahmadjian [1967] and Tschermak-Woess [1988] can be consulted for useful accounts of culturing techniques and *in vitro* identification). Notwithstanding this caveat, the following key incorporates all photobiont genera (or generic groupings) named in this manual. Its successful use will involve preparing a squash mount of the lichen under study, as follows:

1. Apply a drop of water (nonchlorinated water is preferred) to the specimen using an eye dropper.
2. Cut a thin slice (generally in cross-

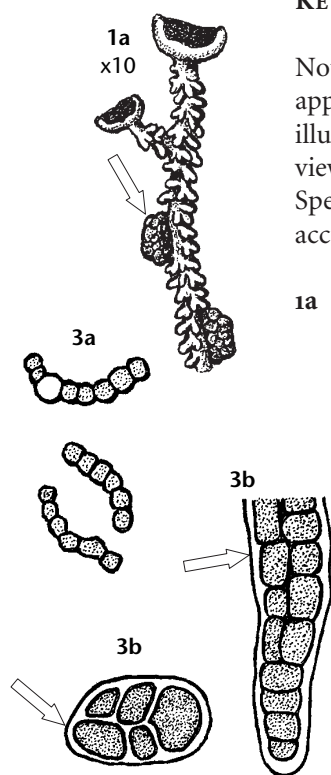
section, though occasionally in long-section, as directed in the keys) using a sharp razor blade.

3. Arrange the section on a glass slide.
4. Cover it with a cover slip.
5. Using the wooden end of a probe or pencil, gently “squash” the section from above.
6. Carefully view the resulting squash mount under a light microscope, typically at 400x or 1000x.

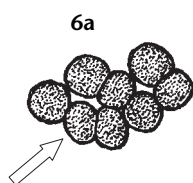
Five of the genera included in this manual (i.e., *Chaenothecopsis*, *Microcalicium*, *Mycocalicium*, *Phaeocalicium*, and *Stenocybe*) are traditionally studied by lichenologists, yet lack a photobiont. Such genera, which contain no “true” lichen species, derive their carbohydrate requirements either from the photobionts of other lichens (in which case they are said to be **parasitic**) or from bark or wood (in which case they are **saprobic**).

KEY TO LICHEN PHOTOBIONTS

Note: In the following key, photobionts are denoted by ***bold italics***, while lichen genera appear in *italics*. Lichen genera handled in Part 1 are accompanied by an asterisk. The illustrations accompanying the keys are diagrammatic, and are based on squash mounts viewed under a light microscope at 1000x magnification (except as otherwise indicated). Special emphasis is given to lichen genera in which photobiont recognition is critical to accurate identification.



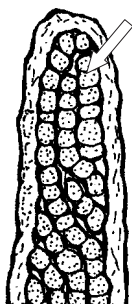
- 1a Photobiont secondary, restricted to tiny, localized cephalodia(←), these either external (and then generally resembling minute darkened “warts”) or internal (and then often resembling “liverspots”) 2
- 2a Cephalodia associated with leaflike foliose lichens. ***Nostoc***
Present in: (green species of): *Lobaria**, *Nephroma**, *Peltigera**, *Psoroma**, *Solorina**
- 2b Cephalodia associated with clublike or shrublike fruticose lichens (i.e., *Pilophorus* and *Stereocaulon*) 3
- 3a Photobiont to less than 5–7 μm along long axis (check under LM at 1000x), at least in part arranged in necklace-like strings, these at most only one cell wide. ***Nostoc***
- 3b Photobiont to more than 8 μm along long axis, arranged in obvious cell clusters(←), or, if in part stringlike, then strings more than one cell wide(←) ***Stigonema***



6a

9a

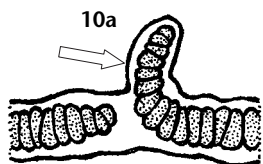
10a
x400



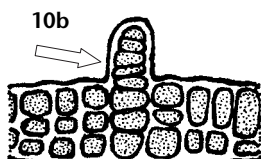
9b
x500



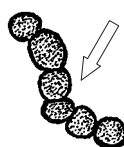
10a



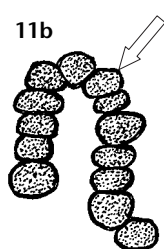
10b



11a



11b



1b Photobiont primary, distributed more or less throughout the thallus, or else restricted to a thin layer near the thallus surface; cephalodia absent 4

4a Cell contents dull greyish green or holly green to dark bluish or yellowish, orangish or brownish; pigmentation generally uniformly distributed 5

5a Thallus fruticose. 6

6a Photobiont solitary or arranged in clusters(←), but not at all in long rows of cells **Nostoc**

Present in: *Polychidium muscicola*, *Sticta oroborealis*

6b Photobiont at least in part arranged in one or more rows of cells (i.e., "photobiont strands"). 7

7a Largest cells to more than 8 µm along long axis; photobiont strands more or less defining the shape of the thallus (check under LM, especially at branch tips) 8

8a Photobiont strands at most one cell wide 9

9a Cells short, at least in part wider than long **Scytonema** s. lat.

Present in: *Lichinodium*, *Polychidium*, *Thermutis*, *Zahlbrucknerella*, *Unknown 2*, *Unknown 3*

9b Cells elongate, much longer than wide **Trentepohlia** (filamentous forms)

Present in: *Cystocoleus*, *Racodium*

8b Photobiont strands in part two or more cells wide, or at least appearing so. 10

10a Photobiont strands densely crowded, and hence appearing more than one cell wide, but in fact arranged in a single row of cells(←); thallus with "false" branching(←) (i.e., branches arising through terminal growth of photobiont strands) **Scytonema** s. lat. (see 9a)

10b Photobiont strands at least in part two or more cells wide (see 3b) (check for longitudinal cell divisions near terminal end of strands); thallus with "true" branching(←) (i.e., branches not arising through terminal growth of photobiont strands) **Stigonema**

Present in: *Ephebe*, *Spilonema*

7b Largest cells to 5–7(–8) µm along long axis; photobiont strands not at all defining thallus shape 11

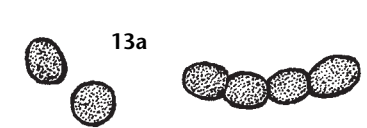
11a Cells dull greyish green, rounded in outline; photobiont strands oriented in a straight line, or at most gently curved(←) **Nostoc**

Present in: *Leciophysma*, *Lempholemma*, *Leptogium**, *Polychidium muscicola* (check in long-section)

11b Cells dark blue-green or dark vivid green, somewhat angular; photobiont strands often strongly U-shaped(←) (check in long-section) **Rivulariaceae** or **Scytonemataceae**

Present in: *Placynthium**

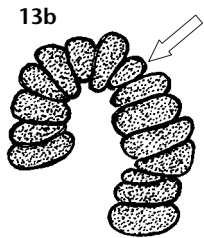
5b Thallus foliose or squamulose 12



12a Photobiont arranged at least in part in “strands” 13

13a Cells dull greyish green, rounded in outline, each photobiont strand oriented in a straight line or at most gently curvaceous (Note: gelatinous species—in which the thallus is distinctly swollen when moist—key here) *Nostoc*

Present in: *Collema**, *Hydrothyria**, *Lemphollemma*, *Leptochidium**, *Peltigera** (in part)⁴



13b Cells dark vivid green to dark bluish green, somewhat angular; photobiont strands often in part strongly U-shaped(←) (especially in long-section) *Rivulariaceae* or *Scytonemataceae*

Present in: *Placynthium**



12b Photobiont solitary or arranged in rounded clusters, not at all arranged in strands 14



14a Individual cells to less than 5–7 (–8) μm along long axis . . . *Nostoc*

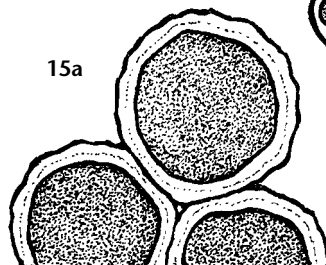
Present in: *Fuscopannaria**, *Lobaria** (in part), *Massalongia**, *Nephroma** (in part), *Pannaria**, *Parmeliella**, *Peltigera** (in part), *Pseudocyphellaria**, *Sticta** (in part)



14b Individual cells to more than 8 μm along long axis 15

15a Individual cells to more than 15 μm along long axis . *Scytonema*

Present in: *Heppia lutosa**



15b Individual cells to less than 13 μm along long axis 16

16a Cells strikingly bluish green (Note: specimens having a thick white medulla key here, regardless of photobiont colour) *Scytonema*

Present in: *Erioderma**, *Leioderma**



16b Cells dull greyish green 17

17a Individual cells or cell clusters at least in part distinctly ensheathed by a gelatinous envelope(←) . . .

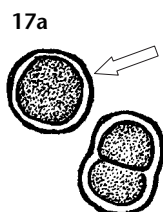
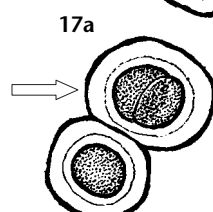
. *Chroococcales*

Present in: *Lichinella nigritella*, *Phylliscum demangeonii**, *Thyrea confusa** Henssen [not handled]

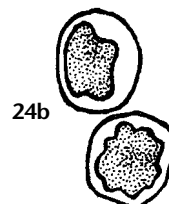
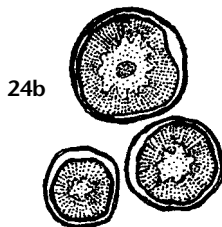
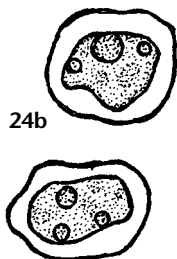
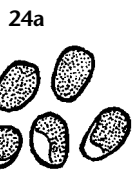
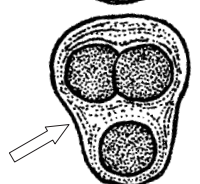
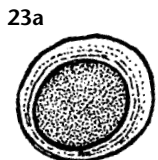
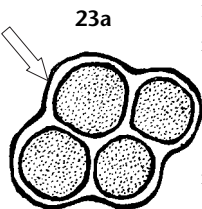
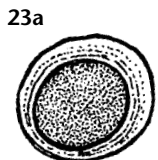
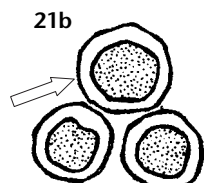
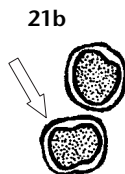
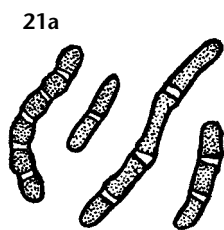
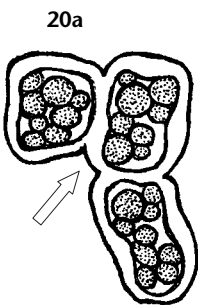
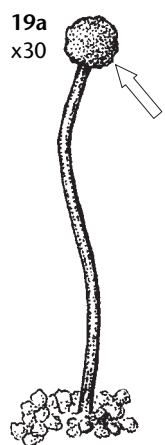


17b Individual cells and cell clusters not at all distinctly ensheathed. *Scytonema*

Present in: *Koerberia**, *Vestergrenopsis**



4 Some species of *Peltigera* contain *Nostoc*, but others do not.



4b Cell contents vivid grass-green to pale yellowish green or rarely reddish green; pigmentation often localized within cells 18

18a Photobiont more or less restricted to the basal crust of lichens bearing minutely stalked sexual fruiting bodies (Note: specimens in which the apothecia terminate in a powdery spore mass key here). 19

19a Photobiont associated with (the basal crust of) minute "stubble" lichens (i.e., in which the apothecia are stalked and terminate upwards in a powdery spore mass)(←) 20

20a Cell walls distinctly thick(←), to more than 1.5 μm in diameter, I-; cell contents yellowish green; cells elongate, to more than 10 μm long. **Trentepohlia**

Present in: *Chaenotheca hispidula*, *Sclerophora*

20b Cell walls thin, to less than 1 μm in diameter, I+ blue (or I- in old collections); cell contents bright green; cells round, elongate, or irregular, to less than 10 μm long. 21

21a Cells elongate-rectangular or irregular (generally with rounded ends): solitary, or in short, often rather fragmented chains **Stichococcus**

Present in: *Chaenotheca* (in part), *Sclerophora*

21b Cells oval to globose, (8–) 10–15 μm in diameter, solitary or in clusters; often resembling fish eggs, each "egg" enveloped in a thin gelatinous sheath(←) Trebouxoid algae (including *Trebouxia*, *Dictyochloropsis*, and others)

Present in: *Calicium*, *Chaenotheca* (in part)

19b Photobiont associated with other lichens. 22

22a Photobiont cells to more than 12 μm along long axis **Coccomyxa** and **Eliptochloris**

Present in: *Baeomyces*, *Dibaeis*

22b Photobiont cells to less than 8 μm along long axis. "micareoid"

Present in: *Szczawinskia*

18b Photobiont not restricted to basal crust: present over the entire upper surface of the lichen. 23

23a Individual cells or cell clusters encased in a distinctly thick, transparent "envelope"(←); medulla absent **Chroococcales**

Present in: *Lichinella stipitula*, ?*Spilonema* sp. 1, *Synalissa symphorea*, ?Unknown 1

23b Individual cells at most encased in a thin, transparent "envelope," or envelope apparently absent; medulla present, plainly visible under hand lens. 24

24a Photobiont associated with *Nephroma**, *Peltigera**, and *Solorina** **Coccomyxa**

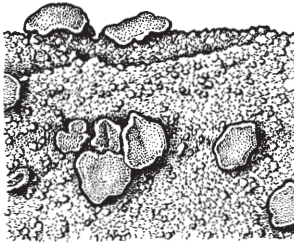
24b Photobiont associated with other lichens Trebouxoid algae: *Trebouxia*, *Chlorella*, *Dictyochloropsis*, *Myrmecia*, *Pleurococcus*, and others

Present in: all remaining macrolichen genera

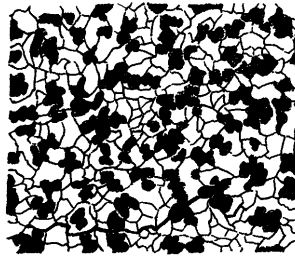
KEY TO LICHEN GROWTH FORMS

- 1a** Entirely crustose: crustlike, paintlike, or powdery, attached to the substrate throughout and inseparable from it Leprose and Crustose Lichens
(i.e., Dust and Crust Lichens) [not handled]

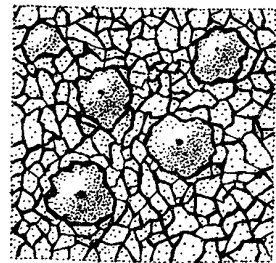
1a



1a



1a

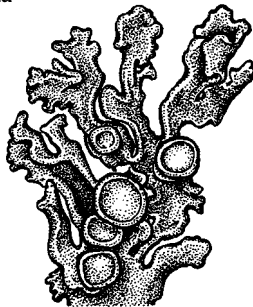


- 1b** Never entirely crustose: consisting at least in part of lobes, stalks, or branches that are either more or less flattened or else clublike, shrublike, or hairlike (Note: all specimens in which the spores produce a blackish or brownish powdery mass/mazaedium key here, regardless of growth form: see KEY B) 2

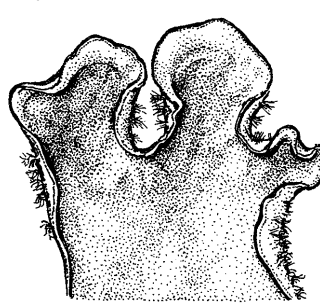
- 2a** Foliose or squamulose: consisting of more or less flattened, dorsiventral lobes that are usually coloured differently above and below . . .

..... Foliose and Squamulose Lichens
(i.e., Leaf and Scale Lichens) [not handled: see Part 1]

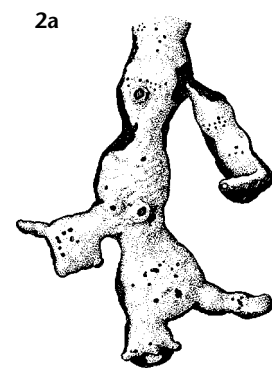
2a



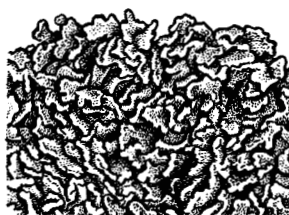
2a



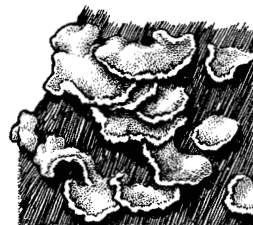
2a



2a



2a

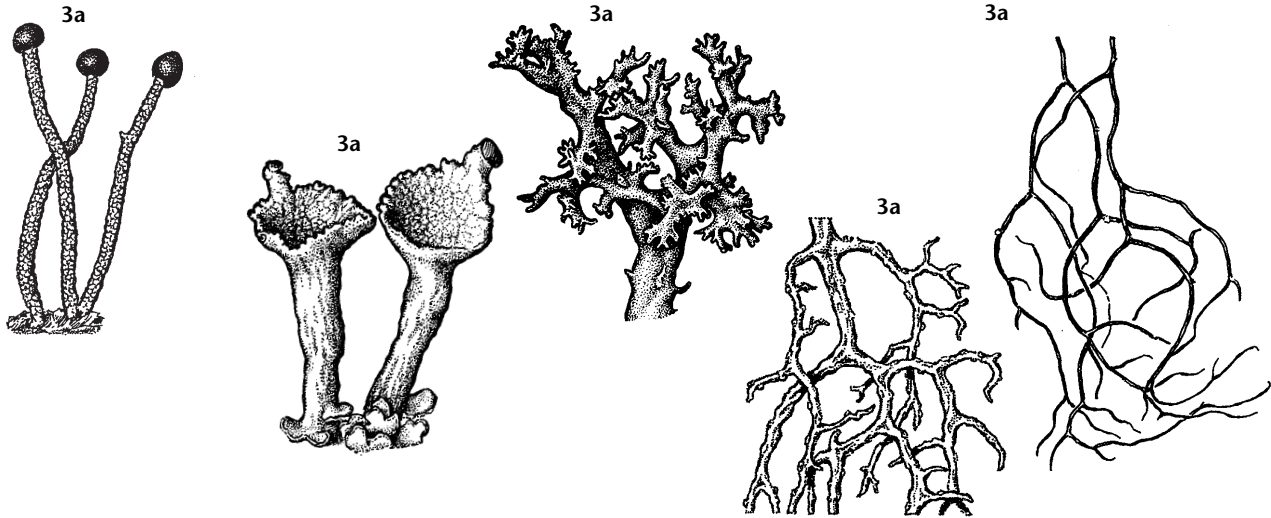


2a



- 2b** Fruticose: consisting at least in part of cylindrical stalks or branches that are clublike, shrublike, or hairlike; or if branches somewhat flattened, then coloured alike on all sides, Fruticose Lichens 3

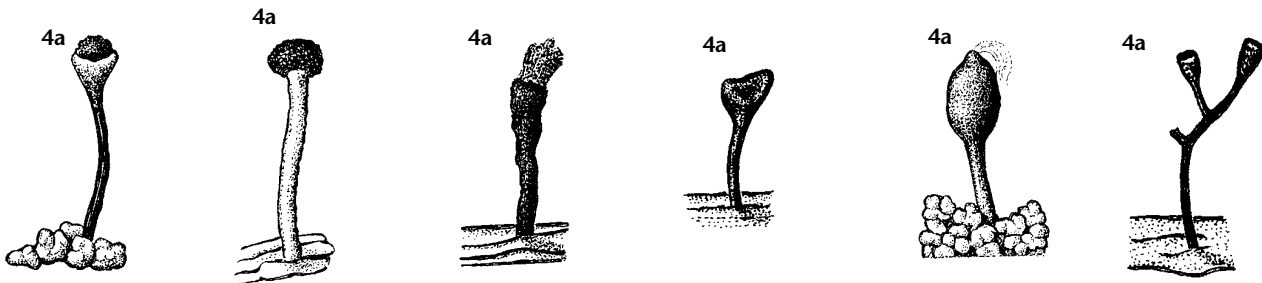
- 3a** Small to large: longest stalks or branches averaging more than 10 mm long at maturity (Note: orange specimens key here regardless of size, as do all specimens having distinctly hollow branches) . . . KEY A: Fruticose Macrolichens



- 3b** Minute: longest stalks or branches averaging less than 10 mm long at maturity (Note: many of the following lichens can be reliably identified only by use of a light microscope) 4

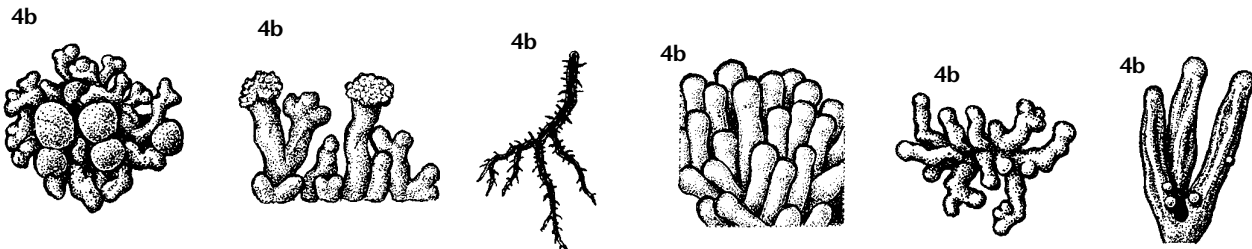
- 4a** Stalks unbranched to sparsely branched, terminating in sexual fruiting bodies, these globose, conical, or triangular, generally distinctly exceeding the width of the supporting stalk (Note: all specimens key here in which: (1) the stalks are thin and hairlike, and measure less than 0.3 mm tall; or (2) the spores are contained in distinctly powdery fruiting bodies (check by rubbing); or (3) both . . .

. KEY B: "Calicioid" Lichens (and Others)

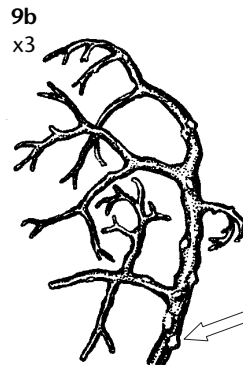
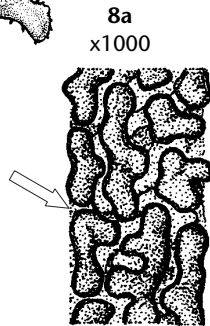
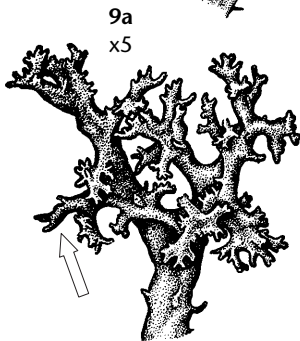
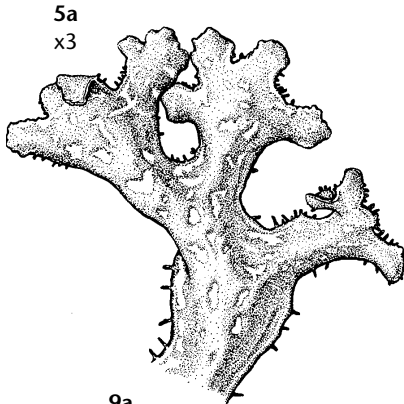
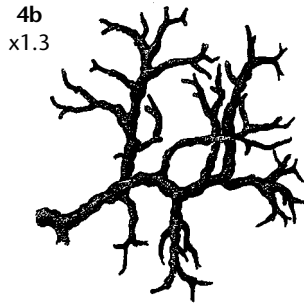
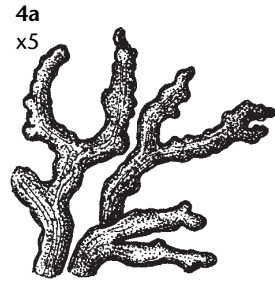


- 4b** Stalks unbranched to copiously branched; sexual fruiting bodies absent or, if present, then rarely terminal, and never distinctly exceeding the width of the supporting stalk, also never powdery (Note: all specimens key here in which the stalks terminate in powdery soredia) . . .


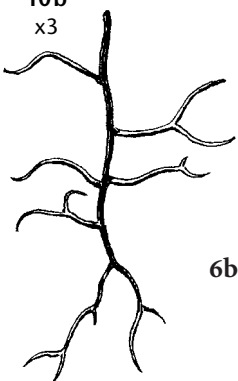

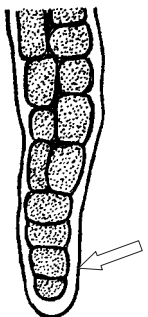
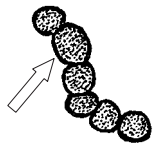
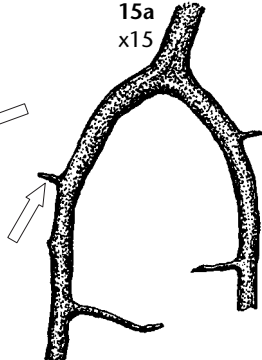
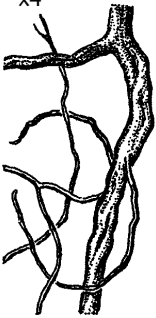
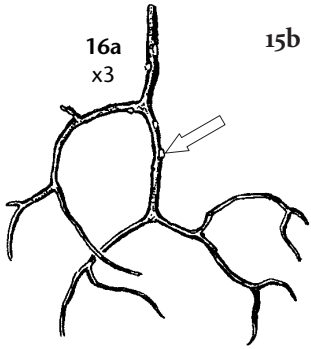
. KEY C: Fruticose Microlichens (and Others)

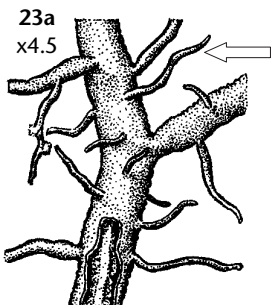
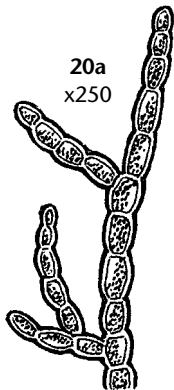
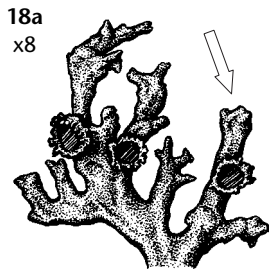
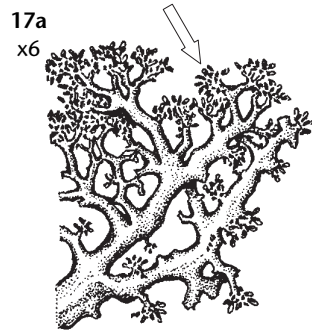


KEY A: FRUTICOSE MACROLICHENS

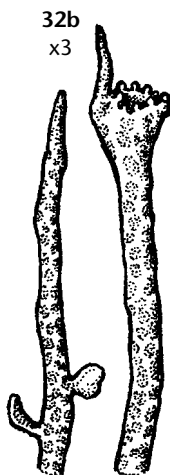
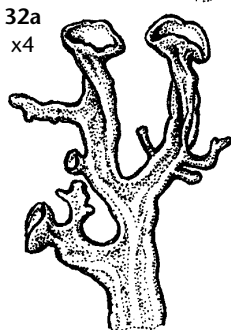
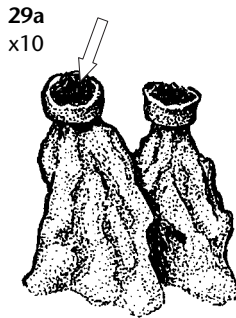
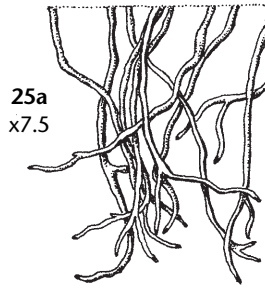


- 1a Thallus dark over the entire surface: blackish, dark greyish, or dark brownish (including dark reddish brown or greenish brown); photobiont variously coloured (check under LM) 2
- 2a Growing over soil, moss, duff, rock, or rarely over exposed logs and at the base of exposed trees (i.e., to within 1 m of the ground) 3
- 3a Thallus firmly attached to rock, not readily removed; exposed sites 4
- 4a Branches distinctly flattened and lobe-like; branching sparse; apothecia, if present, borne at branch tips; alpine. *Cornicularia normoerica*
- 4b Branches essentially round in cross-section, more or less hairlike; branching rather copious; apothecia, if present, borne laterally; at all elevations, though most common in the subalpine and above *Pseudephebe pubescens*
- 3b Thallus over soil, moss, or duff, or, if over rock, then loosely attached; exposure various 5
- 5a Branches distinctly flattened and lobe-like from top to bottom *Cetraria islandica* and others (see Part 1)
- 5b Branches round in cross-section, or at most only partly flattened 6
- 6a Occurring at treeline and above; photobiont green (check under hand lens) 7
- 7a Thallus dark reddish brown (Note: distinctly brittle specimens key here) 8
- 8a Thallus prostrate; pseudocyphellae absent; cortical cells jigsaw-puzzle-like in surface view(←) (check under LM at 1000x) *Nodobryoria*
- 8b Thallus upright or occasionally decumbent; pseudocyphellae often present (check main branches); cortical cells not at all jigsaw-puzzle-like in surface view 9
- 9a Thallus upright; branches short and compact(←); pseudocyphellae plane or indented; medulla KC-; widespread *Coelocaulon*
- 9b Thallus upright or decumbent; branches long and slender; pseudocyphellae often protruding(←); medulla KC+ red; alpine. *Bryocaulon divergens*

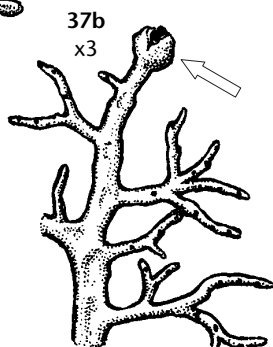
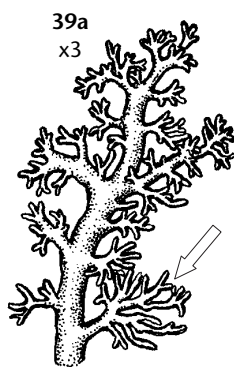
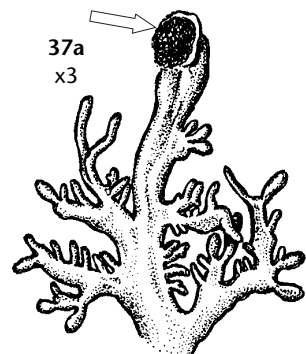
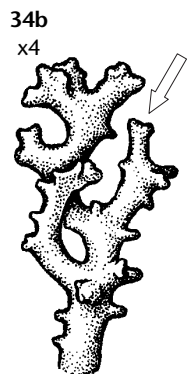
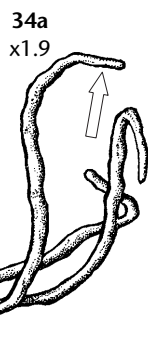
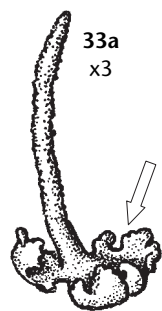
- 10a x10 
- 10b x3 
- 12b x5 
- 13b x500 
- 13a x1000 
- 15a x15 
- 16b x4 
- 16a x3 
- 7b Thallus blackish or brownish, but not at all dark reddish brown. 10
- 10a Thallus at least in part distinctly pale at base; main branches typically bearing distinctly raised pseudocyphellae(←); branch tips mostly reflexed; medulla KC+ red *Alectoria nigricans*
- 10b Thallus dark at base or at least not distinctly pale; pseudocyphellae present or absent, but generally not distinctly raised; branch tips reflexed or not; medulla KC- *Bryoria*
- 6b Occurring at lowland to middle forested elevations; photobiont green or otherwise. 11
- 11a Pseudocyphellae present, generally conspicuous; photobiont green (check under hand lens); white medulla present 12
- 12a Thallus distinctly reddish brown; branches bearing spine-like projections (see 9a); over soil, duff, or rock in open to exposed sites; widespread; common *Coelocaulon*
- 12b Thallus olivaceous grey; branches lacking spine-like projections; over friable soil or plant debris in highly exposed sites; southern; rare. *Agrestia hispida*
- 11b Pseudocyphellae absent; photobiont bluish green; white medulla absent, branches accordingly black within 13
- 13a Lobe tips blunt; photobiont *Nostoc*; cells lacking a gelatinous sheath, bluish green, less than 7 µm along long axis; terminal cells globose or at most oval(←) (check under LM at tips of well-developed branches) *Lempholemma*
- 13b Lobe tips distinctly tapering; photobiont *Stigonema*; cells enveloped or not by an orangish gelatinous sheath, more than 8 µm along long axis; terminal cells rectangular or lens-shaped(←) (check under LM at tips of well-developed branches). *Ephebe*
- 2b Growing over bark or wood of standing trees, usually at 1 m or more above the ground. 14
- 14a Thallus distinctly reddish brown 15
- 15a Thallus dull, lacking pseudocyphellae, bearing short, thornlike side branches(←); soredia absent; cortical cells jigsaw-puzzle-like; medulla KC-; mostly east of coast ranges *Nodobryoria*
- 15b Thallus generally shiny, bearing distinct pseudocyphellae, lacking thorn-like side branches; soredia present or absent; cortical cells not at all jigsaw-puzzle-like; medulla KC- or KC+ red; distribution various 16
- 16a Pseudocyphellae dotlike/punctiform, conspicuous(←); medulla KC+ red; hypermaritime *Bryocaulon pseudosatoanum*
- 16b Pseudocyphellae distinctly elongate, conspicuous or not; medulla KC-; distribution various *Bryoria*



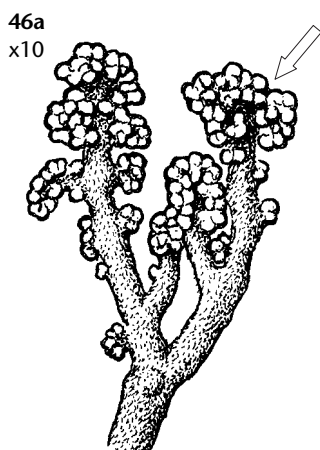
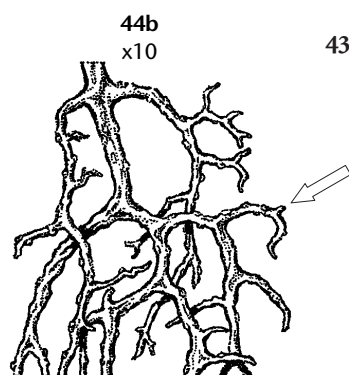
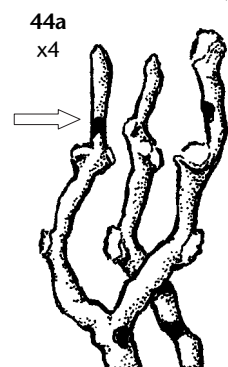
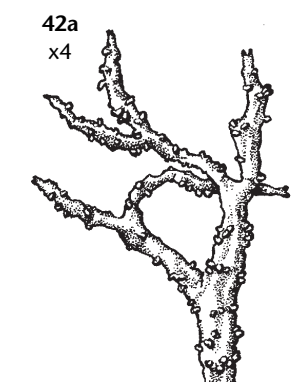
- 14b Thallus brownish, blackish, or greyish, but not at all reddish. 17
- 17a Main stems much paler than branch tips, often in part covered in a woolly tomentum of minute erect hairs; secondary branches terminating in copious dark "isidia" (←); photobiont dark bluish (check under hand lens); humid old-growth forests *Sticta oroborealis*
- 17b Main stems not much paler than branch tips, not at all tomentose; secondary branches occasionally bearing soredia, but never isidiate; photobiont medium green; habitat ecology various. 18
- 18a Terminal branches more or less "dimpled"/foveolate or flattened in cross-section (←), or both; soredia absent; apothecia often present; apothecial disk blackish. *Kaernefeltia*
(see Part 1, under *Cetraria californica* and *C. merrillii*)
- 18b Terminal branches non-foveolate, round in cross-section (see 16b); soredia present or absent; apothecia very rare; apothecial disk brownish *Bryoria*
- 1b Thallus pale, or at least not at all dark throughout (check sheltered portions of branches); primary photobiont strictly medium green (blue-green secondary photobiont present in *Pilophorus* and *Stereocaulon*). 19
- 19a Thallus at least in part yellowish orange or bright medium orange (check sheltered lobes) 20
- 20a Consisting of unbranched or sparsely branched strands, these threadlike; medulla lacking; very humid sites, including the spray zones of waterfalls *Trentepohlia* [an alga: not handled]
- 20b Consisting of copiously branched stems, these not at all threadlike; medulla present, white; arid to humid localities, but absent from the spray zones of waterfalls 21
- 21a Sheltered portions of thallus pale grey; over vertical rock faces sheltered from rain; apothecia, if present, weakly stalked; rare, restricted to semi-arid intermontane regions *Teloschistes contortuplicatus*
- 21b Sheltered portions of thallus yellowish; over bark or, if over rock, then growing exposed to rain; apothecia, if present, not at all stalked; frequent; widespread, especially in humid intermontane regions *Xanthoria candelaria* (see Part 1)
- 19b Thallus variously coloured, but not at all orangish 22
- 22a Thallus more or less hairlike or threadlike throughout (Note: in a few species the main branches may be rather broad and/or flattened, but at least the upper branches are invariably hairlike/threadlike. 23
- 23a Branches reinforced by a tough, cartilaginous central cord (readily demonstrated by pulling the thallus lengthwise); main branches often bearing numerous more or less perpendicular side branchlets/fibrils (←); generally over bark or wood. *Usnea*
- 23b Branches bearing a loose or compact medulla, but not at all reinforced by a central cord; fibrils absent or at least never numerous; habitat ecology various 24
- 24a Extreme branch tips pale green (check under hand lens), at least in part bearing minute fiddlehead-like "hooks" (←), these often minutely sorediate *Ramalina thrausta*
- 24b Extreme branch tips pale or dark, not at all hooked, lacking soredia and granules 25



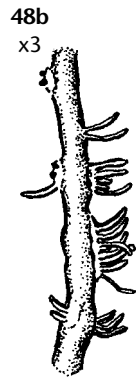
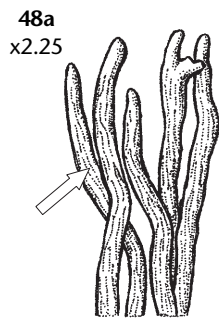
- 25a** Thallus containing usnic acid: pale greenish, at least in part; cortex KC+ yellow (usnic acid present: check pale branches), PD-, K-, or occasionally in part K+ red *Alectoria*
- 25b** Thallus lacking usnic acid: pale yellowish or greyish (at least in part), but never greenish; cortex either KC+ pink/red, or PD+ yellow, or orange, also K+ pale yellow / bright yellow (rarely K+ red 26
- 26a** Tree-dwelling; thallus long-pendent; in sheltered sites, mostly at lower elevations; medulla KC- *Bryoria capillaris*
- 26b** Ground-dwelling or occasionally tree-dwelling; thallus tufted; in exposed sites at treeline and above; medulla KC+ red 27
- 27a** Thallus pale at base, at least in part; main branches bearing distinct pseudocyphellae, these plane to more often raised; soredia absent; branch tips mostly weakly reflexed; widespread; common *Alectoria nigricans* (see 10a)
- 27b** Thallus blackened at base; main branches bearing inconspicuous pseudocyphellae, these plane, narrow; soredia present or occasionally absent; branch tips mostly not reflexed; coastal; apparently rare *Bryoria nadvornikiana*
- 22b** Thallus not at all hairlike or threadlike (Note: specimens in which the upper branches are distinctly angular in cross-section key here). 28
- 28a** Branches distinctly hollow (check basal portions) 29
- 29a** Apothecia present at branch tips, black, powdery(←); over conifers in exposed sites; mostly at or near treeline *Tholurna dissimilis*
- 29b** Apothecia absent or, if present, then variously positioned, not at all black or powdery; habitat ecology and distribution various 30
- 30a** Stalks much branched to intricately branched. 31
- 31a** Cortex lacking; thallus with a dull, soft, appressed-cottony appearance (check under hand lens); soredia absent; basal squamules absent; over soil, duff, logs, and stumps. *Cladina*
- 31b** Cortex present, at least in basal portions of stalks: thallus dull to somewhat shiny, and with a "hard," non-cottony appearance; soredia present or absent; basal scales/squamules present or absent; habitat ecology various. 32
- 32a** Over trees and shrubs, rarely also firmly attached to vertical rock; thallus pale medium greenish, pliant, not bearing squamules; apothecia, if present, with a pale greenish disk. *Ramalina*
- 32b** Mostly over soil, duff, logs, and stumps, occasionally also over (the basal portions of) trees and shrubs, never firmly attached to rock; thallus variously coloured (including pale medium greenish), pliant to more often brittle, often bearing squamules; apothecia, if present, with a brown, red, or rarely flesh-coloured disk, but never pale greenish *Cladonia*



- 30b Stalks unbranched or at most weakly to moderately branched
(Note: specimens with distinctly white-frosted/pruinose branch
tips key here, regardless of branching) 33
- 33a Stalks generally associated with basal squamules(←), these
also often present laterally over the stalks; soredia present
or absent; widespread at all elevations. *Cladonia*
- 33b Stalks not at all associated with squamules; soredia absent;
essentially alpine. 34
- 34a Stalks whitish, pointed-tipped(←) . . .
. *Thamnolia vermicularis*
- 34b Stalks yellowish green to brownish or lavender, blunt-
tipped(←). *Dactylina*
- 28b Branches solid throughout 35
- 35a Apothecia present, distinctly powdery, black 36
- 36a Medulla yellow to orange. *Acrosyphus sphaerophoroides*
- 36b Medulla white 37
- 37a Branches in part flattened, especially toward tips; apothecia
opening downwards(←); medulla I-; hypermaritime . .
. *Bunodophoron melanocarpum*
- 37b Branches round in cross-section from top to bottom, or at
least not distinctly flattened; apothecia opening
outwards(←); medulla I+ purple; widespread in humid
regions. *Sphaerophorus*
- 35b Apothecia absent or, if present, then variously coloured (including
black), not at all powdery. 38
- 38a Branches reinforced by a tough, cartilaginous central cord
(readily demonstrated by pulling the thallus lengthwise); main
branches often bearing numerous more or less perpendicular
fibrils (see 23a); generally over bark or wood *Usnea*
- 38b Branches filled with a loose or compact medulla, but lacking a
reinforcing central cord; habitat ecology various. 39
- 39a Basal portions of main stems bearing groups of clustered
branchlets(←), these well differentiated from the main
stems; branches round in cross-section, or at least not dis-
tinctly flattened; humid regions *Sphaerophorus*
- 39b Basal portions of main stems not at all associated with clus-
tered branchlets; branches round in cross-section or more
or less distinctly flattened; distribution various 40



- 40a Branches upright, appearing inflated more or less throughout (see 34b), filled with a loose, cobwebby medulla; upper branches often distinctly white-frosted/pruinose; ground-dwelling; alpine *Dactylina*
- 40b Branches upright to more often decumbent to pendent, not at all appearing inflated throughout; medulla compact; upper branches not at all pruinose; habitat ecology and distribution various 41
- 41a Thallus yellowish or yellowish green (check sheltered branches); usnic acid present 42
- 42a Thallus distinctly more yellowish than green; mostly inland, southern *Letharia*
- 42b Thallus distinctly more greenish than yellow; distribution various (Note: distinctly pendulous specimens key here) . . . 43
- 43a Branches rather stiff, or at least not at all flaccid, hard to the touch; branch tips predominantly green; cortex not at all black-spotted; medulla thin, distinctly compact *Ramalina* (see 32a)
- 43b Branches rather flaccid, rather soft to the touch; branch tips predominantly black or cortex distinctly black-spotted, or both; medulla rather thick, loose 44
- 44a Branch tips predominantly green; cortex often distinctly black-spotted(←); in the herbarium often covered in fine crystalline “hairs”; restricted to seaside localities [*Niebla cephalota*]
- 44b Branch tips predominantly black(←); cortex generally lacking black spots (Note: specimens infected with lichen parasites may appear black-spotted); crystalline hairs absent; widespread, but absent from seaside localities *Evernia*
- 41b Thallus variously coloured, including pale whitish green, but not at all yellowish or yellowish green; usnic acid absent 45
- 45a Main stems lumpy, bearing sparse to numerous corticate outgrowths; cephalodia generally present, these darkish and ball-like; basal crust often present; generally over rock or soil . . . 46
- 46a Stalks bearing distinct rounded to scale-like or fingerlike outgrowths/phylocladia, these generally well developed(←); main stems copiously branched or terminating in plane to weakly convex apothecia, or both; over soil, duff, or rock *Stereocaulon*
- 46b Stalks more or less lumpy, but never bearing well developed scale-like or fingerlike outgrowths; main stems at most sparsely branched or terminating in strongly hemispherical, cylindrical, and/or “triangular” apothecia(←); over rock *Pilophorus*
- 45b Main stems smooth to weakly wrinkled, but not at all lumpy; cephalodia and basal crust absent; habitat ecology various . . . 47
- 47a Thallus variously coloured, but not at all whitish, also not densely colonial; sparsely branched to copiously branched; over wood, bark, duff, or rock 41



- 47b** Thallus whitish (check sheltered branches), consisting of more or less densely packed colonies of upright stems, these unbranched or at most sparsely branched; over soil or duff 48
- 48a** Stems to more than 20 mm long, distinctly longitudinally furrowed(←), dull, growing in standing water; humid regions *Siphula ceratites*
- 48b** Stems to less than 20 mm long, not at all longitudinally furrowed, more or less shiny; exposed sites; alpine *Sphaerophorus fragilis*

KEY B: "CALICIOID" LICHENS (AND OTHERS)

Note: As a group, "calicioid" lichens are useful indicators of ecological continuity in forest ecosystems (Tibell 1992). To assist with future studies of old-growth forests, the following keys incorporate all "crustose" members of this group known to occur in British Columbia (i.e., irrespective of growth form).

6a x10

7a x40

8a x3

9a x5

10a x30

11a x30

12a x2000

1a Fruiting bodies distinctly stalked. 2

2a Stalks dark, distinctly swollen in middle or upper portions *Caliciopsis*
[non-lichenized fungus: not handled]

2b Stalks pale or dark, of uniform thickness from top to bottom, or at least never distinctly swollen in middle or upper portions (Note: specimens with pale stalks key here) 3

3a Sexual fruiting bodies (i.e., spore mass) appearing black or greenish black. . . . 4

4a Fruiting bodies mazaediate: asci dissolving into a conspicuously powdery spore mass, coming off on the fingers when rubbed 5

5a Stalks stout (Note: all specimens with hollow stalks key here) 6

6a Medulla white; stalks longitudinally ridged(←), distinctly hollow; mostly subalpine *Tholurna dissimilis*

6b Medulla yellow to orange; stalks not at all longitudinally ridged, never hollow; distribution various *Acroscyphus sphaerophoroides*

5b Stalks slender, more or less threadlike. 7

7a Spore mass black; spores 8–16 µm long *Calicium*

7b Spore mass greenish black (check under LM); spores 5–8 µm long *Microcalicium*

4b Fruiting bodies not mazaediate: asci, if present, persistent, or at least not dissolving into a conspicuously powdery spore mass, not coming off on the fingers when rubbed 8

8a Over rock; stalks robust, at least partly corticate or sorediate *Pilophorus*

8b Over bark, wood, or pitch; stalks delicate, not at all corticate or sorediate 9

9a Spores (= conidiospores) needle-like to hairlike, to more than 75 µm long; hypermaritime *Szczawinskia tsugae*

9b Spores (= ascospores) ellipsoid to elongate, but never needle-like or hairlike, to less than 60 µm long; distribution various 10

10a Spores 4- to multi-celled at maturity; apothecial rim generally distinctly incurved(←) *Stenocybe*

10b Spores 1- or 2-celled at maturity; apothecial rim not at all incurved 11

11a Over bark of deciduous trees and shrubs *Phaeocalicium*

11b Over bark or wood of conifers, or over wood of deciduous trees and shrubs 12

12a Spores 2-celled at maturity. *Chaenothecopsis*

12b Spores 1-celled at maturity 13

13a
x30



- 13a Ascus tip rather thin-walled, partially interrupted by an apical "canal" (check at 1000x under LM); spores strongly obliquely arranged in the ascus; on wood or bark of conifers, or on wood of deciduous trees and shrubs . . .

..... *Chaenothecopsis*

- 13b Ascus tip strongly thickened, lacking a visible canal at 1000x; spores longitudinally arranged in the ascus, or at least not strongly obliquely arranged; on wood of conifers . . .

..... *Mycocalicium subtile*

- 3b Sexual fruiting bodies appearing brown, or at least not black or greenish black 14

- 14a Fruiting bodies mazaediate: asci present, but dissolving into a conspicuously powdery spore mass, coming off on the fingers when rubbed. 15

- 15a Spore mass/mazaedium generally medium brownish or greyish from the first, or at most weakly covered in yellowish or whitish pruina; stalks occasionally more than 1.5 mm long; widespread over trees; common (Note: specimens in which the basal thallus is distinctly powdery, granular, or warty key here, regardless of mazaedial colour) *Chaenotheca*

- 15b Spore mass/mazaedium often bright rusty brown (never medium brown) at maturity, but at least initially covered in dense yellow, violet, or white pruina; stalks invariably to less than 1.5 mm long; restricted to the base of trees and tip-up mounds; rare *Sclerophora*

- 14b Fruiting bodies not mazaediate: asci absent or, if present, then not dissolving into a conspicuously powdery spore mass, not coming off on the fingers when rubbed 16

- 16a Over soil, rock, or duff; stalks whitish or pale pinkish, stout, often patchy-corticate below, terminating in sexual fruiting bodies (apothecia), these bearing ellipsoid or spindle-like/fusiform spores 17

- 17a Apothecial discs distinctly pinkish; basal thallus PD+ yellow, containing baeomycic acid; apparently rare *Dibaeis*

- 17b Apothecial discs brownish, not at all pinkish (the stalks, however, can be pinkish); basal thallus PD+ yellow or orange, containing norstictic or stictic acids; locally common *Baeomyces*

- 16b Over conifer bark; stalks dark brownish or blackish, slender, not at all corticate, terminating in asexual fruiting structures (conidial heads), these bearing threadlike/filiform conidia 18

- 18a Stalks to more than 0.8 mm tall at maturity, terminating in a cone-shaped conidial head(←) *Microlychnus epicorticis*

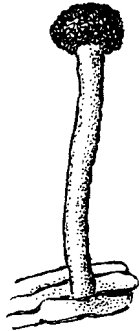
- 18b Stalks (=hyphophores) to less than 0.3 mm tall at maturity, terminating in a scale-shaped conidial head(←) . . . *Gyalideopsis*

- 1b Fruiting bodies not at all stalked 19

- 19a Spore mass/mazaedium with a dark greenish cast as viewed under hand lens; spores also greenish under LM *Microcalicium disseminatum*

- 19b Spore mass appearing blackish under hand lens; spores colourless/hyaline or brownish under LM (Note: the following crustose species are not handled in the present volume; they are keyed out below in recognition of their usefulness as indicators of environmental continuity) 20

15a
x40



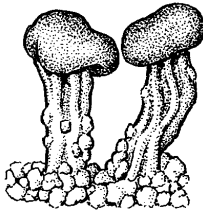
15b
x30



17a
x6



17b
x8



18a
x20



18b
x40



19a
x50



- 20a** Over dung in semi-arid localities; spores to more than 30 µm long . . .
 [*Texosporium sancti-jacobi* (Tuck.) Nádv.] [not handled]
- 20b** Over tree bark or wood (including fence posts) or over rock; spores to less
 than 30 µm long 21
- 21a** Over acid rock, coastal; spores globose . . .
 *Thelomma mammosum* (Hepp) A. Massal. [not handled]
- 21b** Over bark or wood; spores more or less elongate 22
- 22a** Spore mass/mazaedium immersed in a distinctly protruding areole
 (resembling a Chameleon's eye); over wood; spores 22–28 µm
 long 23
- 23a** Thallus bearing black, well-delimited isidia, these more or less
 clustered; medulla I+ dark blue; widespread . . .
 *Thelomma ocellatum* (Körber) Tibell [not handled]
- 23b** Thallus lacking isidia; medulla I-; coastal . . .
 *Thelomma occidentale* (Herre) Tibell [not handled]
- 22b** Spore mass immersed in or sessile on a flat to weakly convex areole;
 over bark or wood; spores 13–22 µm long 24
- 24a** Thallus intensely greenish yellow; inland 25
- 25a** Apothecia immersed in basal thallus; tissues surrounding
 spore mass/mazaedium thin throughout; spores 17–21 µm
 long *Cyphelium tigillare* (Ach.) Ach. [not handled]
- 25b** Apothecia protruding from basal thallus; tissues surround-
 ing mazaedium strongly thickened at base; spores 13–17 µm
 long *Cyphelium pinicola* Tibell [not handled]
- 24b** Thallus greenish to brownish, or at least not at all yellow; distri-
 bution various 26
- 26a** Apothecia immersed in basal thallus; largest apothecia to
 less than 0.4 mm wide; spores smooth-walled, 18–22 µm
 long *Cyphelium trachylioides*
 (Branth & Rostrup) Erichsen [not handled]
- 26b** Apothecia protruding from basal thallus; largest apothecia
 to more than 0.4 mm wide; spores variously ornamented,
 13–19 µm long 27
- 27a** Thallus pale medium grey; largest apothecia to 0.6–2.5
 mm wide; mature spores spirally striate or apparently
 smooth (check at 1000x under LM) . . .
 *Cyphelium inquinans*
 (Sm.) Trevisan [not handled]
- 27b** Thallus faintly greenish grey to brownish grey; largest
 apothecia to 0.4–0.7 (–1.0) mm wide; mature spores
 distinctly and irregularly roughened . . .
 *Cyphelium karelicum*
 (Vainio) Räsänen [not handled]

KEY C: FRUTICOSE MICROLICHENS (AND OTHERS)

1a Thallus pale or brightly coloured (check sheltered portions of branches), or at least not dark from top to bottom. 2

2a Thallus at least in part yellowish 3

3a Over soil or duff; medulla KC+ yellow to red; alpine 4

4a Thallus crustose, but bearing isidia-like outgrowths/verrucae (and hence appearing fruticose), these to less than 4 mm tall, in part terminating in soredia(←) *Pertusaria geminipara* (Th. Fr.) Brodo [not handled]

4b Thallus truly fruticose, stalks to more than 4 mm tall, not at all sorediate *Dactylina*

3b Directly attached to bark or rock; medulla KC-; lowlands 5

5a Sheltered portions of thallus whitish or pale grey; over vertical rock faces sheltered from rain; apothecia, if present, weakly stalked; rare, restricted to semi-arid intermontane regions *Teloschistes contortuplicatus*

5b Sheltered portions of thallus yellowish; over bark or rock; apothecia, if present, essentially unstalked; frequent; widespread, especially in humid intermontane regions *Xanthoria candelaria* (see Part 1)

2b Thallus variously coloured, but not at all yellowish 6

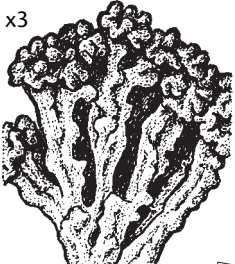
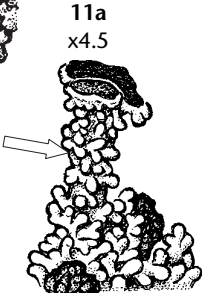
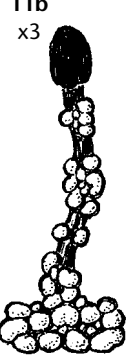
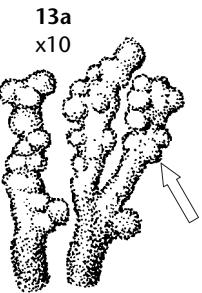
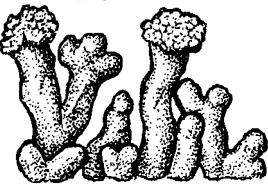
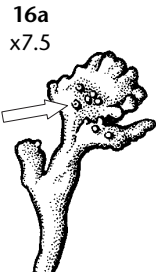

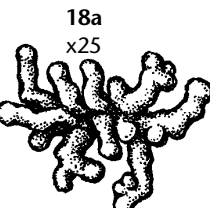
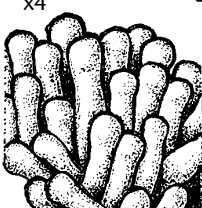
6a Photobiont a cyanobacterium: dark or at least not grass-green under LM (Note: specimens collected from conifer branches in humid localities key here) 7

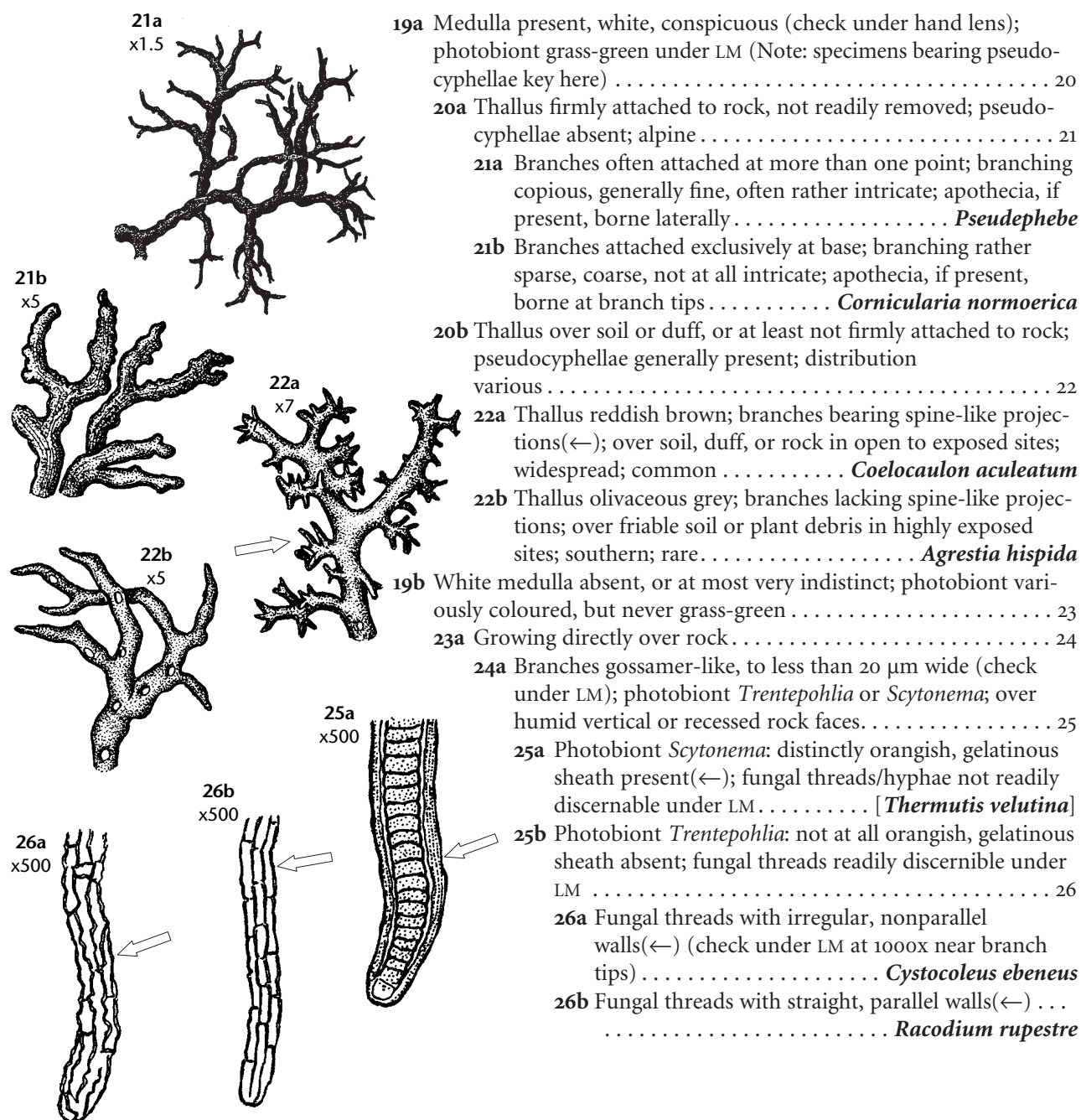
7a Medulla present (i.e., thallus white within: check basal portions); branches terminating in dark, isidia-like outgrowths(←); photobiont *Nostoc*, cells to 5–7 μm along long axis. *Sticta oroborealis*

7b Medulla absent (i.e., thallus dark within); branches smoothly tapering to a pointed tip; photobiont *Scytonema*, *Stigonema*, or at least not *Nostoc*, cells to more than 8 μm along long axis 8

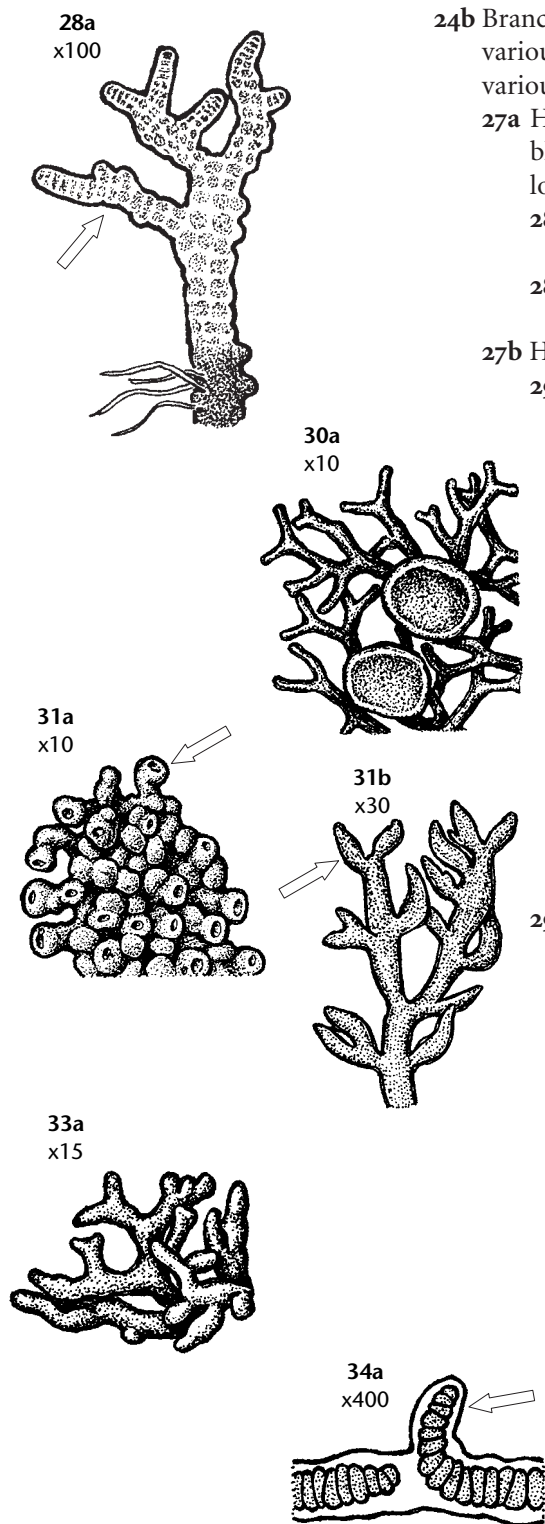
8a Photobiont *Scytonema*, arranged in roughly parallel rows (←), branching “false” (i.e., branches arising through terminal growth of photobiont strands); thallus dark throughout; rhizoids absent *Polychidium*

8b Photobiont *Stigonema*, arranged in an irregular “brickwork” pattern(←), branching “true” (i.e., branches not arising through terminal growth of photobiont strands); thallus dark above, but often somewhat pale in basal portions, often bearing scattered hairlike rhizoids. *Spilonema* sp. 1

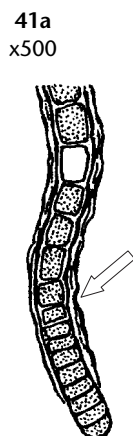
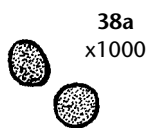
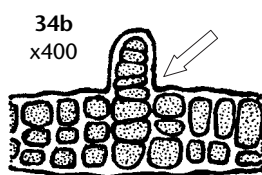
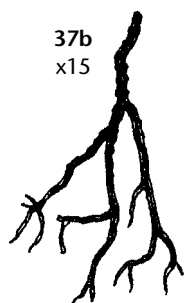
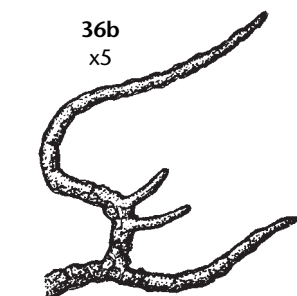
- 10a x3 
- 11a x4.5 
- 11b x3 
- 13a x10 
- 14b x15 
- 16a x7.5 
- 16b x8 
- 18a x25 
- 18b x4 
- 6b Photobiont an alga: grass-green under LM 9
- 9a Main stems terminating at least in part in apothecia; tips distinctly black. 10
- 10a Stems crowded into compact cushions that conceal the point of attachment; thallus lacking cephalodia; over vertical rock; alpine *Lecanora pringlei* (Tuck.) Lamb [not handled]
- 10b Stems scattered, not at all cushion-forming, clearly revealing point of attachment; thallus bearing scattered brownish or greyish cephalodia (check basal crust); over rock or soil; distribution various. 11
- 11a Stems bearing a “foliage” of scale-like/squamulose or finger-like/coralloid phyllocladia(←); over rock or soil . . . *Stereocaulon*
- 11b Stems smooth, lumpy, or sorediate, but not at all bearing squamulose or coralloid phyllocladia; over rock. *Pilophorus*
- 9b Main stems terminating or not in apothecia; tips pale or at least not black. 12
- 12a Thallus sorediate or apparently so (Note: specimens in which a hard outer cortex is entirely lacking key here) 13
- 13a Cortex absent: main stems with a “soft,” “lumpy” appearance throughout(←) *Leprocaulon*
- 13b Cortex present: main stems with a “hard,” smooth appearance throughout, except terminating in part in powdery soredia. . . . 14
- 14a Cortex KC+ red (flash); over soil or moss; alpine *Pertusaria geminipara* (Th. Fr.) Brodo [not handled] (see 4a)
- 14b Cortex KC-; over rock; lowland regions *Stereocaulon pileatum*
- 12b Thallus lacking soredia 15
- 15a Thallus brownish, pale greenish, or (in herbarium) becoming pinkish; fruiting bodies invariably present, frequent (Note: specimens growing firmly attached to rock key here) 16
- 16a Fruiting bodies consisting of tiny dotlike perithecia(←), these much less than the diameter of the supporting branch; exposed outcrops; inland *Endocarpon pulvinatum* (see Part 1)
- 16b Fruiting bodies consisting of large disc-like or hemispherical apothecia(←), these greater than the diameter of the supporting stalk; humid regions; distribution various. 17
- 17a Apothecia brownish *Baeomyces*
- 17b Apothecia pinkish. *Dibaeis*
- 15b Thallus whitish; fruiting bodies absent or, if present, very sparse 18
- 18a Over bark in humid localities; humid lowlands *Loxosporopsis corallifera*
- 18b Over soil or duff in somewhat exposed localities; alpine *Pertusaria dactylina* (Ach.) Nyl. [not handled]
- 1b Thallus dark from top to bottom (including sheltered portions of branches) 19



- 19a Medulla present, white, conspicuous (check under hand lens); photobiont grass-green under LM (Note: specimens bearing pseudocyphellae key here) 20
- 20a Thallus firmly attached to rock, not readily removed; pseudocyphellae absent; alpine 21
- 21a Branches often attached at more than one point; branching copious, generally fine, often rather intricate; apothecia, if present, borne laterally *Pseudephebe*
- 21b Branches attached exclusively at base; branching rather sparse, coarse, not at all intricate; apothecia, if present, borne at branch tips *Cornicularia normoerica*
- 20b Thallus over soil or duff, or at least not firmly attached to rock; pseudocyphellae generally present; distribution various 22
- 22a Thallus reddish brown; branches bearing spine-like projections(←); over soil, duff, or rock in open to exposed sites; widespread; common *Coelocaulon aculeatum*
- 22b Thallus olivaceous grey; branches lacking spine-like projections; over friable soil or plant debris in highly exposed sites; southern; rare *Agrestia hispida*
- 19b White medulla absent, or at most very indistinct; photobiont variously coloured, but never grass-green 23
- 23a Growing directly over rock 24
- 24a Branches gossamer-like, to less than 20 µm wide (check under LM); photobiont *Trentepohlia* or *Scytonema*; over humid vertical or recessed rock faces 25
- 25a Photobiont *Scytonema*: distinctly orangish, gelatinous sheath present(←); fungal threads/hyphae not readily discernible under LM [*Thermutis velutina*]
- 25b Photobiont *Trentepohlia*: not at all orangish, gelatinous sheath absent; fungal threads readily discernible under LM 26
- 26a Fungal threads with irregular, nonparallel walls(←) (check under LM at 1000x near branch tips) *Cystocoleus ebeneus*
- 26b Fungal threads with straight, parallel walls(←) *Racodium rupestre*



- 24b Branches threadlike or broader, to more than 50 μm wide; photobiont various (including *Scytonema*, but not *Trentepohlia*); habitat various 27
- 27a Hairlike rhizoids copious in basal portions of thallus, distinctly visible under LM, often bluish (Note: specimens having a bluish black lower surface key here). 28
- 28a Thallus erect and shrublike throughout(\leftarrow); photobiont cells 15–20 μm along long axis *Spilonema revertens*
- 28b Thallus at least in part appressed and flattened; photobiont cells to 10–12 μm along long axis *Placynthium* (see Part 1)
- 27b Hairlike rhizoids absent or at most inconspicuous, never bluish . . . 29
- 29a Photobiont 1-celled or arranged in rounded clusters of two or three cells. 30
- 30a Among moss over rock; branching rather loose; thallus distinctly shiny; photobiont *Nostoc*: cells to 5–7 μm along long axis, not at all enveloped in a distinct gelatinous sheath *Polychidium muscicola*
- 30b Attached directly to rock; branching compact; thallus more or less dull; photobiont Chroococcales: cells to 8–12 (–15) μm along long axis, often enveloped by a distinct gelatinous sheath 31
- 31a Branches to more than 200 μm wide, terminating in coarse, blunt tips, these in part bearing sunken, pore-like apothecia(\leftarrow). *Synalissa symphorea*
- 31b Branches to less than 150 μm wide, terminating in tapering, often pointed tips(\leftarrow); apothecia unknown in local material *Lichinella stipatula*
- 29b Photobiont at least in part arranged in obvious strands or chains (check near tips of young, well-developed branches). 32
- 32a Photobiont *Nostoc*: cells mostly to 5–7 μm along long axis, “end cells” globose or at most oval (check in cross-section near tips of well-developed branches). 33
- 33a Branches dull; cellular cortex absent; directly attached to rock *Lempholemma fennicum*
- 33b Branches shiny; cellular cortex well developed, readily discernible in cross-section (see Figure 5b); usually indirectly attached to rock (i.e., over thin soil or plant material). *Leptogium* (see Part 1)
- 32b Photobiont *Scytonema* or *Stigonema*: cells to more than 8 μm along long axis, “end cells” rectangular or lens-shaped (check for both characters in long-section at tips of well-developed branches). 34
- 34a Photobiont *Scytonema*: remaining strandlike throughout; branching “false”(\leftarrow) (i.e., branches arising though terminal growth of photobiont strands) 35
- 35a Branches shiny, often difficult to distinguish from unlichenized algae; photobiont strands arranged throughout in a single row [*Thermutis velutina*] (see 25a)



35b Branches dull, obviously consisting of photobiont strands embedded in a fungal matrix (check under LM); photobiont strands at least partly arranged in two parallel rows (check at tips of well-developed branches) 36

36a Collected over acid rock, generally colonizing *Parmelia* or other rock-dwelling lichens; main branches bearing numerous side branches; photobiont strands often in part arranged in three or four parallel rows . . .

. *Lichinodium sirosiphoideum*

36b Collected over calcium-rich rock, directly attached; main branches bearing few if any side branches; photobiont strands mostly arranged in two parallel rows . . .

. *Zahlbrucknerella calcarea*

34b Photobiont *Stigonema*: strands soon disassociating into irregular cell clusters; branching “true(←)” (i.e., branches not arising through terminal growth of photobiont strands) 37

37a Thallus erect, strongly cushion-forming, generally to less than 5 mm long, attached below by at least some hairlike basal rhizoids (see **28a**) (Note: specimens supporting a tiny brownish squamulose lichen with dark bluish margins key here) . . .

. *Spilonema revertens*

37b Thallus prostrate to occasionally in part erect, but not distinctly cushion-forming, to more than 5 mm long, lacking rhizoids. *Ephebe*

23b Growing over bark, wood, soil, or duff, but not directly over rock 38

38a Photobiont *Nostoc*: 1-celled to weakly strandlike, composed entirely of globose to oval cells (←), these to less than 7 μ m along long axis; over bark, wood, soil, or duff; distribution various 39

39a Thallus greyish, associated with apothecia of *Solorina spongiosa*; over soil; mostly alpine . . .

. (cephalodia belonging to) *Solorina spongiosa* (see Part 1)

39b Thallus brownish; never associated with *Solorina spongiosa*; habitat ecology and distribution various. 40

40a Cellular cortex present, distinctly visible in cross-section at 40x in dissecting microscope (see Figure 5b); over soil, wood, or bark; lowlands *Leptogium* (see Part 1)

40b Cellular cortex absent; over plant material in exposed sites; mostly at treeline and above *Leciophysma*

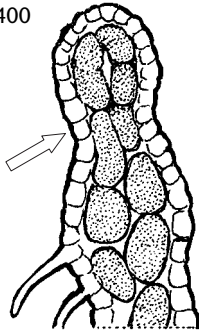
38b Photobiont *Scytonema* or at least not *Nostoc*: strandlike, composed at least in part of rectangular to lens-shaped cells to more than 8 μ m along long axis; over bark; humid lowland regions. 41

41a Photobiont strands arranged mostly in a single row(←); branches bluish grey; over deciduous shrubs Unknown 3

42a
x25



44a
x400



- 41b Photobiont strands arranged mostly in two or more roughly parallel rows; branches variously coloured (including bluish grey); over conifers 42
- 42a Cellular cortex absent (i.e., cross-walls not evident in surface view under LM); branches dull, blackish *Lichinodium canadense*
- 42b Cellular cortex present (cross-walls evident in surface view under LM); branches often somewhat shiny, greyish, bluish, brownish, or occasionally blackish 43
- 43a Branches neither distinctly constricted nor bearing hairlike rhizoids *Polychidium* (see 8a)
- 43b Branches distinctly constricted at intervals and/or bearing hair-like rhizoids below, these solitary, tufted, or scattered along the length of the branches. 44
- 44a Branches to 0.5 mm long, distinctly constricted at intervals(←); rhizoids mostly scattered Unknown 1
- 44b Branches to 2–4 mm long, not at all distinctly constricted; rhizoids generally in part tufted Unknown 2

ACROSCYPHUS Lévillé

The Crab-eye Lichen

Medium-sized stratified fruticose (**shrub**) lichen, consisting of dense tufts of semi-erect to erect branches, these **pale greyish**, except becoming blackish toward base, round in cross-section, rather stout, to 15–20 (–30) mm long and 2 mm wide, dull, corticate, pliant, solid, sparsely branched; branching uneven/anisotomic. Soredia, isidia, and pseudocyphellae absent. **Medulla yellow to orange**, compact. Attached to substrate by basal holdfasts. Photobiont green, chlorococcoid.

Ascocarp an apothecium. **Apothecia black**, borne at **branch tips**, consisting of a narrowly cup-shaped excipulum and a

powdery black spore mass/mazaedium, this to 1 (–1.5) mm wide, somewhat recessed. Spores 2-celled, peanut-shell-shaped, with a constricted septum, dark brown, smooth, arising from short-lived asci, later extruded.

Over wood and acid rock.

Reference: Tibell (1984).

Common Name: Refers to the stalked, eye-like fruiting bodies.

Notes: *Acroscyphus* is a rare, but widely distributed, genus occurring at tropical to temperate latitudes. It contains only one species.

Acroscyphus sphaerophoroides Lévillé

Map 2

The crab-eye



Habitat/Range: Rare over base-enriched rock or conifer wood in exposed coastal hyper-maritime and subalpine localities; western N Am - western Eurasia; N to BC, S to MX.

Reactions: Medulla K+ yellow, KC+ red, C+ red.

Contents: Atranorin, calycin, chrysophanol, gyrophoric acid, rugulosin, skyrin, usnic acid, and zeorin.

Variability: High.

Notes: In North America, *A. sphaerophoroides* has hitherto been detected only in British Columbia and Mexico. This is a widespread lichen, though apparently rare throughout its range; only about a dozen localities are known worldwide (Tibell 1984).

Small to medium-sized fruticose (**shrub**) lichen, consisting of **loose tufts** of decumbent to semi-erect branches, these pale to **dark olivaceous grey**, round to oval or irregular in cross-section, **slender**, to **5–10 (–13) mm long** and 0.5–1.0 (–2.0) mm wide, dull, smooth, corticate, brittle, solid, rather richly branched; branching even/isotomic to more often uneven/anisotomic. Soredia and isidia absent. **Pseudocyphellae conspicuous**, white, often somewhat depressed, scattered. **Medulla white**. Weakly attached to substrate by indistinct basal holdfasts, or often growing unattached. Photobiont green, chlorococcoid: *Trebouxia*.

Ascocarp an apothecium, borne laterally, disc generally blackish, rare. Spores 1-celled, globose, colourless, two to four per ascus. Pycnidia not reported.

Over **friable soil in highly exposed sites**.

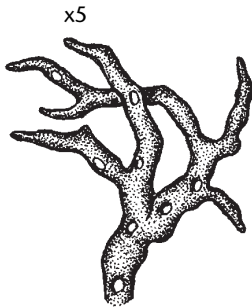
References: Thomson (1960); Brodo (1977).

Common Name: Refers to the tendency of this species to grow unattached, and hence to “wander” from place to place.

Notes: *Agrestia* occurs in semi-arid climates in cool-temperate latitudes. It is perhaps more appropriately accommodated within the crustose genus *Aspicilia*.

Agrestia hispida (Mereschk.) Hale & Culb.
(Syn. *Aspicilia hispida* Mereschk.)
Desert vagabond

Map 3



Habitat/Range: Rare over thin, granular, generally volcanic soil in exposed outcrops in the dry intermontane (IDF) at lower to middle elevations; western N Am - eastern Eurasia, N to BC, S to ID, (MT), (OR), WY, (NV), UT, (CO), NM; AB.

Reactions: All spot tests negative.

Contents: No lichen substances reported.

Variability: Medium.

Notes: The occurrence in semi-arid regions over dry friable soils in open, wind-blasted, south-facing sites is unique among British Columbia's macrolichens.

Medium-sized to large fruticose (**hair**) lichens, consisting of **tufts or tresses** of semi-erect to decumbent or pendent branches, these **greenish** to greenish yellow or occasionally becoming blackish, round in cross-section to occasionally somewhat flattened or angular, hairlike, to **50–400 (–1000!) mm long** and 0.5–3.0 (–40!) mm wide, shiny or dull, mostly smooth, corticate, pliant or brittle, solid or in part hollow, richly branched, lacking spinules, but spinule-like “isidia” occasionally arising from pseudocyphellae; branching even/isotomic to uneven/anisotomic. Soredia present or absent. Isidia present (and then spinule-like) or absent. **Pseudocyphellae present**, white. Medulla white. Attached to substrate by basal hold-

fasts. Photobiont green, chlorococcoid: *Trebouxia*.

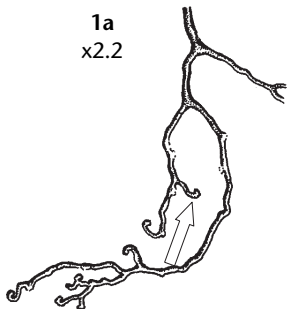
Ascocarp an apothecium, borne laterally, disc generally brownish or blackish, concave to convex. Spores 1-celled, ellipsoid, brown at maturity, two to four per ascus. Pycnidia rare.

Mostly **over bark**, but also over ground or rock in exposed sites.

References: Brodo and Hawksworth (1977); McCune and Goward (1995).
Common Name: Traditional.

Notes: *Alectoria* is a cool-temperate to arctic genus consisting of seven species worldwide. All of these occur in North America, though only four are present in British Columbia.

KEY TO ALECTORIA AND SIMILAR LICHENS



1a
x2.2

1a Branch tips pale green (check extreme tips), at least in part bearing minute fiddlehead-like “hooks” (←), these frequently minutely sorediate (check under hand lens); pseudocyphellae generally inconspicuous (check main branches); mostly over trees *Ramalina thrausta*

1b Branch tips pale or dark, not at all hooked, lacking soredia and granules; pseudocyphellae generally conspicuous; substrate various. 2

2a Thallus containing usnic acid: pale greenish, at least in part; cortex KC+ yellow (usnic acid present: check pale branches), PD-, K-, or occasionally in part K+ red; pseudocyphellae abundant, generally conspicuous 3

3a Pseudocyphellae bearing distinct isidia or isidia-like spinules, or both; tree-dwelling 4

4a Main branches conspicuously and irregularly flattened in cross-section; spinules borne in more or less tufted clusters (←), at least in part; intermontane *Alectoria imshaugii*

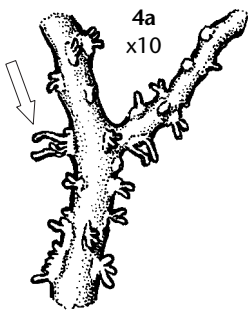
4b Main branches mostly round in cross-section; spinules scattered more or less singly along branches, or at least not tufted; thallus generally pendent; hypermaritime see *Alectoria imshaugii*

3b Pseudocyphellae not at all spinulose; tree- or ground-dwelling. 5

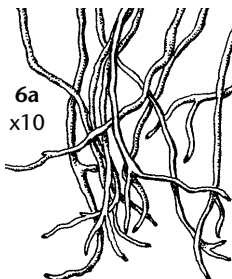
5a Tree-dwelling 6

6a Thallus distinctly yellowish green, or at least usually not greyish green; medulla lax, at least in part (check main branches), C-; branches pliant to distinctly brittle; widespread in humid forests at all elevations *Alectoria sarmentosa* ssp. *sarmentosa*

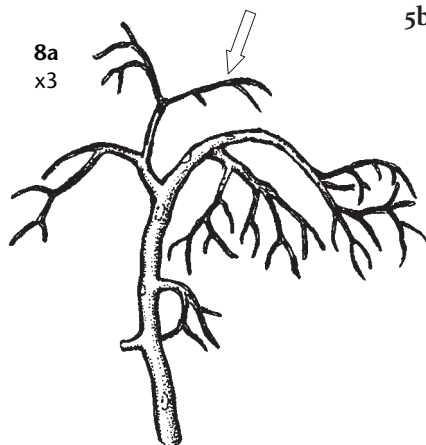
6b Thallus greyish green, or at least usually not yellowish green; medulla generally compact throughout, C+ red (or rarely C-); branches distinctly brittle; coastal at lower elevations. . . *Alectoria vancouverensis*



4a
x10



6a
x10



- 5b Ground-dwelling. 7
- 7a Main branches distinctly flattened/strap-shaped in cross-section, usually to more than 2 mm wide; thallus prostrate . . .
Alectoria sarmentosa ssp. *vexillifera*
- 7b Main branches more or less circular in cross-section, usually to less than 2 mm wide; thallus erect to prostrate 8
- 8a Thallus erect to rarely prostrate; upper portion of branches often distinctly blackened(←); medulla CK+ golden yellow (diffractaic acid present); alpine; common *Alectoria ochroleuca*
- 8b Thallus prostrate; upper portion of branches not blackened (except blackened at extreme branch tips: check under hand lens); medulla CK- (diffractaic acid absent); exposed outcrops at all elevations *Alectoria sarmentosa* ssp. *sarmentosa*
 (rare ground-dwelling form)
- 2b Thallus lacking usnic acid: pale yellowish or greyish (at least in part), but never greenish; cortex either KC+ pink/red or PD+ yellow or orange (alectorialic or barbatolic acids present, or both), also K+ pale yellow/bright yellow (rarely K+ red); pseudocyphellae abundant or sparse, conspicuous or not 9
- 9a Tree-dwelling; thallus long-pendent; in sheltered sites, mostly at lower elevations; medulla KC- *Bryoria capillaris*
- 9b Ground-dwelling or occasionally tree-dwelling; thallus tufted; in exposed sites at treeline and above; medulla KC+ red 10
- 10a Thallus pale at base, at least in part; main branches bearing distinct pseudocyphellae(←), these plane to raised, often rather broad; soredia absent; branch tips mostly weakly reflexed; widespread; common . . .
 *Alectoria nigricans*
- 10b Thallus blackened at base; main branches bearing inconspicuous pseudocyphellae, these plane, narrow; soredia present or occasionally absent; branch tips mostly not reflexed; coastal; apparently rare . . .
 *Bryoria nadvornikiana*

Alectoria imshaugii Brodo & D. Hawksw.
 Spiny witch's hair

Map 4

Habitat/Range: Infrequent over conifers, especially Douglas-fir and lodgepole pine, in open intermontane (ICH) forests at lower elevations, also apparently present at low elevations in hypermaritime regions, mostly south of 50°N (but see Notes, below); western N Am, N to BC, S to WA, ID, MT, OR, CA.

Reactions: Cortex KC+ yellow; medulla K+ yellow or K-, KC- or rarely KC+ red, PD- or PD+ yellow to orange.

Contents: Usnic acid and squamatic acid or thamnolic acid.

Variability: High.

Notes: In specimens from hypermaritime regions, the main branches are predominantly round in cross-section, not angular-compressed, as in inland material; the former material may represent a separate species.

Alectoria nigricans (Ach.) Nyl.

Grey witch's hair

Habitat/Range: Frequent over acid and often base-rich rock, stony soil, and duff in exposed alpine sites throughout, also infrequent over low branches of conifers; circumpolar, N to sAK, AK, YU, wNT, S to WA, MT, OR, CO, NM; AB.

Reactions: Cortex and medulla K+ faintly yellowish or rarely K+ red, C+ rose red, KC+ red, PD+ yellowish.

Contents: Alectorialic acid (and barbatolic acid and an unidentified compound).

Variability: Medium.

Notes: This is a ground-dwelling species in which the branches are generally blackened toward the tips, but pale toward the thallus centre.

Alectoria ochroleuca (Hoffm.) A. Massal.

Green witch's hair

Habitat/Range: [All chemotypes] Frequent over acid and often base-rich rock, stony soil, and duff in exposed inland localities at alpine elevations, also infrequent over low branches of conifers; circumpolar, N to sAK, AK, YU, wNT, S to WA, OR, MX; AB.

Reactions: Chemotype 1: Cortex K-, KC+ yellow; medulla CK+ yellowish orange, KC-. Chemotype 2: Cortex K-, KC+ yellow; medulla KC+ red. Chemotype 3: Cortex K-, KC+ yellow.

Contents: Chemotype 1: Diffractaic and usnic acids. Chemotype 2: Alectoronic and usnic acids. Chemotype 3: Usnic acid.

Variability: Medium.

Notes: The cortex in this species is occasionally K+ reddish in basal portions, owing to an unidentified compound.

Alectoria sarmentosa (Ach.) Ach. ssp. ***sarmentosa***

Common witch's hair (stringy mane)

Habitat/Range: [Both chemotypes] Common over trees, especially conifers, in sheltered to open or occasionally exposed forests at all elevations throughout, except essentially absent from the dry intermontane and from boreal regions; incompletely circumpolar, N to sAK, S to WA, ID, MT, OR, CA, NV, CO; AB.

Reactions: Chemotype 1: Cortex KC+ yellow; medulla K- or rarely K+ yellow, C- or C+ slowly yellow, KC- or KC+ red, PD- or rarely PD+ yellow. Chemotype 2: Cortex KC+ yellow.

Contents: Chemotype 1: Usnic acid (and alectoronic acid or thamnolic acid/squamatic acid or barbatic acid). Chemotype 2: Usnic acid.

Variability: Low.

Notes: The cortex is occasionally K+ reddish and C+ greenish black in basal portions, owing to an unidentified compound. A few coastal specimens from upper-elevation forests have a rather tufted habit, and thus approach *A. lata* (Taylor) Lindsay. That species, however, characteristically bears apothecia, whereas the local material is sterile.

Alectoria sarmentosa (Ach.) Ach. ssp. ***vexillifera*** (Nyl.) D. Hawksw.
(Syn. *Alectoria vexillifera* (Nyl.) Stizenb.)

Map 5

Alpine witch's hair

Habitat/Range: Rare (probably overlooked) over stony soil or humus in exposed alpine sites, probably throughout; western N Am - eastern N Am - eastern Eurasia, N to sAK, S to WA, MT, MX.

Reactions: Cortex KC+ yellow; medulla K- or rarely K+ yellow, C- or C+ slowly yellow, KC- or KC+ red, PD- or rarely PD+ yellow.

Contents: Usnic acid (and alectoronic acid or squamatic acid or barbatic acid).

Variability: High.

Notes: The cortex is occasionally K+ reddish and C+ greenish black in basal portions, owing to an unidentified compound. The taxonomic distinctness of this subspecies is questionable.

Alectoria vancouverensis (Gyelnik) Brodo & D. Hawksw.

Friable witch's hair

Habitat/Range: Common over trees, especially conifers, in open coastal forests at lower elevations, north to 51°N; western N Am, N to BC, S to WA, OR, CA, MX.

Reactions: Cortex KC+ yellow; medulla C+ red or rarely C-, KC+ red.

Contents: Usnic acid (and olivetoric acid or alectoronic acid or barbatic acid and various unidentified compounds).

Variability: Medium.

Notes: Though currently recognized as a distinct species, *A. vancouverensis* appears to intergrade freely with *A. sarmentosa*; it may more appropriately be regarded as a subspecies of that species. Intergrading specimens can be referred to as *A. sarmentosa* s. lat. The holotype specimen is from Vancouver Island.

Small to medium-sized stratified “fruticose” (**club**) lichens, consisting of a **basal crust** and **stalked apothecia**. Basal crust crustose to granular or scale-like, or in part nearly leaflike/foliose, smooth, pale greenish (becoming pale pinkish in herbarium), corticate. Soredia present or absent. Isidia and pseudocyphellae absent. Medulla white. Photobiont green, chlorococcoid: *Coccomyxa* or *Elliptochloris*.

Apothecial stalks whitish, stout, to 2.0–5.0 (–6.0) mm long (including apothecial disc) and 0.3–0.8 mm wide (excluding disc), longitudinally ridged, **solid**, tough, nonlichenized (except often patchy-thalline near base). Ascocarp an apothecium, **borne atop a stout, unbranched to occasionally sparsely branched stalk**, this **whitish or pale pinkish**, longitudinally ridged, **solid**, nonlichenized (except often patchy-

thalline near base). **Apothecial disc borne at stalk tips**, concave to more often **strongly convex, pale reddish brown to medium brown**. Spores 1- to 4-celled, ellipsoid to spindle-shaped/ fusiform, colourless/hyaline, eight per ascus. Pycnidia immersed in basal thallus.

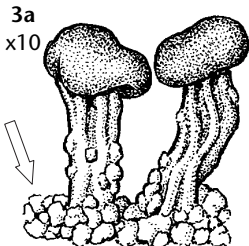
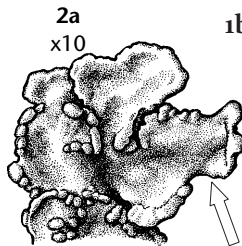
Over soil, rocks, and occasionally duff.

References: Thomson (1984).

Common Name: Refers to the caplike apothecial discs.

Notes: *Baeomyces* is a cosmopolitan genus consisting of about eight species worldwide. Three of these have been reported for North America, and all are present in British Columbia. Though technically classified as a crustose genus, *Baeomyces* is included here owing to the stalked apothecia. See also the notes under *Dibaeis*.

KEY TO BAEOMYCES AND SIMILAR LICHENS



- 1a Apothecial discs, if present, distinctly pink; stalks UV+ ice-blue; basal crust PD+ yellow; containing baeomycesic and squamatic acids; known in British Columbia only from hypermaritime regions; rare . . .
 see *Dibaeis baeomyces*
- 1b Apothecial discs, if present, distinctly brownish; stalks UV-; basal crust PD+ yellow to more often orangish; containing norstictic or stictic acid, or both; distribution and frequency status various 2
- 2a Basal thallus consisting of lobes generally to more than 1 mm wide and 2 mm long (check margins of thallus)(←); mostly northern; rare *Baeomyces placophyllus*
- 2b Basal thallus crustose or consisting of squamules generally less than 1 mm wide and 2 mm long; distribution and status various. 3
- 3a Squamules present, to 2 mm long; cortex K+ yellow, orange, or red (norstictic acid predominating); mostly northern; rare . . .
 *Baeomyces carneus*
- 3b Granular crust present or, if squamules present, then these to less than 1 mm long(←); cortex K+ yellow (stictic acid predominating); widespread; common *Baeomyces rufus*

Baeomyces carneus Flörke
Scale beret

Map 6

Habitat/Range: Rare over soil in open intermontane localities, local distribution poorly known; probably circumpolar, N to AK, YU, wNT, S to BC, WA.

Reactions: Cortex and medulla K+ yellow, orange, or red, PD+ yellow or orange.

Contents: Norstictic acid (and trace of stictic acid).

Variability: Medium.

Notes: Reported in British Columbia only from Wells Gray Park (Goward and Ahti 1992). See notes under *B. rufus*.

Baeomyces placophyllus Ach.
Carpet beret (lobed beret lichen)

Map 7

Habitat/Range: Rare over soil, duff, or mossy rock in sheltered intermontane localities at lower elevations, also rare in coastal regions, local distribution poorly known; circumpolar, N to sAK, AK, YU, S to BC, MX.

Reactions: Cortex and medulla K+ yellow, PD+ orange.

Contents: Stictic acid.

Variability: Medium.

Notes: Reported in British Columbia only from Wells Gray Park (Goward and Ahti 1992).

Baeomyces rufus (Hudson) Rebert.
Crust beret (brown beret lichen)

Habitat/Range: Frequent over soil, rock, moss, and occasionally duff and decaying wood in sheltered to shady sites at lower to middle forested elevations throughout, except rare in the dry intermontane; circumpolar, N to sAK, AK, YU, wNT, S to WA, ID, OR, CA, CO, AZ, NM; AB.

Reactions: Cortex and medulla K+ yellow, PD+ orange.

Contents: Stictic acid (and constictic acid).

Variability: Medium.

Notes: This species is often parasitic over moss. In addition to stictic acid, some of the British Columbia material also contains trace amounts of norstictic acid; such material may on this account be referable to *B. carneus*. Problematic specimens can be referred to as *B. rufus* s. lat.

Medium-sized to large stratified fruticose (**hair**) lichens, consisting of **tufts or tresses** of semi-erect to decumbent or pendent branches, these **reddish brown** to dark brown or blackish in basal portions, round in cross-section or in part somewhat angular, hairlike, to **40-150 (-200) mm long** and 0.3-1.0 mm wide, generally shiny, smooth, corticate, brittle, solid, richly branched; branching uneven/anisotomic. Soredia and isidia absent.

Pseudocyphellae present, white, often protruding. Medulla white. Attached to substrate by a basal holdfast. Photobiont green, chlorococcoid: *Trebouxia*.

Ascocarp an apothecium, borne laterally, disc brownish, concave to convex.

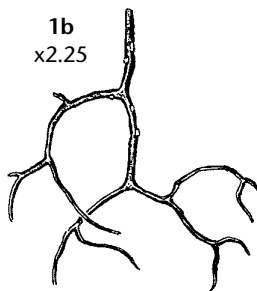
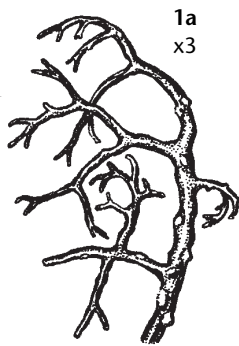
Spores 1-celled, ellipsoid, colourless, eight per ascus. Pycnidia rare.

Over conifers and over ground in open to exposed sites.

References: Kärnefelt (1986).

Common Name: Refers to the colour, gloss, and general habit of the species.

Notes: *Bryocaulon* is a cool-temperate to arctic genus consisting of three species worldwide. Two of these occur in North America, including British Columbia. The KC+ red medulla is diagnostic for the genus. For points of separation with similar lichens, see the key under *Bryoria*.



KEY TO *BRYOCAULON*

- 1a** Over ground; thallus semi-erect to erect; alpine; widespread . . . *Bryocaulon divergens*
1b Over conifer branches; thallus more or less pendent; temperate; coastal . . . *Bryocaulon pseudosatoanum*

Bryocaulon divergens (Ach.) Kärnefelt

(Syn. *Coelocaulon divergens* (Ach.) R. Howe; *Cornicularia divergens* Ach.)

Northern foxhair (reddish heath lichen; blackbeard lichen)

Habitat/Range: Frequent over stony acid heaths in exposed inland localities at alpine elevations, mostly north of 58°N; circumpolar, N to sAK, AK, YU, wNT, S to BC; AB.

Reactions: Medulla and pseudocyphellae C+ reddish, KC+ red.

Contents: Olivetoric acid.

Variability: Medium.

Notes: This species must be carefully distinguished from *Bryoria nitidula*, with which it often occurs. That species, however, yields a C- and KC- medullary reaction.

Bryocaulon pseudosatoanum (Asah.) Kärnefelt

(Syn. *Cornicularia pseudosatoana* Asah.)

Southern foxhair

Habitat/Range: Frequent over conifers in open old-growth hypermaritime forests and forested bogs at lower elevations; western N Am - eastern Eurasia, N to sAK, AK, S to BC.

Reactions: Medulla and pseudocyphellae C+ reddish or rarely C-, KC+ red.

Contents: Olivetoric acid.

Variability: Low.

Medium-sized to large stratified fruticose (**hair**) lichens, consisting of **tufts or tresses** of semi-erect to decumbent or pendent branches, these **brownish** or blackish to occasionally greyish, round in cross-section to occasionally in part somewhat angular, hairlike, to **30-150 (-900!) mm long** and 0.1-1.5 (-4) mm wide, shiny or dull, mostly smooth, corticate, pliant or brittle, mostly solid, copiously branched, in some species bearing short side branches/"spinules," these often somewhat basally constricted and growing more or less at right angles to main branches; branching even/isotomic to uneven/anisotomic. Soredia present or absent; soredia rarely bearing isidia-like spinules. Isidia absent. Pseudocyphellae present or absent, white, brownish, or rarely yellow. Medulla white. Photobiont green, chlorococcoid: *Trebouxia*.

Ascocarpan apothecium, borne laterally, disc brownish, concave to convex. Spores 1-celled, ellipsoid, colourless, eight per ascus. Pycnidia rare.

Over bark, also over ground in exposed sites.

References: Brodo and Hawksworth (1977); Holien (1989, 1992); McCune and Goward (1995).

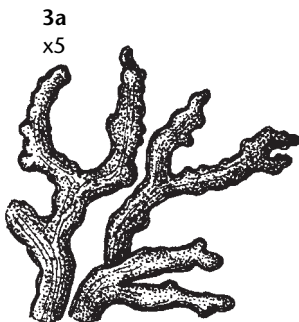
Common Name: Descriptive.

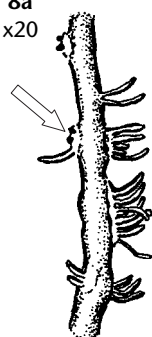
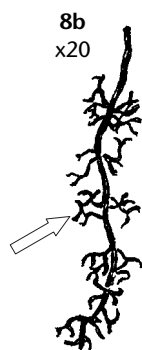
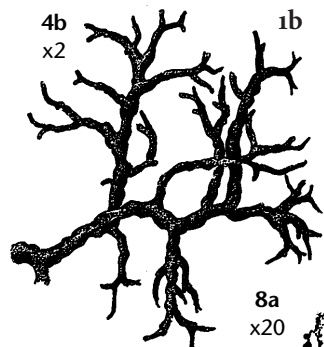
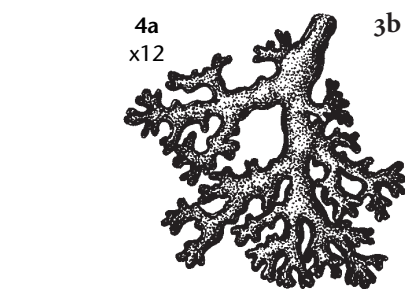
Notes: *Bryoria* is a boreal to cool-temperate genus consisting of approximately 45 species worldwide. Twenty-four of these occur in North America, and 20 in British Columbia. This is a difficult genus in which positive identification often requires detailed chemical testing using spot tests or thin-layer chromatography.

Spot tests of the cortex and medulla are most successfully performed using filter paper, as follows: (1) tear off short lengths of 3-6 strands of thallus; (2) place these under a dissecting microscope on small scraps of white (filter) paper; (3) carefully apply a drop of reagent (i.e., K, C, or PD) using a capillary pipette; (4) examine for yellow, orange, or red pigments diffusing outward from the lichen onto the paper (in some cases the reaction may be ephemeral!); (5) carefully discard both the lichen filaments and the used filter paper. Spot tests of the soralia can be performed without use of filter paper. In *Bryoria*, PD reactions give optimum results when performed using Steiner's Solution; see page 21. In *B. tenuis* and a few other species, positive PD reactions tend to be localized; reliable assessment may require that several branches be tested.

KEY TO *BRYORIA* AND SIMILAR LICHENS

- 1a Thallus firmly attached to rock; branches often less than 10 mm in length, brown to black; medulla KC-, PD- 2
- 2a Branches very fine, to less than 0.1 (-0.14) mm wide; photobiont in chains or clusters, variously coloured (check under LM); sheltered sites, especially in humid localities; generally inconspicuous. various genera (see key under *Cystocoleus*)
- 2b Branches fine to coarse, to more than 0.1 mm wide; photobiont 1-celled, bright green (check under LM); exposed sites; conspicuous (Note: species with an obvious white medulla key here) 3
- 3a Branches attached only at base; branching rather sparse, coarse, not at all intricate; apothecia, if present, borne at branch tips; alpine . . .
..... *Cornicularia normoerica*





3b Branches often attached at more than one point (check tips); branching copious, generally fine, often rather intricate; apothecia, if present, borne laterally; distribution various. 4

4a Branches becoming flattened in cross-section, uneven; internodes short, 0.2–0.5 (–1.0) mm; thallus becoming closely appressed to nearly crustose or foliose toward the thallus centre; alpine *Pseudephebe minuscula*

4b Branches generally round in cross-section, even; internodes longer, (0.6–) 1–3 (–5) mm; thallus becoming bushy, prostrate, or erect toward thallus centre; alpine to lowland *Pseudephebe pubescens*

1b Thallus over bark or wood, or at least not firmly attached to rock; branches usually exceeding 10 mm in length, variously coloured (including brown to black); medulla KC+ or KC–, PD+ or PD– 5

5a Soralia present (check carefully!) 6

6a Soralia distinctly yellow 40

6b Soralia whitish, greenish, or in part blackish, not at all yellow 7

7a Isidia-like spinules present, these associated or not with soralia. 8

8a Spinules distinctly associated with soralia(←), not at all contorted, unbranched or sparsely branched; thallus tufted, generally pale; main branches (not base) generally more than 0.3 mm wide [*Bryoria furcellata*]

8b Spinules not at all associated with soralia, at maturity contorted and richly branched(←); thallus pendent, generally dark; main branches generally less than 0.2 mm wide. *Bryoria lanestris*

7b Isidia-like spinules absent. 9

9a Soralia K+ bright yellow; thallus tufted; treeline; rare (Note: specimens causing a pinkish stain on the herbarium packet key here) *Bryoria nadvornikiana*

9b Soralia K–; thallus tufted to pendent; distribution various; frequent to common 10

10a Soralia typically greenish and black-flecked(←), PD–; east of coast ranges. *Bryoria simplicior*

10b Soralia typically whitish or brownish, PD+ yellow, orange, or red; distribution various 11

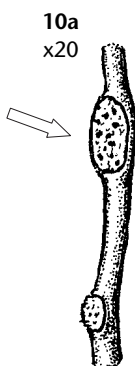
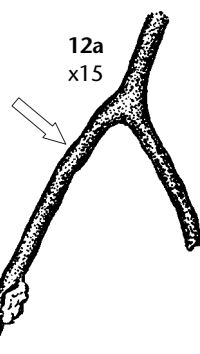
11a Main branches (not base) generally less than 0.2 mm wide; thallus dark brown to dark olivaceous or black (rarely pale) 12

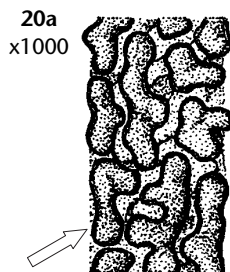
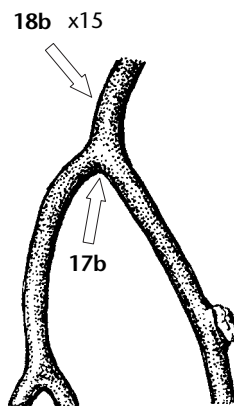
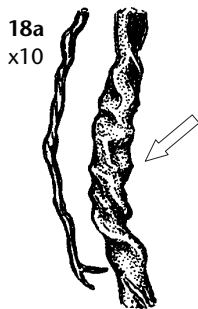
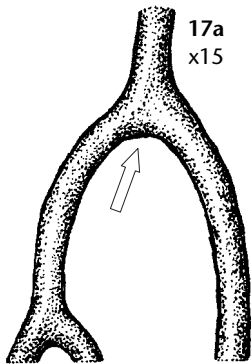
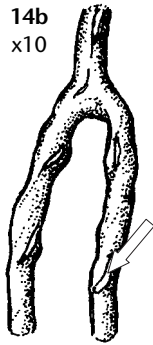
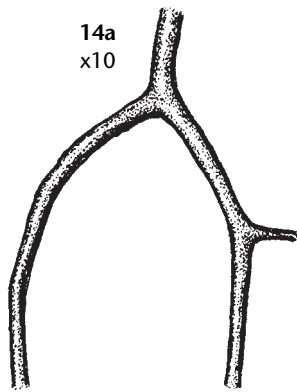
12a Branches even to distinctly uneven in diameter(←) (check terminal branches), also distinctly brittle, tending to fragment in herbarium packets; pseudocyphellae essentially absent; widespread, mostly east of coast ranges. *Bryoria lanestris*

12b Branches even in diameter, not distinctly brittle; pseudocyphellae sparse to abundant; humid regions, westward to western slope of coast ranges

. . . . *Bryoria* cfr. *lanestris* (sorediate, olivaceous form)

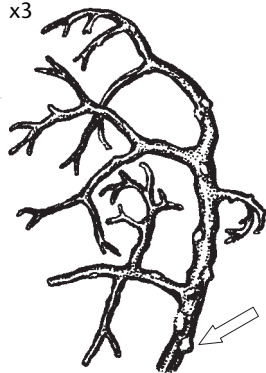
11b Main branches (not base) generally more than 0.2 mm wide; thallus reddish brown to olivaceous, but rarely darkening to blackish 13





- 13a Thallus reddish brown; pseudocyphellae present, abundant or sparse, generally conspicuous; hypermaritime (except rarely present also in old-growth forest in humid intermontane regions at lower elevations) 14
- 14a Branches more or less even in diameter throughout; pseudocyphellae generally sparse; thallus usually dark *Bryoria trichodes* ssp. *americana* (rare sorediate form)
- 14b Branches distinctly uneven in diameter; pseudocyphellae abundant(←), generally conspicuous; thallus often pale *Bryoria trichodes* ssp. *trichodes* (rare sorediate form)
- 13b Thallus pale brown to dark olivaceous brown, but never reddish brown; pseudocyphellae absent or at most sparse, inconspicuous; distribution various 15
- 15a Cortex PD+ intense red (fumarprotocetraric acid in high concentration) 16
- 16a Thallus pale grey throughout, except occasionally pale brownish toward branch tips; hypermaritime *Bryoria subcana*
- 16b Thallus brownish throughout, except usually pale in basal portions; maritime *Bryoria fuscescens* (see 18b)
- 15b Cortex PD- (Note: specimens collected in inland regions key here) 17
- 17a Branches even in diameter throughout, shiny, olivaceous, distinctly wiry; angles between main branches U-shaped(←) *Bryoria glabra*
- 17b Branches even or uneven in diameter, shiny to dull, not wiry; angles between main branches V-shaped(←) 18
- 18a Thallus distinctly shiny, more or less uniformly coloured throughout; main branches distinctly irregular in cross-section, contorted(←); exposed sites at or near treeline *Bryoria chalybeiformis*
- 18b Thallus dull to occasionally somewhat shiny, generally paler at base; main branches even to rarely somewhat contorted; widespread *Bryoria fuscescens*
- 5b Soralia absent 19
- 19a Over ground in exposed sites; medulla KC+ or KC- 20
- 20a Cortex reddish brown, dull, brittle, composed of "knobby" cells, these jigsaw-puzzle-like in surface view(←) (check under LM); main branches in part distinctly flattened; at treeline *Nodobryoria subdivergens*

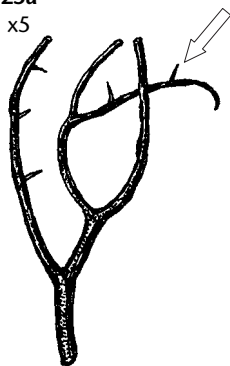
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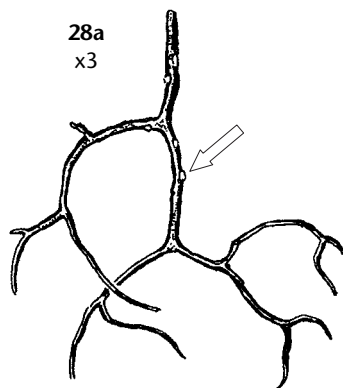
23a
x10



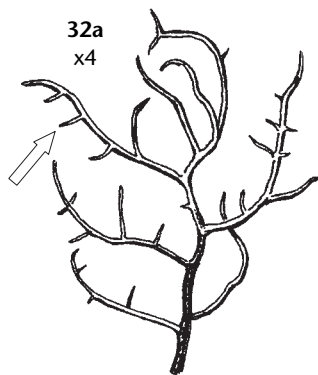
25a
x5



28a
x3



- 20b Cortex variously coloured (including reddish brown), dull or shiny, brittle or pliant, composed of straight, elongate cells (check under LM); main branches round or occasionally flattened in cross-section; distribution various. 21
- 21a Medulla KC+ red; at treeline or above. 22
- 22a Thallus dark reddish brown, generally shiny; pseudocyphellae mostly dotlike/punctiform(←); cortex K-, KC-; medulla PD-; alpine *Bryocaulon divergens*
- 22b Thallus some shade of grey, white, yellowish grey, or black, generally dull; pseudocyphellae irregular or elongate; cortex K+ yellow, KC+ red (check pale areas); medulla PD+ yellowish to orange or red; alpine or subalpine 23
- 23a Thallus pale at base, at least in part; main branches typically bearing distinctly raised white pseudocyphellae; branch tips mostly reflexed; widespread; common *Alectoria nigricans*
- 23b Thallus blackened at base; main branches generally not bearing distinctly raised white pseudocyphellae; branch tips mostly not reflexed; coastal; apparently rare *Bryoria nadvornikiana* (nonsorediate form)
- 21b Medulla KC-; distribution various 24
- 24a Hypermaritime; lowland to alpine. 27
- 24b East of coast ranges; alpine. 25
- 25a Thallus erect or occasionally prostrate; branches very dark brown; short, spine-like lateral branches (= spinules) present(←), often abundant; basal portions generally round in cross-section; pseudocyphellae present or occasionally absent; medulla PD+ yellow, orange, or red (at least in part); mostly north of 58°N. *Bryoria nitidula*
- 25b Thallus prostrate; branches olivaceous black; spinules absent or at most sparse; basal portions irregular in cross-section; pseudocyphellae absent; medulla PD- throughout; widespread *Bryoria chalybeiformis* (see 18a)
- 19b Over trees or shrubs; medulla KC- (except KC+ red in *Bryocaulon pseudosatoanum*) 26
- 26a Hypermaritime. 27
- 27a Cortex K+ distinctly yellow and/or KC+ red or pink (the reactions may fade quickly: use filter paper for best results); thallus pendent (Note: specimens containing alectorialic acid key here, regardless of the KC reaction; such specimens often cause herbarium packets to turn pink with age) 44
- 27b Cortex K-, KC-; thallus tufted to pendent 28
- 28a Medulla distinctly C+ red, KC+ red; cortex reddish brown; pseudocyphellae abundant, generally dotlike/punctiform (←), conspicuous *Bryocaulon pseudosatoanum*
- 28b Medulla C-, KC-; cortex variously coloured; pseudocyphellae absent to abundant, rarely conspicuous (and then more or less elongate). 29



- 29a** Terminal branches more or less “dimpled”/foveolate or flattened in cross-section, or both; soredia absent; apothecia often present; apothecial disk blackish. *Kaernefeltia californica*
[see Part 1, under *Cetraria californica*]

- 29b** Terminal branches nonfoveolate, round in cross-section; soredia present or absent; apothecia very rare; apothecial disk brownish 30

- 30a** Thallus distinctly tufted; medulla at least in part PD+ yellow, orange, or red 31

- 31a** Main branches black, bearing numerous third-order side branches, these short, spine-like, greyish to pale brown or olivaceous brown. 32

- 32a** Thallus forming dense tufts; third-order branches copious(←) and short to long, but generally not flexuous. *Bryoria bicolor*

- 32b** Thallus not forming dense tufts; third-order branches sparse and long-flexuous. *Bryoria tenuis*

- 31b** Main branches and spine-like third-order side branches more or less uniformly reddish brown to dark brown or blackened at base, or else appearing variegated. *Bryoria cervinula*

- 30b** Thallus pendent; medulla PD+ yellow, orange, or red, or PD- (check terminal branches) 33

- 33a** Branching distinctly uneven/anisotomic, consisting predominantly of long primary and especially secondary branches, the latter bearing sparse to numerous short, perpendicular, spine-like side branches; thallus therefore appearing “spiny”; medulla PD+ yellow, orange, or red 34

- 34a** Primary branches to more than 0.3 mm wide at base; side branches copious, mostly short and spine-like(←); thallus pale to dark brown, often more or less mottled. *Bryoria cervinula*

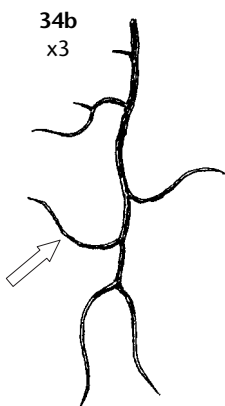
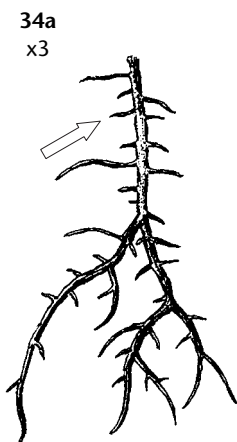
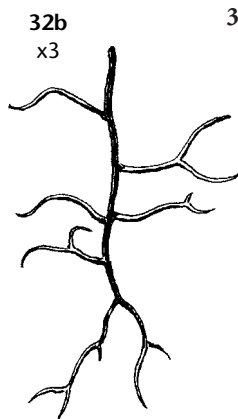
- 34b** Primary branches to less than 0.25 mm wide at base; side branches sparse, often long and flexuous(←); thallus olivaceous, more or less uniformly coloured throughout. *Bryoria carlottae*

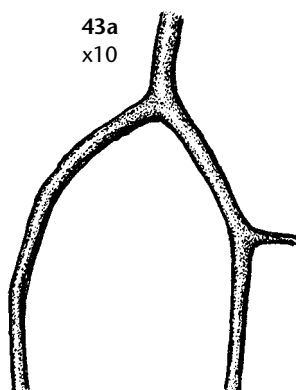
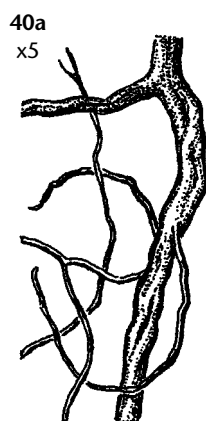
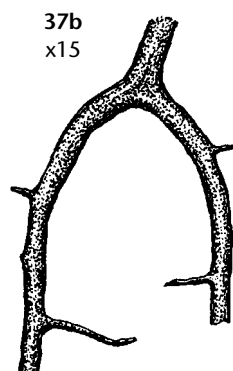
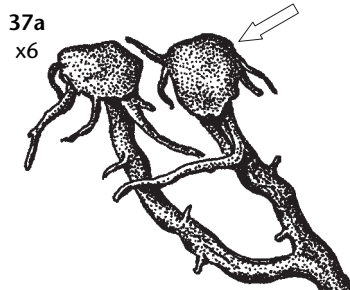
- 33b** Branching even/isotomic to uneven/anisotomic, but never as above; thallus not at all spiny; medulla PD- (Note: specimens with branches of uneven diameter key here). 35

- 35a** Branches of even diameter throughout; pseudocyphellae generally sparse and narrowly lens-shaped; thallus usually dark . . .

- *Bryoria trichodes* ssp. *americana* (see 14a)

- 35b** Branches very uneven in diameter; pseudocyphellae generally abundant, often ellipsoid; thallus often pale *Bryoria trichodes* ssp. *trichodes* (see 14b)





- 26b Distribution various, but not collected from hypermaritime localities 36
- 36a Thallus reddish brown, brittle, generally dull; cortex composed of “knobby” cells, these jigsaw-puzzle-like in surface view (check under LM); short thornlike side branches present. 37
- 37a Thallus tufted, to 2–3 cm long; apothecia generally present(←), located near the branch tips; inland *Nodobryoria abbreviata*
- 37b Thallus tufted to more often pendent, to 4–20 cm long; apothecia rare, located along the branches; widespread in southern regions *Nodobryoria oregana*
- 36b Thallus variously coloured: if reddish brown, then shiny, generally pliant; cortex composed of long rectangular cells, these regularly arranged in surface view (check under LM); short thornlike side branches present or more often absent (Note: specimens bearing yellow pseudocyphellae key here). 38
- 38a Main branches much broader than secondary branches, the former generally to more than 0.4 mm wide, flattened or irregular in cross-section, or both; cortex and medulla PD- (i.e., producing no coloration on filter paper) 39
- 39a Thallus olivaceous brown to olive-black, shiny, to 4–10 (–12) cm long; main branches often bearing spine-like secondary branches; generally near treeline. . . . *Bryoria chalybeiformis* (see 18a)
- 39b Thallus yellowish brown to reddish brown or blackish brown, dull or shiny, to 10–30 (–100!) cm long; main branches not spinulose; present at all forested elevations 40
- 40a Pseudocyphellae absent or white, or at least not distinctly yellow; cortex generally shiny. *Bryoria fremontii*
- 40b Pseudocyphellae present, distinctly yellow; cortex generally dull *Bryoria tortuosa*
- 38b Main branches not much broader than secondary branches, to less than 0.4 mm wide, round or irregular in cross-section; cortex and/or medulla PD+ red, PD+ yellow, or rarely PD- (use filter paper for cortex reactions) (Note: specimens with a K+ yellow cortex key here) 41
- 41a Thallus dark reddish brown to occasionally dark olivaceous brown or blackish; main branches generally round in cross-section; cortex K-, KC-, and PD+ yellow, orange, or red, or PD- 42
- 42a Thallus generally olivaceous to blackish, distinctly brittle, tending to fragment in herbarium packets; pseudocyphellae essentially absent; mostly east of coast ranges *Bryoria lanestris* (nonsorediate form)
- 42b Thallus olivaceous to more often dark reddish brown, not distinctly brittle; pseudocyphellae sparse to abundant; mostly west of coast ranges 43
- 43a Branches of even diameter throughout; pseudocyphellae generally sparse, more or less lens-shaped; thallus usually dark *Bryoria trichodes* ssp. *americana*

43b
x10



- 43b Branches very uneven in diameter; pseudocyphellae generally abundant, often ellipsoid; thallus often pale *Bryoria trichodes* ssp. *trichodes*
- 41b Thallus pale or dark brown, but not reddish brown; main branches round or often in part irregular in cross-section; cortex K+ distinctly yellow or KC+ pink or red, or PD+ yellow 44
- 44a Cortex K+ persistently strong yellow; occurring mostly at lower to middle forested elevations, generally in sheltered, humid forests, often near water or wetlands *Bryoria capillaris*
- 44b Cortex not K+ persistently strong yellow (either K+ pale yellow, K+ strong yellow changing to dingy orangish, or K-); distribution various 45
- 45a Cortex K+ pale yellow becoming dingy orangish; norstictic acid present; widespread, but most common in the intermontane at upper forested elevations *Bryoria pseudofuscescens*
- 45b Cortex K- (or rarely K+ persistently pale yellow), norstictic acid absent; distribution various 46
- 46a Cortex KC-; psoromic acid present; branches generally uneven, dull; inland *Bryoria implexa* s. str.
- 46b Cortex KC+ pink (flash) or apparently KC-; psoromic acid absent; branches even or uneven, shiny or dull; mostly coastal, but also present in humid intermontane regions 47
- 47a Thallus friable, readily fragmenting in herbarium packet; cortex very pale brown, PD-; alectorialic acid absent; gyrophoric acid present; coastal and humid intermontane regions *Bryoria friabilis*
- 47b Thallus not readily fragmenting in herbarium packet; cortex olive brown, PD+ yellow (or apparently PD-); alectorialic acid present; gyrophoric acid present or absent; coastal (Note: specimens causing their herbarium packet to turn pink with age key here) *Bryoria pikei* (See also *B. capillaris*)

Bryoria bicolor (Ehrh.) Brodo & D. Hawksw.

(Syn. *Alectoria bicolor* (Ehrh.) Nyl.)

Electric horsehair

Habitat/Range: Frequent over rock and heath, also conifers, in exposed hypermaritime localities at all elevations; incompletely circumpolar, N to sAK, S to WA, OR.

Reactions: Inner cortex and medulla PD+ orange or red (at least at branch tips).

Contents: Fumarprotocetraric acid.

Variability: High.

Notes: The rather compact, often decumbent habit and abundant perpendicular third-order branches are diagnostic. See the notes under *B. tenuis*.

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

(Syn. *Alectoria capillaris* (Ach.) Crombie)

Grey horsehair (dun horsehair)

Habitat/Range: Common over trees in open to more often sheltered or shaded forests at lower to middle elevations throughout, except rare in the dry intermontane, and in boreal regions. Especially frequent at forest edges near standing water; probably incompletely circumpolar, N to sAK, S to WA, ID, MT, OR, CA, CO; AB.

Reactions: Cortex and medulla K+ bright yellow (persistent) or rarely K+ pale yellow, KC+ red, C+ pink or C-, PD+ yellow.

Contents: Barbatolic acid (and alectorialic acid), or rarely alectorialic acid alone.

Variability: Medium.

Notes: *Bryoria capillaris* may rarely produce barbatolic acid at low or negligible concentration; such specimens lack the characteristic K+ bright yellow reaction and hence can be confused with *B. pikei*; see the notes under that species.

Bryoria carlottae Brodo & D. Hawksw.

Map 8

Languid horsehair

Habitat/Range: Rare over conifers in exposed hypermaritime sites at lower elevations, mostly north of 54°N; western N Am, N to sAK, S to BC.

Reactions: Inner cortex and medulla PD+ orange or red.

Contents: Fumarprotocetraric acid.

Variability: Low.

Notes: Distinctive characters include the uniformly olivaceous main branches, and the long, flexuous side branches. *Bryoria cervinula* can be similar, but tends to be more mottled, and has shorter, more spine-like side branches. The holotype specimen is from the vicinity of Port Clements, on the Queen Charlotte Islands.

Bryoria cervinula Brodo & D. Hawksw.

Map 9

(Syn. *Alectoria cervinula* Mot.)

Spiny horsehair

Habitat/Range: Rare over soil, duff, and conifers in open hypermaritime sites at middle to upper forested and alpine elevations; western N Am, N to sAK, AK, S to BC.

Reactions: Inner cortex and medulla K- or K+ brown, PD+ orange or red.

Contents: Fumarprotocetraric acid.

Variability: Low.

Notes: See notes under *B. carlottae*.

Bryoria chalybeiformis (L.) Brodo & D. Hawksw.

(Syn. *Alectoria chalybeiformis* (L.) Gray)

Resplendent horsehair

Habitat/Range: Frequent over base-rich or acid rocks or soil, also over coniferous trees in exposed intermontane localities at all elevations, also rare in maritime regions; circumpolar, N to sAK, AK, YU, wNT, S to WA, MT, OR, CA, UT, CO, AZ, NM; AB.

Reactions: Medulla PD- (except very rarely in part PD+ orange or red); soralia PD+ orange or red.

Contents: Fumarprotocetraric acid.

Variability: High.

Notes: See notes under *B. fuscescens*.

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

(Syn. *Alectoria fremontii* Tuck.; *Alectoria corneliae* Gyelnik; *Alectoria tenerrima* Mot.)

Edible horsehair (tree hair lichen; black tree lichen)

Habitat/Range: Common over trees, especially conifers, in open to exposed intermontane forests at all elevations, also infrequent in similar sites in maritime regions in the CDF; western N Am - western Eurasia - eastern Eurasia, N to BC (with outlier in YU), S to WA, ID, MT, OR, WY, CA, CO, NM, MX; AB.

Reactions: All spot tests negative.

Contents: Vulpinic acid (in soralia and apothecia only).

Variability: Medium.

Notes: See comments under *B. tortuosa*.

Bryoria friabilis Brodo & D. Hawksw.
Friable horsehair

Map 10

Habitat/Range: Rare (overlooked?) over conifers in open coastal and humid intermontane (ICH) forests at lower elevations, local distribution poorly known; western N Am - eastern N Am, N to sAK, S to WA, ID, MT, OR, CA.

Reactions: Cortex C+ red or pink, KC+ pink; apothecia KC+ pink (often faint and difficult to observe), PD+ deep yellow.

Contents: Medulla: gyrophoric acid; apothecia: psoromic acid.

Variability: Medium.

Notes: The combination of friable branches and a KC+ cortical reaction are diagnostic.

PD- specimens of *B. pikei* are similar, though in that species the branches are not distinctly brittle, and the cortex tends to be olivaceous, not pale brown, as in *B. friabilis*.

Difficult specimens can be recognized as *B. implexa* s. lat.

[***Bryoria furcellata*** (Fr.) Brodo & D. Hawksw.]

(Syn. *Alectoria nidulifera* Norrlin; *Cornicularia fibrillosa* (Ach.) Halsey)

Burred horsehair

Habitat/Range: Expected over conifers and rock outcrops in sheltered to somewhat exposed sites in the Rocky Mountains; circumpolar, N to AK, YU, S to WA, OR, CA, CO, AZ, NM, MX; AB.

Reactions: Inner cortex and medulla PD+ orange or red; soralia PD+ orange or red.

Contents: Fumarprotocetraric acid.

Variability: High.

Notes: In no other western *Bryoria* do the soralia regularly contain “nests” of isidia-like spinules.

Bryoria fuscescens (Gyelnik) Brodo & D. Hawksw.

(Syn. *Alectoria fuscescens* Gyelnik; *Bryopogon pacificus* Gyelnik)

Pale-footed horsehair (speckled horsehair)

Habitat/Range: Common over trees, especially conifers, in open to shady forests throughout, except rare or possibly absent in hypermaritime regions; also rare over rocks in exposed sites; circumpolar, N to sAK, AK, YU, wNT, S to WA, ID, MT, OR, WY, CA, CO, AZ, NM; AB.

Reactions: Cortex PD+ orange or red, or PD-; medulla PD+ orange or red (at least in part); soralia PD+ orange or red.

Contents: Fumarprotocetraric acid.

Variability: High.

Notes: Exposed forms of *B. fuscescens* are similar to *B. chalybeiformis*. However, the former material has brownish to greyish brown branches and a PD+ medulla, whereas the latter is generally olivaceous brown to black, and almost invariably gives a PD-medullary reaction.

Bryoria glabra (Gyelnik) Brodo & D. Hawksw.

(Syn. *Alectoria glabra* Gyelnik)

Shiny horsehair (wiry horsehair)

Habitat/Range: Common over trees, especially conifers, in open to somewhat sheltered localities at all forested elevations throughout, except absent from boreal regions; western N Am - eastern N Am - western Eurasia (Norway), N to sAK, AK, wNT, S to WA, ID, MT, OR, WY, CA, NM; AB.

Reactions: Soralia PD+ orange or red.

Contents: Fumarprotocetraric acid.

Variability: Medium.

Notes: In inland regions, *B. glabra* often tends to intergrade with *B. fuscescens*. Difficult specimens can be referred to as *B. fuscescens* s. lat.

Bryoria implexa (Hoffm.) Brodo & D. Hawksw.

Map 11

(Syn. *Alectoria implexa* (Hoffm.) Nyl.)

Boreal horsehair

Habitat/Range: Rare (overlooked?) over conifers in exposed to sheltered inland regions at all forested elevations, especially in boreal regions, local distribution poorly known; possibly circumpolar, N to AK, S to WA, ID, MT, CA; AB.

Reactions: Outer cortex PD+ yellow or PD-; medulla PD+ yellow or PD-.

Contents: Psoromic acid.

Variability: Medium.

Notes: See the notes under *B. pseudofuscescens*.

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

(Syn. *Alectoria lanestris* (Ach.) Gyelnik; *Bryopogon negativus* Gyelnik)

Brittle horsehair

Habitat/Range: Common over conifers in open to somewhat sheltered inland regions at all forested elevations, except rare in the dry intermontane, also infrequent in coast ranges; circumpolar, N to sAK, AK, YU, wNT, S to WA, ID, MT, OR, WY, CO, AZ, NM; AB.

Reactions: Soralia PD+ orange or red.

Contents: Fumarprotocetraric acid.

Variability: High.

Notes: As currently circumscribed, *B. lanestris* is a highly variable species. The local material is unusual in having rather even branches. This is especially true of specimens from the coast mountains, which can be characterized as smooth, olivaceous, and shiny. In semi-arid regions, by contrast, the branches can be highly contorted and much broader than average. In some populations the apical portions of the branches bear minute, contorted, black, densely branching spinules. Further work is needed.

Bryoria nadvornikiana (Gyelnik) Brodo & D. Hawksw.

Map 12

(Syn. *Alectoria nadvornikiana* Gyelnik; *Alectoria altaica* (Gyelnik) Räsänen)

Witch's horsehair (spiny grey horsehair)

Habitat/Range: Rare over conifers, perhaps also rock outcrops, in exposed localities at or near treeline, local distribution poorly known; N Am - western Eurasia - eastern Eurasia, N to sAK, wNT, S to WA, MT, OR; AB.

Reactions: Cortex, medulla, and soralia K+ bright yellow, KC+ red, C+ pink or C-, PD+ deep orange to reddish.

Contents: Barbatolic, alectorialic, and fumarprotocetraric acids, and chloroatranorin (and atranorin).

Variability: High.

Notes: In British Columbia, *B. nadvornikiana* is currently known only from near treeline on Vancouver Island, where it appears to tolerate burial within the winter snowpack to an extent unusual for this genus.

Bryoria nitidula (Th. Fr.) Brodo & D. Hawksw.

Map 13

(Syn. *Alectoria irvingii* Llano; *Alectoria nitidula* (Th. Fr.) Vainio)

Tundra horsehair

Habitat/Range: Infrequent over rocky acidic outcrops in exposed sites at treeline and above, mostly north of 58°N; circumpolar, N to sAK, AK, YU, wNT, S to BC, WA, NM; AB.

Reactions: Inner cortex and medulla PD+ orange or red (at least in part).

Contents: Fumarprotocetraric acid.

Variability: High.

Notes: *Bryoria nitidula* is similar in appearance to *B. bicolor*, but is restricted to alpine elevations, whereas *B. bicolor* occurs only at lower elevations in coastal regions.

Bryoria pikei Brodo & D. Hawksw.

Map 14

Streaked horsehair

Habitat/Range: Infrequent over conifers in open coastal localities at lower to middle forested elevations; western N Am - eastern N Am, N to BC, S to WA, OR.

Reactions: Cortex K+ faint yellow or K-, KC+ pink, C+ pink, PD+ yellow.

Contents: Alectorialic acid (and gyrophoric or barbatolic acids).

Variability: Medium.

Notes: In the absence of detailed chemical testing with thin-layer chromatography, *B. pikei* might be mistaken for barbatolic-deficient strains of *B. capillaris* in which the cortex gives a K+ pale yellow or K- reaction. In general, however, *B. pikei* has dark, shiny, olivaceous branches that bear conspicuous white pseudocyphellae; in *B. capillaris*, by contrast, the branches are pale, dull, greyish, and rather inconspicuously pseudocyphellate. Intermediate specimens can be referred to as *B. implexa* s. lat. See also the notes under *B. friabilis*.

Bryoria pseudofuscescens (Gyelnik) Brodo & D. Hawksw.
(Syn. *Alectoria pseudofuscescens* Gyelnik)
Mountain horsehair

Habitat/Range: Common over conifers in exposed to sheltered sites, most abundant in intermontane regions at upper forested elevations, but also present in maritime regions; apparently circumpolar, N to sAK, AK, S to WA, ID, MT, OR, (WY), CA; AB.
Reactions: Cortex and medulla K+ yellow becoming red or faintly yellow (rarely K-), PD+ yellow.

Contents: Norstictic acid (and connorstictic acid).
Variability: Medium.

Notes: *Bryoria pseudofuscescens* is very close in appearance to *B. implexa*, with psoromic acid, and possibly represents a chemical form of that species. In British Columbia, however, *B. implexa* can usually be distinguished by its generally pale brownish branches; it also tends to be restricted to boreal regions. Material yielding a K- reaction, however, must often be subjected to thin-layer chromatography for reliable identification. Difficult specimens can be referred to as *B. implexa* s. lat.

Bryoria simplicior (Vainio) Brodo & D. Hawksw.
(Syn. *Alectoria simplicior* (Vainio) Lynge)
Spangled horsehair (simple horsehair)

Habitat/Range: Frequent over conifers in open inland forests at all elevations, except rare in humid localities; also rare over the ground in exposed sites; circumpolar, N to AK, YU, wNT, S to WA, ID, MT, OR, CA, CO, AZ; AB.
Reactions: All spot tests negative.

Contents: No lichen substances present.
Variability: Medium.

Notes: Some forms of *B. simplicior* are readily confused with *B. fuscescens*, though in that species the soralia give a PD+ orange or red reaction.

Bryoria subcana (Stizenb.) Brodo & D. Hawksw.
(Syn. *Alectoria subcana* (Stizenb.) Gyelnik)
Seaside horsehair

Map 15

Habitat/Range: Rare over conifers in open hypermaritime localities at lower elevations; western N Am - western Eurasia, N to sAK, S to WA, OR, CA.
Reactions: Outer cortex, medulla, and soralia PD+ rapidly bright red.
Contents: Fumarprotocetraric acid (at high concentration).
Variability: Medium.

Notes: The hypermaritime distribution and rapid PD+ orange or red thallus reaction are diagnostic for the species.

Bryoria tenuis (E. Dahl) Brodo & D. Hawksw.

Map 16

(Syn. *Alectoria tenuis* E. Dahl)

Pied horsehair

Habitat/Range: Infrequent over mossy conifers and rocks in exposed hypermaritime localities at treeline and above; N Am - western Eurasia, N to sAK, AK, S to WA, OR.

Reactions: Inner cortex and medulla PD+ orange or red (at least in part).

Contents: Fumarprotocetraric acid.

Variability: Medium.

Notes: *Bryoria tenuis* is similar in appearance to *B. bicolor*, but is usually more erect and less compact, and bears fewer and less spine-like third-order side branches.

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

(Syn. *Alectoria tortuosa* G. Merr.)

Inedible horsehair (yellow-twist horsehair lichen)

Habitat/Range: Common over conifers and deciduous trees in open to exposed maritime (CDF) and especially intermontane forests at all elevations, mostly south of 53°N; western N Am - western Eurasia, N to BC, S to WA, ID, OR, CA.

Reactions: All spot tests negative (except PD+ yellowish on filter paper).

Contents: Vulpinic acid.

Variability: Medium.

Notes: *Bryoria tortuosa* freely intergrades with *B. fremontii*, and may be regarded as a chemical strain of that species. Intermediate specimens can be referred to as *B. fremontii* s. lat. The holotype specimen is labelled as “near Westminster,” in British Columbia.

Bryoria trichodes (Michaux) Brodo & D. Hawksw. ssp. ***americana*** (Mot.) Brodo & D. Hawksw.

(Syn. *Alectoria ambigua* Mot.; *Alectoria americana* Mot.)

Elegant horsehair

Habitat/Range: Frequent over trees, especially conifers, in open coastal localities at lower elevations; also rare in the humid intermontane (ICH) in old-growth forests; western N Am - eastern N Am, N to sAK, AK, S to WA, OR, CA.

Reactions: Inner cortex or medulla PD+ orange or red (at least in part) or rarely PD-.

Contents: Fumarprotocetraric acid.

Variability: High.

Notes: Subspecies *americana* intergrades freely with ssp. *trichodes*. Difficult specimens can be referred to as *B. trichodes* s. lat.

Bryoria trichodes (Michaux) Brodo & D. Hawksw. ssp. ***trichodes***
(Syn. *Alectoria canadensis* Mot.)

Map 17

Inelegant horsehair

Habitat/Range: Infrequent over conifers in open hypermaritime sites at lower elevations;
also rare over exposed rock; western N Am - eastern N Am - eastern Eurasia, N to
sAK, S to WA, (OR); AB.

Reactions: Inner cortex and medulla PD+ orange or red (at least in part).

Contents: Fumarprotocetraric acid (and chloroatranorin).

Variability: High.

Notes: See notes under ssp. *americana*.

[Local material only] **Medium-sized** stratified fruticose (**shrub**) lichens, consisting of loose tufts of decumbent to semi-erect branches, these **whitish** or greenish, round in cross-section to in part **flattened**, slender, to 15–35 (–50) mm long and 1–2 (–3) mm wide, dull, smooth, corticate, pliant, **solid**, moderately branched to richly branched (with side branches); branching irregular, often terminating in fruiting bodies (see below). Soredia, isidia, and pseudocyphellae absent. Medulla white. Attached to substrate by basal holdfasts. Photobiont green, chlorococcoid.

Ascomycete an apothecium, **borne at branch tips, flattened, discus-shaped**, apothecial surface **powdery/mazaediate, black, oriented towards the lower surface**. Spores 1-celled, globose to oval,

colourless to greyish (but under LM appearing almost blackish owing to a dark incrustation), 6–9 µm across, arising within short-lived asci. Pycnidia located at branch tips, and over lower surface near branch tips.

Over conifers.

References: Lye (1969); Tibell (1975, 1984); Wedin (1993a, 1993b).

Common Name: Refers to the flattened branches.

Notes: *Bunodophoron* is widely distributed at temperate latitudes in humid, rather cool regions, as well as in high-elevation cloud forests in the subtropics and tropics. Approximately 20 species are recognized worldwide, though only one occurs in North America.

***Bunodophoron melanocarpum* (Sw.) Wedin**

(Syn. *Sphaerophorus compressus* Ach.; *Sphaerophorus melanocarpus* (Sw.) DC.)
Northern fancoral

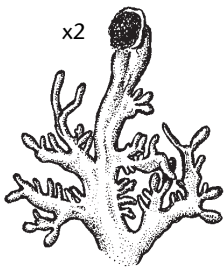
Habitat/Range: Frequent over conifers in sheltered hypermaritime old-growth forests at lower elevations, also rare in humid maritime regions; incompletely circumpolar, N to sAK, S to BC.

Reactions: Medulla K+ slowly dingy orange or K–, UV+ blue (ours).

Contents: Sphaerophorin (and constictic and stictic acids).

Variability: Medium.

Notes: *Bunodophoron melanocarpum* is widespread in both hemispheres, though the material currently assigned to it may include more than one species (Wedin 1995); it is uncertain whether the local material belongs to *B. melanocarpum* s. str.



Minute “fruticose” (club) microlichens, consisting of a **basal crust** and **stalked apothecia**. Basal crust crustose, granulose, or immersed in substrate, more or less stratified, corticate or not. Upper surface whitish, pale greyish, pale greenish, or visible from above as a whitish or coloured stain. Photobiont green, chlorococcoid: *Trebouxia*.

Apothecial stalks nonlichenized, brownish to black or occasionally pale (but surface colour occasionally obscured above by a whitish, yellowish, or rust-coloured pruina), **hairlike, to 0.5–1.5 (–2.0) mm long** (including apothecial heads) and 100–200 µm wide (excluding heads), smooth, brittle, unbranched. **Apothecial heads/capitula** borne at stalk tips, **top-shaped/turbinate to hemispherical**, consisting of an upwardly expanding excipulum (occasionally pruinose or poorly developed, or both), and a **powdery black spore mass/mazaedium**.

Spores **2-celled**, ellipsoid to peanut-shell-shaped, to 8–12 (–15) µm long, brown under LM, generally ornamented or spirally striate at maturity, arising from short-lived asci, later extruded.

Over dry bark or wood, also rarely over rock.

References: Tibell (1975, 1984, 1994);

Purvis et al. (1992: Purvis); E.B.

Peterson, Oregon State University, pers. comm., 1998.

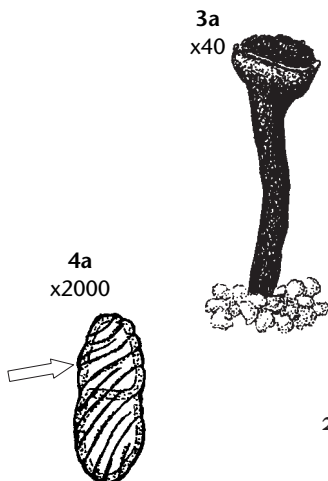
Common Name: Refers to the stalked, stubble-like apothecia.

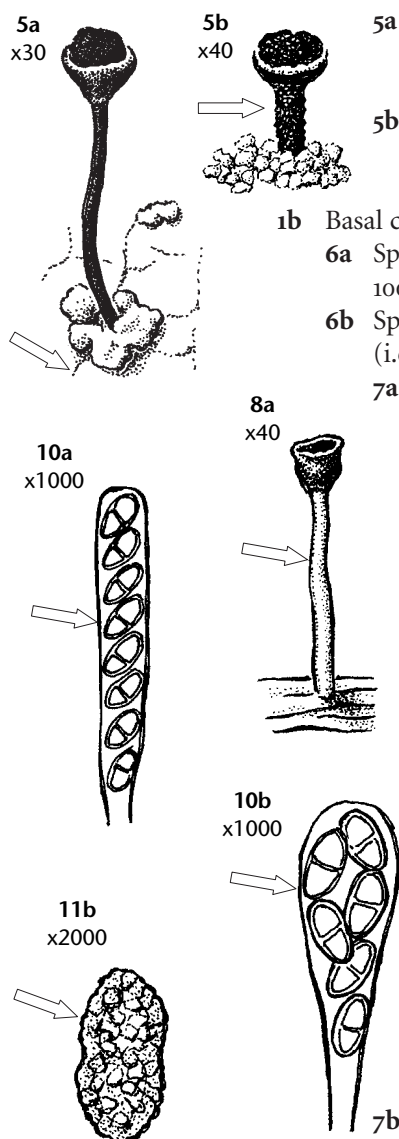
Notes: *Calicium* is widespread at boreal to tropical latitudes, and consists of approximately 19 species worldwide.

Twelve species have been reported from North America, and nine from British Columbia. Though usually classified as a crustose genus, *Calicium* is included here owing to its stalked apothecia.

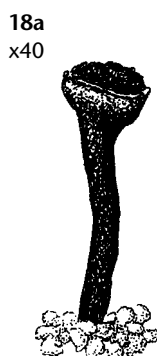
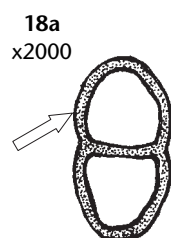
KEY TO *CALICIUM*

- 1a Basal crust plainly visible over substrate: crustose or powdery/leprose 2
- 2a Basal crust greyish or occasionally greyish green 3
- 3a Stalks black or more often reddish brown (check upper portion), I+ blue (check under LM); spore mass/mazaedium black or faintly white-pruinose; spores minutely warted, to 5.5–7 µm wide; hypermaritime *Calicium lenticulare*
- 3b Stalks black, I–; mazaedium black or faintly yellow-pruinose; spores minutely warted or spirally striate, to 4–5 µm wide; apparently absent from hypermaritime regions 4
- 4a Spores distinctly spirally striate(←); spore mass/mazaedium often bearing a faint yellow pruina (check young apothecia); maritime and intermontane *Calicium adspersum*
- 4b Spores at most minutely warted; spore mass lacking any trace of yellow; apparently restricted to intermontane regions *Calicium parvum*
- 2b Basal crust yellowish green to medium green (Note: specimens collected over rock key here, regardless of thallus colour) 5





- 5a Total height of apothecia 9–16 times greater than width of stalk (estimate stalk width in central portions); basal crust corticate-granular(←); over bark or wood of conifers; widespread; common. *Calicium viride*
- 5b Total height of apothecia 3–5 times greater than width of stalk(←); basal crust mostly powdery/leprose; over rock; restricted to humid intermontane regions; rare *Calicium corynellum*
- 1b Basal crust immersed in substrate: visible, if at all, as a pale stain. 6
- 6a Spores 1- or 2-celled, smooth-walled or at most minutely warted as viewed at 1000x, not at all constricted in mid-portions; spore mass thin . . . *Chaenothecopsis*
- 6b Spores 2-celled, distinctly cracked or striate, often constricted in mid-portions (i.e., peanut-shell-shaped); spore mass thick. 7
- 7a Excipulum black, lacking pruina. 8
- 8a Over bark of deciduous trees and shrubs; stalk often pale(←), I+ dark blue (check under LM); spores spirally striate (check at 1000x) *Calicium adaequatum*
- 8b Never over bark of deciduous trees (but occasionally colonizing wood of deciduous trees); stalk black or dark reddish brown, I-; spores spirally striate or minutely warted 9
- 9a Over wood of conifers and/or deciduous trees and shrubs; spores minutely warted; rare 10
- 10a Spores to 12–16 x 5–7 µm at maturity; asci cylindrical(←); over conifers and deciduous trees and shrubs . . . *Calicium abietinum*
- 10b Spores to 8–11 x 3–5 (–5.5) µm at maturity; asci club-shaped/clavate(←); probably restricted to conifers *Calicium parvum*
- 9b Over bark of conifers; spores minutely warted or spirally striate; frequency status various 11
- 11a Spores spirally striate *Calicium adspersum* (see 4a)
- 11b Spores at most minutely warted(←). 12
- 12a Spores to 12–16 µm long at maturity; asci to 45–50 µm long *Calicium abietinum*
- 12b Spores to 9–13 µm long at maturity; asci to 35–45 µm long *Calicium glaucellum*
- 7b Excipulum another colour, or pruinose (at least in part) 13
- 13a Excipulum white-pruinose (check rims of young apothecia) 14
- 14a Stalks reddish brown (check upper portions), I+ dark blue (under LM); hypermaritime *Calicium lenticulare* (see 3a)
- 14b Stalks black throughout, I-; apparently absent from hypermaritime regions. 15
- 15a Asci club-shaped/clavate, broadest near tip (view under LM at 1000x) (see 10b); spores to 3–5 (–5.5) µm wide; over conifer bark; intermontane; rare *Calicium parvum*
- 15b Asci cylindrical; spores to 5–6 µm wide; generally over conifer wood (rarely over conifer bark); widespread; frequent *Calicium glaucellum*
- 13b Excipulum brownish or yellow-pruinose 16
- 16a Excipulum yellow-pruinose (check rim); height of apothecia (including stalk) 5–8 times greater than width of stalk (Note: estimate width in middle portions of stalk); intermontane *Calicium trabinellum*



- 16b Excipulum rusty brown to dark brown; height of apothecia often more than nine times greater than width of stalk; distribution various. 17
- 17a Excipulum rusty brown; spores spirally striate at maturity, to 8–11 μm long; rare *Calicium salicinum*
- 17b Excipulum medium brown to dark brown; spores minutely and irregularly warted at maturity, to 11–14 μm long; frequent . . . 18
- 18a Spores 5.5–8 μm wide(\leftarrow); stalk I+ dark blue, often (but not always!) expanding gradually upward into excipulum; hypermaritime *Calicium lenticulare* (see 3a)
- 18b Spores 4–5.5 μm wide; stalk I-, often expanding abruptly upward into excipulum; widespread, but not known from hypermaritime regions *Calicium viride* (see 5a)

Calicium abietinum Pers.
Black stubble

Map 18

Habitat/Range: Infrequent (overlooked?) over wood of conifers and deciduous trees in open to sheltered coastal and humid intermontane (ICH) localities at lower elevations, also over bark of redcedar (*Thuja*), local distribution poorly known; circumpolar, N to wNT, S to WA, ID, OR, CA, AZ, MX; AB.

Reactions: All spot tests negative.

Contents: No lichen substances reported.

Variability: Medium.

Notes: Diagnostic characters include the nonpruinose excipulum and the large, minutely warty spores. Weakly pruinose and nonpruinose forms of *C. glaucellum* are similar, and must carefully be distinguished by: (1) the spores, which measure to 12–16 μm long in *C. abietinum* versus to 9–13 μm long in *C. glaucellum*; and (2) the asci, which measure to 45–50 μm long versus 35–42 μm long, respectively. Both species are typically confined to wood, but in humid old forests they can occasionally also colonize the bark of redcedar (*Thuja*).

Calicium adaequatum Nyl.
Shrub stubble

Map 19

Habitat/Range: Rare (probably overlooked) over thin twigs of deciduous trees and shrubs in open to somewhat sheltered coastal and humid intermontane (ICH) localities at lower elevations throughout, except probably absent in hypermaritime and boreal regions, local distribution poorly known; western N Am - western Eurasia, N to sAK, S to WA, MT, OR, CA.

Reactions: Stalk I+ dark blue (check under LM).

Contents: No lichen substances reported.

Variability: Medium.

Notes: No other local *Calicium* has whitish stalks yielding an I+ blue reaction. The occurrence over the twigs of deciduous trees and shrubs is also diagnostic. In Canada, *C. adaequatum* is known to occur only in British Columbia.

Calicium adpersum Pers.
Paleface stubble

Map 20

Habitat/Range: Rare over conifer bark, especially redcedar (*Thuja*), in open to somewhat sheltered maritime and humid intermontane (ICH) forests at lower elevations, local distribution poorly known; incompletely circumpolar, N to BC, S to WA, OR, CA, (AZ), MX.

Reactions: Basal crust K+ dingy yellow, PD+ yellow.

Contents: Norstictic acid. The pruina contains vulpinic acid.

Variability: Medium.

Notes: In Canada, *C. adpersum* is known only from British Columbia. See notes under *C. trabinellum*.

Calicium corynellum (Ach.) Ach.
Rock stubble

Map 21

Habitat/Range: Rare over overhanging acidic outcrops in humid, sheltered intermontane forests at lower elevations, local distribution poorly known; apparently western N Am - western Eurasia, N to BC, S to AZ.

Reactions: All spot tests negative.

Contents: Rhizocarpic acid and possibly usnic acid.

Variability: Medium.

Notes: Diagnostic characters include the short, often almost unstalked apothecia, the powdery basal crust, and especially the occurrence over humid rock overhangs. In Canada, *C. corynellum* has been reported only from British Columbia.

Calicium glaucellum Ach.
White-collar stubble (chippendale stubble)

Habitat/Range: Frequent over wood and bark of conifers in open maritime and humid intermontane localities at all forested elevations; circumpolar, N to BC, S to WA, OR, CA, AZ, MX.

Reactions: All spot tests negative.

Contents: One unknown substance reported.

Variability: Medium.

Notes: Diagnostic characters include the short black stalks, and especially the rim of white pruina on the excipulum. See also the remarks under *C. abietinum*.

***Calicium lenticulare* Ach.**

(Syn. *Calicium subquercinum* Asah.)

Candle-wax stubble

Habitat/Range: Frequent over bark of conifers in sheltered hypermaritime localities at lower to middle forested elevations; circumpolar, N to sAK, S to OR, CA, MX.

Reactions: Stalk and excipulum I+ dark blue (under LM).

Contents: No lichen substances reported.

Variability: Medium.

Notes: *Calicium lenticulare* can be identified by its presence in hypermaritime regions, but especially by its dark brown, “waxen” stalks that yield a strong I+ blue reaction. Some specimens are superficially similar to *C. salicinum* and *C. viride* in which the basal thallus is immersed, but in those species the spores measure 4–5.5 µm wide, versus 6–8 µm wide in *C. lenticulare*.

***Calicium parvum* Tibell**

Map 22

Pygmy stubble

Habitat/Range: Rare (overlooked?) over conifer bark in sheltered, humid intermontane (ICH, ESSF) localities at lower to middle forested elevations, local distribution poorly known; incompletely circumpolar, N to BC, S to CA.

Reactions: Basal crust: K+ dingy yellow, PD+ pale yellow, UV+ blue.

Contents: Diffractaic acid and one unknown substance.

Variability: High.

Notes: *Calicium parvum* is a variable species in which the basal crust can be immersed in the substrate or not, and in which the excipulum, though typically black, occasionally bears a thin whitish pruina along the rim. Diagnostic for the species, however, are the small spore size (8–11 x 3.5–5 µm) and the distinctly club-shaped/clavate asci.

***Calicium salicinum* Pers.**

Map 23

Rusted stubble

Habitat/Range: Rare over bark and wood of conifers in open maritime and intermontane localities at lower to middle forested elevations, local distribution poorly known; incompletely circumpolar, N to wNT, S to WA, ID, OR, MX; AB.

Reactions: All spot tests negative (ours).

Contents: No lichen substances reported (ours).

Variability: Medium.

Notes: The rusty brown excipulum and immersed thallus are diagnostic. See notes under *C. viride*.

Calicium trabinellum Ach.
Yellow-collar stubble

Map 24

Habitat/Range: Rare over wood of conifers in sheltered intermontane forests at lower to middle elevations, local distribution poorly known; circumpolar; N to wNT, S to WY, AZ, MX; AB.

Reactions: All spot tests negative.

Contents: Pruina: vulpinic acid.

Variability: Medium.

Notes: Diagnostic for this species are: (1) the black apothecia that bear a faint yellow pruina on the rims of the excipula; (2) the immersed basal crust; and (3) the irregularly cracked spores. *Calicium glaucellum* has white-pruinose excipular rims, but is otherwise virtually identical. *Calicium adpersum* is also similar, at least in having yellow-pruinose excipula, but in that species the basal crust is greyish and granular and the spores are spirally striate.

Calicium viride Pers.

Frog stubble (green stubble)

Habitat/Range: Frequent over bark and wood of conifers in humid, sheltered forests throughout, except perhaps absent in hypermaritime localities; incompletely circumpolar, N to sAK, YU, wNT, S to WA, ID, MT, OR, WY, CA, AZ; AB.

Reactions: All spot tests negative.

Contents: Epanorin and rhizocarpic acid.

Variability: High.

Notes: The medium-brown excipulum and frequent production of a bright green, granular basal crust are diagnostic. *Calicium salicinum* is similar, but invariably lacks a visible basal crust, and has a distinctly rusty brown excipulum, and spirally striate spores. In *C. viride* the spores can be spirally striate when young, but are irregularly cracked at maturity. In *C. salicinum*, by contrast, the spores are spirally striate only at maturity. See also the notes under *C. lenticulare*.

Minute “fruticose” (club) microlichens, consisting of a **basal crust** and **stalked apothecia**. Basal crust crustose, powdery, granular, squamulose, or immersed in substrate, more or less stratified, corticate or not. Upper surface whitish, pale greyish, pale yellowish, pale greenish, or visible from above as a whitish or coloured stain. Photobiont green or yellowish green: chlorococcoid (*Dictyochloropsis*, *Stichococcus*, *Trebouxia*, *Trentepohlia*).

Apothecial stalks nonlichenized, brownish to black (but surface colour often at least partly obscured by whitish, yellowish, yellowish green, or brownish pruina), generally **black within, hairlike, to 0.5–2 (–2.5) mm long** (including apothecial heads) and 40–80 µm wide (excluding heads), smooth, brittle, unbranched. **Apothecial heads/capitula** borne at stalk tips, **top-shaped/turbinate to hemispherical or globose**, consisting of an upwardly expanding excipulum (often pruinose or poorly developed), and a **powdery brownish or pale greyish spore mass/mazaedium**, this **occasionally obscured by a brightly coloured pruina**. Spores 1-celled to rarely 3- or 4-celled, globose to ellipsoid or cylindrical, brown to nearly colourless/hyaline under LM, ornamented or not at maturity, arising from short-lived asci, later extruded.

Over dry bark or wood, also rarely over soil or rock.

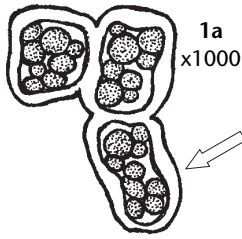
References: Tibell (1975, 1980, 1981, 1984, 1987); Middelborg and Mattson (1987); Purvis et al. (1992: Purvis and James); E.B. Peterson, Oregon State University, pers. comm., 1998; L. Tibell, University of Uppsala, pers. comm., 1999.

Common Name: Refers to the delicately stalked, whiskerlike apothecia.

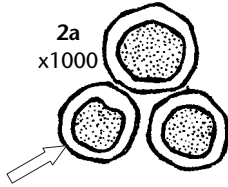
Notes: *Chaenotheca* is a genus of temperate to boreal latitudes consisting of approximately 26 species worldwide. Twenty-three species are known to occur in North America, and 19 in British Columbia. Though traditionally classified as crustose, *Chaenotheca* is included here owing to its stalked apothecia. For many species, it is important to establish the identity of the algal partner/photobiont. In doing so, take care to exclude any extraneous algal material growing above or within the basal crust. Another important microscopic character is provided by the asci, which under LM can appear either basally stalked or chainlike/catenulate, but not both. To view the asci, prepare squash mounts of young apothecia. See Tibell (1980) for further details.

Three keys are provided: the first is to algal partners/photobionts associated with the basal crust; the second is to *Chaenotheca* (and similar) species, and emphasizes macroscopic characters; and the third is to *Chaenotheca* species, and emphasizes microscopic characters.

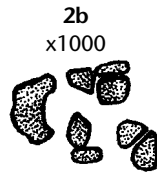
KEY TO PHOTOBIONTS IN *CHAENOTHECA*



1a
x1000



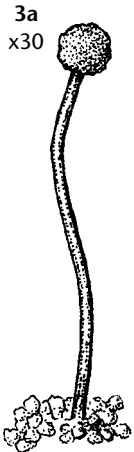
2a
x1000



2b
x1000



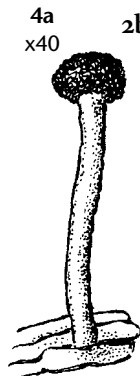
2b
x1000



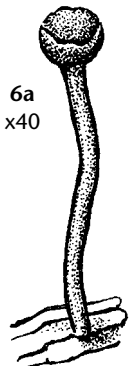
3a
x30

KEY TO *CHAENOTHECA* AND SIMILAR LICHENS, EMPHASIZING MACROSCOPIC CHARACTERS

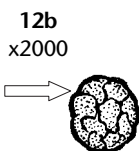
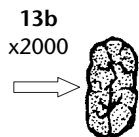
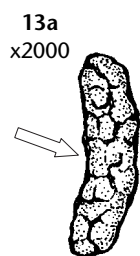
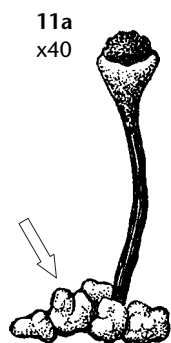
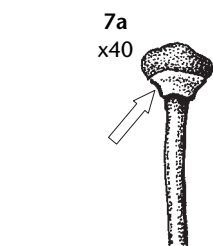
- 1a Spore mass/mazaedium appearing pale and/or brightly coloured under hand lens: pale greyish, pale brownish, bright rusty brown, whitish, yellowish, or purplish; spores colourless under LM or at most very pale brown. 2
- 2a Basal crust well developed, green to yellowish green, powdery/leprose, more or less covering the substrate. 3
- 3a Basal crust distinctly yellowish green; mazaedium also yellowish green *Chaenotheca furfuracea*
- 3b Basal crust medium green or at least not at all yellowish; mazaedium pale creamy greyish *Chaenotheca gracilentia*
- 2b Basal crust immersed in substrate, scarcely or not at all visible from above (Note: basal crust occasionally well developed in *C. brunneola*, but then greyish green) 4
- 4a Stalks strongly yellow-pruinose, especially when young; intermontane *Chaenotheca brachypoda*
- 4b Stalks pale or dark, but never yellow-pruinose; distribution various. 5
- 5a Basal crust containing *Trentepohlia* (see preceding key); and/or mazaedium appearing whitish, yellowish, or violet at maturity; and/or excipulum forming a distinct "collar" at the summit of the stalk; mostly rare 6
- 6a Young apothecial heads appearing bright rusty brown under hand lens; excipulum conspicuously cupping the spore mass/mazaedium at maturity, but not at all collarlike; spores 5–6 μm diameter *Sclerophora coniophaea*



4a
x40

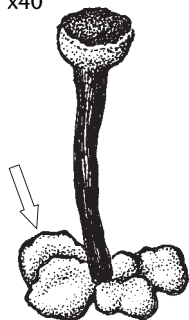


6a
x40



- 6b Young apothecial heads appearing strong yellow, violet, or white under hand lens, becoming bright rusty brown only at maturity, if at all; excipulum either not conspicuously cupping the spore mass at maturity or soon becoming distinctly collarlike; spores often larger or smaller than above. 7
- 7a Excipulum conspicuous, distinctly collarlike at maturity(←); spores to 6–7 μm diameter *Sclerophora amabilis*
- 7b Excipulum inconspicuous, not at all collarlike at maturity; spores to 3–5 μm diameter 8
- 8a Stalks distinctly yellow-pruinose (check young apothecia), dull as viewed under hand lens, blackish within (check broken stalks under LM); basal thallus bearing *Stichococcus*. *Chaenotheca brachypoda* (see 4a)
- 8b Stalks lacking pruina, more or less shiny as viewed under hand lens, pale within; basal thallus bearing *Trentepohlia*. *Sclerophora peronella*
- 5b Basal crust containing *Stichococcus* or a trebouxoid alga (see preceding key); mazaedial surface never whitish, yellowish, or purplish at maturity; excipulum funnel-like, gobletlike, or inconspicuous, but never forming a distinct “collar” 9
- 9a Excipulum conspicuous(←), distinctly rusty-pruinose (check young apothecia); mazaedium pale rust-coloured; basal crust containing *Stichococcus* *Chaenotheca gracillima*
- 9b Excipulum poorly developed, obscured by mazaedium(←); pruina absent; mazaedium medium brown; basal crust containing a trebouxoid alga *Chaenotheca brunneola*
- 1b Mazaedium medium brown to dark brown; spores distinctly brown under LM; excipulum well developed in most species, usually distinctly cupping the mazaedium . . . 9
- 10a Excipulum and/or upper portion of stalk yellow-pruinose (Note: specimens in which the spores are at least in part elongate key here, regardless of pruina) 11
- 11a Basal crust bright yellow, conspicuous(←) (except occasionally sparse or restricted to vicinity of the stalked apothecia) . . *Chaenotheca chrysocephala*
- 11b Basal crust whitish grey, greenish, or immersed in substrate 12
- 12a Spores at least in part ellipsoid to elongate-cylindrical 13
- 13a Spores at least in part elongate-cylindrical(←), 1- to 4-celled, to more than 10 μm long; basal crust containing a trebouxoid alga *Chaenotheca laevigata*
- 13b Spores at most ellipsoid(←), 1-celled, to less than 10 μm long; basal crust bearing *Stichococcus* or a trebouxoid alga. 14
- 14a Basal crust bearing *Stichococcus*. *Chaenotheca chlorella*
- 14b Basal crust bearing a trebouxoid alga *Chaenotheca chrysocephala* (see 11a)
- 12b Spores more or less globose(←) 15
- 15a Spores 3–3.5 μm in diameter; basal crust immersed in substrate; mostly over conifer wood. 16
- 16a Basal crust bearing *Trentepohlia*; apparently restricted to spray zones of waterfalls *Chaenotheca* sp. 1
- 16b Basal crust bearing *Stichococcus*; widespread in humid localities. *Chaenotheca brachypoda* (see 4a)

18a
x40



18b
x40



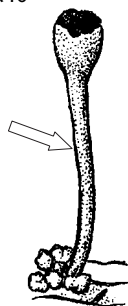
19a
x40



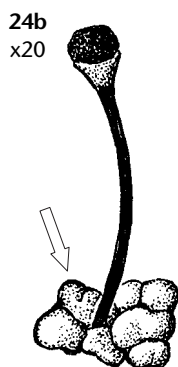
22a
x40



23a
x40



- 15b Spores 5–8 μm diameter; basal crust consisting of whitish grey or brownish green granules, or basal crust immersed in substrate; mostly over conifer bark (Note: specimens having a trebouxiod photobiont key here) 17
- 17a Basal crust immersed in substrate; photobiont *Trentepohlia*; rare *Chaenotheca hispidula*
- 17b Basal crust conspicuous, brownish or whitish, or rarely immersed; photobiont trebouxiod; frequency status various. . . 18
- 18a Basal crust brownish green, wartlike or scale-like/squamulose(\leftarrow); stalk generally robust; total length of apothecia 6–15 times greater than stalk width (as measured in central portions); rare. *Chaenotheca phaeocephala*
- 18b Basal crust whitish grey, granular(\leftarrow), or rarely immersed; stalk generally slender; total length of apothecia 13–22 times greater than stalk width; frequent *Chaenotheca subroscida*
- 10b Excipulum and/or upper portion of stalk white-pruinose, dull brownish pruinose, rusty-pruinose, or lacking pruina. 19
- 19a Spores in part distinctly platy-cracked at 1000x, generally to more than 5.5 μm in diameter; excipulum well developed, black(\leftarrow); basal crust occasionally with scattered orangish patches (“watermarks”), these often K+ reddish; algal partner trebouxiod. *Chaenotheca ferruginea*
- 19b Spores smooth at 1000x, or at most in part weakly cracked, but never platy-cracked, generally to less than 5.5 (–6.0) μm in diameter; excipulum various, often whitish or brownish; basal crust lacking orangish patches, K- through-out; algal partner trebouxiod or *Stichococcus*. 20
- 20a Excipulum and/or stalk rusty-pruinose (check young apothecia); mazaedium also often pale rust-coloured; stalk typically long, thread-like, flexuous; spores to 3.2–6.0 μm diameter; basal crust immersed in substrate *Chaenotheca gracillima*
- 20b Excipulum and/or stalk white-pruinose, dull brownish pruinose, or pruina lacking; stalks short or long, but generally not threadlike or flexuous; spores to 2.0–5.0 μm diameter; basal crust immersed or not. . . 21
- 21a Basal crust containing *Stichococcus*; excipulum and/or stalk generally white-pruinose (Note: check upper portion of stalk) 22
- 22a Basal crust immersed in substrate; over wood of conifers *Chaenotheca xyloxena*
- 22b Basal crust powdery, granular or minutely scale-like/squamulose (check immediate vicinity of apothecial stalks); habitat various. 23
- 23a Basal crust strong greyish white, granular; lower portion of stalk generally whitish or creamy(\leftarrow), often semi-translucent; rare *Chaenotheca cinerea*
- 23b Basal crust bluish grey or greenish grey, powdery or scale-like/squamulose; lower portion of stalk dark, not at all translucent; frequency status various. 24
- 24a Basal crust powdery, pale greenish or bluish green; excipular pruina often with a brownish tinge; intermontane; rare *Chaenotheca stemonea*



24b Basal crust more or less minutely scale-like/squamulose(←), greyish green; excipular pruina whitish, without brownish tinge; widespread; frequent . . .

. *Chaenotheca trichialis*

21b Basal crust containing a trebouxoid alga; excipulum and stalk lacking true pruina, but excipulum occasionally appearing dull brownish pruinose or white-pruinose; stalks also occasionally appearing white-pruinose 25

25a Basal crust immersed in substrate, containing baeomycesic and squamatic acids, UV+ ice-blue; stalk black, shiny . . .

. *Chaenotheca brunneola* (see **9b**)

25b Basal crust minutely granular, containing barbatic and obtusatic acids, UV-; stalk often appearing faintly white-pruinose 26

26a Asci irregular in shape, unstalked, produced in continuous chains (i.e., catenulate) *Chaenotheca sphaerocephala*

26b Asci cylindrical, distinctly long-stalked, not produced in continuous chains *Chaenotheca hygrophila*

KEY TO CHAENOTHECA EMPHASIZING MICROSCOPIC CHARACTERS

1a Photobiont *Trentepohlia* 2

2a Spore surface appearing smooth or minutely net-ridged/reticulate at 1000x (Note: specimens in which the apothecial heads are in part whitish, violet, or strong rusty brown key here) *Sclerophora*

2b Spore surface platy-cracked at 1000x 3

3a Spores to 3.0–3.5 μm in diameter *Chaenotheca* sp. 1

3b Spores to 5.0–7.5 μm in diameter *Chaenotheca hispidula*

1b Photobiont trebouxoid or *Stichococcus* (Note: species with elongate spores and/or a visible basal crust key here) 4

4a Excipulum, mazaedium, and/or stalks bearing yellowish, yellowish green, or bright greenish pruina 5

5a Spores appearing smooth at 1000x (or at least not platy-cracked), globose; mostly restricted to sheltered tree bases and upturned roots 6

6a Basal crust immersed in substrate; apothecia to 0.4–1.4 mm tall *Chaenotheca brachypoda*

6b Basal crust yellowish green; apothecia to more than 1.5 mm tall *Chaenotheca furfuracea*

5b Spores at least in part distinctly platy-cracked at 1000x, globose or elongate; not restricted to tree bases, generally absent from upturned roots 7

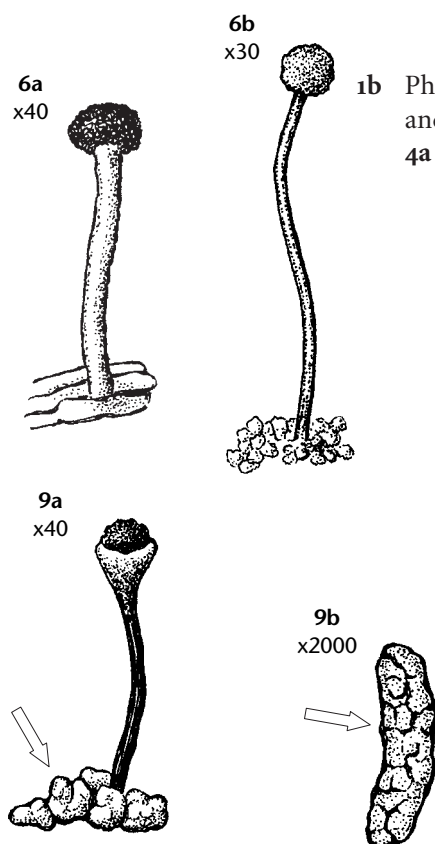
7a Photobiont *Stichococcus* *Chaenotheca chlorella*

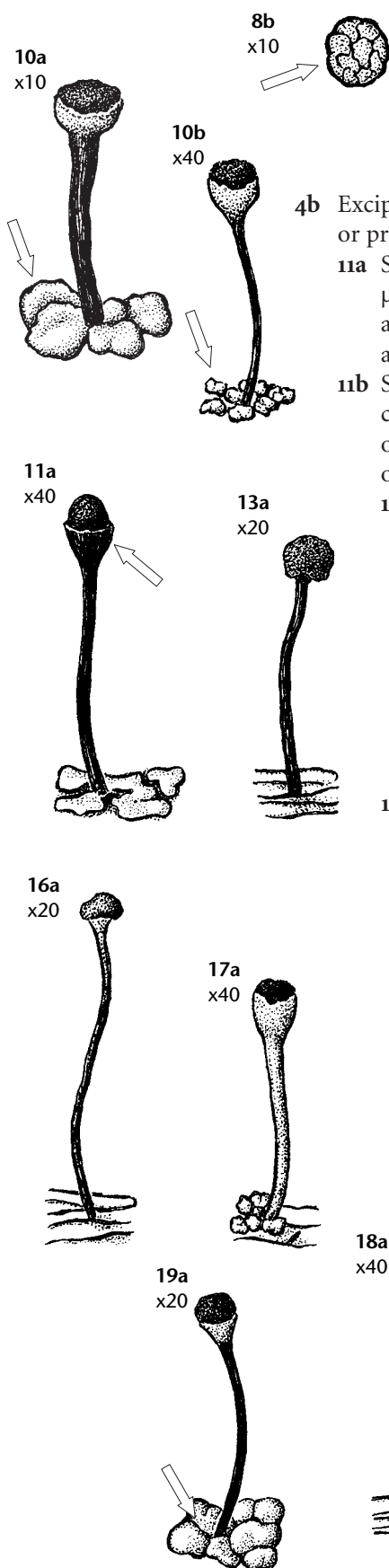
7b Photobiont trebouxoid 8

8a Spores at least in part ellipsoid or elongate 9

9a Basal crust visible(←), yellow, or occasionally immersed in substrate; spores to less than 10 μm long, 1-celled *Chaenotheca chrysocephala*

9b Basal crust greyish green, or more often immersed; spores often to more than 10 μm long(←), 1- to 5-celled *Chaenotheca laevigata*





- 8b Spores globose(←) 10
- 10a Basal crust brownish, minutely scale-like/squamulose(←); apothecial stalks distinctly stout; rare *Chaenotheca phaeocephala*
- 10b Basal crust greyish white, granular(←); apothecial stalks thin, hairlike; common *Chaenotheca subrosida*
- 4b Excipulum, mazaedium, and/or stalks bearing whitish or reddish brown pruina, or pruina apparently absent. 11
- 11a Spores in part distinctly platy-cracked at 1000x, generally to more than 5.5 μm in diameter; excipulum well developed, black(←); basal crust occasionally with scattered orangish patches ("watermarks"), these often K+ reddish; algal partner trebouxoid *Chaenotheca ferruginea*
- 11b Spores smooth at 1000x, or at most in part weakly cracked, but never platy-cracked, generally to less than 5.5 (–6.0) μm in diameter; excipulum various, often whitish or brownish; basal crust lacking orangish patches, K- throughout; algal partner trebouxoid or *Stichococcus* 12
- 12a Photobiont trebouxoid 13
- 13a Basal crust immersed in substrate, containing baeomycesic and squamatic acids, UV+ ice-blue; stalk black, shiny *Chaenotheca brunneola*
- 13b Basal crust minutely granular, containing barbatic and obtusatic acids, UV-; stalk often appearing faintly white-pruinose 14
- 14a Asci irregular in shape, unstalked, produced in continuous chains (i.e., catenulate) *Chaenotheca sphaerocephala*
- 14b Asci cylindrical, distinctly long-stalked, not produced in continuous chains *Chaenotheca hygrophila*
- 12b Photobiont *Stichococcus* 15
- 15a Apothecia long, generally flexuous, to more than 1.6 mm in length; mostly restricted to upturned roots and the bases of trees 16
- 16a Basal crust immersed in substrate *Chaenotheca gracillima*
- 16b Basal crust powdery, greyish green *Chaenotheca gracilentia*
- 15b Apothecia short to long, but generally not flexuous, to less than 1.5 mm in length 17
- 17a Basal crust distinctly whitish; apothecial pruina thick, white, generally present over both excipulum and stalks *Chaenotheca cinerea*
- 17b Basal crust greenish or immersed in substrate; apothecial "pruina" thin, white, generally restricted to excipulum 18
- 18a Basal crust immersed in substrate; spores mostly to less than 4 μm in diameter; over wood *Chaenotheca xyloxena*
- 18b Basal crust generally visible; spores mostly to more than 4 μm in diameter; over bark or wood 19
- 19a Thallus minutely scale-like/squamulose(←), distinctly corticate; excipulum conspicuous; common *Chaenotheca trichialis*
- 19b Thallus powdery, not at all scale-like; excipulum inconspicuous; rare *Chaenotheca stemonea*

Chaenotheca brachypoda (Ach.) Tibell
(Syn. *Coniocybe sulphurea* (Retz.) Nyl.)
Gilded whiskers

Map 25

Habitat/Range: Infrequent (probably overlooked) over conifer wood and bark in humid, shady intermontane localities at lower to middle forested elevations, also rare in maritime regions; incompletely circumpolar, N to BC, S to WA, OR, CA.

Reactions: All spot tests negative.

Contents: Pruina: pulvinic and vulpinic acids.

Variability: High.

Notes: Diagnostic characters include the immersed basal crust and rather short, heavily yellow-pruinose stalks that are black within. Some species of *Sclerophora* are similar, but in these the stalks lack pruina and are pale within. The algal partner is *Stichococcus*.

Chaenotheca brunneola (Ach.) Müll. Arg.
Ball-headed whiskers (brown-head stubble lichen)

Habitat/Range: Common over wood of conifers in open to sheltered coastal and humid intermontane localities at lower to middle forested elevations; also rare over bark of redcedar (*Thuja*); incompletely circumpolar, N to sAK, S to WA, ID, OR, CA.

Reactions: Basal crust PD+ yellow or apparently PD-, UV+ ice-blue.

Contents: Baeomycesic and squamatic acids.

Variability: Medium.

Notes: Characteristic features include the rather globose apothecia, the inconspicuous excipula, the shiny, black, nonpruinose stalks, the immersed basal crust, and the presence of Dictyochloropsis. Some forms appear to intergrade with *C. hygrophila*, in which, however, the excipulum is well developed, the stalks are often somewhat pruinose, and the basal crust gives a UV- reaction (squamatic acid lacking). This species also differs in producing barbatic and obtusatic acids. Difficult specimens can be referred to as *C. brunneola* s. lat. See also the comments under *C. sphaerocephala*.

Chaenotheca chlorella (Ach.) Müll. Arg.
(Syn. *Chaenotheca carthusiae* (Harm.) Lettau)
Lemonseed whiskers

Habitat/Range: Frequent over bark and wood of conifers in coastal and humid intermontane localities at lower to middle forested elevations; incompletely circumpolar, N to BC, S to OR, CA.

Reactions: All spot tests negative.

Contents: Pruina: vulpinic acid.

Variability: Medium.

Notes: Diagnostic characters include the yellowish excipulum, the platy-cracked, somewhat ellipsoid spores to less than 10 µm long, and the association with *Stichococcus* or a trebouxoid alga. *Chaenotheca laevigata* is similar, but has elongate spores to more than 10 µm long, and is invariably associated with a trebouxoid alga. See also the notes under *C. chrysocephala*. In Canada, *C. chlorella* is known only from British Columbia.

Chaenotheca chrysocephala (Ach.) Th. Fr.
Canary whiskers

Habitat/Range: Frequent over bark and wood of conifers and deciduous trees in humid, sheltered maritime (CDF) and intermontane (ICH) forests at lower elevations; circumpolar, N to sAK, S to WA, ID, OR, CA, AZ, MX; AB.

Reactions: All spot tests negative.

Contents: Thallus and pruina: vulpinic acid.

Variability: Low.

Notes: Diagnostic characters include the lemon-yellow basal crust, the trebouxoid algal partner, and the ellipsoid spores less than two times longer than wide. Specimens in which the basal crust is poorly developed or immersed in the substrate are readily mistaken for *C. chlorella*, though in that species the algal partner is usually *Stichococcus*, and at least some of the spores are more than two times longer than wide.

Chaenotheca cinerea (Pers.) Tibell
Old man's whiskers

Map 26

Habitat/Range: Infrequent over bark of deciduous trees (cottonwood [*Populus*]) in humid intermontane (ICH) old-growth forests at lower elevations, also rare over conifer bark (yellow-cedar [*Chamaecyparis*]) in maritime localities at middle elevations; western N Am - western Eurasia, N to BC, S to OR.

Reactions: All spot tests negative.

Contents: No lichen substances reported.

Variability: Medium.

Notes: *Chaenotheca cinerea* is recognized by its whitish, granular basal crust, its densely white-pruinose and/or semi-translucent stalks, its somewhat "tattered" excipulum, and its association with *Stichococcus* as an algal partner.

Chaenotheca ferruginea (Turner & Borrer) Migula
Blood whiskers

Habitat/Range: Frequent over bark of conifers in maritime (CDF) and humid inland old-growth forests at lower elevations; incompletely circumpolar, N to BC, S to WA, OR, CO.

Reactions: Basal crust (reddish spots) K+ red; mazaedium K+ reddish.

Contents: One unidentified substance.

Variability: Medium.

Notes: The distinctly platy-cracked spores, the well-developed, black excipulum, and the (occasional) presence of yellowish to reddish spots over a whitish, tile-like basal crust are diagnostic. The algal partner is trebouxoid.

Chaenotheca furfuracea (L.) Tibell
(Syn. *Coniocybe furfuracea* (L.) Ach.)
Sulphur whiskers (sulphur stubble lichen)

Habitat/Range: Frequent over sheltered bark and wood of upturned roots in shady maritime and humid intermontane localities at lower to middle forested elevations; also collected from sheltered cut banks and tip-up mounds; incompletely circumpolar, N to sAK, YU, S to WA, ID, MT, OR, WY, CA, AZ.

Reactions: All spot tests negative.

Contents: Pulvinic and vulpinic acids, and pulvinic acid dilactone.

Variability: Low.

Notes: The powdery yellow basal crust and densely yellow-pruinose apothecia are diagnostic. The algal partner is *Stichococcus*.

Chaenotheca gracilenta (Ach.) Mattsson & Middelborg
(Syn. *Coniocybe gracilenta* (Ach.) Ach.; *Cybebe gracilenta* (Ach.) Tibell)
Rat's whiskers

Map 27

Habitat/Range: Infrequent over wood, especially among upturned roots in humid, sheltered intermontane (ICH) old-growth forests at lower elevations, usually near the ground, local distribution poorly known; western N Am - eastern N Am - western Eurasia, N to BC, S to WA, OR.

Reactions: All spot tests negative.

Contents: Various unidentified substances.

Variability: Medium.

Notes: Diagnostic characters include the greenish, rather powdery basal crust, the flexuous, hairlike stalks, and the pale greyish mazaedium. The algal partner is *Stichococcus*.

Chaenotheca gracillima (Vainio) Tibell
(Syn. *Coniocybe gracillima* Vainio)
Cat's whiskers

Habitat/Range: Frequent over wood of conifer snags, stumps, and upturned roots in humid, sheltered intermontane old-growth forests at all elevations, usually near the ground; western N Am - western Eurasia - eastern Eurasia, N to BC, S to WA.

Reactions: All spot tests negative.

Contents: One unidentified substance.

Variability: Medium.

Notes: The flexuous, hairlike stalks, the rusty brown excipulum, and the immersed basal crust are distinctive. The algal partner is *Stichococcus*.

Chaenotheca hispidula (Ach.) Zahlbr.
Lemon whiskers

Map 28

Habitat/Range: Rare over conifer bark in humid maritime localities; probably incompletely circumpolar, local distribution poorly known; N to BC, S to OR.

Reactions: All spot tests negative.

Contents: Pruina: Vulpinic acid.

Variability: Medium.

Notes: Diagnostic characters include the yellow-pruinose excipulum, the large globose spores that measure to 5.0–7.5 μm in diameter, and the association with *Trentepohlia*. The only other species of *Chaenotheca* to associate with *Trentepohlia* is *Chaenotheca* sp. 1, in which, however, the spores are much smaller, at 3.0–3.5 μm . *Chaenotheca hispidula* was recently reported for British Columbia by Goward et al. (1996).

Chaenotheca hygrophila Tibell
Collared whiskers

Habitat/Range: Frequent over bark of conifers, especially redcedar (*Thuja*), in humid, sheltered, coastal old-growth forests at lower elevations; incompletely circumpolar, in western N Am known only from BC.

Reactions: Basal crust PD+ yellow becoming orangish red.

Contents: Two unidentified substances.

Variability: High.

Notes: Diagnostic characters include the well-developed excipulum, the minutely granular basal crust, the often weakly pruinose stalks, and the trebouxoid photobiont. For points of separation with similar species, see the notes under *C. brunneola* and *C. sphaerocephala*.

Chaenotheca laevigata Nád. v.
Lemon-twist whiskers

Map 29

Habitat/Range: Infrequent (probably overlooked) over bark of conifers, especially redcedar (*Thuja*), in open maritime and intermontane localities at lower to middle forested elevations, local distribution poorly known; western N Am - western Eurasia, N to BC, S to WA, OR.

Reactions: All spot tests negative.

Contents: Pruina: vulpinic acid.

Variability: Medium.

Notes: The presence of 2- to 4-celled spores measuring to more than 10 μm long is unique within the genus; see also the notes under *C. chlorella*. The algal partner is trebouxoid.

Chaenotheca phaeocephala (Ach.) Th. Fr.
Toad whiskers

Map 30

Habitat/Range: Rare over bark or possibly wood of conifers in open maritime and intermontane localities, apparently at all forested elevations, local distribution poorly known; western N Am - western Eurasia, N to BC, (outlier in wNT), S to OR, CA.

Reactions: All spot tests negative.

Contents: Pruina: vulpinic acid.

Variability: High.

Notes: The algal partner is trebouxoid. See the notes under *C. subroscida*.

Chaenotheca sphaerocephala Nádv.
Ball-headed whiskers

Habitat/Range: Rare over conifers in humid intermontane (ICH) regions at lower elevations, local distribution poorly known; western N Am - eastern N Am - western Eurasia, in western N Am currently known only from BC.

Reactions: Basal crust PD+ yellow or becoming orangish red.

Contents: Barbatic and obtusatic acids (and squamatic acid).

Variability: High.

Notes: *Chaenotheca sphaerocephala* can be recognized by its granular, UV- basal crust, its trebouxoid photobiont, its often somewhat pruinose stalks, and its production of barbatic and obtusatic acids. *Chaenotheca brunneola* is similar, but has an immersed, UV+ ice-blue basal crust and nonpruinose stalks, and produces baeomycesic and squamatic acids. Also similar is *C. hygrophila*, in which, however, the excipulum is well developed and cuplike, and the asci are distinctly stalked, cylindrical, and borne singly. In *C. sphaerocephala*, by contrast, the excipulum is poorly developed, and the asci are unstalked, irregular in shape, and produced in “chains”/catenulate. In both species, the basal crust yields a UV- reaction; difficult specimens can be referred to as *C. brunneola* s. lat.

Chaenotheca stemonea (Ach.) Müll. Arg.
Miner's whiskers

Map 31

Habitat/Range: Rare over bark and wood of conifers in humid, shady intermontane old-growth forests at lower and middle elevations, local distribution poorly known; incompletely circumpolar, N to sAK, S to OR; AB.

Reactions: Basal crust PD+ yellow or becoming reddish.

Contents: Barbatic and obtusatic acids.

Variability: Medium.

Notes: The algal partner is *Stichococcus*. *Chaenotheca stemonea* is close in most regards to *C. trichialis*, but has a rather powdery basal crust that is not at all scale-like/squamulose, as in the latter species.

Chaenotheca subroscida (Eitn.) Zahlbr.
Lemondrop whiskers

Habitat/Range: Frequent over conifer bark and rarely over wood in sheltered, humid intermontane old-growth forests at lower and middle elevations; in maritime regions (CDF), also rare over bark of oak (*Quercus*); western N Am - western Eurasia, N to BC, S to WA, OR, CA.

Reactions: All spot tests negative.

Contents: Thallus: pseudoplacodiolic acid. Pruina: vulpinic acid.

Variability: Medium.

Notes: *Chaenotheca subroscida* can be identified by its yellowish excipulum, its greyish, rather granular basal crust, its platy-cracked, globose spores, and its trebouxiod algal partner. In most regards it is identical to *C. phaeocephala*, though in that species the apothecia are more robust and the basal crust is brownish green and more or less scale-like/squamulose. In Canada, *C. subroscida* is known only from British Columbia.

Chaenotheca trichialis (Ach.) Th. Fr.
Frog whiskers

Habitat/Range: Frequent over bark and wood of conifers (also birch [*betula*]) in open to sheltered intermontane old-growth forests at lower to middle elevations, also rare in maritime regions; circumpolar, N to BC, S to WA, ID, OR, CA; AB.

Reactions: All spot tests negative.

Contents: Two unidentified substances.

Variability: High.

Notes: Diagnostic features include the well-developed, sparsely white-pruinose excipulum, and the greenish scale-like/squamulose basal crust (check near the stalked apothecia) that contain *Stichococcus*. Specimens lacking a basal crust can be confused with *C. xyloxena*. That species, however, has a densely white-“pruinose” excipulum, and occurs strictly over wood. *Chaenotheca brunneola* and *C. sphaerocephala* are also superficially similar, but lack a conspicuous excipulum, and contain a trebouxiod alga in the basal crust. Another similar species, *C. hygrophila*, also associates with a trebouxiod alga. See also the notes under *C. stemonea*.

Chaenotheca xyloxena Nádv.
Snag whiskers

Map 32

Habitat/Range: Rare (probably overlooked) over wood of conifers in open maritime and intermontane localities at all forested elevations, local distribution poorly known; incompletely circumpolar, N to BC, S to WA, CA; AB.

Reactions: All spot tests negative.

Contents: No lichen substances reported.

Variability: Low.

Notes: The algal partner is *Stichococcus*. See the notes under *C. trichialis*.

***Chaenotheca* sp. 1**

Mist whiskers

Habitat/Range: Rare over wood of conifers in humid intermontane (ICH) forests at lower elevations, possibly restricted to the spray zones of waterfalls, local distribution poorly known; global distribution unknown.

Reaction: All spot tests negative.

Contents: Unknown.

Variability: Unknown.

Notes: The yellow-pruinose excipulum, the globose spores, and the association with *Trentepohlia* are diagnostic. See the notes under *C. hispidula*.

Minute “fruticose” microfungi, consisting of **basal threads/hyphae** and **stalked apothecia**. Either parasitic (i.e., living off lichens or free-living algae) or saprobic (i.e., living off dead bark, wood, and other organic matter). **Photobiont absent**. Basal hyphae immersed in substrate, not readily discernible.

Apothecial stalks nonlichenized, black or brownish (but surface colour occasionally in part obscured by a whitish or coloured “pruina”), **hairlike, to 0.4–1 (–2) mm long** (including heads) and 30–120 µm wide (excluding heads), smooth, brittle, unbranched. **Apothecial heads/capitula** borne at stalk tips, top-shaped/turbinate to hemispherical or globose, consisting of an upwardly expanding excipulum (often poorly developed), and a **compact black spore mass** (i.e., lacking a powdery mazaedium). **Spores 1-celled or 2-celled**, ellipsoid to spindle-shaped/fusiform, blunt-tipped to pointed-tipped, to 10–15 (–20) µm long (ours), smooth-walled to minutely cracked or ornamented, pale to dark brownish or dull greenish/aeruginose under LM, arising within persistent vial-shaped asci, eight spores per ascus. Ascus tip unevenly thickened, penetrated by a narrow to rather broad canal extending upward toward the apex.

Mostly over conifer bark and wood, also free-living algal colonies, lichens, or unlichenized fungi.

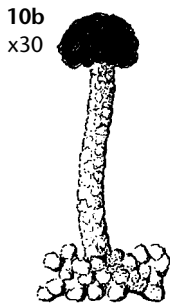
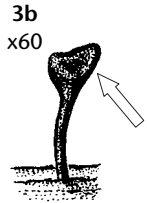
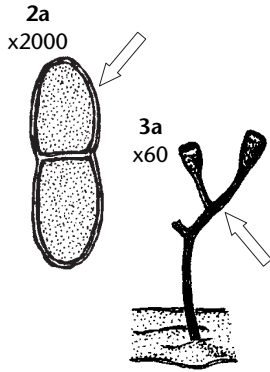
References: Tibell (1975, 1981, 1984, 1987, 1994); Titov and Tibell (1992); S. Selva, University of Maine, pers. comm., 1996; E.B. Peterson, Oregon State University, pers. comm., 1998; Rikkinen [1999]; L. Tibell, University of Uppsala, pers. comm., 1999.

Common Name: Alludes to the stalked apothecia that terminate in a “pin-head.”

Notes: *Chaenothecopsis* is widely distributed at cool temperate to warm temperate latitudes. It is poorly known, with approximately 45 species described to date. Apparently only 13 of the 22 taxa included in the following account have been described. Although not technically a lichen genus, *Chaenothecopsis* has been traditionally studied by lichenologists, and is therefore included here, owing to its stalked apothecia. No chemical substances have been reported, though spot test reactions are often important for species recognition. In the following accounts, only definite colour changes associated with application of K and H are recorded.

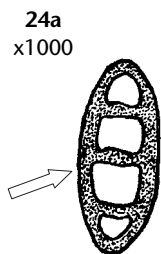
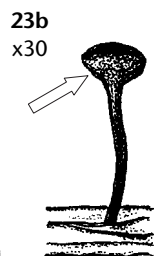
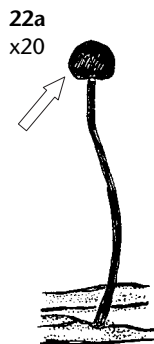
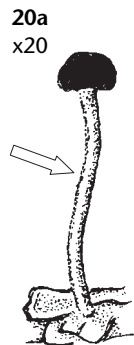
Note: The keys are preliminary. Unnamed species marked with an asterisk are poorly understood, and are therefore not included in the species accounts pending further collection and study. Microscopic characters are based on squash mounts flooded with water, and viewed under LM at 1000x.

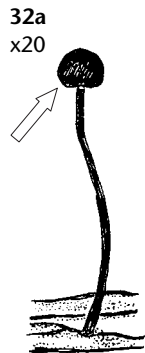
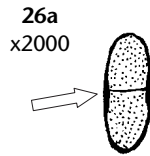
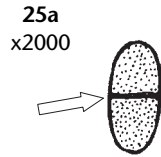
KEY TO CHAENOTHECOPSIS AND SIMILAR UNLICHENIZED GENERA WITH STALKED APOTHECIA



- 1a Over bark of deciduous trees and shrubs 2
- 2a Over aspen or cottonwood (*Populus*); spores 2-celled at maturity(←) . . .
 *Phaeocalicium populneum*
- 2b Over alder (*Alnus*) or birch (*Betula*); spores 1-celled or 4-celled at maturity 3
- 3a Over alder; excipulum round in cross-section; stalk often branched(←);
 spores 4-celled at maturity *Stenocybe pullatula*
- 3b Over alder or birch; excipulum strongly flattened in cross-section(←);
 stalk unbranched; spores 1-celled. *Phaeocalicium compressulum*
- 1b Not over bark of deciduous trees and shrubs 4
- 4a Stalks emerging from exudate/resin of conifers 5
- 5a Spores 1-celled *Chaenothecopsis tsugae*
- 5b Spores 2-celled 6
- 6a Apothecia to less than 1 mm tall (including head); stalks pale green,
 appearing smooth *Chaenothecopsis edbergii*
- 6b Apothecia to more than 1 mm tall; stalks dark green, appearing granular
 *Chaenothecopsis* sp.*
- 4b Stalks not emerging from exudate of conifers 7
- 7a Stalks emerging from lichens or other fungi 8
- 8a Spores 1-celled 9
- 9a Stalks emerging from the undersurface of tree-inhabiting polypores;
 spores very pale, 3–5 x 2.5–3 µm; stalks dark under LM; head K-
 under LM *Chaenothecopsis* sp.*
- 9b Stalks emerging from a powdery/leprose lichen (belonging to
 Lepraria or *Lecanora*); spores medium brown to dark brown, to
 7–14 (–16) x 3–4.5 µm; stalks whitish under LM; heads K- or K+ dull
 greenish or pinkish under LM 10
- 10a Stalks absent or, if present, then to less than 0.8 mm long
 (including head); spores to 9–14 (–16) µm long; apothecial
 heads K- or K+ dull greenish/aeruginose under LM; asci to
 60–75 µm long. *Chaenothecopsis* sp. 1
- 10b Stalks present, to more than 0.8 mm long; spores to 7–9 µm
 long; apothecial heads K+ distinctly pink under LM; asci to
 50–55 µm long. *Chaenothecopsis* sp. 2
- 8b Spores 2-celled 11
- 11a Stalks emerging from a wood decay microfungus, this appearing
 tiny, black, and dotlike *Chaenothecopsis* sp.*
- 11b Stalks at least in part emerging from lichen thalli or fruiting struc-
 tures. 12
- 12a Stalks emerging from thallus of *Hypocenomyce scalaris*
 (see Part 1). *Chaenothecopsis* sp. 3
- 12b Stalks emerging from thallus or fruiting structures of *Calicium*
 or *Chaenotheca* (see this volume) 13
- 13a Stalks at least in part emerging from the corticate basal
 thallus of *Chaenotheca* 14

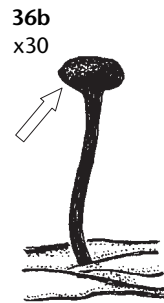
- 14a Stalks emerging from the (pale greyish green) basal thallus of *Chaenotheca trichialis* . . .
 *Chaenothecopsis epithallina*
- 14b Stalks emerging from the (bright yellow) basal thallus of *Chaenotheca chrysocephala* . . .
 *Chaenothecopsis consociata*
- 13b Stalks emerging from species of *Calicium* or *Chaenotheca* having an immersed basal thallus. 15
- 15a Host lichen growing over bark 24
- 15b Host lichen growing over wood 33
- 7b Stalks not emerging from lichens or other fungi. 16
- 16a Stalks emerging from bark of conifers 17
- 17a Spores 1-celled or appearing so 18
- 18a Spores to 12–13 x 4–5 µm, dark brown . . . *Chaenothecopsis* sp.*
- 18b Spores to 5–9 x 2–3 µm, pale brown to dark brown. 19
- 19a Stalks distinctly reddish or reddish brown under LM, especially above. *Chaenothecopsis haematopus*
- 19b Stalks dull greenish/aeruginose under LM, or at least not at all distinctly reddish. 20
- 20a Stalks distinctly whitish(←) (check under hand lens); apothecial head at least in part K+ dull greenish/aeruginose *Chaenothecopsis viridialba*
- 20b Stalks blackish or at least not distinctly whitish; apothecial head K- under LM. 21
- 21a Asci to more than 55 µm long (check asci with a full complement of eight spores) . *Chaenothecopsis* sp.*
- 21b Asci to less than 50 µm long. 22
- 22a Apothecial heads globose(←); stalks elongate-threadlike, often to more than 1 mm tall (excluding heads); spores to 5 x 2.5 µm, very pale, distinctly blunt-tipped . . .
 *Chaenothecopsis* sp. 4
- 22b Apothecial heads variously shaped, but rarely globose; stalks thick or thin, but not more than 1 mm long; spores to 6–9 x 3–4 µm, pale or dark, distinctly blunt-tipped to more often spindle-shaped/fusiform 23
- 23a Asci to 25–33 µm long (check mature asci containing eight spores); apothecia (including head) to 0.4–0.7 mm tall; excipulum generally black, or at least not pale or white-pruinose; frequent over bark *Chaenothecopsis nana*
- 23b Asci to 35–50 µm long; apothecia to 0.6–1.0 (–1.2) mm tall; excipulum occasionally pale or white-pruinose(←); rare over bark *Mycocalicium subtile*
- 17b Spores at least in part 2- to multi-celled 24
- 24a Spores in part 3- to multi-celled(←) *Stenocybe*
- 24b Spores at most 2-celled 25





- 25a Septum strong, distinct, at least as dark as spore wall(←) (check under LM at 1000x); apothecial heads often becoming “lumpy” with age, or covered in thin, whitish pruina, or both; associated with trebouxoid algae; frequent . . .
Chaenothecopsis tasmanica
- 25b Septum weak, much paler than spore wall, often readily overlooked; apothecial heads generally neither “lumpy” nor covered in whitish pruina; not associated with chlorococcoid algae; rare to infrequent 26
- 26a Stalks blackish or at least not whitish when viewed under hand lens; apothecial head mostly dull greenish/aeruginose under LM; spore wall appearing thickened and blackish in vicinity of septum(←) (check at 1000x) *Chaenothecopsis* sp. 5
- 26b Stalks whitish when viewed under hand lens; apothecial head not at all dull greenish under LM; spore wall not at all thickened or black in vicinity of septum 27
- 27a Spores to 5–7 x 2.5 µm; stalks pale under LM; associated with *Chaenotheca gracilentia* . . .
Chaenothecopsis sp. 6
- 27b Spores to 7–11 x 3–5 µm; stalks dark under LM; not associated with *Chaenotheca gracilentia* . . .
Chaenothecopsis sp.*
- 16b Stalks emerging from wood of conifers or deciduous trees and shrubs . . 28
- 28a Spores 1-celled 29
- 29a Stalks pale or distinctly coloured under LM: whitish, reddish, reddish brown, pale medium brown, or dull greenish/aeruginose 30
- 30a Stalks distinctly reddish or reddish brown under LM, often weakly coated in crystals; apothecia at least in part distinctly K+ dull greenish/aeruginose . . .
Chaenothecopsis haematopus
- 30b Stalks dull greenish/aeruginose under LM, or at least not at all distinctly reddish; apothecia K- throughout 31
- 31a Spores to 7–9 µm long; asci to more than 35 µm long; coastal *Chaenothecopsis* sp. 7
- 31b Spores to 4–6 µm long; asci to less than 35 µm long; inland *Chaenothecopsis savonica*
- 29b Stalks distinctly dark under LM: black or dark greyish brown . . 32
- 32a Apothecial heads globose(←); stalks elongate-threadlike, often to more than 1 mm tall (excluding heads); asci to less than 35 µm long; spores very pale, distinctly blunt-tipped *Chaenothecopsis* sp. 4
- 32b Apothecial heads variously shaped, but rarely globose; stalks thick or thin, but not more than 1 mm long; asci to more than 35 µm long; spores generally dark, blunt-tipped to more often spindle-shaped/fusiform . . .
Mycocalicium subtile
- 28b Spores 2-celled 33

- 33a Apothecia K+ distinctly violet or dull greenish/aeruginose (check under LM); associated with algae 34
- 34a Apothecial head reddish under LM, K+ distinctly greenish *Chaenothecopsis viridireagens*
- 34b Apothecial head aeruginose under LM, K+ reddish or violet (flash) *Chaenothecopsis pusiola*
- 33b Apothecia K-, or at least not K+ distinctly violet or aeruginose; associated with algae or not. 35
- 35a Stalk H+ reddish or violet; not associated with algae . . . 36
- 36a Stalk H+ reddish, pigment contained within stalk, not at all bleeding outward; heads only gradually flaring at point of attachment with stalks *Chaenothecopsis* sp. 8
- 36b Stalk H+ violet, pigment bleeding outward; heads abruptly flaring at point of attachment with stalks(←) *Chaenothecopsis debilis*
- 35b Stalk H-; associated or not with algae 37
- 37a Apothecial head distinctly brownish under LM *Chaenothecopsis pusilla* s. lat.
- 37b Apothecial head dull greenish/aeruginose under LM 38
- 38a Stalk predominantly whitish or pale brownish under LM; spores to 3–3.5 μm wide; associated with *Calicium glaucellum* *Chaenothecopsis* sp. 9
- 38b Stalks dull greenish/aeruginose more or less throughout under LM; spores to 2–2.5 μm wide; not associated with *Calicium glaucellum* *Chaenothecopsis* sp. 7



Chaenothecopsis consociata (Nádv.) A. Schmidt
Canary pin

Map 33

Habitat/Range: Parasitic; rare (probably overlooked) over *Chaenotheca chrysocephala* on bark and wood of conifers and deciduous trees in humid, sheltered maritime (CDF) and especially humid intermontane (ICH) forests at lower elevations, local distribution poorly known; circumpolar, N to BC, S to OR.

Reactions: All reddish tissues K+ dull greenish/aeruginose.

Variability: Low.

Notes: The occurrence of this species over the stalks and especially the yellow basal crust of *Chaenotheca chrysocephala* is diagnostic.

Chaenothecopsis debilis (Sm.) Tibell
King pin

Map 34

Habitat/Range: Saprobic; infrequent (probably overlooked) over wood of conifers and deciduous trees in open intermontane forests at lower to middle elevations; probably incompletely circumpolar, N to YU, S to WA, OR, CA.

Reactions: Stalk H+ violet (bleeding).

Variability: Low.

Notes: Diagnostic characters include the 2-celled spores, the H+ violet stalks that bleed outward, and the occurrence over wood.

Chaenothecopsis edbergii Selva & Tibell, ined.
Lime pin

Map 35

Habitat/Range: Saprobic; rare over resin of conifers, especially hemlock (*Tsuga*), in humid old-growth intermontane (ICH) forests at lower elevations, local distribution poorly known; western N Am - eastern N Am, in western N Am known only from BC.

Reactions: All spot tests negative.

Variability: Unknown.

Notes: The 2-celled spores, the presence of pale greenish pruina on the stalks, and the occurrence over conifer resin are distinctive for the species.

Chaenothecopsis epithallina Tibell
Frog pin

Habitat/Range: Parasitic; frequent over *Chaenotheca trichialis* on bark and wood of conifers in humid, sheltered intermontane (ICH) old-growth forests at lower and middle elevations; western N Am - western Eurasia, N to BC, S to WA.

Reactions: All spot tests negative.

Variability: Medium.

Notes: Diagnostic characters include the 2-celled spores and the occurrence over the stalks and/or basal crust of *Chaenotheca trichialis*.

Chaenothecopsis haematopus Tibell
Blood pin

Map 36

Habitat/Range: Saprobic; rare over bark of conifers, especially redcedar (*Thuja*), in humid old-growth intermontane (ICH) forests at lower elevations, local distribution poorly known; incompletely circumpolar, in western N Am known only from BC.

Reactions: All reddish tissues K+ dull greenish/aeruginose.

Variability: Medium.

Notes: Diagnostic characters include the distinctly reddish stalks (check upper portions), the pale, blunt-tipped, 1-celled spores measuring to 4–6 (–7) μm long, and the K+ aeruginose reaction. *Chaenothecopsis viridialba* is similar, but has whitish stalks, and spores to 7–9 μm long.

Chaenothecopsis nana Tibell

Pygmy pin

Habitat/Range: Saprobic; frequent over bark of conifers, rarely also over wood, in humid, shady intermontane forests at lower to middle elevations; probably incompletely circumpolar, N to BC, S to WA, OR, CA.

Reactions: All spot tests negative.

Variability: Medium.

Notes: Diagnostic characters include the tiny apothecia (generally to 0.4–0.7 mm tall, including heads), the 1-celled spores, the negative reactions with K and H, and the almost invariable occurrence over conifer bark. *Mycocalicium subtile* is similar in most regards, but has slightly larger apothecia (to 0.6–1.0 mm tall), and almost invariably occurs over wood. Positive identification, however, requires examination of ascus length (25–33 μ m in *C. nana* versus 35–50 μ m in *M. subtile*: check eight-spored asci) and/or ascus tip (penetrated by a narrow “canal” versus not at all penetrated, respectively: stain asci with lactophenol cotton blue, and view under LM at 1000x using phase-contrast microscopy).

Chaenothecopsis pusilla (Ach.) A. Schmidt, s. lat.

Map 37

(Syn. *Calicium floerkei* Zahlbr.; *C. pusillum* Flörke; *Chaenothecopsis subpusilla* (Vainio) Tibell)

Ambiguous pin

Habitat/Range: Saprobic (ours); rare (probably overlooked) over wood of conifers in humid intermontane forests at lower to middle elevations, also known from mid-elevation forests in coastal regions, local distribution poorly known; probably incompletely circumpolar, N to sAK, wNT, S to WA, OR, CA.

Reactions: All spot tests negative.

Variability: High.

Notes: Diagnostic characters include the smooth-walled, 2-celled spores in which the septum is weak, and the negative reactions with K and H. The species is highly variable: included among the local material are specimens in which the spore septum is decidedly strong. Further work is needed to delimit the species; see also the notes under *C. sp. 3* and *C. sp. 9*.

Chaenothecopsis pusiola (Ach.) Vainio

Map 38

(Syn. *Chaenothecopsis lignicola* (Nádv.) A. Schmidt)

Algal pin

Habitat/Range: Parasitic over free-living algae; infrequent over wood of conifers in sheltered old-growth intermontane forests at all forested elevations, also known in coastal regions from mid-elevation forests, local distribution poorly known; probably incompletely circumpolar, N to BC, S to WA, OR.

Reactions: Apothecia head K+ violet (fading).

Variability: Medium.

Notes: Diagnostic characters include the pale, 2-celled spores in which the septum is weak, the K+ violet apothecial head, and the frequent association with free-living algae.

Chaenothecopsis savonica (Räsänen) Tibell
Least pin

Map 39

Habitat/Range: Saprobic; rare over wood of conifers in humid intermontane (ICH) old-growth forests at lower elevations, local distribution poorly known; probably incompletely circumpolar, N to BC, S to WA, OR, CA.

Reactions: All spot tests negative.

Variability: Medium.

Notes: Diagnostic for this species are the pale, blunt-tipped, 1-celled spores, the typically greenish stalks (check under LM), the short asci (to 22–32 µm long), and the occurrence over wood. The material included here may represent two separate taxa.

Chaenothecopsis tasmanica Tibell
Frosted pin

Habitat/Range: Common over bark of conifers, especially redcedar (*Thuja*), in sheltered, humid coastal and intermontane (ICH) old-growth forests at lower elevations; probably western N Am - western Eurasia, in western N Am known only from BC.

Reactions: Apothecial head K+ yellowish to brownish.

Variability: High.

Notes: This is a variable but highly distinctive species. Diagnostic characters include the apothecial heads that become “lumpy” and/or weakly white-pruinose with age, the 2-celled spores that have a thickened, highly contrastive crosswall/septum, and the frequent association with lichenized crusts as well as with unlichenized trebouxoid algae.

Chaenothecopsis tsugae Rikkonen, ined.
Pitch pin

Map 40

Habitat/Range: Infrequent over resin of conifers in humid old-growth intermontane (ICH) forests at lower elevations, local distribution poorly known; western N Am, N to BC, S to OR.

Reactions: Stalks K+ “bleeding” dark greenish.

Variability: Medium.

Notes: Diagnostic characters include the 1-celled spores, the stalks that “bleed” dark greenish in K, and the occurrence over the resin of conifers, especially that of hemlock (*Tsuga*).

Chaenothecopsis viridialba (Kremp.) A. Schmidt
Pale-footed pin

Map 41

Habitat/Range: Saprobic; infrequent over bark of conifers, especially spruce (*Picea*), in humid intermontane old-growth forests at lower and middle elevations, local distribution poorly known; probably incompletely circumpolar, N to BC, S to OR, CA.

Reactions: All reddish tissues K+ dull greenish/aeruginose.

Variability: Medium.

Notes: A distinctive species, *C. viridialba* can be recognized by its long whitish stalks, its abruptly flaring heads (check mature apothecia), its 1-celled spores, its reddish apothecial tissues that turn greenish in K, and its occurrence over conifer bark. See the notes under *C. haematopus*.

Chaenothecopsis viridireagens (Nádv.) A. Schmidt
Red-headed pin

Map 42

Habitat/Range: Saprobic or parasitic on free-living algae; infrequent over decaying wood of conifers in humid, shady intermontane old-growth forests at lower to middle elevations, local distribution poorly known; probably incompletely circumpolar, N to BC, S to WA, OR.

Reactions: All reddish tissues K+ dull greenish/aeruginose.

Variability: Medium.

Notes: This is a distinctive species. Diagnostic characters include the dark stalk, the often gradually flaring head, the 2-celled spores, the reddish apothecial tissues (check head under LM) that instantly turn greenish upon application of K, and the occurrence over wood.

Chaenothecopsis sp. 1 [= "*leprosula*"]
Lesser powder pin

Habitat/Range: Parasitic; rare over bark-inhabiting powdery lichens (i.e., *Lecanora symmicta* (Ach.) Ach., s. lat.) in humid intermontane old-growth forests at lower to middle elevations, local distribution poorly known; global distribution unknown.

Reactions: Apothecial heads K- or K+ dull greenish/aeruginose.

Variability: Medium.

Notes: The short stalks (to less than 0.8 mm long) and especially the occurrence over powdery lichens are diagnostic. Other characters include the white-pruinose stalks, the 1-celled spores to 10–14 (–16) × 4–4.5 µm, and the asci to 60–75 µm long.

Chaenothecopsis sp. 2 is similar, but has longer stalks (to more than 0.8 mm long), shorter spores (to 7–9 µm long), and K+ pink apothecial heads. The material is also close to *C. koerberi* (Nádv.) Tibell (not currently known from North America), but in that species the spores are 6–8 µm long, and the asci are 25–40 µm long.

***Chaenothecopsis* sp. 2 [= “*leprosa*”]**

Greater powder pin

Habitat/Range: Parasitic; rare over bark- or wood-inhabiting powdery lichens in humid intermontane old-growth forests at lower to middle elevations, possibly restricted to the spray zones of waterfalls, local distribution poorly known; global distribution unknown.

Reactions: Apothecial head K+ pink.

Variability: Medium.

Notes: The medium-sized stalks (to more than 0.8 mm long), the K+ pink apothecial heads, and the occurrence over powdery lichens are diagnostic. Other characters include the white-pruinose stalks, the dark brown to medium brown, 1-celled spores to 7–9 x 3–4 µm, and the asci to 50–55 µm long. See also notes under *C. sp. 1*.

***Chaenothecopsis* sp. 3 [= “*hypocenomyceae*”]**

Shingle pin

Habitat/Range: Parasitic; rare over the scales/squamules of *Hypocenomyce scalaris* (see Part 1) on dry conifer wood in humid intermontane old-growth forests at lower elevations, local distribution poorly known; global distribution unknown.

Reactions: All spot tests negative.

Variability: Unknown.

Notes: *Chaenothecopsis* sp. 3 is closely allied with *C. pusilla*, and is perhaps more appropriately included with that species. The occurrence over *Hypocenomyce*, however, appears to be diagnostic. Other characters include the dull greenish/aeruginose stalks and apothecial heads (check under LM), the pale, 2-celled (weakly septate) spores to 6 x 2 µm, and the asci to 30 µm long.

***Chaenothecopsis* sp. 4 [= “*sphaerica*”]**

Ball-headed pin

Habitat/Range: Saprobiic and parasitic; rare over wood (very rare over bark) of conifers, especially redcedar (*Thuja*), in hypermaritime and especially humid intermontane (ICH) old-growth forests at lower elevations, local distribution poorly known; global distribution unknown.

Reactions: All spot tests negative.

Variability: Low.

Notes: Diagnostic for this species are the long, black, threadlike apothecial stalks (to more than 1 mm long), the globose black apothecial heads, the pale, blunt-tipped, 1-celled spores, and the occurrence over wood. Other characters include the blackish stalks (check under LM) and the asci to 33 µm long.

***Chaenothecopsis* sp. 5 [= “*aeruginosa*”]**

Earmuff pin

Habitat/Range: Saprobitic and parasitic; infrequent over bark of conifers in humid intermontane (ICH) old-growth forests at lower elevations, local distribution poorly known; global distribution unknown.

Reactions: All spot tests negative.

Variability: Low.

Notes: This species is closely allied with *C. pusilla*. Diagnostic characters include the dark greenish/aeruginose apothecial heads (view under LM), the 2-celled spores that are laterally thickened and blackish in the vicinity of the septum (view at 1000x), and the occurrence over conifer bark. Other characters include the typically whitish excipulum, the weakly septate (or in part nonseptate) spores to 6–9 (–11) x 3–4 µm, and the asci to 40–50 µm long.

***Chaenothecopsis* sp. 6 [= “*albopes*”]**

Tip-up pin

Habitat/Range: Parasitic; rare over sorediate lichen crusts on upturned roots of conifers in humid intermontane (ICH) old-growth forests at lower elevations, local distribution poorly known; global distribution unknown.

Reactions: All spot tests negative.

Variability: Medium.

Notes: The white-pruinose stalks, the pale, 2-celled, weakly septate spores to 7 x 2.5 µm, and the association with sorediate lichen crusts on upturned roots are diagnostic. Other characters include the asci to 35 µm long.

***Chaenothecopsis* sp. 7 [= “*viridis*”]**

Green pin

Habitat/Range: Probably saprobic. Rare over wood of conifers in humid coastal old-growth forests at lower elevations, local distribution poorly known; global distribution unknown.

Reactions: All spot tests negative.

Variability: Unknown.

Notes: Diagnostic characters include the dull greenish/aeruginose apothecia (check under LM), the pale, 1-celled, pointed-tipped spores to 7–8 x 2–3 µm, the occurrence over wood, and the apparently strictly coastal distribution. Other characters include the asci to 40 µm long.

Chaenothecopsis sp. 8 [= “*rufescens*”]

Birch pin

Habitat/Range: Probably saprobic. Rare over wood of birch (*Betula*) in humid intermontane and coastal forests at lower elevations, local distribution poorly known; global distribution unknown.

Reactions: Stalk H+ reddish (not bleeding).

Variability: Unknown.

Notes: The H+ reddish (but non-bleeding) stalks (check under LM) and the association with birch are diagnostic. *Chaenothecopsis debilis* is similar, but in that species the stalk yields a K+ violet reaction that bleeds outward. Other characters include the blackish colour of the stalks (check under LM), the medium brown, distinctly septate, 2-celled spores to 7–9 x 3–4 µm, and the asci to 40 µm long. The material may belong with *C. exilis* Tibell, ined.

Chaenothecopsis sp. 9 [= “*viridipusilla*”]

White-collar pin

Habitat/Range: Probably parasitic. Rare over wood of conifers in humid intermontane and coastal old-growth forests at lower elevations, local distribution poorly known; global distribution unknown.

Reactions: All spot tests negative.

Variability: Unknown.

Notes: *Chaenothecopsis* sp. 9 is closely allied with *C. pusilla*, and is perhaps more appropriately included with that species. Diagnostic characters include the dark greenish/aeruginose apothecial heads (check under LM), the pale stalks (check under LM), the medium brown, weakly septate, 2-celled spores to 7–8 x 3–3.5 µm, the occurrence over conifer wood, and, perhaps, the association with *Calicium glaucellum*.

Medium-sized to **large** stratified fruticose (**shrub**) lichens, consisting of (short-lived) primary crusts (often not readily seen), and perennial, erect secondary stems/podetia, these **pale greyish, greenish, or yellowish**, except often darkening at base and often brownish at the tips, round in cross-section, slender to rather stout, **to 40–110 (–140) mm long** and 0.6–1.5 (–2) mm wide, dull, minutely textured (check under hand lens), **noncorticate**, brittle, **hollow, richly branched**, the branches often divisible into primary branches and secondary branches; branching even/isotomic or uneven/anisotomic, generally in twos (dichotomies), threes (trichotomies), or fours (tetrachotomies), the outermost branches often curved to one side; **branch axils often open** (ours). Soredia, isidia, and pseudocyphellae absent. Medulla white, consisting of a soft outer surface and a hard, glassy inner surface (= stereome). Attached to substrate by basal holdfasts, but often becoming in part unattached. Photobiont green, chlorococcoid: *Trebouxia*.

Ascocarp an apothecium, borne at podetia tips, disc brownish, convex to hemispherical. Spores 1-celled, oblong, colourless, eight per ascus. Pycnidia often present, black or brown, barrel-shaped or cylindric, borne at podetia tips, containing a colourless or red jelly.

Mostly over **acid soil, humus, and thin soil over rock**.

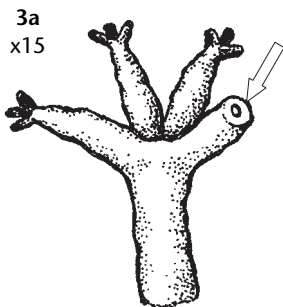
References: Ahti (1961); Thomson (1968); Ahti (1984); Ahti and Hyvönen (1985); Brodo and Ahti (1996).

Common Name: Traditional: alludes to the use of these lichens by reindeer and caribou as a winter food.

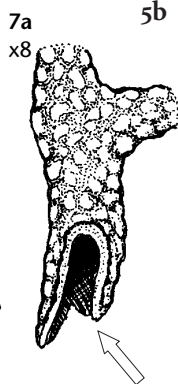
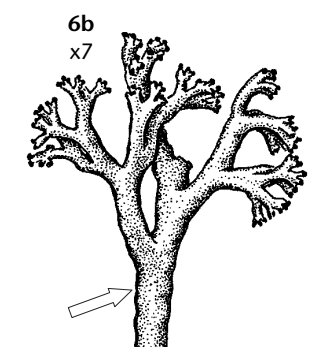
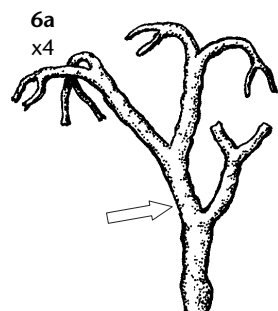
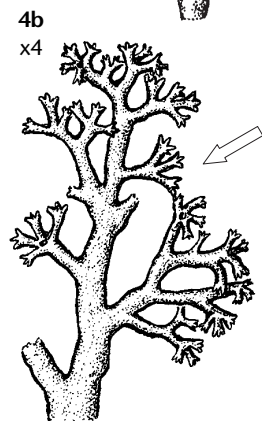
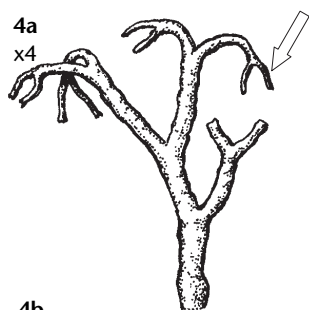
Notes: *Cladina* is a more or less cosmopolitan genus comprising approximately 35 species. Fourteen of these have been reported from North America, and seven from British Columbia. Some authors treat *Cladina* as a subgenus within *Cladonia*. Spot tests should be performed at the tips of the podetia.

KEY TO CLADINA AND SIMILAR LICHENS

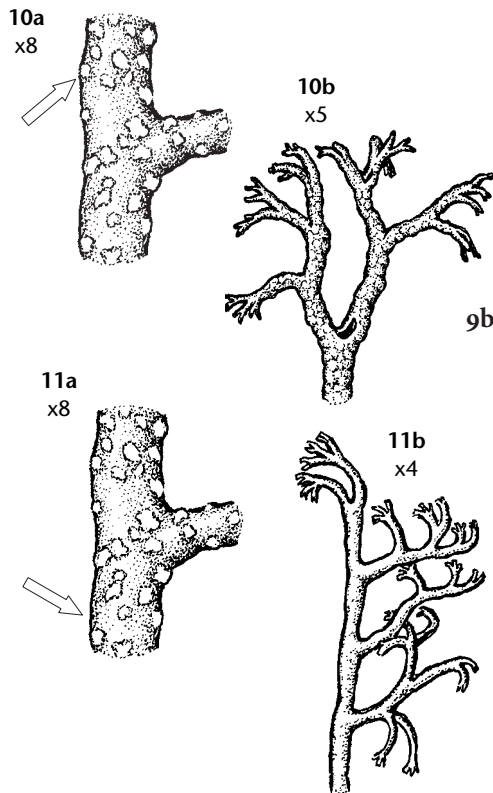
- 1a Surface of podetia tips PD+ red, orange, or yellow (allow at least 30 seconds); fumarprotocetraric acid or psoromic acid present 2
- 2a Podetia greenish yellow, KC+ yellow or apparently KC-, usnic acid present, K-, atranorin absent 3
- 3a Branching mostly in fours and fives (also in part in threes); main stems absent or indistinct; podetia tips densely woolly/tomentose(←), PD+ brilliant sulphur yellow (psoromic acid present); west of coast ranges *Cladina stellaris* (chemotype 2)
- 3b Branching mostly in twos and threes; main stems well developed and conspicuous; podetia tips sparsely tomentose to at most moderately tomentose, PD+ medium yellow, orange, or red (psoromic acid absent); distribution various 4



5 Prepared by Trevor Goward, Teuvo Ahti, and Irwin Brodo.



- 4a Branching mainly in twos(←); pycnidial jelly red; main stems to less than 0.8–1.2 mm wide; west of coast ranges . . .
 *Cladina ciliata* (chemotype 2)
- 4b Branching mainly in threes(←); pycnidial jelly colourless; main stems to more than 1–1.5 mm wide; widespread . . .
 *Cladina arbuscula* ssp. *beringiana*
- 2b Podetia greyish or greenish, but not at all greenish yellow, usnic acid absent or in very low concentration, KC-, K+ yellow or K-, atranorin present or absent 5
- 5a Podetia K-, atranorin absent; main stems occasionally to less than 0.8–1.2 mm wide; west of coast ranges 6
- 6a Main stems fine(←), to less than 0.8–1.2 mm wide; pycnidial jelly red. *Cladina ciliata* (chemotype 1)
- 6b Main stems rather coarse(←), to more than 1–1.5 mm wide; pycnidial jelly colourless. *Cladina rangiferina* (chemotype 2)
- 5b Podetia K+ yellow, atranorin present; main stems to more than 1–1.5 mm wide; widespread. 6
- 7a Basal portions of podetia uniformly black(←) (check inner wall); upper portions of podetia with a greenish or medium greyish cast (check sheltered branches); pycnidial jelly red (not always visible: scan tips of podetia at 40x, or prepare a squash mount of mature pycnidia under LM); apothecia rare; restricted primarily to wet sites and boulder beds *Cladina stygia*
- 7b Basal portions of podetia greyish or brownish (blackened areas at most scattered); upper portions of podetia generally with a whitish cast (rarely greenish or greyish); pycnidial jelly colourless; apothecia often present; colonizing both wet and dry sites . . .
 *Cladina rangiferina* (chemotype 1) (see 6b)
- 1b Podetial tips PD-; fumarprotocetraric and psoromic acids absent 8
- 8a Branching mainly in fours and fives (occasionally mainly in twos and threes, but branches then repeatedly evenly forking, and generally without distinct main stems); podetia tips densely woolly/tomentose (see 3a); forming compact, rounded “heads”; thallus UV+ ice-blue; essentially northern . . .
 *Cladina stellaris* (chemotype 1)
- 8b Branching mainly in twos or threes; main stems well developed and conspicuous; podetia tips sparsely tomentose to at most moderately tomentose; forming rather loose mats; UV-, UV+ dull greyish or UV+ ice-blue; distribution various 9
- 9a Podetia greyish or brownish, KC-, usnic acid absent; collected west of coast ranges 10



- 10a Surface of podetia with a loose, webby texture (check near branch tips), more or less patchy-areolate(←); areoles tiny, rounded, raised, wartlike, distributed over a translucent stereome (check basal portions); podetia K- (atranorin absent) *Cladina portentosa* ssp. *pacifica* (chemotype 2)
- 10b Surface of podetia with a compact texture, more or less continuous or, if in part patchy-areolate, then areoles flattened, distributed or not over a translucent stereome; podetia K+ yellow (atranorin present) *Cladonia wainioi*
- 9b Podetia greenish yellow, KC+ yellow or apparently KC-, usnic acid present; distribution various. 11
- 11a Surface of podetia more or less patchy-areolate; areoles tiny, rounded, raised, wartlike, distributed over a translucent stereome(←) (check basal portions); branching mainly in twos and threes; podetia UV+ strikingly ice-blue, perlatolic acid present; west of coast ranges *Cladina portentosa* ssp. *pacifica* (chemotype 1)
- 11b Surface of podetia more or less continuous or, if in part patchy-areolate, then translucent stereome absent; branching mainly in threes and fours, but also sometimes mainly in twos; podetia UV- or UV+ dull greyish, perlatolic acid absent; widespread, but scarce in coastal regions. *Cladina mitis*

Cladina arbuscula (Wallr.) Hale & W.L. Culb. ssp. *beringiana* (Ahti) Golubk.
(Syn. *Cladonia arbuscula* (Wallr.) Flotow ssp. *beringiana* Ahti; *Cladonia sylvatica* auct.)
Greater green reindeer (green reindeer moss; woodland reindeer moss; tree reindeer lichen; reindeer lichen)

Habitat/Range: Frequent over soil, moss, and mossy rock in open to somewhat sheltered sites at all forested elevations throughout, especially in humid regions, but less common in coastal regions, and essentially absent from exposed localities; western N Am - eastern Eurasia, N to sAK, AK, YU, wNT, S to WA, MT, OR, CO; AB.

Reactions: KC+ yellow or apparently KC-, PD+ yellow, orange, or red, UV- to UV+ bright medium blue.

Contents (major substances): Fumarprotocetraric, usnic, and isousnic acids.

Variability: Medium.

Notes: Diagnostic characters include the green branches and the PD+ yellow, orange, or red reaction; see also the comments under *C. mitis*. The taxonomic status of ssp. *beringiana* requires further study.

Cladina ciliata (Stirton) Trass

(Syn. *Cladina ciliata* (Stirton) Trass var. *tenuis* (Flörke) Ahti and M.J. Lai; *Cladina leucophaea* (Abbayes) Hale & W.L. Culb.; *Cladina tenuis* (Flörke) Hale & W.L. Culb.; *Cladonia leucophaea* Abbayes; *Cladonia tenuis* (Flörke) Harm.)

Least reindeer

Habitat/Range: [Both chemotypes] Frequent over moss or thin soil in open coastal bogs and outcrops at lower elevations, except apparently absent from the Queen Charlotte Islands; incompletely circumpolar, N to sAK, S to WA, (CA).

Reactions: Chemotype 1: KC+ yellow or apparently KC-, PD+ yellow, orange, or red.
Chemotype 2: PD+ yellow, orange, or red.

Contents (major substances): Chemotype 1: Fumarprotocetraric acid. Chemotype 2: Fumarprotocetraric and usnic acids.

Variability: Medium.

Notes: Diagnostic characters include the very slender podetia (mostly to less than 1 mm wide), the generally forking branches, and the hypermaritime distribution. Most of the British Columbia material belongs to chemotype 2. *Cladina rangiferina* occasionally yields a K- reaction, and may then be close to chemotype 1 of *C. ciliata*. The latter species, however, has red pycnidial jelly and is more slender.

Cladina mitis (Sandst.) Hustich

(Syn. *Cladina arbuscula* (Wallr.) Hale & W.L. Culb. ssp. *mitis* (Sandst.) Burgaz; *Cladonia arbuscula* ssp. *mitis* (Sandst.) Ruoss; *Cladonia mitis* Sandst.)

Lesser green reindeer (yellow reindeer lichen; green reindeer lichen)

Habitat/Range: Common over soil, humus, and acidic rocks in open to exposed inland sites at all elevations, also infrequent at alpine elevations in maritime regions; circumpolar, N to sAK, AK, YU, wNT, S to WA, ID, MT, OR, WY; AB.

Reactions: KC+ yellow or apparently KC-, PD- (or rarely PD+ yellow, orange, or red).

Contents (major substances): Usnic and rangiformic acids (and rarely fumarprotocetraric acid).

Variability: Medium.

Notes: The green branches, the PD- reaction, and the inland distribution are important diagnostic features. Also distinctive is the tendency of the primary branches to extend uninterrupted into the upper portion of the thallus; in the similar *C. arbuscula*, the primary branches generally divide rather low in the thallus. Some authors regard *C. mitis* as a subspecies of *C. arbuscula*, with which it appears to intergrade in some portions of its range. Rangiformic acid is diagnostic for *C. mitis*, but is occasionally present in low concentration, and can then be difficult to detect even with thin-layer chromatography.

Cladina portentosa (Dufour) Follmann ssp. ***pacifica*** (Ahti) Ahti
(Syn. *Cladina pacifica* (Ahti) Hale & W.L. Culb.; *Cladonia pacifica* Ahti)
Maritime reindeer (coastal reindeer)

Habitat/Range: [Both chemotypes] Common in bogs and over acid rock in open to exposed coastal sites at lower elevations; western N Am, N to sAK, S to WA, OR, CA.
Reactions: KC+ yellow or KC-, UV+ strikingly ice-blue.

Contents (major substances): Chemotype 1: Perlatolic and usnic acids. Chemotype 2: Perlatolic acid (and ursolic acid).

Variability: High.

Notes: Diagnostic features include the maritime distribution, the tendency for the branches to divide into twos and threes, the presence of discontinuous algal patches over the “glassy” surface of the podetia (check basal portions), and the UV+ ice-blue reaction. The chemotypes are often accorded taxonomic status as f. *pacifica* (Ahti) Ahti (= the greenish material) and f. *decolorans* (Ahti) Ahti (= the greyish form), respectively. Chemotype 2 can be confused with *Cladonia wainioi*, but that species is readily distinguished by its distinctly hard-corticate surface, and especially by its K+ yellow medullary reaction. The holotype locality of f. *pacifica* is at Whytecliffe, near Vancouver, whereas that of f. *decolorans* is on Graham Island in the Queen Charlotte Islands.

Cladina rangiferina (L.) Nyl.
(Syn. *Cladonia rangiferina* (L.) F.H. Wigg.)
Grey reindeer (reindeer moss; true reindeer lichen)

Habitat/Range: [Both chemotypes] Common over soil, humus, moss, and rocks in open to somewhat sheltered sites at all elevations throughout, circumpolar, N to sAK, AK, YU, wNT, S to WA, OR, (MT); AB.

Reactions: Chemotype 1: K+ pale yellow, PD+ yellow, orange, or red. Chemotype 2: PD+ yellow, orange, or red.

Contents (major substances): Chemotype 1: Fumarprotocetraric acid and atranorin.

Chemotype 2: Fumarprotocetraric acid.

Variability: Medium.

Notes: Field characters include the pale greyish “woollen sock” colour, and the often somewhat “windblown” appearance; see also the comments under *C. stygia*.
Chemotype 2 is apparently restricted to coastal localities, where it is rare.

Cladina stellaris (Opiz) Brodo

(Syn. *Cladina alpestris* (L.) Nyl.; *Cladina stellaris* (Opiz) Brodo var. *aberrans* (Abbayes) Ahti; *Cladonia aberrans* (Abbayes) Stuckenb.; *Cladonia alpestris* (L.) Rabenh.; *Cladonia alpestris* (L.) Rabenh. f. *aberrans* Abbayes)

Star-tipped reindeer (elegant reindeer; alpine reindeer moss; northern reindeer lichen)

Habitat/Range: [Both chemotypes] Frequent over soil, humus, moss, and acidic rock in open boreal and alpine sites, mostly north of 54°N, rare in coastal regions; circumpolar, N to sAK, AK, YU, wNT, S to BC, with outliers in WA, OR, CA, CO; AB.

Reactions: Chemotype 1: KC+ yellow or apparently KC-, UV+ strikingly ice-blue.

Chemotype 2: PD+ bright yellow (check branch tips), UV+ strikingly ice-blue.

Contents (major substances): Chemotype 1: Perlatolic and usnic acids. Chemotype 2: Perlatolic, psoromic, and usnic acids.

Variability: Medium.

Notes: Diagnostic field characters include the densely woolly podetia tips (check under hand lens), the lack of a distinct main stem, and the northern distribution. Each of the two chemotypes was formerly accorded taxonomic status as var. *aberrans* (Abbayes) Ahti and var. *stellaris*, respectively. Other names are listed in the synonymy, above.

Cladina stygia (Fr.) Ahti

(Syn. *Cladonia stygia* (Fr.) Ruoss)

Black-footed reindeer (black-base reindeer lichen; red-nosed reindeer)

Habitat/Range: Frequent over moss in open bogs and dry heaths in open coastal and inland localities, mostly north of 54°N, probably rare in bogs farther south; circumpolar, N to sAK, AK, wNT, S to WA; AB.

Reactions: K+ pale yellow, PD+ yellow, orange, or red.

Contents (major substances): Atranorin and fumarprotocetraric acid.

Variability: Medium.

Notes: *Cladina stygia* closely resembles *C. rangiferina*, but is uniformly black within, especially in the basal portions; by contrast the inner wall of *C. rangiferina* is predominantly pale or brown, with only scattered blackish patches. This overlooked species is probably common in some regions of northeastern British Columbia.

Small to medium-sized stratified squamulose (scale) or fruticose (club/shrub) lichens, or both, consisting of basal squamules and/or upright stalks/podetia.

Basal squamules decumbent to semi-erect or erect, pale bluish, **greenish**, yellowish green, or brownish above, and whitish or rarely yellowish below (except often grading to orangish, brownish, or blackish at point of attachment), rounded to elongate, to **0.5–20 (–50) mm long and 0.2–10 mm wide**, incised or not, dull to occasionally somewhat shiny, smooth or minutely roughened, corticate above, **noncorticate below**, generally rather brittle, thin or thick, sorediate or more often lacking soredia, attached at margin. Medulla white (or occasionally orange at point of attachment), or rarely pale yellow. **Podetia erect** or occasionally semi-erect, pale whitish, greyish, greenish, yellowish green, or brownish (occasionally becoming black, brown, or orangish below), round in cross-section or rarely flattened, to **5–100 mm tall** and 0.5–5 (–6) mm wide, dull to occasionally rather shiny, smooth to minutely roughened or weakly tomentose, corticate or not, rather brittle, **hollow**, unbranched to richly branched, **terminating in pointed, blunt, cupped or open tips**; cups, if present, often proliferating from the margins or cup centres, or both; branching even/isotomic to uneven/anisotomic. Soredia, tile-like areoles and/or squamules present or not over podetia. Isidia and pseudocyphellae absent. Medulla white. Attached to substrate by basal holdfasts. Photobiont green, chlorococcoid.

Ascomycarp an apothecium, borne at podetia tips (rarely on basal squamules), **disc brownish (including pale waxen brown) or red**, convex to hemispherical. Spores 1-celled, oblong to somewhat spin-

dle-shaped/fusiform, colourless, eight per ascus. Pycnidia often present, borne at podetia tips or, less often, on basal squamules, black, brown or reddish, usually pear-shaped to cylindrical,

Mostly **over ground**: soil, humus, decaying logs, occasionally also bark of living trees.

References: Thomson (1968, 1984); Stenroos (1989, 1989a, 1990); Ahti (1993); Hammer (1995); Brodo and Ahti (1996); Ahti (1998).

Common Name: *Cladonia* is a morphologically complex genus comprising several distinct growth forms. For convenience, its species have been accorded any of several different “genus” names, most of which are descriptive.

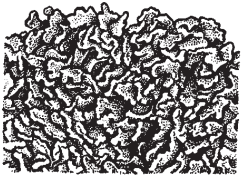
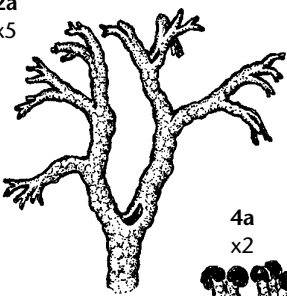

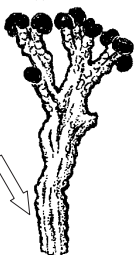
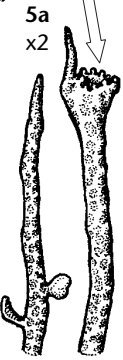
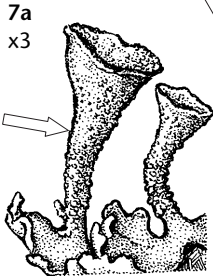
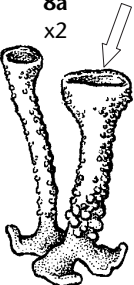
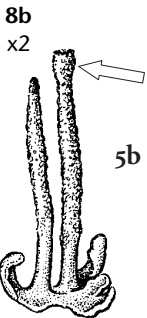
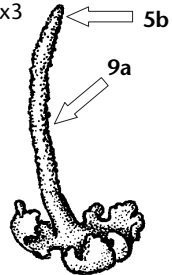
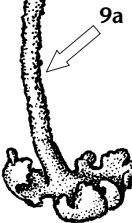
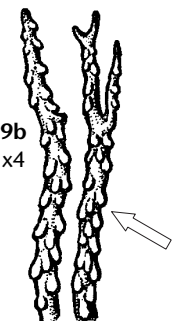
Notes: *Cladonia* is a cosmopolitan genus consisting of approximately 400 species worldwide. One hundred and twenty-six of these occur in North America, and 70 in British Columbia. Many specimens containing fumarprotocetraric acid yield a K⁺ yellowish cortical or medullary reaction that soon turns dingy brown. This reaction, however, is without diagnostic value, and is omitted from the species accounts. Indistinct medullary reactions with uv are also generally omitted, as are the following minor satellite compounds: belidiflorin, confumarprotocetraric acid, conpsoromic acid, convirensic acid, decarboxythamnolic acid, norrangiformic acid, protocetraric acid, and 4-o-demethylbarbatic acid. The presence in some species of usnic acid confers a characteristic “yellow-green” hue. With practice, such material is usually readily distinguished from greyish, “non-yellow” specimens in which usnic acid is lacking.

⁶ Prepared by Trevor Goward, Teuvo Ahti, and Irwin Brodo.

KEYS TO *CLADONIA* AND SIMILAR LICHENS

Note: Ten morphological groups can be recognized within *Cladonia*, as outlined below.

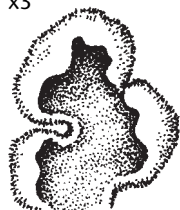
Synopsis

- 1a** x12 
- 1a** Podetia absent; thallus consisting entirely of basal squamules GROUP A (page 109)
- 1b** Podetia present; basal squamules present or absent 2
- 2a** Podetia much branched to richly branched . . . GROUP B (page 112)
- 2b** Podetia unbranched to once or twice branched 3
- 3a** At least some podetia tips opening by a gaping hole(←) GROUP C (page 114)
- 3b** Podetia tips not at all opening by a gaping hole (Note: all specimens key here in which openings are restricted to other portions of the podetia, and the upper portion of the podetia is dull-tomentose) 4
- 4a** Podetia distinctly longitudinally ribbed or fibrous(←) GROUP D (page 115)
- 4b** Podetia not distinctly longitudinally ribbed or fibrous (Note: specimens bearing soredia or forming distinct cups, or both, key here) 5
- 5a** At least some podetia terminating in distinct cups(←) 6
- 6a** Cortex with a distinct yellowish cast (usnic acid present) (Note: specimens bearing red apothecia key here, regardless of podetia colour) GROUP E (page 116)
- 6b** Cortex not distinctly yellowish (usnic acid absent or in low concentration) 7
- 7a** Podetia bearing at least some soredia(←) (check upper portions) 8
- 8a** Cups broad(←), the largest ones to more than 2.5 times wider than the width of the supporting stalk GROUP F (page 118)
- 8b** Cups narrow(←), the largest ones to less than 2.5 times wider than the width of the supporting stalk GROUP G (page 119)
- 7b** Podetia lacking soredia GROUP H (page 121)
- 5b** Podetia not at all cupped(←) 9
- 9a** Podetia bearing soredia or corticate granules(←), or both (check upper portions) GROUP I (page 124)
- 9b** Podetia lacking soredia and corticate granules (Note: dorsiventral squamules(←) and/or microsquamules may, however, be present) GROUP J (page 128)
- 2a** x5 
- 3a** x3 
- 4a** x2 
- 5a** x2 
- 7a** x3 
- 8a** x2 
- 8b** x2 
- 5b** x3 
- 9a** 
- 9b** x4 

GROUP A: PODETIA ABSENT

Note: The following key incorporates only those species in which podetia are frequently lacking.

2a
x3



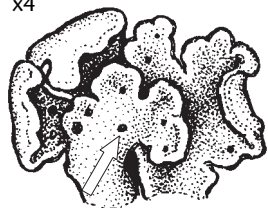
- 1a Cortex distinctly yellowish (usnic acid present), lower surface of squamules K- or K+ finally dingy brown, PD- (except K+ strong yellow and PD + strong yellow in *C. bellidiflora* and *C. digitata*), generally becoming orangish near point of attachment (check larger squamules) 2
- 2a Lower surface thick, spongy, bright lemon-yellow throughout *Cladonia luteoalba*
- 2b Lower surface not distinctly spongy, at least in part whitish. 3
- 3a Medulla K+ strong yellow (thamnolic acid present) 4
- 4a Squamules generally fine-soresdiate over lower surface, to 5–10 (–15) mm long; widespread *Cladonia digitata*
- 4b Squamules lacking soresdia over lower surface, averaging to 2–6 (–12) mm long; west of coast ranges. *Cladonia bellidiflora* (chemotype 2)
- 3b Lower surface K- or K+ finally dingy (thamnolic acid absent) 5
- 5a Lower surface UV+ strikingly ice-blue 6
- 6a Didymic acid present. *Cladonia metacorallifera*
- 6b Didymic acid absent. 7
- 7a Zeorin present (fine needle-like crystals radiating from the thalli of old specimens), squamatic acid absent *Cladonia carneola* (rare UV+ form)
- 7b Zeorin absent (needle-like crystals absent), squamatic acid present. 8
- 8a Squamules to more than 4 mm long; over decaying wood and mossy soil; mostly east of coast ranges *Cladonia sulphurina*
- 8b Squamules to less than 4 mm long; mostly confined to thin humus over rock, but habitat more variable in coastal regions; widespread *Cladonia bellidiflora* (chemotypes 1 and 3)
- 5b Lower surface UV- or UV+ dull blue. 9
- 9a Zeorin present (copious needle-like crystals radiating from the thalli of old specimens); barbatic acid present or absent *Cladonia carneola*, *C. coccifera*, *C. deformis*, *C. pleurota*
- 9b Zeorin absent (needle-like crystals absent); barbatic acid present *Cladonia borealis*
- 1b Cortex not at all yellowish (usnic acid absent); lower surface of squamules K+ strong yellow or K-, PD+ yellow, orange, or red, or PD-, whitish or brownish at point of attachment (except orangish in *C. digitata* and occasionally orangish in *C. umbricola*) 10

14a
x10

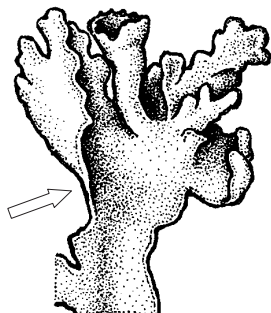


- 10a Over bark or wood; lower surface sorediate or not 11
 - 11a Lower surface K+ strong yellow; thamnolic acid present (Note: species with copious soredia key here) 12
 - 12a Lower surface and margins of squamules lacking soredia; widespread in humid localities 13
 - 13a Lower surface of larger squamules in part yellow or orange at point of attachment; squamules to more than 1 mm wide *Cladonia umbricola* (chemotypes 3 and 4)
 - 13b Lower surface of larger squamules white or dark at point of attachment, never yellow or orange; squamules occasionally to less than 1 mm wide *Cladonia squamosa*
 - 12b Lower surface of squamules weakly to strongly sorediate; mostly east of coast ranges 14
 - 14a Largest squamules to less than 2.5 mm long and 1.7 mm wide; lower surface of largest squamules white at point of attachment; over hard wood; east of coast ranges *Cladonia parasitica*
 - 14b Largest squamules to more than 2.5 mm long and 1.7 mm wide; lower surface of largest squamules yellow or orange at point of attachment; over bark, mossy bark, or decaying wood; distribution various 15
 - 15a Soredia generally copious, more or less broadcast over lower surface of squamules; largest squamules generally to more than 6 mm long; east of coast ranges *Cladonia digitata*
 - 15b Soredia generally sparse, more or less restricted to apical portions of lower surface; largest squamules generally to less than 6 mm long; widespread in humid localities. *Cladonia umbricola*
 - 11b Lower surface K-, K+ pale yellow, or K+ finally dingy brown; thamnolic acid absent 16
 - 16a Lower surface PD-; squamules deeply incised 17
 - 17a Barbatic acid present; widespread in humid climates *Cladonia norvegica*
 - 17b Barbatic acid absent; at lower elevations in humid climates 18
 - 18a Squamules 1–3 mm long, 0.5–3 mm wide *Cladonia squamosa* (chemotype 1)
 - 18b Squamules 1.5–7 mm long, 2–7 mm wide *Cladonia umbricola* (chemotypes 1 and 2)
 - 16b Lower surface PD+ yellow, orange, or red (Note: specimens in which apothecia are borne directly on the squamules key here) *Cladonia coniocraea*, *C. ochrochlora*
- 10b Over soil, humus, moss, or rock; lower surface lacking soredia 19
 - 19a Lower surface PD+ immediately strong sulphur yellow (psoromic acid present) 20
 - 20a Largest squamules averaging to less than 3 mm long *Cladonia acuminata* (chemotype 2)
 - 20b Largest squamules to more than 7 mm long. 21

21b
x4



24a
x3



19b Lower surface PD-, PD+ slowly yellow, or PD+ medium orange or red (psoromic acid absent) 22

22a Lower surface distinctly K+ yellow, orange, or red 23

23a Lower surface soon K+ orange or red; norstictic acid present *Cladonia acuminata* (chemotype 1)

23b Lower surface remaining K+ yellow; norstictic acid absent 24

24a Largest squamules to more than 20 mm long(←); lower surface bearing corticate patches; west of coast ranges *Cladonia schofieldii* (chemotype 2)

24b Largest squamules to 3–15 mm long; lower surface lacking corticate patches; widespread 25

25a Medulla PD+ yellow, orange, or red; fumarprotocetraric acid present *Cladonia macrophyllodes*

25b Medulla PD-; fumarprotocetraric acid absent *Cladonia symphyrcarpia*

22b Lower surface K- or K+ finally dingy brown 26

26a Squamules to less than 4 mm tall (check growing portions); directly over soil, rock, or sand (Note: specimens in which the squamules are more or less decumbent key here) 27

27a Squamules in large part erect; lower surface conspicuous as viewed from above 28

28a Lower surface generally white as viewed from above; squamules to less than 2.5 mm long *Cladonia cariosa*

28b Lower surface often in part violet grey; squamules to more than 2.5 mm tall *Cladonia cervicornis* s. lat.

27b Squamules mostly decumbent or weakly ascending; lower surface generally not conspicuous as viewed from above 29

29a Squamules horizontally oriented, entirely obscuring the substrate; over strongly base-rich soil or rock; east of coast ranges *Cladonia pocillum*

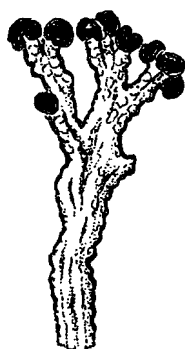
29b Squamules ascending, usually not entirely obscuring substrate; over acidic to weakly base-rich soil or rock; wide-spread *Cladonia pyxidata*

26b Squamules to more than 5 mm tall; over soil, sand, humus, or moss 30

30a Largest squamules often to more than 20 mm long (see 24a); lower surface bearing corticate patches; hypermaritime regions; rare *Cladonia schofieldii* (chemotype 1)

30b Largest squamules to 5–15 mm long (see 28b); lower surface lacking corticate patches; widespread; frequent *Cladonia cervicornis*

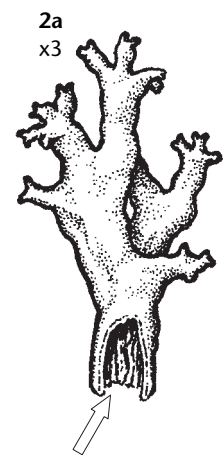
28a
x3



28b
x3



GROUP B: PODETIA RICHLY BRANCHED



1a Podetial surface with a distinctly yellowish cast (usnic acid present), KC+ yellow or apparently KC- 2

2a Inner medullary wall (= stereome) distinctly roughened or fibrous, or both(←); branch tips PD+ yellow, orange, red, or PD-; at lower elevations, west of coast ranges. 3

3a Branch tips PD- *Cladonia kanewskii*

3b Branch tips PD+ yellow, orange, or red 4

4a Podetial surface PD+ bright yellow at podetia tips only; lower portions of podetia PD- [*Cladonia nipponica*]

4b Podetial surface PD+ yellow, orange or red throughout ... [*Cladonia alaskana*]

2b Inner medullary wall smooth or at least not distinctly roughened or fibrous; branch tips PD-; distribution various. 5

5a Podetia lacking a cortex: podetial surface appressed-cottony, matte ... (see key to *Cladina*)

5b Podetia distinctly corticate (at least in part); podetial surface compact, dull or shiny 6

6a Podetia proportionately rather stout(←), especially when fertile (occasionally slender in coastal regions); branch axils at least in part open; podetia tips lacking cups; medulla UV+ ice-blue or UV- (squamic acid present or absent, barbatic acid absent); widespread ... *Cladonia uncialis*

6b Podetia proportionately slender(←); branch axils open or closed; podetia tips cupped or not; medulla UV- (squamic acid absent, barbatic acid present); east of coast ranges *Cladonia amaurocraea*

1b Podetial surface not at all distinctly yellowish (usnic acid absent), KC- (Note: specimens with a K+ yellow cortex key here) 7

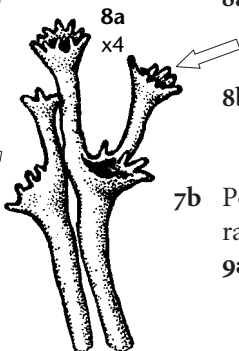
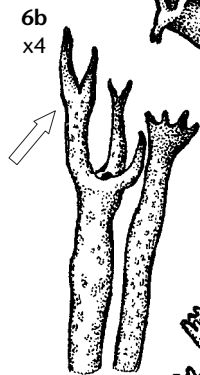
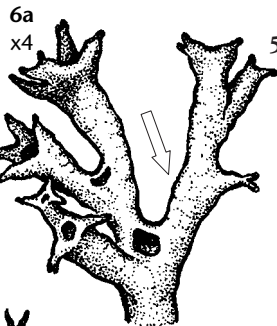
7a Podetia tips regularly expanding as open cups (Note: specimens with a K+ strong yellow and PD+ sulphur yellow medulla key here) 8

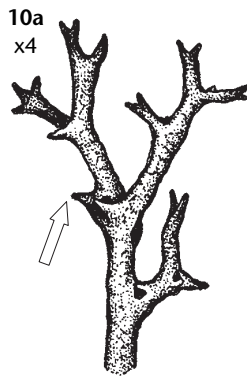
8a Largest cups strongly flaring(←), to more than 1.5 mm wide; branch axils also in part distinctly flaring; podetia slender to more often stout; widespread *Cladonia crispata* var. *crispata*

8b Largest cups at most weakly flaring(←), to less than 1.5 mm wide; branch axils not at all flaring; podetia slender; west of coast ranges ... *Cladonia crispata* var. *cetrariiformis*

7b Podetia tips pointed or expanding, but not distinctly open (except partly perforated in *Cladonia multiformis*) 9

9a Medulla PD- (check podetia tips); merochlorophaeic acid or squamic acid present; at present known only from hypermaritime localities; rare (Note: specimens with a UV+ ice-blue medulla key here) 10



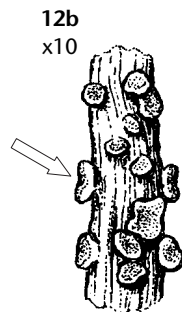
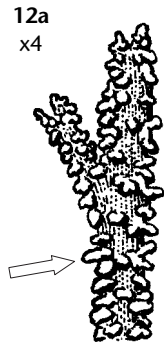


10a Podetia at least in part "thorny" (←), generally dark brownish throughout, more or less continuously corticate, not at all resembling *Cladonia rangiferina*; stereome (i.e., inner wall of podetia) blackening, at least in part (check basal portions); medulla K-, UV+ ice-blue; squamatic acid present; merochlorophaeic acid absent. *Cladonia subfurcata*

10b Podetia not "thorny," generally pale brownish, at most discontinuously corticate, often resembling *Cladonia rangiferina*; stereome not at all blackening; medulla K+ yellow, UV-; squamatic and merochlorophaeic acids present *Cladonia wainioi*

9b Medulla PD+ yellow, orange, or red; merochlorophaeic and squamatic acids absent; distribution and frequency status various 11

11a Podetia more or less distinctly longitudinally ribbed; podetial microsquamules numerous. 12

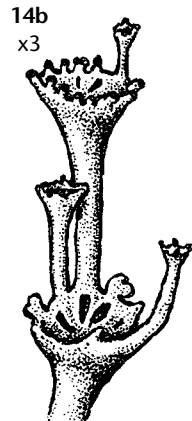


12a Podetial squamules attached by their basal portions, oriented more or less at right angles to surface of podetia (←); podetial surface whitish, distinctly granulose; cortex K+ yellow, medulla K+ yellow or K-; atranorin present; over somewhat base-rich soils; widespread. *Cladonia acuminata*

12b Podetial squamules peltate (attached by their central portions), oriented more or less parallel to surface of podetia (←); cortex and medulla K-; atranorin absent; over acidic soils; primarily alpine *Cladonia macrophylla*

11b Podetia not at all distinctly ribbed; podetial squamules absent to numerous. 13

13a Podetia tips and/or branch axils bearing flaring cups, these closed, but often somewhat sieve-like with minute perforations 14

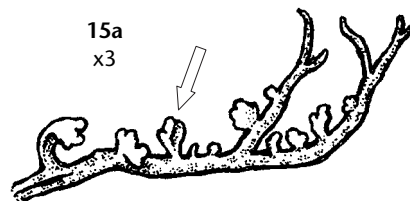


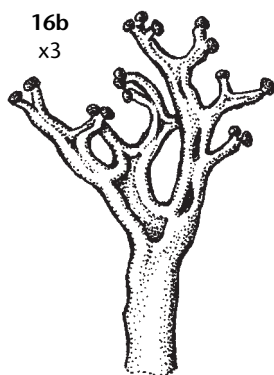
14a Basal portion of podetia white (←); terminal portion of podetia often soft, dull, distinctly cobwebby/arachnoid; west of coast ranges *Cladonia prolifica*

14b Basal portion of podetia brownish or blackish; terminal portion of podetia distinctly hard-corticate; east of coast ranges *Cladonia multififormis* (narrow variant)

13b Podetia uncupped or bearing gaping, cuplike openings, these restricted to branch axils, not at all sieve-like; distribution various (Note: the following taxa are not yet satisfactorily elucidated) 15

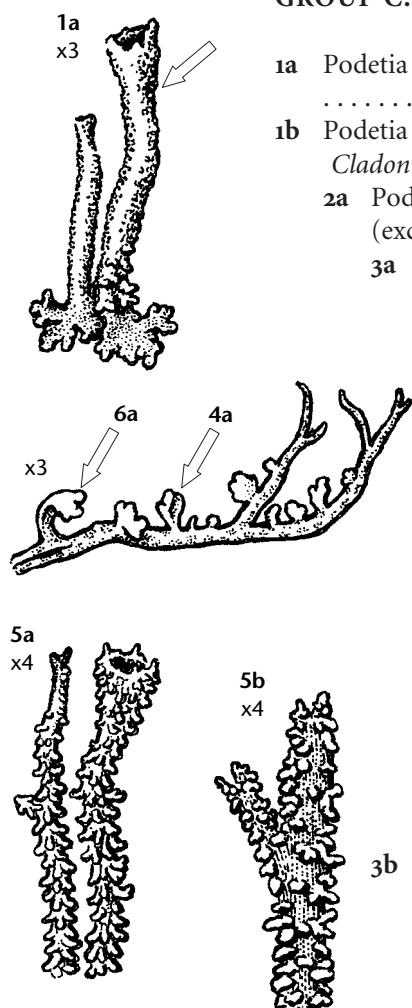
15a Terminal portions of podetia generally in part lacking a cortex, often furnished with soredia, corticate granules and/or detachable microsquamules, these sometimes extending downward into the middle or basal portions of the podetia; podetial squamules sparse to abundant, more or less asymmetrically arranged, the largest ones restricted to the "upper" side of the podetia (←); apothecia generally absent; terminal portions of branches occasionally lacerate, but rarely flattened; west of coast ranges at lower elevations. *Cladonia scabriuscula*



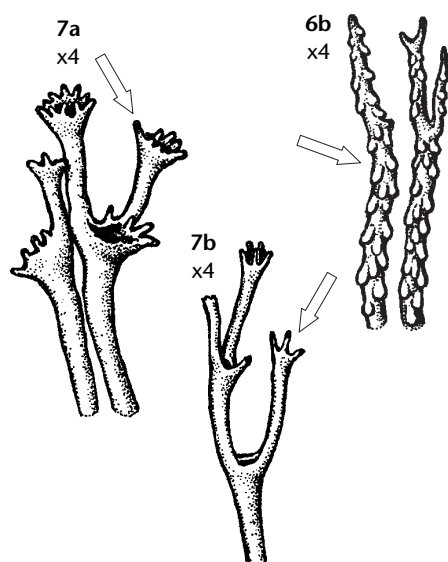


- 15b Terminal portions of podetia corticate more or less throughout, lacking soredia, corticate granules, and detachable microsquamules; podetial squamules absent to occasionally abundant, more or less symmetrically arranged around the podetia; apothecia present, the terminal portions of the supporting branches somewhat flattened or longitudinally lacerate, or both; distribution various. 16
- 16a Lower portion of main stems more or less distinctly flattened in cross-section; mostly east of coast ranges (but also in drier regions west of coast ranges, especially the Coastal Douglas-fir Zone) . . .
 *Cladonia multiformis* (fertile form)
- 16b Lower portion of main stems round in cross-section; in British Columbia, west of coast ranges. *Cladonia furcata* (fertile form)

GROUP C: PODETIA TIPS OPENING BY A GAPING HOLE

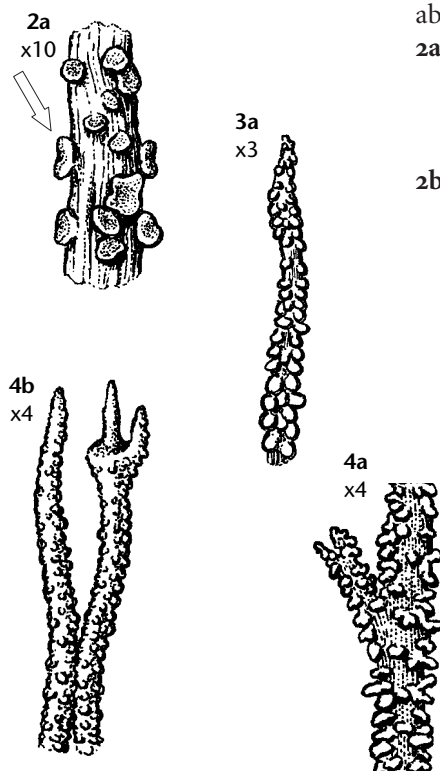


- 1a Podetia strongly and conspicuously sorediate(←) (check upper portions) . . .
 *Cladonia cenotea*
- 1b Podetia lacking soredia (or at most weakly and inconspicuously sorediate in *Cladonia scabriuscula*). 2
- 2a Podetial squamules abundant; podetial cortex sparse to at most discontinuous (except often continuous in *Cladonia singularis*). 3
- 3a Upper portion of podetia squamulose, but otherwise essentially noncorticate, more or less whitish; medulla K- or K+ strong yellow; distribution various 4
- 4a Squamules in part distinctly asymmetrically arranged around podetia, the largest ones restricted to the "upper" surface(←); lower half of podetia generally strongly corticate; medulla K- or K+ finally dingy brown; west of coast ranges. *Cladonia scabriuscula*
- 4b Squamules more or less symmetrically arranged around the podetia; lower half of podetia at most sparsely corticate; medulla K+ yellow or K-; distribution various. 5
- 5a Podetial squamules deeply incised, the largest ones often distinctly branching; medulla K+ strong yellow or K- (atranorin absent); squamatic acid or thamnolic acid present; over acidic soil, wood, or bark; widespread in humid regions *Cladonia squamosa*
- 5b Podetial squamules at most shallowly incised, not at all branching; medulla K+ medium yellow (atranorin present); norstictic acid or psoromic acid present; over base-rich soil or mossy boulders; east of coast ranges *Cladonia acuminata*
- 3b Upper portion of podetia squamulose and abundantly corticate, greenish, brownish, or at least not whitish; medulla K-; west of coast ranges 6
- 6a Medulla PD+ yellow, orange, or red; podetial squamules thin, in part distinctly asymmetrically arranged around podetia, the largest ones restricted to the "upper" surface, strongly reflexed(←); podetia whitish, greenish, or brownish; at lower elevations *Cladonia scabriuscula*

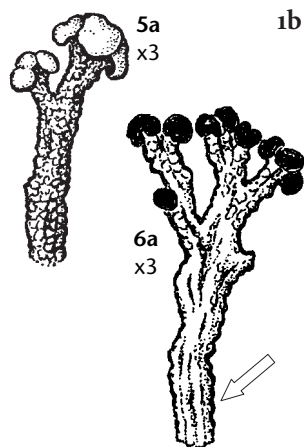


- 6b Medulla PD-; squamules thin or distinctly thick, more or less symmetrically arranged around the podetia, the largest ones generally scarcely reflexed(←); podetia brownish; most common near treeline *Cladonia singularis*
- 2b Podetial squamules absent or at most sparse; podetial cortex discontinuous to continuous 7
- 7a Largest apical cups distinctly flaring(←), to more than 1.5 mm wide; branch axils also in part distinctly flaring; podetia slender to more often stout; widespread *Cladonia crispata* var. *crispata*
- 7b Largest apical cups scarcely flaring(←), to less than 1.5 mm wide; branch axils not at all flaring; podetia slender; mostly west of coast ranges *Cladonia crispata* var. *cetrariiformis*

GROUP D: PODETIA LONGITUDINALLY RIBBED OR FIBROUS

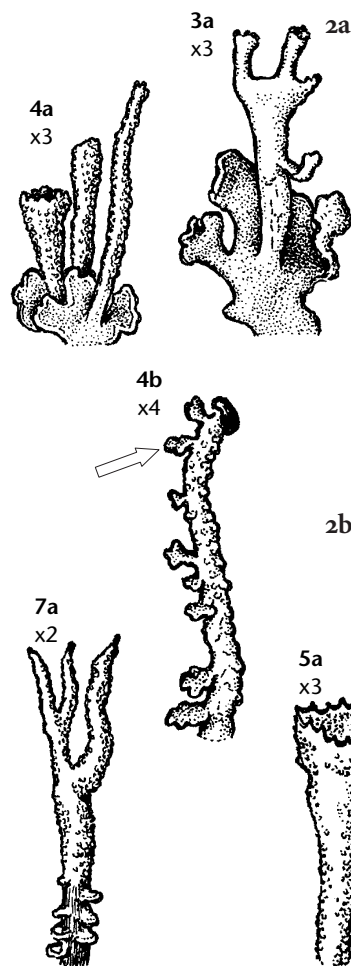


- 1a Podetia more or less densely squamulose (check basal portions), otherwise essentially lacking a cortex, to more than 20 mm tall; apothecia generally absent 2
- 2a Podetial squamules peltate (attached by the central portions of the lower surface), oriented more or less parallel to surface of podetia(←) (check lower portions of podetia); medulla PD+ strong yellow (psoromic acid present); alpine *Cladonia macrophylla*
- 2b Podetial squamules not at all peltate (except occasionally minutely peltate in *Cladonia verruculosa*, restricted to lower elevations), attached by basal portions, shingle-like or oriented more or less perpendicular to surface of podetia; medulla PD+ yellow, orange, or red or PD- (psoromic acid present or absent) 3
- 3a Medulla PD-; perlatolic acid present *Cladonia decorticata*
- 3b Medulla PD+ yellow, orange, or red; perlatolic acid absent. 4
- 4a Upper portion of podetia unbranched to much branched; podetial medulla compact, cartilaginous, often somewhat glassy, darkening only in extreme basal portions, or not at all darkening; podetia tips often PD+ strong yellow; norstictic or psoromic acid present *Cladonia acuminata*
- 4b Upper portion of podetia unbranched to sparsely branched; podetial medulla more or less soft, longitudinally fibrous (check darkened areas), not at all glassy, generally conspicuously darkening in basal portions; podetia tips PD+ medium yellow, orange, or red, but never PD+ strong yellow; fumarprotocetraric acid present *Cladonia verruculosa*

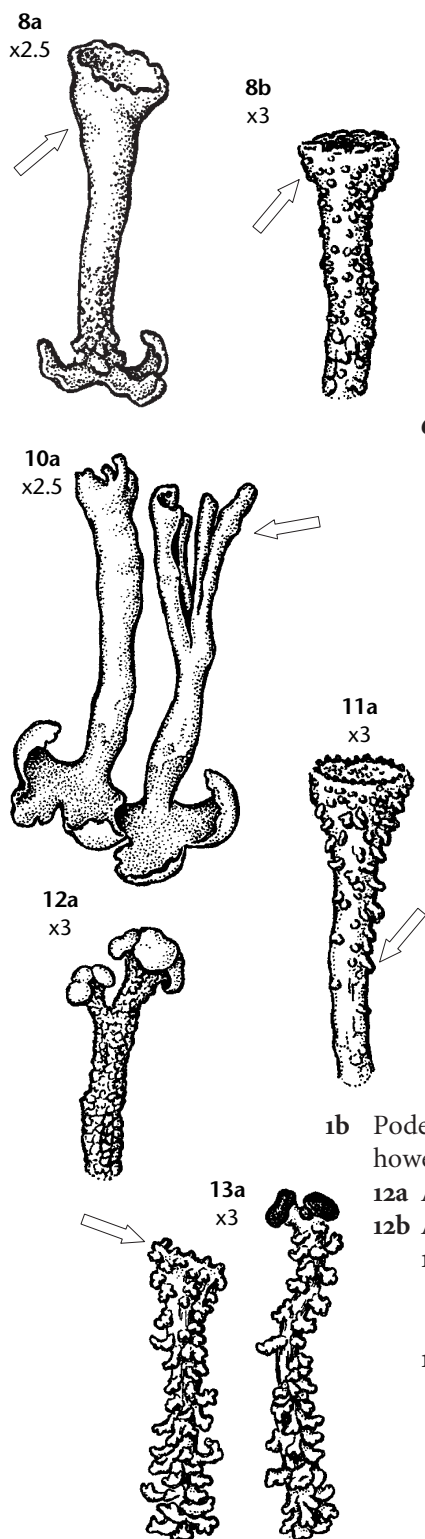


- 1b Podetial squamules, if present, confined to basal portions; podetia often strongly corticate, to less than 20 mm tall; apothecia present 5
- 5a Over decaying wood; apothecia pale brown; podetia with a distinctly yellowish cast, K-, KC+ yellow or KC-; usnic acid present; atranorin absent *Cladonia botrytes*
- 5b Over soil or mossy rock; apothecia dark brown; podetia not at all yellowish, K+ yellow; KC-; usnic acid absent; atranorin present 6
- 6a Basal squamules to less than 2.5 mm tall, ascending more or less throughout; basal portions of podetia invariably roughened(←) and more or less patchy-corticate; semi-arid habitats *Cladonia cariosa*
- 6b Basal squamules to more than 2.5 mm tall, only the apical portions ascending; basal portions of podetia often rather smooth and continuously corticate; semi-arid to humid habitats *Cladonia symphyrcarpia*

GROUP E: PODETIA YELLOWISH, CUPPED

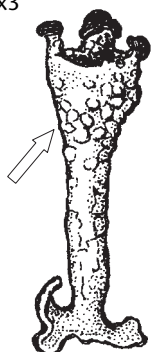


- 1a Podetia bearing soredia or corticate granules, or both. 2
- 2a Medulla K+ strong yellow or orange, PD+ yellow or orange (check podetia tips) 3
- 3a Basal squamules to 5–10 (–15) mm long, at least in part densely sorediate; largest cups to more than 2.5 times wider than the width of the supporting stalk (check well-developed cups); east of coast ranges. *Cladonia digitata*
- 3b Basal squamules to 2–5 (–7) mm long, sorediate or not; largest cups generally less than 2.5 times wider than the width of the supporting stalk; distribution various 4
- 4a Upper portions of podetia bearing fine/farinose soredia, these grading downward into granular soredia; podetial squamules absent or at most confined to basal portions; widespread in humid regions *Cladonia umbricola* (chemotype 4)
- 4b Upper portions of podetia bearing more or less corticate granules, these grading downward into squamules; podetial squamules not confined to basal portions(←); west of coast ranges *Cladonia transcendens*
- 2b Podetial medulla K- or K+ finally dingy brown, PD- 5
- 5a Rim of sterile cups distinctly and regularly dentate, resembling a crown(←); apothecia, if present, pale brown; pycnidia dark brown *Cladonia carneola*
- 5b Rim of cups more or less even, or at least not pointed-crownlike; apothecia, if present, red; pycnidia dark brown or red (Note: specimens with basal squamules more than 5 mm long key here) 6
- 6a Medulla UV- or UV+ dull whitish (squamatic acid absent: check freshly scraped podetial surface); zeorin present (copious needle-like crystals radiating from old specimens) 7
- 7a Podetia tall and distinctly slender, generally less than 1.5 mm wide at maturity (check basal portions), usually distinctly tapering upward to the cup; basal portions often “bruised”-bluish; barbatic acid present; zeorin absent; mossy boulder beds; east of coast ranges. *Cladonia cyanipes*



- 7b Podetia often rather short and moderately broad, generally more than 1.5 mm wide at maturity, often not distinctly tapering upward to the cup; basal portions never bluish; barbatic acid absent; zeorin present; habitat ecology and distribution various (Note: specimens in which the cup is distinctly broader than the stalk key here) 8
- 8a Podetia bearing fine/farinose soredia(←); soredia at maturity covering most of podetia, or occasionally confined to the upper third; east of coast ranges. *Cladonia deformis*
- 8b Podetia bearing corticate granules or distinctly granular soredia, or both(←); soredia, if present, confined at maturity to the cupped, upper portions of podetia; widespread *Cladonia pleurota*
- 6b Medulla UV+ strikingly ice-blue (squamatic acid present); zeorin absent (except present in *C. coccifera*) 9
- 9a Upper portions of podetia bearing fine/farinose soredia 10
- 10a Cups to more than 3 mm wide; podetia bearing only fine/farinose soredia; cups often irregular at maturity; podetia often distinctly torn lengthwise(←); east of coast ranges *Cladonia sulphurina*
- 10b Cups to 1–2.5 mm wide (see 4a); podetia bearing farinose soredia in upper portions and granular soredia in lower portions; cups more or less regular at maturity; podetia not torn; widespread in humid regions. . . *Cladonia umbricola* (chemotype 2)
- 9b Upper portions of podetia bearing corticate granules; farinose soredia absent. 11
- 11a At least lower portions of podetia densely covered in detachable microsquamules(←); didymic acid present; widespread *Cladonia metacorallifera*
- 11b Lower portions of podetia variously roughened or squamulose, or both, but never densely covered in detachable microsquamules; didymic acid absent; west of coast ranges [*Cladonia granulans*]
(see *Cladonia metacorallifera*)
- 1b Podetia lacking soredia and corticate granules (detachable microsquamules may, however, be present) 12
- 12a Apothecia present, pale brownish *Cladonia botrytes*
- 12b Apothecia red or apothecia absent. 13
- 13a Largest cups to less than 2.5 times wider than the width of the supporting stalk(←); podetia 10–40 mm tall; medulla K- or K+ strong yellow, UV- or UV+ strikingly ice-blue. *Cladonia bellidiflora*
- 13b Largest cups to more than 2.5 times wider than the width of the supporting stalk; podetia 7–20 mm tall; medulla K-, UV-, UV+ dull or UV+ strikingly ice-blue 14

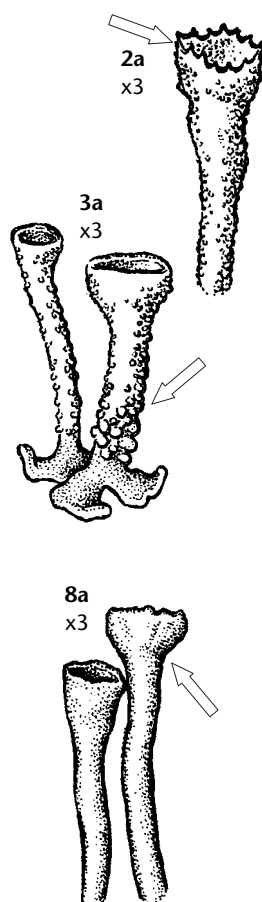
14a
x3



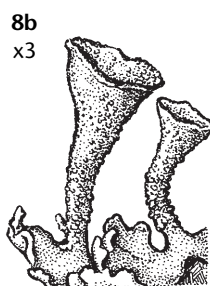
- 14a Upper portions of podetia essentially lacking squamules and detachable microsquamules(←); medulla UV+ dull blue; zeorin and didymic acids absent. *Cladonia borealis*
- 14b Upper portions of podetia bearing numerous dorsiventral squamules or detachable microsquamules, or both; medulla UV-, UV+ dull blue or UV+ strikingly ice-blue; zeorin or didymic acid present. 15
- 15a Podetial squamules generally sparse throughout; podetia more or less distinctly corticate; medulla UV- or UV+ dull blue; zeorin present; didymic acid absent; copious needle-like crystals radiating from old specimens *Cladonia coccifera*
- 15b Podetial squamules generally dense throughout, especially in lower portions (see 11a); podetia otherwise essentially noncorticate; medulla UV+ strikingly ice-blue; zeorin absent; didymic acid present; needle-like crystals also absent. *Cladonia metacorallifera*

GROUP F: PODETIA SOREDIATE OR GRANULAR, BROADLY CUPPED, NOT YELLOWISH

Note: Many of the following species—members of the *Cladonia chlorophaea* and *fimbriata* groups—are “chemical species” that require detailed chemical analysis (e.g., thin-layer chromatography) for reliable identification.

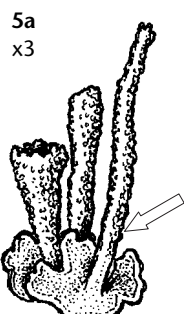


- 1a Medulla PD- (check tips of podetia). 2
- 2a Rim of sterile cups distinctly and regularly dentate, resembling a crown(←); apothecia, if present, pale brown. *Cladonia carneola* (pale form)
- 2b Rim of cups more or less even, not at all pointed-crownlike; apothecia, if present, dark brown. 3
- 3a Lower half of podetia bearing copious detachable microsquamules(←); merochlorophaeic acid present; common. *Cladonia merochlorophaea*
- 3b Lower half of podetia generally bearing few if any detachable microsquamules; grayanic acid present; rare *Cladonia grayi*
- 1b Medulla PD+ yellow, orange, or red (fumarprotocetraric acid present) 4
- 4a Podetial surface K+ persistent yellow (atranorin present) [*Cladonia humilis* (chemotype 1)]
- 4b Podetial surface K- or K+ finally dingy brown (atranorin absent) 5
- 5a Soredia present, predominantly fine/farinose, to less than 0.08 mm (80 µm) in diameter; granulose soredia, if present, restricted to lower half of podetia 6
- 6a Homosekikaic acid present; medulla UV+ ice-blue; west of coast ranges; rare. *Cladonia homosekikaica*
- 6b Homosekikaic acid absent; medulla UV+ ice-blue or UV-; widespread; common 7
- 7a At least some podetia lacking cups, or cups irregular, or both *Cladonia* sp. 1
- 7b Podetia invariably cupped; cups regular 8
- 8a Podetia trumpet-shaped: stem proportionately tall and narrow, typically flaring abruptly upward to the cup; soredia generally in part more than one layer deep over external portions of the cup(←) (check at point of attachment with stalk) *Cladonia fimbriata*

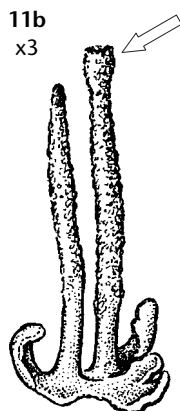
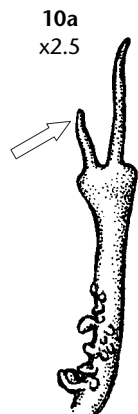
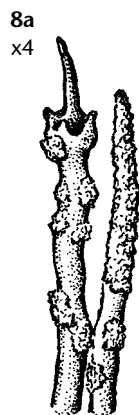
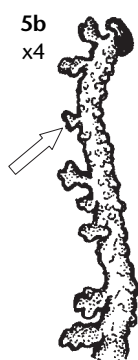


- 8b Podetia goblet-shaped: stem proportionately short and stout, flaring gradually upward to the cup; soredia generally only one layer deep over external portions of the cup *Cladonia chlorophaea* (young form)
- 5b Soredia absent or, if present, predominantly granular, to more than 0.08 mm (80 µm) in diameter; powdery soredia, if present, confined to vicinity of cups 9
- 9a Podetia distinctly blackening toward base(←) (check inner walls of older podetia); proliferations, if present, occasionally arising in part from cup centres; common in humid forests at lower elevations *Cladonia albonigra*
- 9b Podetia pale or brownish, but not at all blackening; proliferations, if present, arising strictly from cup margins; frequency and habitat ecology various 10
- 10a Containing fumarprotocetraric acid alone; common, widespread *Cladonia chlorophaea*, *C. asahinae* (chemotype 3)
- 10b Containing fumarprotocetraric acid as well as one or more other lichen substances; abundance and distribution various 11
- 11a Containing bourgeanic, homosekikaic, rangiformic, or protolichesterinic acid; west of coast ranges 12
- 12a Homosekikaic acid present. *Cladonia homosekikaica*
- 12b Homosekikaic acid absent 13
- 13a Containing bourgeanic acid [*Cladonia humilis* (chemotype 2)]
- 13b Containing rangiformic or protolichesterinic acids *Cladonia asahinae* (chemotypes 1 and 2)
- 11b Containing grayanic or merochlorophaeic acid; distribution various 14
- 14a Containing grayanic acid; rare, inland *Cladonia grayi*
- 14b Containing merochlorophaeic acid; frequent, widespread *Cladonia merochlorophaea*

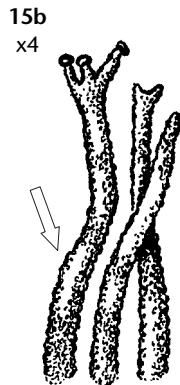
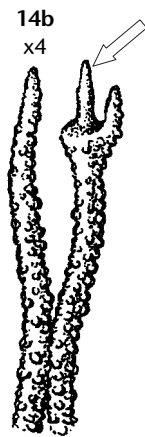
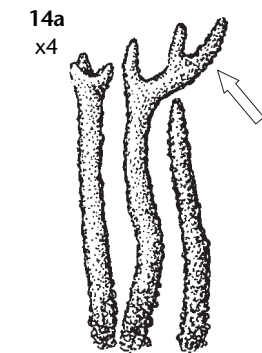
GROUP G: PODETIA SOREDIATE OR GRANULAR, NARROWLY CUPPED, NOT YELLOWISH



- 1a Medulla PD- (check podetia tips); restricted to lower elevations 2
- 2a Podetia less than 5 mm tall at maturity, K+ strong yellow; over hard wood; east of coast ranges *Cladonia parasitica*
- 2b Podetia more than 8 mm tall at maturity, K-; over soil, bark, or soft, decaying wood; distribution various 3
- 3a Podetia dirty brownish; apothecia, if present, brown; medulla UV+ dull blue; homosekikaic acid present; east of coast ranges *Cladonia rei* (see 15b)
- 3b Podetia whitish or greenish; apothecia, if present, red; medulla UV+ strikingly ice-blue; squamatic acid present; widespread in humid regions *Cladonia umbricola* (chemotypes 1 and 2) (see 5a)
- 1b Medulla PD+ yellow, orange, or red; occurring at lower, middle, or upper elevations 4
- 4a Medulla K+ strong yellow; restricted to lower elevations 5
- 5a Upper portions of podetia bearing fine/farinose soredia, these grading downward to granular soredia(←); podetial squamules absent or at most confined to basal portions; widespread in humid regions *Cladonia umbricola* (chemotypes 3 and 4)

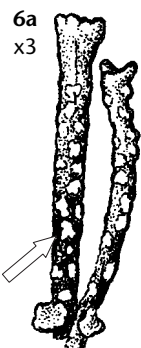
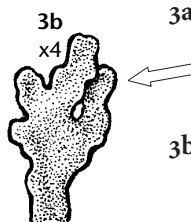
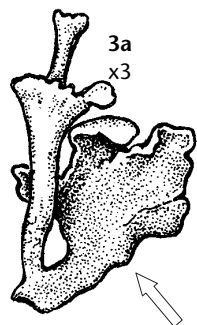


- 5b Upper portions of podetia bearing more or less corticate granules, these grading downward to podetial squamules; podetial squamules not confined to basal portions(←); west of coast ranges *Cladonia transcendens*
- 4b Medulla K- or K+ finally dingy brown (check podetia tips); distribution various 6
- 6a Podetial soredia in part borne in discrete patches 7
- 7a Podetia predominantly greyish green; podetial medulla thin or thick; widespread at all forested elevations *Cladonia ochrochlora*
- 7b Podetia predominantly brownish, or rarely greyish green; podetial medulla rather thin; lower to middle elevations 8
- 8a Basal squamules usually absent, or at most 1–3 mm long; podetia distinctly darkening in basal portions; cups 1–3 mm wide; widespread *Cladonia cornuta* ssp. *cornuta*
- 8b Basal squamules present, 1–6 mm long; podetia scarcely darkening in basal portions; cups 1.5–5 mm wide; mostly west of coast ranges *Cladonia cornuta* ssp. *groenlandica*
- 6b Podetial soredia diffuse, not at all borne in discrete patches, or soredia absent 9
- 9a Over bark or wood, including mossy bark or wood 10
- 10a Cups irregular, often bearing more than one marginal proliferation(←); podetial soredia grading downward to detachable microsquamules, these often extending upward into upper portions of podetia; west of coast ranges at lower elevations *Cladonia* sp. 1
- 10b Cups regular or occasionally irregular, seldom bearing more than one marginal proliferation; detachable microsquamules present only near base of podetia, or microsquamules absent; widespread 11
- 11a Podetia small, to 1 mm wide and 2.5 cm tall at maturity(←), rarely branched; cups developing only at maturity, sorediate, noncorticate within and without; podetial soredia often greenish or greyish; basal squamules 1–6 mm wide; lowlands *Cladonia coniocraea*
- 11b Podetia robust, to 1–2 mm wide and 3–7 cm tall at maturity(←), often somewhat branched; cups often present early in the development of podetia, corticate, generally lacking soredia within and without; soredia often whitish; basal squamules 1–11 mm wide; occurring at all forested elevations *Cladonia ochrochlora*
- 9b Over mineral soil, sand, or humus, including thin humus over rock . . . 12
- 12a Podetial soredia present, with a distinct greenish cast; podetia generally unbranched; basal squamules present, to 1–11 mm wide; open or shady sites 11
- 12b Podetial soredia absent or, if present, then greyish, brownish, or at least not distinctly greenish; podetia branching or not; basal squamules absent or at most to 1–3 mm wide; open sites 13
- 13a Basal portion of podetia distinctly blackening; podetia proliferating, if at all, from cup margins or cup centres, or both; soredia present or absent; homosekikaic acid absent 14



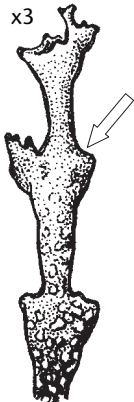
- 14a** Soredia and/or granules thick and abundant, generally more than one layer deep (check upper portions of podetia), at least in part completely obscuring the underlying podetia; podetia proliferating, if at all, strictly from cup margins; proliferations often somewhat resembling deer antlers(←) or, when young, moose antlers . . .
 *Cladonia subulata*
- 14b** Soredia and/or granules relatively sparse, generally only one layer deep, underlying podetia visible; podetia proliferating, if at all, from cup margins or cup centres, or both(←); proliferations generally not at all antlerlike . . .
 *Cladonia verruculosa*
- 13b** Basal portion of podetia not at all blackening; podetia proliferating, if at all, strictly from cup margins; soredia present; homosekikaic acid present or absent. 15
- 15a** Podetial soredia pale greyish (occasionally brownish), never distinctly mottled brown-and-white; cortex generally absent over basal portion of podetia; homosekikaic acid absent; widespread. *Cladonia subulata* (see 14a)
- 15b** Podetial soredia dirty brownish (occasionally pale greenish), often distinctly mottled brown-and-white(←); cortex often present over basal portion of podetia; homosekikaic acid present; east of coast ranges *Cladonia rei*

GROUP H: PODETIA AT LEAST PARTLY CUPPED, NEITHER SOREDIATE NOR GRANULAR, NOT YELLOWISH

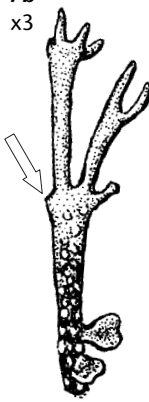


- 1a** Podetia proliferating predominantly from cup centres 2
- 2a** Basal squamules absent or at most sparse and inconspicuous (Note: all specimens with more than two to three-tiered podetia key here) . . .
 *Cladonia cervicornis* s. lat.
- 2b** Basal squamules numerous, conspicuous 3
- 3a** Basal squamules to more than 3–4 mm long, distinctly reflexed, rather broad, the broadest ones generally less than two times longer than wide(←); margins of cups often densely squamulose; atranorin present; east of coast ranges. *Cladonia macrophyllodes*
- 3b** Basal squamules to less than 3–4 mm long, distinctly reflexed or not, distinctly elongate, the broadest ones generally more than three times longer than wide(←); margins of cups rarely densely squamulose; atranorin absent; widespread *Cladonia cervicornis* s. lat.
- 1b** Podetia proliferating predominantly from cup margins, or proliferations lacking. 4
- 4a** Basal portion of podetia distinctly darkening to dark brownish or blackish 5
- 5a** Terminal portion of podetia soft, dull, distinctly cobwebby/arachnoid or appressed-tomentose (Note: specimens in which the podetia are in part pale-spotted against a black background key here) 6
- 6a** Pale-spotted rather coarse(←) (check at base of podetia); medulla and (pale portions of) cortex K+ persistent strong yellow (atranorin present); alpine; northern. *Cladonia trassii*
- 6b** Pale-spotted rather fine; medulla and cortex K- or K+ finally dingy brown (atranorin absent); distribution various. 7

7a
x3



7b
x3



7a Podetia to (1.0-)1.5–2.5 mm wide as measured below cups; cups generally distinctly wider than width of the supporting stalk(←); tomentum generally extending downward to at least mid-portions of podetia; podetia blackening only below the middle; pale-spotting therefore restricted to basal portions; east of coast ranges; lowland to subalpine elevations *Cladonia phyllophora*

7b Podetia to 0.5–1.5 mm wide; cups, if present, generally not much wider than width of the supporting stalk(←); tomentum often restricted to terminal portion of podetia; podetia often blackening upward into upper portions; pale-spotting therefore often conspicuous more or less throughout; widespread in cool sites, especially at alpine elevations *Cladonia stricta*

5b Terminal portion of podetia distinctly hard-corticate, often more or less shiny, at most only very weakly cobwebby/arachnoid 8

8a Podetia invariably cupped; cups to more than 2–3 mm wide at maturity *Cladonia gracilis* ssp. *turbinata*

8b At least some uncupped podetia present; cups to less than 2–3 mm wide at maturity (Note: specimens more than 70 mm tall key here) 9

9a Podetia to more than 1.5 mm in diameter (check basal portions) (Note: specimens more than 100 mm tall key here) 10

10a Podetial wall 0.02–0.04 mm (20–40 µm) thick, tough (check basal portion, especially in vicinity of convex areoles); medulla soft, rather loose; podetial cortex generally distinctly glossy; widespread in base-rich sites *Cladonia macroceras*

10b Podetial wall 0.01–0.02 mm (10–20 µm) thick, brittle; medulla rather hard, compact; podetial cortex dull to somewhat shiny, but not distinctly glossy; west of coast ranges in acidic sites *Cladonia gracilis* ssp. *vulnerata*

9b Podetia to less than 1.5 mm in diameter 11

11a Podetial wall 0.02–0.04 mm (20–40 µm) thick (check basal portion, especially in vicinity of convex areoles); medulla soft, loose; cortex glossy; podetia generally widest near base *Cladonia macroceras* (see 10a)

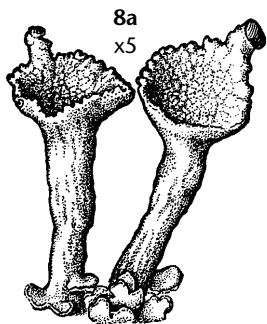
11b Podetial wall 0.01–0.02 mm (10–20 µm) thick; inner portion of medulla hard, compact; cortex dull or somewhat glossy; podetia generally no wider near base than in mid-portions 12

12a Basal portions of podetia distinctly blackening(←), not abundantly perforate; podetial squamules present or absent; cups, if present, well developed, narrow or broad; widespread; alpine to subalpine *Cladonia gracilis* ssp. *elongata*

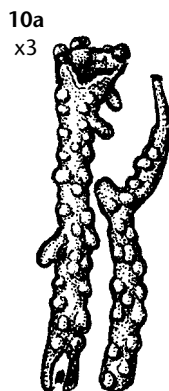
12b Basal portions of podetia pale brown or at least not blackening, abundantly perforate(←); podetial squamules absent; cups, if present, poorly developed, narrow; west of coast ranges at lower elevations *Cladonia gracilis* ssp. *vulnerata*

4b Basal portions of podetia yellowish, orangish, brownish, or at least not distinctly blackening 13

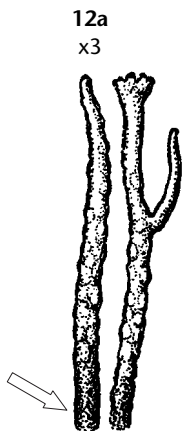
8a
x5



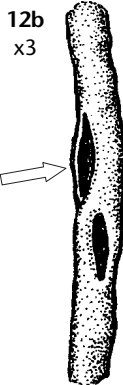
10a
x3

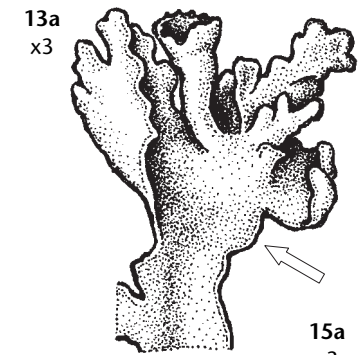


12a
x3



12b
x3





13a Basal squamules present, 4–50 mm long, equal to or surpassing length of podetia(←); west of coast ranges. *Cladonia schofieldii*

13b Basal squamules absent or at most 1–6 mm long, much less than length of podetia; distribution various 14

14a Medulla K+ distinctly yellow (atranorin or thamnolic acid present) 15

15a Podetia to 0.5–1.6 mm wide (excluding cups), often distinctly sinuous(←); podetial squamules absent or, if present, mostly confined to lower half of podetia; cups to 1–3.6 mm wide; mostly west of coast ranges, especially at lower to middle elevations *Cladonia ecmocyna* ssp. *occidentalis*

15b Podetia to 0.5–4 mm wide, generally not distinctly sinuous; podetial squamules present (rarely absent), confined to lower half of podetia or scattered throughout; cups to 1.5–10 mm wide; widespread at middle to alpine elevations. 16

16a Pruina generally abundant over at least upper third to upper half of podetia (check sheltered areas); podetial squamules numerous or sparse, scattered throughout *Cladonia ecmocyna* ssp. *intermedia* (typical form)

16b Pruina absent or sparse over upper third of podetia; podetial squamules sparse(←), mostly confined to basal portions *Cladonia ecmocyna* ssp. *intermedia* (alpine form)

14b Medulla K- or K+ finally dingy brown (atranorin and thamnolic acid absent or in low concentration) 18

17a Medulla PD- (fumarprotocetraric acid absent); west of coast ranges 18

18a Podetia bearing copious squamules(←), narrowly cupped; UV+ strikingly ice-blue (squamic acid present) *Cladonia bellidiflora* (chemotype 3)

18b Podetia at most sparsely squamulose, broadly cupped; UV+ white or pale blue (squamic acid absent) 19

19a Podetia short-stalked, to less than 5 mm long at maturity; medulla UV-; containing sphaerophorin *Cladonia imbricarica*

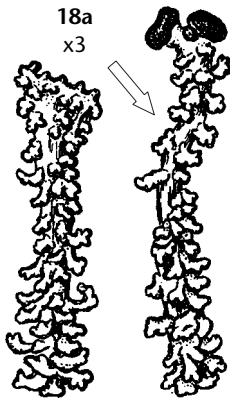
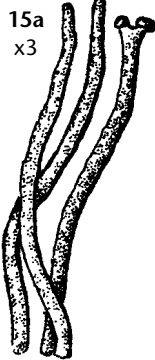
19b Podetia long-stalked, to more than 5 mm long at maturity; containing homosekikaic and sekikaic acids *Cladonia novochlorophaea*

17b Medulla PD+ yellow, orange, or red (fumarprotocetraric acid present); distribution various. 20

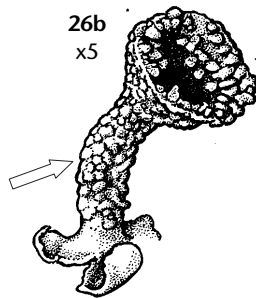
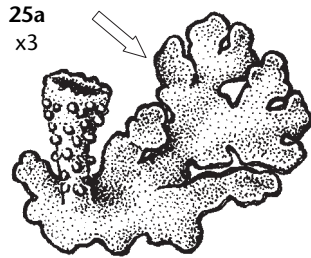
20a Cortex in terminal portions of podetia dull, soft, minutely cobwebby/arachnoid or appressed-tomentose; podetial squamules present 21

21a Tomentum extending downward to at least mid-portions of podetia; east of coast ranges *Cladonia phyllophora* (young form)

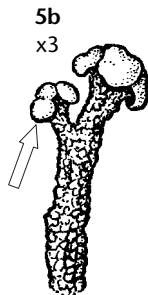
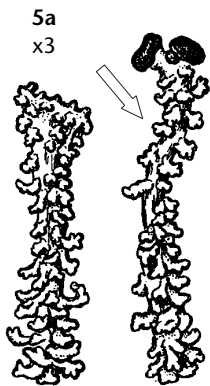
21b Tomentum generally restricted to terminal portions of podetia, or at least not extending downward to mid-portions; west of coast ranges *Cladonia prolifica*



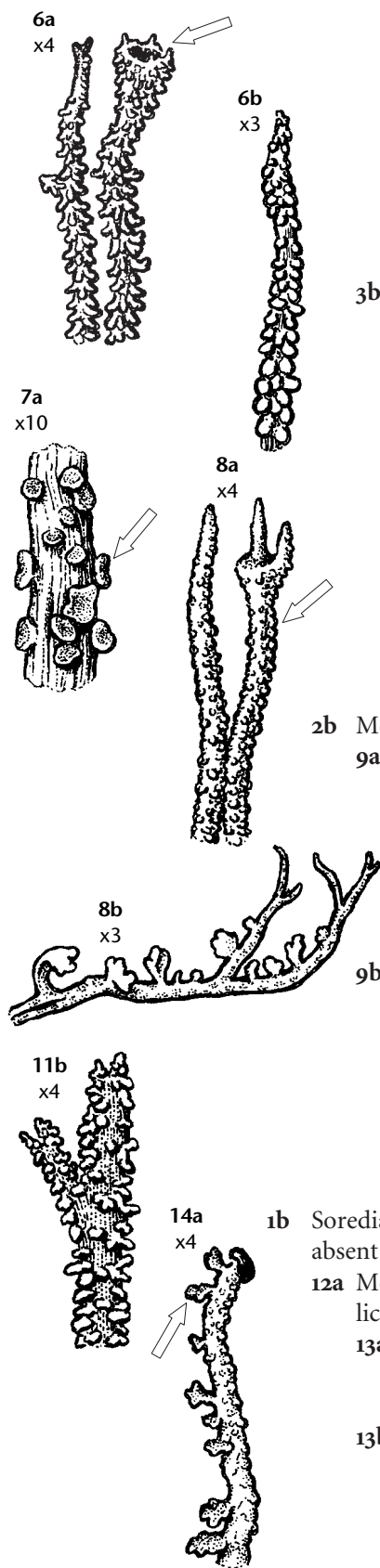
- 20b Cortex in terminal portions of podetia dull or shiny, apparently hard or at least not minutely tomentose; podetial squamules present or absent 22
- 22a Cup interiors smooth or at least not strongly convex-areolate or microsquamulose (check mature cups) 23
- 23a Podetia whitish; cups generally bearing numerous marginal proliferations *Cladonia prolifica* (nontomentose form)
- 23b Podetia greenish or brownish; cups generally bearing few or no marginal proliferations 8
- 22b Cup interiors containing strongly convex granules or areoles, or both, occasionally also microsquamulose 24
- 24a Cup margins generally oblique, bearing numerous proliferations, these to more than 10 mm tall, in part longitudinally fissured *Cladonia dimorpha*
- 24b Cup margins generally horizontal, lacking proliferations, or proliferations to less than 10 mm tall, not at all longitudinally fissured 25
- 25a Basal squamules horizontally spreading, distinctly overlapping, forming compact rosettes, often nearly foliose(←); over base-rich substrates *Cladonia pocillum*
- 25b Basal squamules ascending or erect, tufted or scattered, not forming compact rosettes, not at all foliose; over acidic or base-rich substrates 26
- 26a Podetial cortex continuous, warty or shingle-like/imbricate; basal squamules 1–2.5 mm long; medulla UV+ pale blue; homosekikaic acid present; rare; west of coast ranges *Cladonia novochlorophaea*
- 26b Podetial cortex discontinuous, plated/areolate(←); basal squamules 1–7 mm long; medulla UV- or UV+ pale blue; homosekikaic acid absent; common; widespread *Cladonia pyxidata*



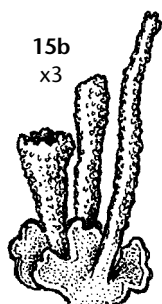
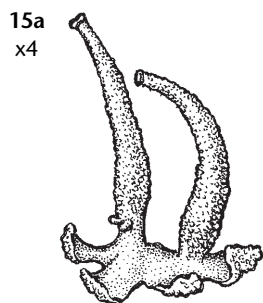
GROUP I: PODETIA SOREDIATE OR GRANULAR, UNCUPPED



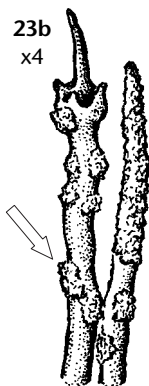
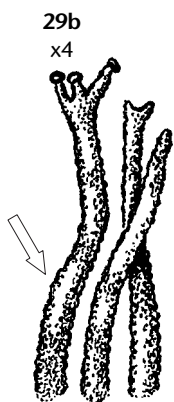
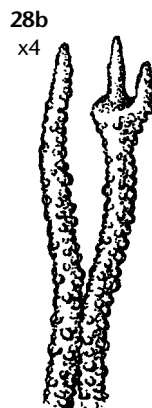
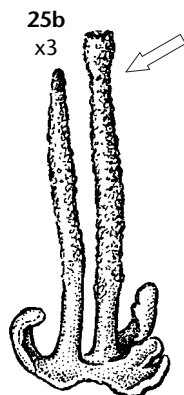
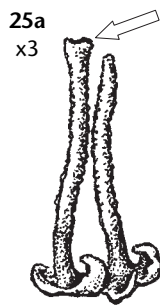
- 1a Podetial soredia absent or at most inconspicuous, restricted to extreme upper portions; corticate granules conspicuous over at least upper portions of podetia 2
- 2a Medulla K- or K+ finally dingy brown 3
- 3a Medulla PD-, UV+ strikingly ice-blue 4
- 4a Cortex with a somewhat yellowish cast (usnic acid present), KC+ yellow or apparently KC- 5
- 5a Podetia densely squamulose(←); apothecia absent or, if present, red; widespread *Cladonia bellidiflora* (chemotypes 1 and 3)
- 5b Podetia sparsely squamulose, or lacking squamules; apothecia present(←), pale brown; east of coast ranges *Cladonia botrytes*



- 4b Cortex not at all yellowish (usnic acid absent or in low concentration), KC- 6
- 6a At least some podetia tips opening by a gaping hole(←) (check carefully); podetial squamules deeply incised, the largest ones often distinctly branching; squamatic acid present; widespread in humid regions. *Cladonia squamosa* (chemotype 1)
- 6b Podetia tips not at all opening (disregard branch axils); podetial squamules at most shallowly incised, scarcely branching; perlatolic acid present; east of coast ranges *Cladonia decorticata*
- 3b Medulla PD+ yellow, orange, or red, UV- or UV+ pale blue. 7
- 7a Podetial squamules peltate (attached by their central portions), oriented more or less parallel to surface of podetia(←); east of coast ranges at middle to alpine elevations *Cladonia macrophylla*
- 7b Podetial squamules attached by the basal portions, oriented more or less perpendicular to surface of podetia; distribution various, but at lower elevations. 8
- 8a Soredia and/or corticate granules abundant over at least upper half of podetia(←); podetia brownish, not at all lacerate; widespread ...
..... *Cladonia verruculosa*
- 8b Soredia and/or corticate granules sparse over podetia, often restricted to apical portions, but occasionally extending downward; podetia greenish or brownish, often in part lacerate; west of coast ranges *Cladonia scabriuscula*
- 2b Medulla K+ strong yellow 9
- 9a Lower surface of larger squamules distinctly yellowish or orangish at point of attachment; apothecia, if present, red; west of coast ranges (Note: specimens with a yellowish cast key here) 10
- 10a Soredia present or absent (check podetia tips); podetial squamules sparse or abundant; over bark or wood. *Cladonia transcendens* (see 14a)
- 10b Soredia absent; podetial squamules abundant; over bark, wood, mineral soil, or moss. *Cladonia bellidiflora* (chemotype 2) (see 5a)
- 9b Lower surface of larger squamules white or brownish at point of attachment; apothecia, if present, brown; distribution various. 11
- 11a Podetial squamules deeply incised, the largest ones often distinctly branching; thamnolic acid present; west of coast ranges; over acidic substrates, especially bark *Cladonia squamosa* (chemotype 2) (see 6a)
- 11b Podetial squamules at most shallowly incised, not at all branching; norstictic and/or psoromic acids present; east of coast ranges; over base-rich substrates *Cladonia acuminata*
- 1b Soredia present over podetia, conspicuous over at least upper half; corticate granules absent or, if present, confined to lower portions of podetia. 12
- 12a Medulla K+ strong yellow, or PD+ strong yellow, or both; psoromic or thamnolic acid present. 13
- 13a Over base-rich soil or mossy boulders; apothecia, if present, brown; psoromic acid present; east of coast ranges ...
..... *Cladonia acuminata* (chemotype 2) (see 11b)
- 13b Over bark or wood; apothecia, if present, red; thamnolic acid present; coastal 14
- 14a Podetial squamules present more or less throughout(←); soredia granular. *Cladonia transcendens*

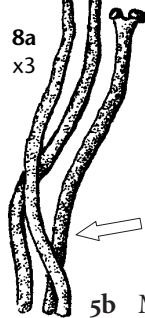
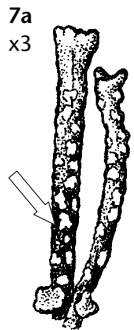
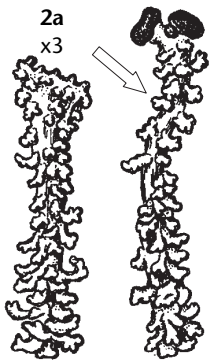


- 14b Podetial squamules absent or confined to basal portions; soredia fine/farinose or granular 15
- 15a Basal squamules 1–2 (–3) mm long, more or less shallowly lobed, usually rather thick; usnic acid absent *Cladonia macilenta* (chemotype 1)
- 15b Basal squamules 1.5–7 mm long, deeply lobed, thin; usnic acid present (Note: specimens with a yellowish cast key here) *Cladonia umbricola* (chemotypes 3 and 4)
- 12b Medulla K- and PD-, or at least not K+ strong yellow or PD+ strong yellow; psoromic and thamnolic acid absent 16
- 16a Medulla PD-; apothecia, if present, red or brown (Note: species with a yellowish green cast key here) 17
- 17a Cortex with a yellowish green cast, KC+ yellow or KC- (usnic acid present); apothecia, if present, red or pale brown. 18
- 18a Podetia to 20–80 mm tall, basal portions often somewhat dark bluish (“bruised”); over mossy rock (rare over decaying wood); east of coast ranges *Cladonia cyanipes*
- 18b Podetia to 5–25 mm tall, basal portions pale orangish or darkening, but never bluish; over bark or wood (rare over moss); distribution various. 19
- 19a Basal squamules 1–3 mm long; apothecia, if present, pale brown; medulla UV- or UV+ dull yellowish; barbatic acid present; east of coast ranges. *Cladonia bacilliformis*
- 19b Basal squamules 1.5–7 mm long; apothecia, if present, red; medulla UV+ strikingly ice-blue; squamatic acid present; widespread in humid regions *Cladonia umbricola* (chemotypes 1 and 2) (see 15b)
- 17b Cortex not yellowish, KC- (usnic acid absent or in low concentration); apothecia, if present, red, pale brown, or dark brown. 20
- 20a Podetial squamules abundant more or less throughout, absent only in uppermost portions; perlatolic acid present; east of coast ranges; over soil. *Cladonia decorticata* (see 6b)
- 20b Podetial squamules absent or confined to basal portions; perlatolic acid absent; distribution various; over soil, moss, or wood 21
- 21a Basal squamules 1–2 (–3) mm long, shallowly lobed, thin or rather thick; over soil, rock, wood, or bark in well-illuminated sites *Cladonia macilenta* (chemotype 2) (see 15a)
- 21b Basal squamules 1–7 mm long, deeply lobed, thin; over bark or wood, often in shaded sites. 22
- 22a Podetia terminating in pointed tips(←); basal squamules 1–3 mm long, the undersides whitish or dark brownish at point of attachment; apothecia, if present, pale brown; barbatic acid present; humid regions at all forested elevations. *Cladonia norvegica*
- 22b Podetia terminating in pointed tips or blunt tips, or both (see 15b); basal squamules 1.5–7 mm long, the undersides often orangish at point of attachment (check largest squamules); apothecia, if present, red; barbatic acid absent; humid regions at lower elevations *Cladonia umbricola* (chemotypes 1 and 2)

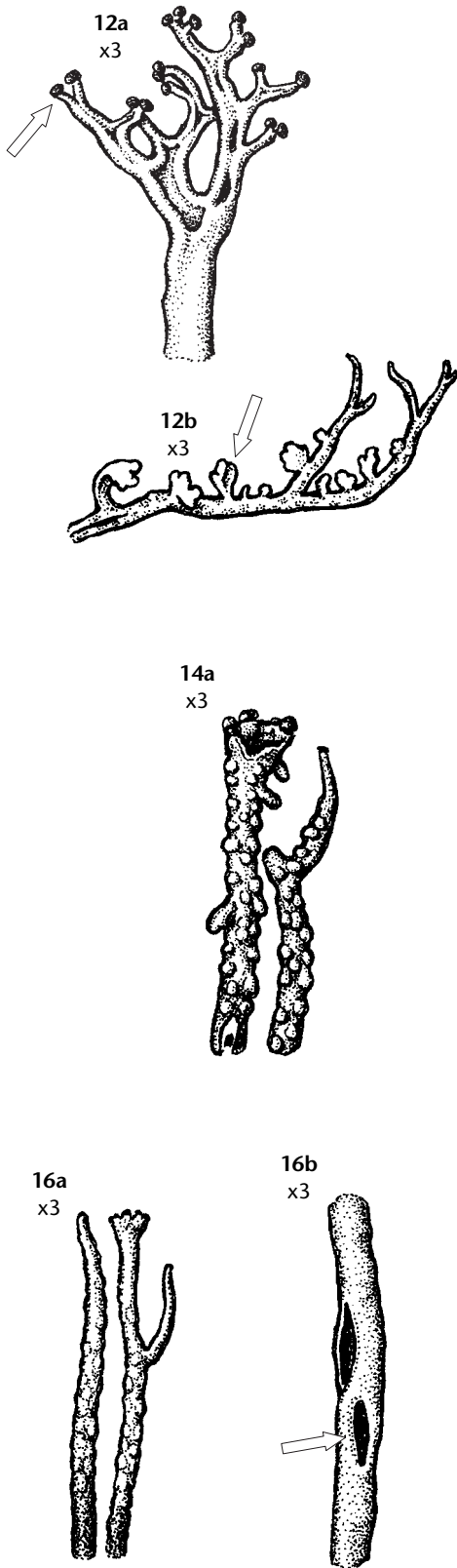


- 16b Medulla PD+ yellow, orange, or red; apothecia, if present, brown 23
- 23a Podetial soredia continuous, not at all borne in discrete patches 24
- 24a Over bark or wood, including mossy bark or wood 25
- 25a Podetia small, to 1 mm wide and 2.5 cm tall at maturity(←), rarely branched; soredia often greenish to greyish; basal squamules 1–6 mm wide, never deeply incised; lowlands *Cladonia coniocraea*
- 25b Podetia often robust, to 1–2 mm wide and 3–7 cm tall at maturity(←), often somewhat branched; soredia often whitish; basal squamules 1–11 mm wide, often deeply incised; occurring at all forested elevations *Cladonia ochrochlora*
- 24b Over mineral soil or humus, including thin humus over rock 26
- 26a Podetial soredia with a distinct greenish cast; podetia generally unbranched; basal squamules present, to 1–11 mm wide; open or shady sites 25
- 26b Podetial soredia greyish, brownish, or at least not distinctly greenish; podetia branching or not; basal squamules absent or at most to 1–3 mm wide; open sites 27
- 27a Basal portion of podetia distinctly blackening 28
- 28a Soredia and/or granules more than one layer deep (check upper portions of podetia), at least in part completely obscuring the underlying podetia; podetia often laterally branching, more or less resembling deer antlers(←) *Cladonia subulata*
- 28b Soredia and/or granules one layer deep, at most incompletely obscuring the underlying podetia; podetia mostly apically branched, never resembling deer antlers *Cladonia verruculosa*
- 27b Basal portion of podetia not at all blackening (Note: specimens containing homosekikaic acid key here) 29
- 29a Podetial soredia pale greyish (occasionally brownish), never distinctly mottled brown-and-white; cortex generally absent over basal portion of podetia; homosekikaic acid absent; widespread *Cladonia subulata* (see 28a)
- 29b Podetial soredia dirty brownish (occasionally pale greenish), often distinctly mottled brown-and-white(←); cortex often present over basal portion of podetia; homosekikaic acid present; east of coast ranges *Cladonia rei*
- 23b Podetial soredia discontinuous, at least in part borne in discrete patches(←) 30
- 30a Podetia predominantly brown or brownish green; podetial medulla generally rather thin; basal squamules absent or at most to 2–3 mm long *Cladonia cornuta* ssp. *cornuta*
- 30b Podetia predominantly grey-green; podetial medulla generally rather thick and tough; basal squamules present, to 2–8 mm long. *Cladonia ochrochlora* (see 25b)

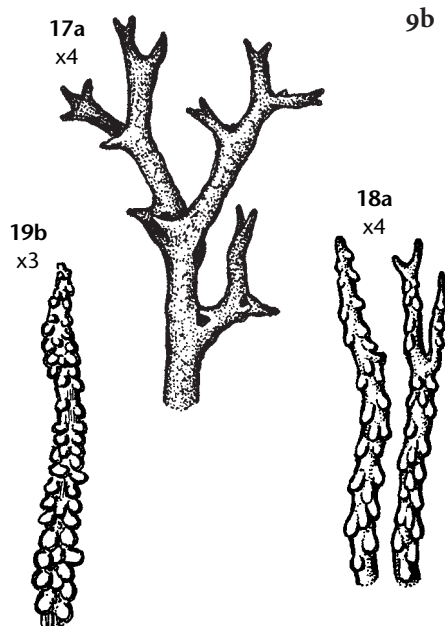
GROUP J: PODETIA UNCUPPED, NEITHER SOREDIATE NOR GRANULAR



- 1a Cortex with a yellowish green cast, KC+ yellow or KC-; apothecia, if present, red or pale to medium brown 2
- 2a Podetia densely squamulose(←); apothecia, if present, red; widespread *Cladonia bellidiflora*
- 2b Podetia sparsely squamulose, or lacking squamules; apothecia, if present, pale brown; mostly east of coast ranges 3
- 3a Podetia to less than 15 mm tall; podetial cortex roughened; apothecia present(←), pale brown *Cladonia botrytes*
- 3b Podetia to more than 15 mm tall; podetial cortex smooth; apothecia absent or rarely present, medium brown . . . *Cladonia amaurocraea*
- 1b Cortex not at all yellowish, KC-; apothecia, if present, dark brown 4
- 4a Podetia less than 5 mm tall; apothecia present *Cladonia ochrochlora* (aberrant form)
- 4b Podetia more than 5 mm tall; apothecia present or absent 5
- 5a Medulla K+ persistent yellow (check podetia tips). 6
- 6a Basal squamules present, the largest ones to 5–15 (–25) mm long; podetial cortex not at all white-pruinose or cobwebby/arachnoid; west of coast ranges; over bark or soil rich in humus *Cladonia squamosa* (chemotype 2)
- 6b Basal squamules absent or at most to 1–6 mm long; podetia white-pruinose or cobwebby/arachnoid or not (check upper portions); distribution various; over soil rich in humus 7
- 7a Basal portion of podetia blackening and distinctly pale-spotted(←); alpine; northern *Cladonia trassii*
- 7b Basal portion of podetia orange or greyish orange, not at all pale-spotted; distribution various 8
- 8a Podetia 0.5–1.6 mm wide, often distinctly sinuous(←); mostly west of coast ranges at lower to middle elevations *Cladonia ecmocyna* ssp. *occidentalis*
- 8b Podetia 0.5–5.0 mm wide, generally not distinctly sinuous; widespread at middle to alpine elevations *Cladonia ecmocyna* ssp. *intermedia* (uncupped form)
- 5b Medulla K- or K+ finally dingy brown 9
- 9a Medulla PD+ yellow, orange, or red, UV-. 10
- 10a Terminal portion of podetia soft, dull, distinctly cobwebby/arachnoid or appressed-tomentose (Note: specimens in which the podetia are in part pale-spotted against a black background key here) *Cladonia stricta*



- 10b** Terminal portion of podetia distinctly hard-corticate, often more or less shiny, at most only very weakly cobwebby/arachnoid 11
- 11a** Podetia branching; axils of branches at least in part longitudinally lacerate and/or opening by a gaping hole; coastal. 12
- 12a** Ultimate branches corticate more or less throughout, lacking soredia, corticate granules, and microsquamules; podetial squamules absent or sparse, more or less symmetrically arranged around the podetia; apothecia often present(←), the supporting branches somewhat flattened or longitudinally lacerate, or both *Cladonia furcata*
- 12b** Ultimate branches generally in part lacking a cortex, often furnished with soredia, corticate granules, and/or microsquamules, these sometimes extending downward into the middle or basal portions of the podetia; podetial squamules sparse to abundant, more or less asymmetrically arranged, the largest ones restricted to the "upper" side of the podetia(←); apothecia generally absent; ultimate branches occasionally longitudinally lacerate, but rarely flattened. *Cladonia scabriuscula*
- 11b** Podetia branching or not; branch axils, if present, not at all lacerate or opening by a gaping hole (perforations, however, may be present elsewhere over podetia); distribution various 13
- 13a** Podetia to more than 1.5 mm in diameter (check basal portions) (Note: specimens more than 100 mm tall key here) 14
- 14a** Podetial wall 0.02–0.04 mm (20–40 μ m) thick, tough (check basal portion); inner portion of medulla soft, loose; podetial squamules generally present; wide-spread in base-rich sites. *Cladonia macroceras*
- 14b** Podetial wall 0.01–0.02 mm (10–20 μ m) thick, fragile; inner portion of medulla rather hard, compact; podetial squamules generally absent or at most sparse; west of coast ranges *Cladonia gracilis* ssp. *vulnerata*
- 13b** Podetia to less than 1.5 mm in diameter. 15
- 15a** Podetial wall 0.02–0.04 mm (20–40 μ m) thick (check basal portion); inner portion of medulla soft, loose; cortex glossy *Cladonia macroceras* (see 14a)
- 15b** Podetial wall 0.01–0.02 mm (10–20 μ m) thick; inner portion of medulla hard, compact; cortex dull or somewhat glossy 16
- 16a** Basal portions of podetia not abundantly perforate; podetial squamules present or absent; wide-spread; alpine to subalpine *Cladonia gracilis* ssp. *elongata*
- 16b** Basal portions of podetia abundantly perforate(←); podetial squamules absent; west of coast ranges at lower elevations *Cladonia gracilis* ssp. *vulnerata*



- 9b Medulla PD-, UV+ ice-blue 17
- 17a Podetial squamules absent or at most confined to base; basal portions of podetia distinctly blackening; west of coast ranges *Cladonia subfurcata*
- 17b Podetial squamules present, scattered more or less throughout; basal portions of podetia blackening or not; distribution various 18
- 18a Upper portion of podetia predominantly brownish, more or less continuously corticate; basal portion of podetia whitish, generally distinctly paler than upper portion; squamatic acid present; west of coast ranges *Cladonia singularis*
- 18b Upper portion of podetia predominantly whitish, lacking a continuous cortex; basal portion of podetia pale or darkening; squamatic acid present or absent; distribution various 19
- 19a Over bark of standing conifers; squamatic acid present; perlatolic acid absent; humid coastal regions *Cladonia squamosa* (see 6a)
- 19b Over soil, mossy rock, or decaying wood; squamatic acid absent; perlatolic acid present; east of coast ranges *Cladonia decorticata*

Cladonia acuminata (Ach.) Norrlin

(Syn. *Cladonia acuminata* (Ach.) Norrlin var. *norrlinii* Lynge; *Cladonia norrlinii* Vainio)

Branching pebblehorn

Habitat/Range: [Both chemotypes] Frequent over base-rich soil and mossy boulders in open inland forests and boulder beds at lower to middle elevations, also rare in similar maritime habitats; circumpolar, N to AK, YU, wNT, S to WY, CA, MX; AB.

Reactions: Chemotype 1: Cortex K+ yellow; medulla K+ yellow, orange, or red, PD+ yellow, orange, or red. Chemotype 2: Cortex K+ yellow; medulla PD+ strong yellow.

Contents (major substances): Chemotype 1: Atranorin and norstictic acid. Chemotype 2: Atranorin and psoromic acid.

Variability: Medium.

Notes: Diagnostic characters include: (1) the unbranched (or sparsely branched), nonperforate, noncorticate, nonyellowish podetia that are sparsely covered in tiny, unlobed or weakly lobed squamules; (2) the occurrence over base-rich ground; and (3) the essentially inland distribution. For points of distinction with similar species, see *C. decorticata*.

[*Cladonia alaskana* A. Evans]

Alaskan clad

Habitat/Range: Expected over alpine heaths; western N Am - eastern N Am (Greenland) - eastern Eurasia, S to sAK, AK, wNT.

Reactions: Cortex KC+ yellow or apparently KC-; medulla PD+ yellow, orange, or red.

Contents (major substances): Fumarprotocetraric and usnic acids (and ursolic acid).

Variability: Unknown.

Notes: *Cladonia alaskana* has been reported in Alaska near the British Columbia border.

It is very similar to *C. kanewskii*; see that species for points of distinction.

Cladonia albonigra Brodo & Ahti

Sordid pixie-cup

Habitat/Range: [All chemotypes] Frequent over acidic soil, moss, or wood in open coastal and humid intermontane localities at lower to upper forested elevations; western N Am - western Eurasia, N to sAK, S to WA, ID, MT, OR, CA.

Reactions: Medulla PD+ yellow, orange, or red, UV+ strikingly ice-blue or UV-.

Contents (major substances): Chemotype 1: Fumarprotocetraric and grayanic acids (and often merochlorophaeic and 4-o-methylgrayanic acids). Chemotype 2: Fumarprotocetraric and 4-o-methylcryptochlorophaeic acids. Chemotype 3: Fumarprotocetraric acid. Chemotype 4: Fumarprotocetraric and merochlorophaeic acids. Chemotype 5: Fumarprotocetraric, homosekikaic, and sekikaic acids.

Variability: High.

Notes: As a member of the *C. chlorophaea* group, *C. albonigra* has broadly cupped, coarsely sorediate, nonyellowish podetia. In this species, however, the podetia are typically blackish below (check inner wall), and tend to proliferate from the cup centres, at least in part. Some forms of *C. albonigra*, however, can be reliably identified only through thin-layer chromatography. The holotype locality is near Port Clements, on Graham Island in the Queen Charlotte Islands.

Cladonia amaurocraea (Flörke) Schaerer

Quill clad (prickle cladonia; prickled pixie; quill lichen)

Habitat/Range: Frequent over thin humus and mossy rock in open forests and boulder beds in cool inland localities at all forested elevations, also rare in the alpine; circum-polar, N to sAK, AK, YU, wNT, S to BC; AB.

Reactions: Cortex KC+ yellow or apparently KC-.

Contents (major substances): Barbatic and usnic acids.

Variability: Medium.

Notes: Diagnostic characters include the inland distribution, the yellowish green colour, and the slender, nonsorediate, much-branched podetia that are often cupped above, at least in some populations. Some forms of *C. uncialis* are similar, but in that species the podetia are generally much stouter, and lack cups.

Cladonia asahinae J.W. Thomson
Asahina's pixie-cup (pixie-cup lichen)

Habitat/Range: [All chemotypes] Frequent over soil, moss, mossy rock, and occasionally decaying wood in open coastal localities at lower elevations; western N Am - western Eurasia, N to sAK, S to WA, ID, MT, OR, CA, (CO).
Reactions: Medulla PD+ yellow, orange, or red, UV+ dull or UV-.
Contents (major substances): Chemotype 1: Fumarprotocetraric, norrangiformic, and rangiformic acids. Chemotype 2: Fumarprotocetraric and protolichesterinic acids (and rangiformic acid). Chemotype 3: Fumarprotocetraric acid.
Variability: Medium.
Notes: This is a highly variable species characterized by its nonyellowish, broadly cupped podetia that are finely to coarsely sorediate or granulose, and that have "toothed" cup rims. It is often confused with *C. chlorophaea* and *C. fimbriata*; see the notes under those species. In the American Pacific Northwest, *C. asahinae* has been reported eastward to Idaho and Montana; it should be looked for in adjacent portions of British Columbia.

Cladonia bacilliformis (Nyl.) Glück
Lesser greenhorn

Habitat/Range: Frequent over decaying wood and occasionally over moss, in open inland sites, especially at lower elevations; circumpolar, N to sAK, AK, YU, wNT, S to OR, WY, CA, UT, CO, AZ; AB.
Reactions: Cortex KC+ yellow or apparently KC-.
Contents (major substances): Barbatic and usnic acids.
Variability: Medium.
Notes: Diagnostic characters include: (1) the small (to 20–25 mm), unbranched, yellowish green, sorediate, pointed-tipped podetia; (2) the occurrence over wood; and (3) the inland distribution. *Cladonia bacilliformis* is most likely to be confused with uncupped forms of *C. umbricola*, though that species yields either a PD+ strong yellow or a UV+ strikingly ice-blue reaction (thamnolic or squamatic acid present, respectively), and is widespread in rather humid localities. See also the comments under *C. cyanipes*.

Cladonia bellidiflora (Ach.) Schaerer
Toy soldiers (flowering cladonia; British soldiers)

Habitat/Range: [Chemotype 1] Common over acidic soil, moss, mossy rock and, in coastal localities, decaying wood in open to shady forest sites and outcrops at all elevations throughout, except perhaps absent from boreal regions; [Chemotypes 2 and 3] infrequent in habitats similar to those described above, but restricted to coastal regions; incompletely circumpolar, N to sAK, AK, YU, wNT, S to WA, OR, CA; AB.

Reactions: Chemotype 1: Cortex KC+ yellow or apparently KC-; medulla UV+ strikingly ice-blue. Chemotype 2: Cortex KC+ yellow or apparently KC-; medulla K+ strong yellow, PD+ strong yellow or orange. Chemotype 3: Medulla UV+ strikingly ice-blue.

Contents (major substances): Chemotype 1: Squamatic and usnic acids. Chemotype 2: Thamnic and usnic acids. Chemotype 3: Squamatic acid.

Variability: High.

Notes: Diagnostic characters include the tall, nonsorediate, abundantly squamulose podetia, each generally terminating upwards in a small cup rimmed, on occasion, with red apothecia. In coastal regions, some forms of *C. transcendens* are similar, but that species has at least partly granular-sorediate podetia, and occurs exclusively over the decaying bark or wood of trees. Throughout most of its range, *C. bellidiflora* has a yellowish green thallus containing usnic acid; in hypermaritime localities, however, a greyish, usnic-deficient race also occurs (= Chemotype 3).

Cladonia borealis S. Stenroos
Boreal pixie-cup (red pixie-cup)

Habitat/Range: Common over acidic soil, humus, mossy rock, and rarely decaying wood in open to somewhat exposed inland localities at all elevations; also infrequent in coastal regions; circumpolar, N to sAK, YU, wNT, S to WA, ID, MT, OR, CO, AZ, (MX); AB.

Reactions: Cortex KC+ yellow or apparently KC-.

Contents (major substances): Barbatic and usnic acids.

Variability: Low.

Notes: *Cladonia borealis* is a red-fruited, ground-dwelling species with unbranched, broadly cupped podetia that are yellowish green, and lack soredia; see also the notes under *C. coccifera*.

Cladonia botrytes (K. Hagen) Willd.
Stump soldiers (stump cladonia)

Habitat/Range: Frequent over decaying wood in open inland forests at lower to rarely middle elevations; circumpolar, N to AK, YU, wNT, S to MT, OR, WY, CO; AB.

Reactions: Cortex KC+ yellow or KC-.

Contents (major substances): Barbatic and usnic acids.

Variability: Low.

Notes: This distinctive species is characterized by its small, nonsorediate, yellowish green podetia, its pale “waxy” brown apothecia (invariably present), its occurrence over wood, and its inland distribution.

***Cladonia cariosa* (Ach.) Sprengel**

Peg-leg soldiers; pygmy thatch (ribbed cladonia; torn club lichen)

Habitat/Range: [Both chemotypes] Common over weakly to strongly base-rich soil and mossy rock in open, often disturbed inland sites at lower and middle elevations, especially in grasslands, also infrequent in maritime (CDF) localities; circumpolar, N to sAK, AK, YU, wNT, S to WA, ID, MT, OR, WY, CA, UT, CO, AZ, NM, (MX); AB.

Reactions: Chemotype 1: Cortex K+ yellow. Chemotype 2: Cortex K+ yellow or K+ dingy brown; medulla PD+ yellow, orange, or red.

Contents (major substances): Chemotype 1: Atranorin. Chemotype 2: Atranorin and fumarprotocetraric acid.

Variability: Medium.

Notes: Fertile forms are easily recognized by their ground-dwelling habitat ecology, their tiny, erect, occasionally brown-pycnidiate squamules (less than 2.5 mm long), and their more or less distinctly “ribbed” podetia that terminate upwards in dark brown apothecia. *Cladonia symphy carpia* is similar, but has larger, less uniformly erect squamules (to more than 2.5 mm long). In typical forms of *C. symphy carpia*, the basal portions of the podetia are smooth and continuously corticate, versus roughened and patchy-corticate in *C. cariosa*. Unfortunately, intermediate forms seem to exist between these two species, and can for convenience be referred to as *C. cariosa* s. lat. Further work is needed.

***Cladonia carneola* (Fr.) Fr.**

Crowned pixie-cup (royal pixie-cup; pale-fruited pixie cup)

Habitat/Range: [Both chemotypes] Common over acidic soil, humus, mossy boulders, decaying wood, and conifer bark at the bases of trees in open to somewhat shady sites at lower to especially middle and upper forested elevations throughout; circumpolar, N to sAK, AK, YU, wNT, S to WA, ID, MT, OR, WY, CA, UT, CO, AZ, (MX); AB.

Reactions: Chemotype 1: Cortex KC+ yellow or apparently KC-. Chemotype 2: Cortex KC+ yellow or apparently KC-; medulla UV+ ice-blue or (more often) UV-.

Contents (major substances): Chemotype 1: Usnic acid and zeorin (and isousnic acid). Chemotype 2: Usnic and barbatic acids and zeorin.

Variability: Medium.

Notes: Diagnostic characters include the sorediate, yellowish green podetia that terminate upwards in broad, crown-rimmed cups. Some forms of *C. carneola* are similar to *C. pleurota*, though that species has more granular soredia, lacks the crownlike rims, and never contains barbatic acid.

Cladonia cenotea (Ach.) Schaerer

Miner's funnel (powdered funnel cladonia; powdered pixie-funnel; funnel cladonia; floury funnel lichen; tube lichen)

Habitat/Range: [Chemotype 1] Common over humus, mossy rock, and especially decaying wood in sheltered to rather shady inland forests at all forested elevations, also rare in maritime (CDF) localities; circumpolar, N to sAK, AK, YU, wNT, S to WA, ID, MT, OR, WY, UT, CO, AZ, MX; AB.

Reactions: Chemotype 1: Medulla UV+ strikingly ice-blue. Chemotype 2: Medulla K+ strong yellow, PD+ strong yellow to orange.

Contents (major substances): Chemotype 1: Squamatic acid (and barbatic acid).

Chemotype 2: Thamnic acid.

Variability: Medium.

Notes: This is the only local species in which the podetia are both sorediate and distinctly open above. Chemotype 2 has not previously been reported for North America; in British Columbia it appears to be restricted to humid inland forests.

Cladonia cervicornis (Ach.) Flotow, s. lat.

Laddered pixie-cup; soil thatch (ladder cladonia; ladder lichen)

Habitat/Range: Frequent over acidic to weakly base-rich soil, moss, or mossy rock in open steppe and forested sites throughout, especially at lower elevations; possibly circumpolar (but global distribution poorly known), N to sAK, AK, YU, wNT, S to WA, ID, MT, OR, WY, CA, CO, AZ, NM, MX; AB.

Reactions: Medulla PD+ yellow, orange, or red.

Contents (major substances): Fumarprotocetraric acid.

Variability: Medium.

Notes: This is a nonsorediate, nonyellowish, broadly cupped species in which the cups proliferate primarily from the cup centres, and in which the basal squamules are rather small (less than 3–4 mm long) and typically rather narrow and strap-shaped. *Cladonia macrophyllodes* is similar, but contains atranorin (K+ strong and persistent yellow), and typically has larger, broader basal squamules (more than 3–4 mm long, and not much longer than wide), as well as much more abundantly squamulose cup rims; it is most frequent in inland localities. The British Columbia material assigned to *C. cervicornis* is heterogeneous, and apparently represents two, or possibly three, different taxa. The most widespread of these has been referred to *C. cervicornis* ssp. *verticillata* (Hoffm.) Ahti. Further work is needed. See also the comments under *C. symphy carpia*.

Cladonia chlorophaea (Sommerf.) Sprengel

Mealy pixie-cup (false pixie-cup; fairy-cup; mealy goblet; fringed cup moss; peppered pixie-cup)

Habitat/Range: Common over acidic to weakly base-rich soil, moss, mossy rock, humus, and decaying wood in open to rather sheltered localities at all forested elevations throughout, except essentially absent from hypermaritime regions; circumpolar, N to sAK, AK, YU, wNT, S to WA, ID, MT, OR, WY, CA, NV, UT, CO, AZ, NM, MX; AB.

Reactions: Medulla PD+ yellow, orange, or red.

Contents (major substances): Fumarprotocetraric acid.

Variability: Medium.

Notes: This is a broadly cupped, nonyellowish species in which the podetia are covered (at least above) in a thin layer of powdery to more often granular soredia. The exclusive presence in *C. chlorophaea* of fumarprotocetraric acid often serves to distinguish it from various closely related “chemical species,” including *C. albonigra*, *C. asahinae*, *C. grayi*, *C. homosekikaica*, *C. humilis*, and *C. merochlorophaea*; see the comments under these species for other points of distinction. In the absence of detailed chemical testing, all of the above taxa can be referred to as *C. chlorophaea* s. lat. *Cladonia pyxidata* is also similar, but in that species the cups bear microsquamules that are dorsiventral even when young.

Cladonia coccifera (L.) Willd.

Map 43

Madame’s pixie-cup

Habitat/Range: Rare over acidic soil and mossy rock in open inland regions; circumpolar, N to AK, wNT, S to WA, OR, WY, CO, MX.

Reactions: Cortex KC+ yellow or apparently KC-.

Contents (major substances): Usnic acid and zeorin.

Variability: Low.

Notes: Nearly all British Columbia records formerly attributed to *C. coccifera* belong to *C. borealis*. In both of these lichens the podetia are yellowish green, broadly cupped, red-fruited (when fertile), and nonsorediate. The most reliable point of distinction is the presence of zeorin in *C. coccifera*, versus barbatic acid in *C. borealis*. With prolonged storage in the herbarium, zeorin produces a dense “halo” of needle-like crystals that protrude from the cortex; no such crystals are produced in *C. borealis*. Typical specimens of *C. coccifera* also bear numerous microsquamules over the podetia, whereas microsquamules are absent in *C. borealis*.

Cladonia coniocraea (Flörke) Sprengel

Lesser powderhorn (powderhorn lichen; lesser toothpick cladonia; tiny toothpick cladonia; awl-shaped stump lichen)

Habitat/Range: Frequent over decaying wood and bark at the base of trees, also occasionally over acidic soil, in sheltered to somewhat shady forests at lower elevations throughout, especially in inland localities; circumpolar, N to sAK, AK, wNT, S to WA, ID, MT, OR, WY, CA, UT, CO, AZ, NM, MX; AB.

Reactions: Medulla PD+ yellow, orange, or red.

Contents (major substances): Fumarprotocetraric acid.

Variability: Low.

Notes: *Cladonia coniocraea* can be recognized by its small, nonyellowish, diffusely sorediate podetia (less than 25 mm tall) that generally taper upward to a point, but are occasionally weakly cupped, especially at maturity; the podetia are also PD+ yellow, orange, or red. Cups, when present, are generally sorediate and noncorticate both within and without. *Cladonia norvegica* is similar, but gives a PD- reaction. *Cladonia ochrochlora* is also similar, but in that species the podetia are larger (to 30–70 mm tall) and more inclined to bear cups, even when rather young; the cups, when present, are often corticate both within and without, and typically lack soredia. Young specimens, however, are often difficult to distinguish, and can be referred to as *C. coniocraea* s. lat. See also the comments under *C. cornuta*.

Cladonia cornuta (L.) Hoffm. ssp. ***cornuta***

Common bighorn (greater pixie-stick; horn cladonia; horn lichen; pioneer cladonia)

Habitat/Range: Common over acidic soil, humus, moss, mossy boulders, and occasionally decaying wood in rather open sites at all forested elevations throughout, except rare in coastal regions; circumpolar, N to AK, YU, wNT, S to WA, ID, MT, OR, (CA), CO, AZ; AB.

Reactions: Medulla PD+ yellow, orange, or red.

Contents (major substances): Fumarprotocetraric acid.

Variability: Medium.

Notes: This is a sorediate, ground-dwelling species in which the podetia are tall, unbranched, brownish, and typically pointed-tipped (but see ssp. *groenlandica*, below). In most specimens, the medulla is rather thin, and the lowermost soredia are arranged in discrete patches. Ground-dwelling forms of *C. ochrochlora* are similar, but tend to have more greyish green podetia, and a thicker, tougher podetial medulla. In other similar ground-dwelling species (e.g., *C. rei*, *C. subulata*, *C. verruculosa*), the soredia are more diffuse, and not at all arranged in discrete patches. Some forms of *C. cornuta* are only sparsely sorediate, and must then be carefully distinguished from *C. gracilis* ssp. *elongata*. That species, however, has a distinctly blackened base, at least at maturity.

Cladonia cornuta (L.) Hoffm. ssp. ***groenlandica*** (E. Dahl) Ahti
(Syn. *Cladonia groenlandica* (E. Dahl) Trass)
Maritime bighorn

Habitat/Range: Frequent over decaying wood and humus in open to rather shady coastal forests at lower elevations, especially in hypermaritime regions; incompletely circumpolar, N to sAK, S to (WA), MT, CO.

Reactions: Medulla PD+ yellow, orange, or red.

Contents (major substances): Fumarprotocetraric acid.

Variability: Medium.

Notes: Subspecies *groenlandica* is similar in most regards to cupped forms of ssp. *cornuta*, but has broader cups (1.5–5 mm wide versus 1–3 mm wide), paler basal portions, more copious basal squamules, and a coastal distribution—at least in British Columbia.

Cladonia crispata (Ach.) Flotow var. ***cetrariiformis*** (Delise) Vainio
(Syn. *Cladonia poroscypha* S. Hammer)
Lesser organpipe

Habitat/Range: [Both chemotypes] Frequent over heaths and mossy outcrops in open coastal localities at all forested elevations, also rare in inland regions; probably incompletely circumpolar, N to sAK, S to WA, OR, CA.

Reactions: Chemotype 1: Medulla UV+ strikingly ice-blue. Chemotype 2: Medulla K+ strong yellow, PD+ strong yellow to orange.

Contents (major substances): Chemotype 1: Squamatic acid. Chemotype 2: Thamnic acid.

Variability: Medium.

Notes: *Cladonia crispata* is a nonsorediate species easily recognized by its branched, nonyellowish, mostly nonsquamulose podetia that terminate upwards in open cups. In var. *cetrariiformis*, the podetia are slender, the apical cups tend not to flare, and the distribution is strictly coastal. Variety *crispata*, by contrast, is a more widespread species in which the podetia are stouter, and the apical cups more flaring (generally more than 1.5 mm wide). The material assigned here to Chemotype 2 of var. *cetrariiformis* was recently described as a separate species, *C. poroscypha* S. Hammer (Hammer 1993, 1995). Further work is needed.

Cladonia crispata (Ach.) Flotow var. ***crispata***

(Syn. *Cladonia artuata* S. Hammer; *Cladonia japonica* Vainio)

Greater organpipe (shrub funnel cladonia; shrub funnel lichen; broccoli lichen)

Habitat/Range: [Both chemotypes] Frequent over decaying wood, moss, mossy rock, and acidic soil in open bogs and somewhat sheltered forests at lower to middle elevations throughout; circumpolar, N to sAK, AK, YU, wNT, S to WA, ID, MT, OR, WY, CA; AB.

Reactions: Chemotype 1: Medulla UV+ strikingly ice-blue. Chemotype 2: Medulla K+ strong yellow, PD+ yellow or orange.

Contents (major substances): Chemotype 1: Squamatic acid (and barbatic acid).

Chemotype 2: Thamnolic acid (and barbatic acid).

Variability: High.

Notes: See var. *cetrariiformis* for a synopsis of the species. Part of the material included here was recently described as *C. artuata* S. Hammer (Hammer 1993, 1995), based on material from California. That species is said to be distinguished from *C. crispata* by the presence of thamnolic and barbatic acids, and irregularly lacerate podetial walls. In fact, the British Columbia material assignable to *C. artuata* appears to freely intergrade with Chemotype 2 of *C. crispata* var. *crispata* (restricted to coastal localities), and is probably conspecific with it. The Californian material, however, may indeed warrant separate taxonomic status.

Cladonia cyanipes (Sommerf.) Nyl.

Map 44

Greater greenhorn

Habitat/Range: Rare (probably overlooked) over humus and mossy boulders in cool, sheltered, inland boulder beds at lower to middle elevations, local distribution poorly known; circumpolar, N to sAK, AK, YU, wNT, S to WA, WY, CO; AB.

Reactions: Cortex KC+ yellow or KC-.

Contents (major substances): Barbatic and usnic acids.

Variability: Medium.

Notes: Diagnostic characters include the tall (20–60 mm), unbranched, yellowish green, sorediate, pointed-tipped podetia, the often somewhat bluish basal portions, the inland distribution, and the occurrence over mossy boulders. *Cladonia bacilliformis* and some forms of *C. umbricola* are similar, but have shorter podetia (to less than 20–25 mm tall), and occur primarily over bark or wood. *Cladonia umbricola* is also either PD+ strong yellow (= thamnolic acid) or UV+ ice-blue (= squamatic acid). When cupped, *C. cyanipes* can be confused with *C. deformis* and *C. pleurota*. In those species, however, the podetia are generally broader (mostly more than 1.5 mm in diameter), the basal portions are never bluish, and zeorin is present.

Cladonia decorticata (Flörke) Sprengel
Perlatolic pebblehorn (molted cladonia)

Map 45

Habitat/Range: Infrequent over acidic soil, humus, and mossy rock in open sites in inland localities at lower elevations, local distribution poorly known; circumpolar, N to AK, YU, wNT, S to WA, WY, CO, MX; AB.

Reactions: Medulla UV+ ice-blue.

Contents (major substances): Perlatolic acid.

Variability: Medium.

Notes: This is a soil-dwelling species characterized by its noncorticate, generally unbranched, densely squamulose, nonyellowish podetia that taper upwards to a point, and that contain perlatolic acid. *Cladonia acuminata* is similar, but is more often branched, and yields a K+ yellow, orange, or red reaction. Another similar species, *C. squamosa*, typically opens above by a gaping hole, and contains squamatic or thamnolic acid.

Cladonia deformis (L.) Hoffm.

Lesser sulphur-cup (red-fruited trumpet lichen; scarlet wand lichen)

Habitat/Range: Frequent over humus, moss, decaying wood, and bark at the base of conifers in sheltered inland forests, especially at lower and middle elevations; circumpolar, N to sAK, AK, YU, wNT, S to WA, ID, MT, OR, WY, (UT), CA, CO, AZ, NM; AB.

Reactions: Cortex KC+ yellow or apparently KC-.

Contents (major substances): Usnic acid and zeorin (and isousnic acid).

Variability: Medium.

Notes: Diagnostic characters include the cupped, unbranched, yellowish green podetia, the copious powdery soredia, the small basal squamules (to less than 4 mm long), the UV- medullary reaction, and the strictly inland distribution. *Cladonia deformis* is most likely to be confused with *C. pleurota* (soredia coarse) and *C. sulphurina* (soredia fine); see the discussion under those species.

Cladonia digitata (L.) Hoffm.

Fingered pixie-cup; miner's thatch (finger lichen)

Habitat/Range: Frequent over decaying wood and (mossy) bark at the bases of trees in sheltered humid intermontane (ICH) forests at lower elevations, also rare in maritime localities; circumpolar, N to sAK, wNT, S to WA, ID, MT, NM; AB.

Reactions: Medulla K+ strong yellow, PD+ strong yellow.

Contents (major substances): Thamnolic acid.

Variability: High.

Notes: This is a distinctive species easily recognized by its pale, sorediate, nonyellowish podetia, its PD+ strong yellow to orange medullary reaction, and especially its large (to 6–15 mm long), usually copiously sorediate basal squamules. The apothecia, when present, are red, and the lower surface of the larger squamules is yellow or orange at the point of attachment. *Cladonia sulphurina* also has large basal squamules, but yields a PD- medullary reaction.

Habitat/Range: Rare over soil and mossy rocks in open coastal localities at lower elevations, local distribution poorly known; western N Am - western Eurasia, N to BC, S to WA, ID, OR, CA.

Reactions: Medulla PD+ yellow, orange, or red.

Contents (major substances): Fumarprotocetraric acid.

Variability: High.

Notes: This is a broadly cupped, nonyellowish, nonsorediate species in which the cup interiors bear convex granules or areoles, and in which the cup margins are oblique, and often support one or more tiers of (fissured) podetia. *Cladonia pyxidata* and *C. novochlorophaea* are similar, but have more horizontal cup margins that are not at all fissured. *Cladonia novochlorophaea* also produces homosekikaic and sekikaic acids, whereas the other species produce fumarprotocetraric acid alone.

Cladonia ecmocyna Leighton ssp. *intermedia* (Robbins) Ahti

Greater frost-soldiers (orange-footed cladonia; orange-footed pixie; orange-foot lichen; frosted cladonia)

Habitat/Range: Common over acidic soil, moss, and mossy rock, and infrequently over decaying wood, in exposed to somewhat sheltered intermontane sites, especially at middle to subalpine and alpine elevations subject to prolonged snow cover, infrequent in maritime localities, essentially absent from hypermaritime regions; western N Am, N to sAK, AK, YU, wNT, S to WA, ID, MT, OR, WY, CO, NM; AB.

Reactions: Cortex K+ yellow; medulla K+ yellow, PD+ yellow, orange, or red.

Contents (major substances): Atranorin and fumarprotocetraric acid.

Variability: High.

Notes: Distinctive characters include: (1) the unbranched (or at most sparsely branched), nonsorediate, bluish or faintly purplish podetia that are cupped or not above, and that typically grade to orangish in the basal portions; (2) the K+ yellow cortex (check podetia tips); and (3) the occurrence in localities subject to prolonged snow cover. Members of the *C. gracilis* group are similar, but in these species the podetia yield a K- reaction, and grade downward to black or brown. The material included here is heterogeneous, and may represent two distinct taxa. In the "typical" form, pruina is present over at least the upper third of the podetia, and numerous to sparse podetial squamules are distributed throughout. By contrast, in the "alpine" form, pruina is absent or sparse over the upper third of the podetia, and squamules, if present at all, are mostly confined to the basal portions. Further work is required. See also the notes under ssp. *occidentalis*, below.

Cladonia ecmocyna Leighton ssp. *occidentalis* Ahti
Lesser frost-soldiers

Habitat/Range: Frequent over mossy rock and boulder beds in open to somewhat sheltered coastal localities, especially at lower elevations, also rare in humid intermontane (ICH) regions; western N Am, N to BC, S to WA, ID, MT, OR.

Reactions: Cortex K+ yellow; medulla K+ pale yellow, PD+ yellow, orange, or red, UV- or UV+ dull.

Contents (major substances): Atranorin and fumarprotocetraric acid.

Variability: Medium.

Notes: In common with ssp. *intermedia*, this is an unbranched, nonsorediate lichen in which the podetia are cupped above or not, and typically grade to orangish in the basal portions; and in which the podetial cortex yields a K+ yellow reaction.

Subspecies *occidentalis*, however, can be distinguished by its narrower, often distinctly sinuous podetia (to 0.5–1.6 mm wide) and coastal distribution. By contrast, ssp. *intermedia* is a widespread species with broad podetia (to 0.5–5.0 mm wide) that are generally not distinctly sinuous.

Cladonia fimbriata (L.) Fr.

(Syn. *Cladonia major* (K. Hagen) Sandst.)

Powdered trumpet (trumpet lichen; brown-fruited cup cladonia)

Habitat/Range: Frequent over acidic to weakly base-rich soil, humus, moss, mossy rock, wood, and bark at the bases of trees in open to somewhat sheltered forests at lower to middle elevations throughout; circumpolar, N to sAK, AK, YU, wNT, S to WA, ID, MT, OR, WY, CA, NV, UT, CO, AZ, NM, MX; AB.

Reactions: Medulla PD+ yellow, orange, or red.

Contents (major substances): Fumarprotocetraric acid.

Variability: High.

Notes: Diagnostic characters include the unbranched, finely sorediate, nonyellowish podetia that terminate upwards in flaring or more often rather nonflaring cups.

Cladonia fimbriata must be carefully distinguished from some forms of *C. chlorophaea* by the presence, in the former, of powdery soredia more than one layer deep on the lower (external) portions of the cups; in *C. chlorophaea* the soredia are more granular, and are typically arranged in only a single layer. Rare forms of *C. asahinae* containing fumarprotocetraric acid alone can also be difficult to distinguish; in that species, however, the soredia are again more granular, and the rims of the cups are often “toothed” and crownlike. Profusely proliferating material collected in hypermaritime regions may represent a separate, undescribed taxon; see *C. sp. 1*. Further work is needed.

Cladonia furcata (Hudson) Schrader

(Syn. *Cladonia herrei* J. Hedrick)

Many-forked clad (forking clad; fork cladonia; fork lichen)

Habitat/Range: Common over acidic to weakly base-rich soil and moss, and infrequently over decaying wood, in open to rather shady coastal forests and rock outcrops at lower to middle elevations; probably incompletely circumpolar, N to sAK, S to WA, ID, MT, OR, CA, CO, AZ, MX; AB.

Reactions: Medulla PD+ yellow, orange, or red.

Contents (major substances): Fumarprotocetraric acid.

Variability: High.

Notes: Diagnostic characters include: (1) the continuously corticate, nonsorediate, nonyellowish, moderately branched podetia over which squamules, if present, are arranged more or less symmetrically; (2) the PD+ yellow, orange, or red medullary reaction; and (3) the coastal distribution. When apothecia are present, the supporting main stems are usually round in cross-section. *Cladonia furcata* is a rather variable species that appears, at its extremes, to intergrade with *C. scabriuscula* (another coastal species) and *C. multiformis*. In *C. scabriuscula*, the ultimate branches are often discontinuously corticate, and also often sorediate or at least granulose, whereas the podetial squamules are positioned predominantly on the “upper” surface of the podetia. *Cladonia multiformis*, by contrast, occurs primarily east of the coast ranges, and typically bears conspicuous cups, which are somewhat sieve-like/perforate within. When fertile, the main stems are generally flattened.

Cladonia gracilis (L.) Willd. ssp. ***elongata*** (Jacq.) Vainio

(Syn. *Cladonia gracilis* (L.) Willd. ssp. *nigripes* (Nyl.) Ahti)

Black-footed soldiers

Habitat/Range: Frequent over acidic soil, moss, and mossy rock in open to somewhat exposed subalpine and alpine localities throughout, also infrequent in cool sites at lower to middle elevations; circumpolar, N to sAK, AK, YU, wNT, S to OR.

Reactions: Medulla K- or K+ weakly yellow, PD+ yellow, orange, or red.

Contents (major substances): Fumarprotocetraric acid (and trace amounts of atranorin).

Variability: Low.

Notes: Distinctive features include: (1) the unbranched, nonsorediate, at least partly pointed-tipped podetia that generally lack squamules, and grade to black toward the base; and (2) the K- cortex (check pale areas of podetia). *Cladonia macroceras* is similar in appearance and distribution, but: (1) has a “softer,” thicker podetial medulla (to 0.02–0.04 mm [2–4 µm] thick in basal portions); (2) often bears podetial squamules; (3) grades downward to dark brown; and (4) is restricted to base-rich localities. *Cladonia phyllophora* and *C. stricta* are “soft corticate” in the upper portions of the podetia, and are often white-spotted below. *Cladonia gracilis* ssp. *turbinata* is invariably cupped above, and occurs at all elevations.

***Cladonia gracilis* (L.) Willd. ssp. *turbinata* (Ach.) Ahti**

(Syn. *Cladonia gracilis* (L.) Willd. var. *dilatata* (Hoffm.) Schaerer auct.)

Bronzed pixie-cup (brown-footed cladonia; brown-foot cladonia; spoon lichen; slender cup lichen)

Habitat/Range: Common over acidic to weakly base-rich soil, moss, mossy rock, decaying wood, and conifer bark at the bases of trees in somewhat open sites at all forested elevations throughout, except essentially absent from hypermaritime regions; circumpolar, N to sAK, AK, YU, wNT, S to WA, ID, MT, OR, (CO), (MX).

Reactions: Medulla PD+ yellow, orange, or red.

Contents (major substances): Fumarprotocetraric acid.

Variability: Medium.

Notes: This is a distinctive species characterized by its generally unbranched, hard-corticate, nonsorediate, nonyellowish, and broadly cupped podetia that grade to blackish below, and yield a K- cortical reaction. It is sometimes confused with *C. ecmocyna*, but that species grades to orangish below, and yields a K+ yellow cortical reaction. See also the comments under *C. gracilis* ssp. *elongata*, above.

***Cladonia gracilis* (L.) Willd. ssp. *vulnerata* Ahti**

Wounded soldiers

Habitat/Range: Frequent over moss, mossy rock, mossy logs, and heath in open hypermaritime sites, especially bogs, at all forested elevations, also rare in maritime regions; western N Am - eastern Eurasia, N to sAK, S to WA, OR.

Reactions: PD+ yellow, orange, or red, UV- or UV+ dull.

Contents (major substances): Fumarprotocetraric acid.

Variability: Low.

Notes: Diagnostic features include: (1) the unbranched, nonsorediate, nonyellowish, at least partly pointed-tipped podetia that are typically somewhat “torn” lengthwise; (2) the K- cortical reaction; and (3) the coastal distribution. Some forms of *C. macroceras* are similar, but that species can be distinguished by its alpine distribution, as well as by the broader podetia (0.2–0.4 mm [2–4 µm] wide) and the distinctly “soft,” thick podetial medulla (0.02–0.04 mm wide in basal portions). Subspecies *vulnerata* has also been confused with *C. maxima* (Asah.) Ahti, which is common in maritime regions of eastern Canada, but appears to be absent from the Pacific coast of North America.

***Cladonia grayi* Sandst.**

Map 47

Gray’s pixie-cup

Habitat/Range: Rare over acidic soil and conifer wood and at the bases of trees in inland localities, local distribution poorly known; probably circumpolar, N to sAK, AK, YU, wNT, S to WA, OR, CA, (MX); AB.

Reactions: Medulla PD- or PD+ yellow, orange, or red, UV+ ice-blue.

Contents (major substances): Grayanic acid (and fumarprotocetraric acid).

Variability: Unknown.

Notes: This is a broadly cupped, more or less sorediate “chemical species” closely allied to *C. chlorophaea*; it cannot reliably be distinguished from this and other related species, except by detailed chemical analysis: the presence of grayanic acid is diagnostic.

Cladonia homosekikaica Nuno
Homosekikaic pixie-cup

Map 48

Habitat/Range: Rare over thin soil, wood, and mossy rocks in open coastal sites at lower elevations, local distribution poorly known; probably incompletely circumpolar, N to sAK, S to BC.

Reactions: Medulla PD+ yellow, orange, or red, UV+ ice-blue.

Contents: Fumarprotocetraric and homosekikaic acids (and trace amounts of sekikaic acid).

Variability: Unknown.

Notes: This is a broadly cupped, more or less sorediate member of the *C. chlorophaea* group. It can be reliably distinguished from closely related species only by its chemical profile; that is, its copious production of homosekikaic acid alone, or with trace amounts of sekikaic acid. *Cladonia novochlorophaea* is similar, but contains both homosekikaic and sekikaic acids in abundance. The local material differs in some regards from the type, and may actually represent an undescribed species (Brodo and Ahti 1996).

[***Cladonia humilis*** (With.) J.R. Laundon]

(Syn. *Cladonia conista* A. Evans; *Cladonia conistea* auct.; *Cladonia humilis* (With.) J.R. Laundon var. *bourgeanica* A.W. Archer)

Humble pixie-cup

Habitat/Range: [Both chemotypes] Expected over somewhat base-rich soil in open to exposed coastal sites at lower elevations, especially road cuts; probably circumpolar, N to sAK, S to WA, OR, CA, (MX); AB.

Reactions: Chemotype 1: Cortex K+ yellow; medulla PD+ yellow, orange, or red.

Chemotype 2: Medulla PD+ yellow, orange, or red.

Contents (major substances): Chemotype 1: Atranorin and fumarprotocetraric acid.

Chemotype 2: Bourgeanic and fumarprotocetraric acids.

Variability: Unknown.

Notes: This is a broadly cupped, finely sorediate member of the *C. chlorophaea* group. It can be reliably distinguished from other related species only by its production of atranorin (chemotype 1) or bourgeanic acid (chemotype 2). It is expected to occur in southern British Columbia. Chemotype 2 is often recognized as a distinct species, *C. conista* A. Evans, but is apparently morphologically indistinguishable from *C. humilis*.

Cladonia imbricarica Kristinsson
Pygmy pixie-cup

Map 49

Habitat/Range: Rare over acidic soil and mossy rock in maritime (CDF) sites at lower elevations; local distribution poorly known, probably circumpolar, N to BC, S to WA, ID.

Reactions: Medulla UV+ white.

Contents (major substances): Sphaerophorin (and isosphaeric acid).

Variability: Medium.

Notes: Diagnostic features include: (1) the rather broad, nonsorediate, nonyellowish, short-stalked or often unstalked cups; (2) the presence of sphaerophorin; and (3) the coastal distribution. *Cladonia novochlorophaea* is similar, but is distinctly stalked (podetia to more than 5 mm long at maturity), and contains abundant homosekikaic and sekikaic acids.

Cladonia kanewskii Oxner
Kanewski's clad

Map 50

Habitat/Range: Infrequent over acidic soil, moss, rocks, especially in open to exposed bogs and rock outcrops in hypermaritime localities at upper forested and alpine elevations, apparently south to the Queen Charlotte Islands; western N Am - western Eurasia - eastern Eurasia, N to sAK, AK, YU, S to BC.

Reactions: Cortex KC+ yellow.

Contents (major substances): Usnic acid and various unidentified triterpenes and fatty acids (and isousnic acid).

Variability: Medium.

Notes: Diagnostic characters include: (1) the rather stout, yellowish green, nonsorediate, richly branched podetia; (2) the distinctly roughened and/or fibrous inner podetial wall; and (3) the hypermaritime distribution. *Cladonia alaskana* and *C. nipponica* are similar both in distribution and in appearance, differing only in thallus chemistry. In the former species, the podetia are PD+ throughout, whereas the latter gives a PD+ reaction only at the podetia tips. *Cladonia uncialis* is another similar species in which, however, the inner wall of the podetia is smooth, or at least not distinctly roughened or fibrous; it is widespread in British Columbia.

Cladonia luteoalba Wheldon & A. Wilson
Lemon thatch

Map 51

Habitat/Range: Rare over acidic soil and humus in open intermontane sites at middle and upper elevations, especially in localities subject to prolonged snow cover, local distribution poorly known; western N Am - western Eurasia - eastern Eurasia, N to AK, wNT, S to ID, MT.

Reactions: Medulla UV+ pale bluish or UV-.

Contents (major substances): Barbatic and usnic acids (ours).

Variability: Low.

Notes: The large yellowish green basal squamules and distinctly lemon-yellow medulla are diagnostic for the species. Four chemotypes are recognized within *C. luteoalba* (Stenroos 1990), although only one of these has been detected at temperate latitudes in western North America.

Cladonia macilenta Hoffm.

(Syn. *Cladonia bacillaris* Genth)

Lipstick powderhorn (lipstick cladonia; white pin lichen; scarlet toothpick cladonia; scarlet-tipped cladonia; smaller pin lichen; pin lichen)

Habitat/Range: Common over decaying wood and conifer bark at the bases of trees in open coastal [Chemotype 1] or inland and maritime [Chemotype 2] localities at lower to occasionally middle forested elevations; also occasionally over duff and mossy rock; circumpolar, N to sAK, AK, YU, wNT, S to WA, ID, MT, OR, WY, CA, UT, CO, AZ, NM, MX; AB (both chemotypes).

Reactions: Chemotype 1: Medulla K+ strong yellow, PD+ yellow to orange. Chemotype 2: Medulla UV+ strikingly ice-blue.

Contents (major substances): Chemotype 1: Thamnic acid (and barbatic and didymic acids). Chemotype 2: Barbatic acid (and didymic and squamatic acids).

Variability: High.

Notes: Diagnostic characters include: (1) the small, unbranched, soresiate, nonyellowish podetia that taper upwards to a point; and (2) the tiny, shallowly lobed basal squamules (mostly to 1–2 mm long). Some forms of *C. umbricola* are similar, though in that species the basal squamules are larger and more deeply lobed (to 1.5–7 mm long), and are typically yellowish or orangish at point of attachment with the podetia (check medulla, below). Chemotype 2 has traditionally been referred to a separate species, *C. bacillaris*.

Cladonia macroceras (Delise) Hav.

Map 52

Bullet-proof soldiers

Habitat/Range: Infrequent over base-rich or acidic soils in open inland localities at alpine elevations; circumpolar, N to AK, YU, wNT, S to WA, CO.

Reactions: Cortex K+ yellow or more often K-; medulla PD+ yellow, orange, or red.

Contents (major substances): Fumarprotocetraric acid (and rarely atranorin).

Variability: Medium.

Notes: This species is characteristic of slight depressions. Distinctive features include: (1) the unbranched, nonsorediate, nonyellowish podetia that taper upwards to a point (at least in part), that grade downwards to dark brownish (check mature podetia), and that often bear at least sparse squamules; and (2) the K- cortical reaction. *Cladonia gracilis* ssp. *elongata* is similar in appearance and distribution, but has a thinner, more compact podetial medulla (to 0.01–0.02 mm [1–2 µm] thick in basal portions), is black below, and generally lacks podetial squamules. It is also not restricted to base-rich sites in alpine localities. *Cladonia phyllophora* and *C. stricta* are “soft corticate” in the upper portions of the podetia, and are often white-spotted below. *Cladonia gracilis* ssp. *turbinata* is invariably cupped above, and occurs at all elevations. See also *C. gracilis* ssp. *vulnerata*.

Cladonia macrophylla (Schaerer) Stenh.
(Syn. *Cladonia alpicola* (Flotow) Vainio)
Plated pebblehorn

Map 53

Habitat/Range: Rare over humus and mossy rock in open inland sites at upper forested and alpine elevations, also known from maritime localities; circumpolar, N to sAK, AK, YU, wNT, S to WA, UT; AB.

Reactions: Medulla PD+ strong yellow.

Contents (major substances): Psoromic acid.

Variability: Medium.

Notes: *Cladonia macrophylla* can be distinguished by: (1) its unbranched to moderately branched podetia that taper upwards to a point, and that bear numerous peltate squamules (i.e., in which the point of attachment occurs in the central portions rather than at the base); (2) its PD+ strong yellow medullary reaction (psoromic acid present); and (3) its inland distribution. In *C. acuminata*, *C. decorticata*, and other similar species, the podetial squamules are attached by their basal portions, and the podetia never give a PD+ strong yellow reaction.

Cladonia macrophyllodes Nyl.

Stepladdered pixie-cup; leaf lettuce (large-leaf cladonia)

Habitat/Range: Frequent over acidic to weakly base-rich soil and mossy rock in open to somewhat sheltered inland sites at all forested elevations, also rare in maritime regions; probably circumpolar, N to sAK, AK, YU, wNT, S to WA, ID, MT, OR, (WY), CA, UT, CO, AZ; AB.

Reactions: Cortex K+ yellow. Medulla K+ yellow, PD+ yellow, orange, or red.

Contents (major substances): Atranorin and fumarprotocetraric acid.

Variability: High.

Notes: This is a nonsorediate, nonyellowish species in which the podetia, when present, bear broad, often richly squamulose cups that proliferate, if at all, primarily from the cup centres. Nonpodetiate forms are common: in these the basal squamules are distinctly large and broad (5–15 mm long, and not much longer than wide), and have a K+ persistently yellow medulla. *Cladonia cervicornis* s. lat. is similar, but lacks atranorin, and has narrower basal squamules that are often considerably longer than wide; the cups, when present, are also less richly squamulose. Nonpodetiate forms of *C. macrophyllodes* can also resemble *C. symphylicarpa*, though in that species the medulla is PD- (or PD+ sulphur yellow when psoromic acid is present), and the upper surface of the basal squamules often bears large, brown, barrel-shaped pycnidia. In one rather uncommon form (form “pynotheliza”) in which the podetia fail to develop, brown apothecia occur directly on the basal squamules. See also the comments under *C. schofieldii*.

Cladonia merochlorophaea Asah.
Gritty pixie-cup

Map 54

Habitat/Range: Infrequent (probably overlooked) over acidic moss and mossy rock in open to somewhat sheltered intermontane sites at all forested elevations, also rare in maritime localities; circumpolar, N to sAK, AK, YU, wNT, S to WA, ID, MT, OR, CA; AB.
Reactions: Medulla PD- or PD+ yellow, orange, or red.
Contents (major substances): Merochlorophaeic and 4-o-methylcryptochlorophaeic acids (and usually fumarprotocetraric acid).
Variability: Medium.
Notes: This is a member of the “*C. chlorophaea* group,” in which the podetia are greyish or brownish, broadly cupped, and at least partly covered in soredia or corticate granules, or both. *Cladonia merochlorophaea* can be distinguished from other related species by its pale podetia that bear copious microsquamules (check lower portions), and contain merochlorophaeic acid.

Cladonia metacorallifera Asah.
Dragon’s pixie-cup

Map 55

Habitat/Range: Infrequent (probably overlooked) over humus, mossy rock, bark or decaying wood in open coastal and humid intermontane localities at lower to alpine elevations; probably incompletely circumpolar, N to sAK, AK, YU, wNT, S to WA; AB.
Reactions: Cortex KC+ yellow or apparently KC-; medulla UV+ strikingly ice-blue.
Contents (major substances): Usnic, didymic, and squamatic acids (and barbatic acid).
Variability: Medium.
Notes: Diagnostic for *C. metacorallifera* are: (1) the yellowish green, cupped podetia that bear copious microsquamules (check lower portions); (2) the UV+ ice-blue medullary reaction (squamatic acid present); and (3) the presence of didymic acid. *Cladonia borealis* and *C. coccifera* are somewhat similar, but neither of these produces copious microsquamules, nor yields a UV+ ice-blue reaction. *Cladonia granulans* Vainio is UV+ ice-blue (squamatic acid present), but lacks both didymic acid and microsquamules. It has been reported from coastal regions of southeast Alaska (Krog 1968), and can be expected also in adjacent north coastal British Columbia.

Cladonia multiformis G. Merr.

Slotted clad (sieve lichen; sieve cup lichen)

Habitat/Range: Frequent over acidic to somewhat base-rich soil or thin moss in open to rather sheltered inland forests, mostly at lower to middle elevations, also rare in maritime (CDF) localities; N Am, N to AK, YU, wNT, S to WA, ID, MT, OR, (CA), CO, NM, MX.

Reactions: Medulla PD+ yellow, orange, or red.

Contents (major substances): Fumarprotocetraric acid (and ursolic acid).

Variability: High.

Notes: Diagnostic characters include: (1) the continuously corticate, nonsorediate, nonyellowish, moderately branched podetia that bear distinct cups; (2) the presence of sieve-like perforations in the interiors of the cups; (3) the PD+ yellow, orange, or red medullary reaction; and (4) the primarily inland distribution. In fertile specimens, however, the cups are usually absent and the main stems tend to be somewhat flattened in cross-section. Noncupped forms of *C. multiformis* occurring in coastal regions can be confused with *C. furcata*, but in that species the main stems are invariably round in cross-section, never flattened.

[***Cladonia nipponica*** Asah.]

Nippon's clad

Habitat/Range: Expected over alpine heaths in northern coastal regions at alpine elevations; western N Am - eastern Eurasia, in N Am known only from sAK, AK.

Reactions: Cortex KC+ yellow or apparently KC-; medulla PD+ strong yellow (at tips of podetia only).

Contents (major substances): Psoromic and usnic acids.

Variability: Unknown.

Notes: *Cladonia nipponica* has been reported from southeast Alaska and adjacent British Columbia (Thomson 1984), but no authentic material from Canada has yet been seen. It is very close in appearance to *C. kanewskii*; see that species for points of distinction.

Cladonia norvegica Tønsberg & Holien
Least powderhorn

Habitat/Range: Frequent over decaying wood and conifer bark at the bases of trees in sheltered to shady sites throughout, especially in humid regions at lower to middle forested elevations; incompletely circumpolar, N to sAK, S to WA, WY, AZ, (MX); AB.

Reactions: Medulla UV+ strikingly ice-blue.

Contents (major substances): Barbatic acid (and traces of squamatic acid).

Variability: Medium.

Notes: Diagnostic characters include: (1) the small, unbranched, finely sorediate podetia that taper upwards to a point; (2) the tiny basal squamules (to 1–3 mm long); (3) the occurrence over bark or wood; and (4) the K- and PD- medullary reaction. *Cladonia coniocraea* and *C. ochrochlora* are similar, but have larger basal squamules, and give PD+ medullary reactions. Some forms of *C. umbricola* are also similar, but in that species the podetia are generally at most blunt-tipped, not pointed-tipped, the basal squamules are often orange below at the point of attachment, and barbatic acid is absent. As circumscribed here, *C. norvegica* includes hypermaritime material having thick basal squamules and rather large podetia containing squamatic acid in addition to barbatic acid; such material may represent a separate taxon.

Cladonia novochlorophaea (Sipman) Brodo & Ahti
(Syn. *Cladonia merochlorophaea* Asah. var. *novochlorophaea* Sipman)
Sekikaic pixie-cup

Map 56

Habitat/Range: Rare over mossy rock in rather exposed sites, currently recorded only from upper forested elevations in hypermaritime regions, local distribution poorly known; western N Am - western Eurasia, N to wNT, S to WA.

Reactions: Medulla PD+ yellow, orange, or red, UV+ pale blue.

Contents (major substances): Homosekikaic and sekikaic acids (and fumarprotocetraric acid).

Variability: Unknown.

Notes: This is a nonyellowish, nonsorediate, broadly cupped species in which corticate “tiles”/areoles occur on the insides of the cups in all stages of development, and in which homosekikaic and sekikaic acids are present in abundance. See *C. pyxidata* for points of distinction with that species. See also the comments under *C. homosekikaica* and *C. imbricarica*. The British Columbia record is based on a single specimen from the Queen Charlotte Islands (Brodo and Ahti 1996).

Cladonia ochrochlora Flörke
Greater powderhorn (powderhorn lichen)

Habitat/Range: Common over decaying conifers, tree bases, and occasionally mossy rocks in open to somewhat shady sites at all forested elevations throughout, except apparently absent from boreal regions; circumpolar, N to sAK, S to WA, ID, MT, OR, WY, CA, CO, AZ, NM, MX.

Reactions: Medulla PD+ yellow, orange, or red.

Contents (major substances): Fumarprotocetraric acid.

Variability: High.

Notes: *Cladonia ochrochlora* can be characterized by its medium-sized, diffusely soresiate, nonyellowish podetia (to 30–70 mm tall) that either taper upward to a point, or bear narrow cups (even in young podetia!); the podetia also give a PD+ yellow, orange, or red medullary reaction. Cups, when present, are often granular-corticate within and occasionally also without. *Cladonia norvegica* is similar, but gives a PD- reaction. Some forms of *C. coniocraea* are also similar, but in that species the podetia are smaller (to less than 25 mm tall) and are cupped, if at all, only at maturity; the cups, when present, are generally soresiate and noncorticate both within and without. Young specimens, however, are difficult to distinguish, and can be referred to as *C. coniocraea* s. lat. See also the comments under *C. cornuta*.

Cladonia parasitica (Hoffm.) Hoffm.
Fence-rail thatch (fence-rail cladonia)

Map 57

Habitat/Range: Rare over hard or somewhat decayed wood in open, humid intermontane (ICH) forests at lower elevations, local distribution poorly known; probably incompletely circumpolar, N to BC, S to UT, MX.

Reactions: Cortex and medulla: K+ strong yellow, PD+ strong yellow.

Contents (major substances): Thamnic acid.

Variability: Low.

Notes: This is a distinctive wood-inhabiting species unlikely to be confused with any other *Cladonia*. It consists entirely of small basal squamules (to less than 2.5 mm long) that are more or less soresiate, and yield a K+ strong yellow medullary reaction (thamnic acid present).

Cladonia phyllophora Hoffm.

(Syn. *Cladonia degenerans* (Flörke) Sprengel)

Greater felt-soldiers (black-foot cladonia)

Habitat/Range: Common over acidic to somewhat base-rich soil, humus, moss, and mossy rock in open inland forests, especially at lower to middle elevations, but occasionally also to treeline; also rare in maritime regions; circumpolar, N to sAK, AK, YU, wNT, S to WA, ID, MT, OR, (WY), (CA), CO, NM; AB.

Reactions: Medulla K-, PD+ yellow, orange, or red.

Contents (major substances): Fumarprotocetraric acid.

Variability: High.

Notes: Diagnostic characters include the K- medullary reaction and the tall, rather broadly cupped podetia that are apparently “soft-corticate” (actually minutely woolly tomentose) above, and white-spotted below against a black background. *Cladonia stricta* is similar, but has distinctly narrow cups, and often yields a K+ yellow reaction. Also similar is *C. trassii*, in which, however, the white spotting consists of much larger “spots,” the medullary reaction is K+ invariably yellow, and the distribution is northern (in British Columbia, south to 59°N). Some forms of *C. phyllophora* also resemble *C. prolifica*, but in that species the basal portions are whitish, not black, and the cups are often abundantly proliferate.

Cladonia pleurota (Flörke) Schaerer

Mind-altering pixie-cup (red-fruited pixie-cup; red-tipped goblet lichen)

Habitat/Range: Common over acidic soil, humus, moss, mossy rock, and decaying wood in open to somewhat sheltered inland sites at all elevations, but especially at upper forested and alpine elevations, also rare in maritime localities; circumpolar, N to sAK, AK, YU, wNT, S to WA, ID, MT, OR, WY, CO, AZ, MX; AB.

Reactions: Cortex KC+ yellow or apparently KC-.

Contents (major substances): Usnic and isousnic acids and zeorin (and porphyritic acid).

Variability: Medium.

Notes: Diagnostic characters include the ground-dwelling habitat ecology and the coarsely sorediate, yellowish green podetia that terminate upwards in broad cups. *Cladonia deformis* is similar, but has taller podetia (to 4 cm tall) that are covered in mostly powdery soredia. See also the comments under *C. carneola*.

Cladonia pocillum (Ach.) Grognot
Rosetted pixie-cup

Habitat/Range: Frequent over base-rich soil and mossy rock in open inland sites at all elevations, also rare in maritime (CDF) regions; circumpolar, N to sAK, AK, YU, wNT, S to WA, ID, MT, OR, WY, CA, UT, CO, AZ, NM, MX; AB.

Reactions: Medulla PD+ yellow, orange, or red.

Contents (major substances): Fumarprotocetraric acid (and rarely atranorin).

Variability: Medium.

Notes: Diagnostic characters include: (1) the nonsorediate, nonyellowish, unbranched podetia, each of which terminates upwards in a broad cup that supports numerous corticate granules or plates/areoles; (2) the large, lobe-like, horizontally spreading basal squamules; and (3) the strict occurrence in base-rich sites. Unfortunately, some forms are difficult to reliably distinguish from *C. pyxidata*; for convenience, these can be referred to as *C. pyxidata* s. lat.

Cladonia prolifica Ahti & S. Hammer
Phantom pixie-cup

Map 58

Habitat/Range: Infrequent over acidic soil, especially thin soil over rocks in open to somewhat sheltered coastal localities at lower elevations, also rare in humid intermontane (ICH) regions; western N Am - western Eurasia, N to BC, S to WA, ID, OR, CA.

Reactions: Medulla PD+ yellow, orange, or red.

Contents (major substances): Fumarprotocetraric acid.

Variability: Medium.

Notes: Diagnostic characters include the entirely whitish, nonsorediate, broadly cupped podetia that are often “soft-corticate” above, and that typically bear numerous marginal proliferations. *Cladonia phyllophora* is similar, but in that species the basal portions of the podetia are typically black, or at least not white, and the cups are seldom, if ever, abundantly proliferate. Based on the recent report of *C. prolifica* from Idaho (Hammer 1995), this species should be searched for also in adjacent portions of inland British Columbia.

Cladonia pyxidata (L.) Hoffm.

Pebbled pixie-cup (brown pixie-cup; pixie-cup lichen; goblet lichen; true pixie-cup lichen; chalice moss; cup moss)

Habitat/Range: Common over acidic to somewhat base-rich soil, moss, mossy rock, and decaying wood in open to somewhat sheltered sites at all forested and alpine elevations throughout, except rare in hypermaritime regions; circumpolar, N to sAK, AK, YU, wNT, S to WA, ID, MT, OR, WY, CA, NV, UT, CO, AZ, NM, MX; AB.

Reactions: Medulla PD+ yellow, orange, or red.

Contents (major substances): Fumarprotocetraric acid.

Variability: Low.

Notes: This is a nonyellowish, nonsorediate, broadly cupped species in which corticate “tiles”/areoles occur on the insides of the cups at all stages of development. *Cladonia pocillum* is similar, but has larger, more decumbent basal squamules, and occurs primarily over base-rich soil. In coastal regions, *C. pyxidata* must be carefully distinguished from (the very rare) *C. novochlorophaea*, in which the podetial cortex is continuous and convex-warty (versus discontinuous and plated/areolate in *C. pyxidata*), and in which homosekikaic acid is present. See also *C. dimorpha*.

Cladonia rei Schaerer

Map 59

(Syn. *Cladonia nemoxyna* (Ach.) Arnold)

Sordid powderhorn (wand lichen)

Habitat/Range: Infrequent (probably overlooked) over sandy and often somewhat base-rich soil, also over mossy rock, in open inland sites at lower elevations, especially disturbed sites, also known from maritime (CDF) localities, local distribution poorly known; circumpolar, N to sAK, S to WA, ID, MT, OR, WY, MX; AB.

Reactions: Medulla PD- or PD+ yellow, orange, or red, UV+ dull bluish.

Contents (major substances): Homosekikaic and sekikaic acids (and fumarprotocetraric acid).

Variability: Medium.

Notes: Diagnostic characters include: (1) the continuously sorediate, green-and-brown-mottled, typically PD- podetia that taper upward to a point; (2) the presence of homosekikaic and sekikaic acids; (3) the inland distribution; and (4) the occurrence over base-rich soil. It is often confused with inland forms of *C. subulata* and *C. verruculosa*. The former species, however, has pale greyish, often laterally branched podetia, whereas the latter has much larger (to 30–65 mm tall) podetia that are often distinctly blackish below, and bear copious granules or microsquamules, or both. See also the comments under *C. cornuta*.

Cladonia scabriuscula (Delise) Nyl.

(Syn. *Cladonia macroptera* Räsänen)

Many-winged clad (shingled cladonia; dusty shrublet lichen; forked shore lichen; mealy-forked cladonia)

Habitat/Range: Frequent over acidic soil, moss, or decaying wood in open to shaded coastal localities at lower elevations; probably incompletely circumpolar, N to sAK, AK, wNT, S to WA, ID, OR, CA, (MX); AB.

Reactions: Medulla PD+ yellow, orange, or red.

Contents (major substances): Fumarprotocetraric acid.

Variability: High.

Notes: Diagnostic characters include: (1) the large, unbranched or moderately branched podetia bearing numerous squamules over the “upper” surface, and (often) soredia and/or granules at the extreme branch tips; (2) the PD+ yellow, orange, or red medullary reaction; and (3) the coastal distribution. The material included here is highly variable in morphology, and appears to be heterogeneous. On the other hand, fertile specimens are very similar in appearance to *C. furcata*, at least in British Columbia; see the comments under that species. Difficult specimens can be referred to as *C. furcata* s. lat. See also the comments under *C. squamosa*.

Cladonia schofieldii Ahti & Brodo

Map 60

Haida thatch

Habitat/Range: [Both chemotypes] Rare over acidic soil or rock in open hypermaritime sites at middle to upper elevations, mostly northern, south to 53°N; western N Am, N to sAK, S to BC.

Reactions: Chemotype 1: Medulla PD+ yellow, orange, or red. Chemotype 2: Medulla K+ pale yellow, PD+ yellow, orange, or red.

Contents (major substances): Chemotype 1: Fumarprotocetraric acid. Chemotype 2: Atranorin and fumarprotocetraric acid.

Variability: Medium.

Notes: This is a distinctive hypermaritime species in which the basal squamules are very large (to more than 20 mm long), and often partly corticate below; they often considerably exceed the podetia in size. *Cladonia macrophyllodes* also has rather large basal squamules, but is apparently absent from hypermaritime localities, and is seldom, if ever, corticate below. The holotype locality is near Tasu on Moresby Island in the Queen Charlotte Islands.

Cladonia singularis S. Hammer

Ragged soldiers

Habitat/Range: Frequent over soil, humus, or wood in open coastal forests, at middle to upper forested elevations, especially near treeline; western N Am, N to BC, S to WA.

Reactions: Medulla UV+ strikingly ice-blue.

Contents (major substances): Squamatic acid.

Variability: Medium.

Notes: This is an easily recognized species in which the podetia are nonyellowish, nonsorediate, abundantly squamulose, mostly unbranched, and continuously corticate, and occasionally open above by a gaping hole. *Cladonia squamosa* is similar, but in that species the podetia lack a continuous cortex. In many specimens, however, the podetia do not open, but taper upwards to a point; such specimens might be confused with *C. scabriuscula*, though in that species the medulla gives a PD+ yellow, orange, or red reaction.

Cladonia squamosa Hoffm.

(Syn. *Cladonia squamosa* Hoffm. ssp. *subsquamosa* (Vainio) Vainio; *Cladonia squamosa* Hoffm. var. *subsquamosa* (Leighton) Vainio; *Cladonia subsquamosa* (Leighton) Crombie, nom. illeg.)

Dragon funnel (dragon cladonia; funnel lichen; scaly funnel lichen)

Habitat/Range: [Chemotype 1] Common over acidic soil, moss, mossy rock, and occasionally decaying wood and conifer bark at the base of trees in open to somewhat shady coastal and humid intermontane localities at all forested elevations, also infrequent above treeline; [Chemotype 2] common in similar habitats in coastal localities at lower elevations; circumpolar, N to sAK, AK, wNT, S to WA, ID, MT, OR, CA, UT, CO, (WY), (MX); AB.

Reactions: Chemotype 1: Medulla UV+ strikingly ice-blue. Chemotype 2: Medulla K+ strong yellow, PD+ yellow or orange.

Contents (major substances): Chemotype 1: Squamatic acid (and consquamatic acid).

Chemotype 2: Thamnic acid.

Variability: High.

Notes: This is a highly variable species characterized by the nonsorediate, nonyellowish, abundantly squamulose, and essentially noncorticate podetia that typically open above. *Cladonia singularis* is similar, but has more or less continuously corticate podetia (check upper portions) that are less inclined to open above. Chemotypes 1 and 2, though identical in appearance, have been treated by many authors as separate taxa, the latter being referred to *C. subsquamosa*.

Cladonia stricta (Nyl.) Nyl.
(Syn. *Cladonia lepidota* auct.)
Lesser felt-soldiers

Habitat/Range: Frequent over acidic to weakly base-rich soil, moss, and mossy outcrops in open sites at all elevations throughout, except apparently absent from boreal regions, otherwise favouring cool localities; circumpolar, N to sAK, AK, YU, wNT, S to WA, UT, CO, MX; AB.

Reactions: Medulla K- or occasionally K+ yellow; PD+ yellow, orange, or red.

Contents (major substances): Fumarprotocetraric acid (and atranorin).

Variability: Medium.

Notes: Diagnostic characters include: (1) the tall, narrowly cupped podetia that are apparently “soft-corticate” (actually minutely woolly tomentose) above, and white-spotted below against a black background; and (2) the K- or occasionally K+ yellow medullary reaction. *Cladonia phyllophora* is similar, but has distinctly broad cups, and is invariably K-. Also similar is *C. trassii*, in which, however, the white spotting consists of much larger “spots,” the medullary reaction is K+ invariably yellow, and the distribution is northern (in British Columbia, south to 58°N) in inland regions, where their ranges overlap. As defined here, *C. stricta* is apparently not homogeneous, but may contain at least two taxa. Further work is needed.

Cladonia subfurcata (Nyl.) Arnold
Rosegarden clad

Map 61

Habitat/Range: Rare (overlooked?) over moss and humus in open boreal and hypermaritime heaths and wetlands, local distribution poorly known; circumpolar, N to sAK, AK, wNT, S to BC; AB.

Reactions: Medulla UV+ strikingly ice-blue.

Contents (major substances): Squamatic acid (and zeorin).

Variability: Unknown.

Notes: This is a distinctive species characterized by: (1) its brownish, nonsorediate, non-squamulose, richly branching podetia that taper upwards to a point, but that have open branch axils; (2) its blackening stereome (i.e., inner podetial wall: check basal portions); and (3) its K-, UV+ ice-blue medullary reactions (squamatic acid present). *Cladonia subfurcata* might be mistaken for *C. crispata*, which it resembles in general form, but that species has open podetia tips.

Cladonia subulata (L.) F.H. Wigg.

Antlered powderhorn (antler cladonia; tall toothpick cladonia)

Habitat/Range: Frequent over weakly base-rich to somewhat acidic soil, humus, and mossy rock in open, often disturbed sites at all forested elevations (but especially at lower elevations) throughout, but probably absent from hypermaritime regions; also rare over decaying wood; circumpolar, N to sAK, AK, YU, wNT, S to WA, ID, MT, OR, WY, CA, CO, NM, MX; AB.

Reactions: Medulla PD+ yellow, orange, or red.

Contents (major substances): Fumarprotocetraric acid.

Variability: Medium.

Notes: Diagnostic characters include: (1) the pale greyish, finely and deeply sorediate, mostly pointed-tipped podetia that tend to bear “antlerlike” lateral branches; (2) the occurrence over soil; and (3) PD+ medullary reaction. *Cladonia verruculosa* is similar, but bears coarse soredia and microsquamules mostly in a single layer, and tends to branch, if at all, only at the tips. *Cladonia rei* is also somewhat similar, but has small, mostly unbranched podetia that are typically mottled grey and brown, and contain homosekikaic and sekikaic acids. Most specimens also give a PD+ medullary reaction. See also the comments under *C. cornuta*.

Cladonia sulphurina (Michaux) Fr.

(Syn. *Cladonia gonecha* (Ach.) Asah.)

Greater sulphur-cup (sulphur cladonia; sulphur pixie-cup lichen)

Habitat/Range: Common over decaying wood, humus, and mossy acidic soil in open to shady inland forests, especially at middle and upper forested elevations, also rare in maritime regions; circumpolar, N to sAK, AK, YU, wNT, S to WA, ID, MT, OR, WY, UT, CO, AZ; AB.

Reactions: Cortex KC+ yellow or apparently KC-; medulla UV+ strikingly ice-blue.

Contents (major substances): Squamatic and usnic acids.

Variability: Medium.

Notes: Diagnostic characters include: (1) the large basal squamules (to more than 5 mm long); (2) the finely sorediate, unbranched, yellowish green podetia that terminate upwards in nonflaring, often lacerate cups; and (3) the UV+ ice-blue medullary reaction. Some forms of *C. sulphurina* must be carefully distinguished from *C. deformis* by the latter's UV- medulla, and smaller squamules (less than 4 mm long). See also the comments under *C. digitata*.

Cladonia symphy carpia (Flörke) Fr.

(Syn. *Cladonia dahlia na* Kristinsson)

Thatch soldiers; studded thatch (peg lichen)

Habitat/Range: [Both chemotypes] Frequent over acidic to somewhat base-rich soil and mossy rock in open to sheltered sites at all forested elevations throughout, especially at lower and middle elevations, but probably rare in hypermaritime regions; circumpolar, N to sAK, AK, YU, wNT, S to WA, ID, MT, OR, UT, CO, AZ; AB.

Reactions: Chemotype 1: Medulla K+ pale yellow, UV+ dull or UV-. Chemotype 2: Cortex K+ yellow; medulla PD+ sulphur yellow.

Contents (major substances): Chemotype 1: Atranorin. Chemotype 2: Atranorin and psoromic acid.

Variability: High.

Notes: Diagnostic characters include: (1) the nonyellowish, nonsorediate, distinctly “ribbed” podetia that terminate upwards in dark-brown apothecia; (2) the large, somewhat ascending squamules (more than 2.5 mm tall) that occasionally bear large, brown, barrel-shaped pycnidia; (3) the presence of atranorin or psoromic acid, or both; and (4) the ground-dwelling habitat ecology. *Cladonia cariosa* is similar, but has tiny, essentially erect basal squamules, and occasionally produces fumarprotocetraric acid, but never psoromic acid. Difficult specimens can be referred to as *C. cariosa* s. lat.; see also the notes under that species. Some forms of *C. symphy carpia* consist entirely of basal squamules, and can then be difficult to reliably distinguish from non-podetiate forms of *C. cervicornis* and *C. macrophyllodes*—at least in the absence of thin-layer chromatography. Unlike *C. symphy carpia*, however, *C. cervicornis* contains fumarprotocetraric acid alone, whereas *C. macrophyllodes* contains atranorin and fumarprotocetraric acid. The basal squamules of both species, moreover, lack the barrel-shaped pycnidia characteristic of *C. symphy carpia*. Five chemotypes of *C. symphy carpia* are recognized worldwide (Stenroos and Ahti 1990), but only two are known to occur in British Columbia. Chemotype 2, though morphologically identical with Chemotype 1, is often treated as a separate species, *C. dahlia na*.

Cladonia transcendens (Vainio) Vainio

Magic pebblehorn (variable pebblehorn)

Habitat/Range: Frequent over decaying wood and tree bases in open to shady coastal forests at lower elevations; western N Am, N to sAK, S to WA, ID, OR, CA.

Reactions: Cortex UV+ yellow or UV-; medulla K+ strong yellow, PD+ yellow or orange.

Contents (major substances): Thamnic acid (and usnic acid).

Variability: Medium.

Notes: This is a highly variable species characterized by: (1) its whitish, often red-fruited, coarsely sorediate and/or copiously squamulose podetia that either taper upwards to a point, or are narrowly cupped; (2) its occurrence over decaying wood or bark; (3) its coastal distribution; and (4) its K+ strong yellow medullary reaction (thamnic acid present). Some forms of *C. bellidiflora* (chemotype 2) can be similar, but in that species the podetia are generally yellowish green, and soredia are entirely absent. Finely sorediate forms of *C. transcendens* are very close to *C. umbricola* (chemotypes 3 and 4), and can be difficult to distinguish. In the former species, however, the podetia tend to arise from the centres of the basal squamules, whereas in the latter they often arise from the squamule edges.

Cladonia trassii Ahti

Map 62

(Syn. *Cladonia stricta* auct., non (Nyl.) Nyl.)

Spotted black-foot (winged cladonia)

Habitat/Range: Rare over humus and mossy boulder beds in open intermontane sites at alpine (AT) elevations; circumpolar, N to sAK, AK, YU, wNT, S to BC.

Reactions: Cortex K+ yellow or apparently K-; medulla K+ yellow, PD+ yellow, orange, or red.

Contents (major substances): Atranorin and fumarprotocetraric acid.

Variability: High.

Notes: Diagnostic characters include: (1) the tall, narrowly cupped or uncupped podetia that are typically “soft-corticate” above, and broadly white-spotted below against a black background; (2) the K+ yellow medullary reaction; and (3) the northern, alpine distribution (south to 59°N). *Cladonia stricta* is similar, but in that species the white spotting consists of much smaller “spots,” the medullary reaction is often K- (but also occasionally K+ yellow), and the distribution is much more widespread.

Cladonia umbricola Tønsberg & Ahti

Because-it’s-there (shaded cladonia)

Habitat/Range: [Chemotypes 1 and 2] Common over decaying wood and conifer bark at the base of trees in open to shady old-growth forests in coastal and humid intermontane regions at lower to middle elevations; [Chemotypes 3 and 4] common in similar habitats in coastal localities at lower elevations; western N Am - western Eurasia, N to sAK, S to WA, ID, MT, OR, CA, UT.

Reactions: Chemotypes 1 and 2: Cortex KC+ yellow or KC-; medulla UV+ ice-blue.

Chemotypes 3 and 4: Cortex KC+ yellow or KC-; medulla K+ strong yellow, PD+ yellow or orange.

Contents (major substances): Chemotype 1: Squamatic acid. Chemotype 2: Squamatic and usnic acids. Chemotype 3: Thamnic acid. Chemotype 4: Thamnic and usnic acids.

Variability: High.

Notes: As presently circumscribed, this species is highly variable both in appearance and in chemistry. Diagnostic characters include: (1) the small, unbranched, often yellowish green, finely soresiate podetia that are either cupped or taper upwards to a blunt tip; (2) the medium-sized, deeply lobed basal squamules (to 1.5–7 mm long); and (3) the strict occurrence over wood or bark. Some forms of *C. macilenta* are similar, though in that species the basal squamules are smaller and more shallowly lobed (mostly to 1–2 mm long). See also the comments under *C. transcendens* and *C. norvegica*.

***Cladonia uncialis* (L.) F.H. Wigg.**

(Syn. *Cladonia pseudostellata* Asah.)

Thorn clad (prickle cladonia; thorn lichen; spike lichen)

Habitat/Range: [All chemotypes] Common over acidic to somewhat base-rich soil, moss, and mossy rock in open forests, wetlands, boulder beds, and outcrops at all forested and alpine elevations throughout; circumpolar (except western N Am - eastern Eurasia for Chemotype 2), N to sAK, AK, YU, wNT, S to WA, ID, OR, MX; AB.

Reactions: Chemotype 1: Cortex KC+ yellow or apparently KC-. Chemotype 2: Cortex KC+ yellow or apparently KC-; medulla UV+ strikingly ice-blue. Chemotype 3: Cortex KC+ yellow, or apparently KC-; medulla UV- or UV+ strikingly ice-blue.

Contents (major substances): Chemotype 1: Usnic acid. Chemotype 2: Usnic and squamatic acids. Chemotype 3: Usnic and hypothamnolic acids (and squamatic acid).

Variability: High.

Notes: Diagnostic characters include the yellowish green colour, and the stout, nonsorediate, richly branched podetia that fail to produce cups, and that are rather smooth-walled within. *Cladonia kanewskii* is similar, but is restricted to hypermaritime localities, and is distinctly roughened and/or fibrous within; see the comments under that species. Slender forms can be confused with *C. amaurocraea*—an inland species in which the podetia typically bear distinct cups. Chemotype 3 is sometimes given separate species status as *C. pseudostellata* Asah. Further work is needed.

***Cladonia verruculosa* (Vainio) Ahti**

Greater pebblehorn (western wand lichen)

Habitat/Range: Frequent over bare or mossy soil in open coastal and humid intermontane (ICH) localities, especially outcrops, at lower elevations; western N Am, N to sAK, S to WA, ID, MT, OR, WY, CA.

Reactions: Medulla PD+ yellow, orange, or red.

Contents (major substances): Fumarprotocetraric acid.

Variability: Medium.

Notes: This is a distinctive species characterized by: (1) its tall, coarsely sorediate, nonyellowish, uncupped or narrowly cupped podetia that are blackish below, and that bear at least some microsquamules; (2) its occurrence over soil; and (3) its PD+ medullary reaction. In inland regions, *C. verruculosa* can be confused with *C. rei* and *C. subulata*; see those species for points of distinction. See also the comments under *C. cornuta*. The holotype specimen is from Vancouver Island.

Cladonia wainioi Savicz
(Syn. *Cladonia pseudorangiformis* Asah.)
Reindeer clad

Map 63

Habitat/Range: Infrequent over acidic soil, moss, and mossy rock in hypermaritime heaths and bogs at lower to subalpine elevations, mostly north of 52°N; western N Am - eastern N Am - eastern Eurasia, N to sAK, AK, YU, wNT, S to WA.

Reactions: Medulla K+ pale yellow.

Contents (major substances): Atranorin and merochlorophaeic and 4-o-methylcryptochlorophaeic acids.

Variability: High.

Notes: *Cladonia wainioi* is a hypermaritime species with fine, copiously branched podetia, a patchy cortex, and a K+ yellow medullary reaction. It is very close to *Cladonia* (especially *C. portentosa* ssp. *pacifica*: another coastal species), but is distinctly corticate, and contains merochlorophaeic acid.

***Cladonia* sp. 1**
Ambiguous trumpet

Map 64

Habitat/Range: Rare over decaying wood and disturbed banks in humid maritime (CWH) localities at lower elevations; global distribution unknown, perhaps western N Am, N to BC, S to CA.

Reactions: Medulla PD+ yellow, orange, or red.

Contents: Fumarprotocetraric and protocetraric acids (and confumarprotocetraric and convirensic acids).

Variability: High.

Notes: This unnamed species is allied with *C. fimbriata* (whitish, finely soresiate, cupped above), but has more elongate podetia, and bears narrower, less regular cups covered in powdery and granular soredia as well as in copious detachable microsquamules. When well developed, the microsquamules have a bluish lower surface.

Medium-sized stratified fruticose (**shrub**) lichens, consisting of tufts of erect branches, these **reddish brown** to yellowish brown, round in cross-section to somewhat angular (and then longitudinally furrowed), slender to **somewhat stout**, to **10–30 (–40) mm long** and 0.3–1.0 (–4.0) mm wide, generally shiny, smooth, **corticate, brittle, solid**, more or less richly branched, bearing lateral and apical **spine-like projections**, occasionally also ciliate; branching even/isotomic to more often uneven/anisotomic. Soredia and isidia absent (ours). **Pseudocyphellae present, white**, depressed or plane. Attached to substrate by basal holdfasts, often becoming detached. Medulla white. Photobiont green, chlorococcoid.

Ascocarp an apothecium, borne lateral-

ly, disc brownish, concave to convex. Spores 1-celled, ellipsoid, colourless, eight per ascus. Pycnidia common, located on short spine-like projections. **Over ground.**

References: Kärnefelt (1986).

Common Name: Describes the habitat ecology of the species.

Notes: *Coelocaulon* is a temperate to arctic genus consisting of five species world-wide. Two of these have been reported for North America, but only one species is recognized here for British Columbia. For points of separation with similar lichens, see the key under *Bryoria*.

Coelocaulon is closely allied with *Cetraria*, and can appropriately be included in that genus (Kärnefelt et al., 1993).

***Coelocaulon aculeatum* (Schreber) Link**

(Syn. *Cetraria aculeata* (Schreber) Fr.)

Spiny heath (spiny shield lichen)

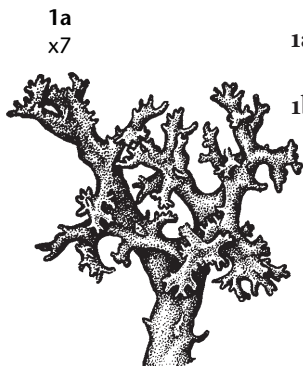
Habitat/Range: Common over stony acid heaths in exposed sites at all elevations throughout; circumpolar, N to sAK, AK, YU, wNT, S to WA, ID, MT, OR, WY, CA, UT, CO, NM; AB.

Reactions: All spot tests negative.

Contents: Lichesterinic and protolichesterinic acids.

Variability: High.

Notes: *Coelocaulon muricatum* (Ach.) J.R. Laundon has been reported from British Columbia (Kärnefelt 1986), but the report is not accepted here, pending further study. Some coastal specimens are indeed similar to *C. muricatum* (e.g., in having narrow, unfurrowed branches that are essentially round in cross-section); they differ, however, in the presence of large, deeply sunken pseudocyphellae and sparse, open branching. This material possibly warrants separate taxonomic recognition. The British Columbia material can in fact be divided into three “forms,” as follows:



- 1a Main branches to more than 0.6 mm wide, mostly flattened in cross-section, longitudinally furrowed *Coelocaulon aculeatum* s. str.
- 1b Main branches to less than 0.6 mm wide, mostly round in cross-section, longitudinal furrows absent or at most sparse 2
- 2a Upper portions of thallus rather sparsely branched; pseudocyphellae present, to 0.4–1.0 mm long, distinctly depressed; widespread, but most common in coastal regions *Coelocaulon aculeatum* s. lat.
- 2b Upper portions of thallus rather densely branched; pseudocyphellae absent or, if present, then to 0.1–0.3 mm long, plane to at most weakly depressed; alpine, east of coast ranges *Coelocaulon* “*muricatum*”

Medium-sized stratified fruticose (**shrub**) lichens, consisting of loose tufts of semi-erect to decumbent branches, these **dark brown or blackish** (except often paler below), oval in cross-section to more or less **flattened**, slender, to **5–15 (–20) mm long** and 0.3–0.5 (–1.0) mm wide, generally shiny, smooth, corticate, **tough** (but pliant), solid, rather sparsely branched; branching even/isotomic to uneven/anisotomic. Soredia, isidia, and pseudocyphellae absent. Medulla white. **Firmly attached** to substrate by basal holdfasts. Photobiont green, chlorococcoid: *Trebouxia*.

Ascocarp an apothecium, borne at

branch tips, disc brownish, concave to convex. Spores 1-celled, ellipsoid, colourless, eight per ascus. Pycnidia common, located along the branch margins.

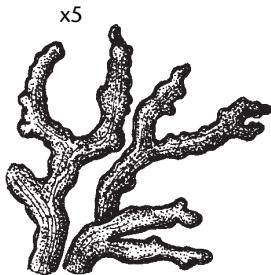
Over acid rock, mostly alpine.

References: Kärnefelt (1986).

Common Name: Describes the characteristic tough, straplike branches.

Notes: *Cornicularia* is a widespread genus of temperate and boreal latitudes. It consists of a single species primarily of alpine habitats. See the key to *Bryoria* for points of distinction with similar lichens in other genera.

Cornicularia normoerica (Gunn.) Du Rietz
The bootstrap



Habitat/Range: Frequent over acid rock in exposed inland localities at alpine elevations throughout, except possibly absent from boreal regions; also rare in maritime localities in similar habitats at forested elevations and in the alpine; incompletely circumpolar, N to sAK, S to WA, ID, MT, OR, CA; AB.

Reactions: All spot tests negative.

Contents: No lichen substances reported.

Variability: Medium.

Small nonstratified fruticose (**hair**) lichen, consisting of **mats** of decumbent to weakly ascending **cyanobacterial filaments**, these dark brown to blackish, round in cross-section, **gossamery**, to **2–5 mm long and 15–20 µm wide**, weakly shiny, **noncorticate**, **brittle**, solid, moderately branched, closely **ensheathed in fungal threads/hyphae**, these elongate, and with thick, **sinuous hyphal walls**. Soredia, isidia, pseudocyphellae, and

medulla absent. Attached to substrate by basal holdfasts. Photobiont dark brown: *Trentepohlia*.

Ascocarps and pycnidia unknown.

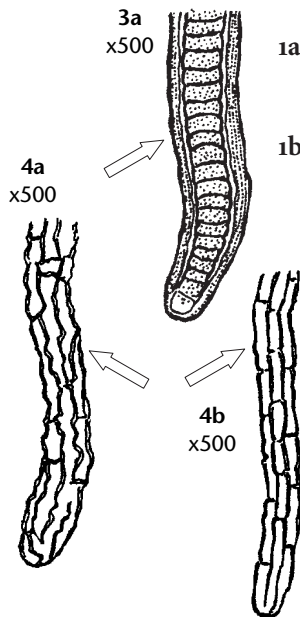
Over vertical **rock**.

References: Purvis et al. (1992: Dalby).

Common Name: Describes the habitat and the delicate, threadlike branches.

Notes: *Cystocoleus* is a cool-temperate genus consisting of only one species.

KEY TO CYSTOCOLEUS AND SIMILAR BLACK, PENDENT HAIRLIKE LICHENS OCCURRING OVER ROCK



- 1a Branches to more than 0.1 mm wide; photobiont 1-celled, medium green (check under LM); exposed habitats; conspicuous (Note: specimens with branches more than 2 cm long key here) . . . *Alectoria*, *Bryoria*, *Pseudephebe* (see key under *Bryoria*)
- 1b Branches to less than 0.1 mm wide; photobiont 1-celled, or more often in chains or in clusters, often blue-green; habitat various; often inconspicuous (Note: reliable identification of most of the following species requires careful study under LM) 2
- 2a Branches more than 50 µm wide; photobiont various (including *Scytonema*, but not *Trentepohlia*); habitat various. . . . various genera (see key under *Spilonema*)
- 2b Branches less than 20 µm wide; photobiont *Trentepohlia* or *Scytonema*; over humid vertical or recessed rock faces 3
- 3a Photobiont *Scytonema*: distinctly orangish, gelatinous sheath present(←); fungal threads not readily discernible [*Thermutis velutina*]
- 3b Photobiont *Trentepohlia*: not at all orangish, gelatinous sheath absent; fungal threads readily discernible 4
- 4a Outermost fungal threads/hyphae with irregular, nonparallel walls(←) (check at 1000x near branch tips) *Cystocoleus ebeneus*
- 4b Outermost fungal threads/hyphae with straight, parallel walls(←) *Racodium rupestre*

Cystocoleus ebeneus (Dillwyn) Thwaites
(Syn. *Cystocoleus niger* (Hudson) Hariot)
The rockgossamer

Map 65

Habitat/Range: Infrequent (probably overlooked) over acid rock or duff, especially on the undersides of humid outcrops sheltered from direct precipitation, at low to middle elevations throughout, except perhaps absent from hypermaritime and boreal regions; probably incompletely circumpolar, N to sAK, S to WA, ID, MT, CO.

Reactions: All spot tests negative.

Contents: No lichen substances reported.

Variability: Low.

Notes: This species often grows intermixed with *Racodium rupestre*, from which it can reliably be distinguished only under a light microscope.

Medium-sized stratified fruticose (**club**) lichens, consisting of clusters of erect to semi-erect, **fingerlike** branches, these **yellowish green** to pale brownish, more or less round in cross-section, rather stout, to (5-) 10-40 (-70) mm long and 2-8 (-14) mm wide, dull, often pale-frosted/pruinose above, corticate, pliant, **hollow** or with a continuous cobwebby medulla (check branch tips), unbranched to **sparsely branched**; branching even/isotomic to more often uneven/anisotomic. Soredia, isidia, and pseudocyphellae absent. Medulla white. Attached to substrate by basal holdfasts. Photobiont green, chlorococcoid: *Trebouxia*.

Ascocarp an apothecium, borne laterally or at tips of branches, disc brownish. Spores 1-celled, globose to broadly ellipsoid, colourless, eight per ascus. Pycnidia immersed.

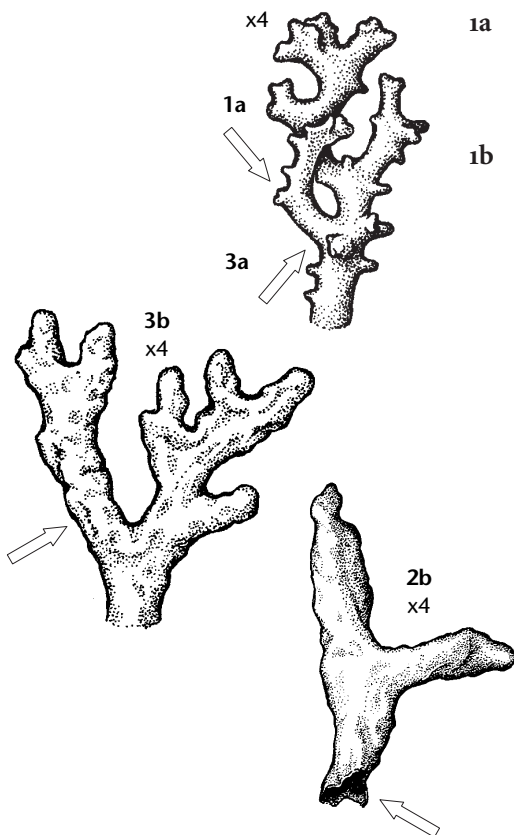
Over ground in alpine sites.

References: Thomson and Bird (1978); Thomson (1984); Kärnefelt and Thell (1996).

Common Name: Descriptive.

Notes: As circumscribed here, *Dactylina* is an arctic-alpine genus comprising three species (five taxa) worldwide. All three species occur in British Columbia.

KEY TO *DACTYLINA*

- 
- 1a** Branch tips generally at least in part white-frosted/pruinose; main stems bearing at least some short, thumblike, rather pointed-tipped outgrowths(←); thallus less than 2.5 cm tall; over base-rich substrates *Dactylina ramulosa*
- 1b** Branch tips not at all pruinose (pruina may, however, rarely be present over lower portions of stems); main stems smooth, or at least lacking pointed-tipped outgrowths; thallus occasionally more than 2.5 cm tall; habitat ecology various 2
- 2a** Main stems weakly cobwebby to more often distinctly cobwebby within, usually at most weakly inflated; over base-rich substrates 3
- 3a** Main stems with predominantly uneven/anisotomic branching(←); medulla PD+ orangish to reddish, or occasionally PD-; frequent *Dactylina ramulosa*
- 3b** Main stems with predominantly even/isotomic branching(←); medulla PD-; rare *Dactylina madreporiformis*
- 2b** Main stems hollow to at most weakly cobwebby within, usually strongly inflated (balloonlike)(←); generally over acidic substrates. 4
- 4a** Medulla PD+ orangish to reddish; northern *Dactylina arctica* ssp. *beringica*
- 4b** Medulla PD-; widespread in inland regions *Dactylina arctica* ssp. *arctica*

Dactylina arctica (Richardson) Nyl. ssp. ***arctica***

Mountain butter-fingers (few fingers)

Habitat/Range: Frequent over open, acid heaths in inland regions at alpine elevations; circumpolar, N to sAK, AK, YU, wNT, S to WA; AB.

Reactions: Cortex KC+ yellowish or pinkish; medulla C+ reddish, KC+ reddish.

Contents: Gyrophoric and usnic acids (and hiascic, lecanoric, and orsellinic acids).

Variability: High.

Notes: Specimens occurring over base-rich substrates are often somewhat white-frosted/pruinose below.

Dactylina arctica (Richardson) Nyl. ssp. ***beringica*** (Bird & J.W. Thomson) Kärnefelt & Thell

(Syn. *Dactylina beringica* Bird and J.W. Thomson)

Arctic butter-fingers (arctic fingers)

Habitat/Range: Frequent over open, acid heaths in generally exposed northern inland regions at alpine elevations, mostly north of 57°N; western N Am - eastern Eurasia, N to sAK, AK, YU, wNT, S to BC; AB.

Reactions: Cortex KC+ yellowish; medulla KC+ reddish, PD+ orangish red.

Contents: Gyrophoric, physodalic, physodic, and usnic acids (and hiascic, lecanoric, and orsellinic acids, and one unknown substance).

Variability: High.

Notes: Subspecies *beringica* is primarily a northern taxon extending southward to about 57°N. One anomalous record, however, comes from Mt. Robson Provincial Park, at 54°N. The holotype specimen of ssp. *beringica* was collected at Summit Lake, at Mile 292.5 of the Alaska Highway.

Dactylina madreporiformis (Ach.) Tuck.

Map 66

(Syn. *Allocetraria madreporiformis* (Ach.) Kärnefelt & Thell; *Dufourea madreporiformis* (Ach.) Ach.)

V-fingers

Habitat/Range: Rare over dry, often somewhat sheltered, generally base-rich heaths in inland regions at alpine elevations, local distribution poorly known; circumpolar, N to AK, YU, S to MT, WY, NV, UT, CO, NM, MX; AB.

Reactions: Cortex KC+ yellow.

Contents: Lichesterinic, protolichesterinic, and usnic acids.

Variability: Medium.

Notes: This species appears to be only distantly related to other *Dactylina* species, and can more appropriately be placed in a separate genus, *Allocetraria* (Kärnefelt and Thell 1996).

Dactylina ramulosa (Hook.) Tuck.

Frosted fingers

Habitat/Range: Frequent over dry to rather moist, often somewhat exposed, generally base-rich heaths in inland regions at alpine elevations; circumpolar, N to sAK, AK, YU, wNT, S to MT, WY; AB.

Reactions: Cortex KC+ yellow or pinkish, or KC-; medulla KC+ reddish, KC+ pale yellowish to orangish, or KC-, PD+ orangish red (or very rarely PD-).

Contents: Usnic acid (and physodalic, physodic, protocetraric, and virensic acids).

Variability: High.

Notes: *Dactylina ramulosa* is usually described as having a K- and KC+ red medullary reaction. However, some local specimens consistently give a K+ yellow or slowly orangish reaction (i.e., physodalic acid present and physodic acid absent), whereas others are KC- (i.e., physodalic and physodic acids absent). Thomson and Bird (1978) report a PD- strain of *D. ramulosa* from northern British Columbia, though all specimens examined during the present study have given a PD+ orangish red medullary reaction.

Small to medium-sized stratified “fruticose” (club) lichens, consisting of a **basal crust** and **stalked apothecia** (ours). Basal crust crustose to warty-granular, pale creamy to pale greyish (becoming pinkish in herbarium), corticate. Soredia present or absent. Isidia and pseudocyphellae absent. Medulla white. Photobiont green, chlorococcoid: *Coccomyxa*.

Apothecial stalks nonlichenized (except rarely patchy-thalline near base), **whitish**, stout, **to 2.0–5.0 (–6.0) mm long** (including apothecial disc) and 0.8–1.0 mm wide (excluding disc), longitudinally ridged, solid to in part hollow, tough, unbranched or sparsely branched.

Apothecial discs borne at stalk tips, globose, pale pink. Spores 1-celled, spin-

dle-shaped/fusiform, colourless/hyaline, eight per ascus. Pycnidia immersed in basal thallus.

Over soil (ours) or rocks.

References: Thomson (1967, 1984); Gierl and Kalb (1993).

Common Name: Reflects the habitat ecology of the local species.

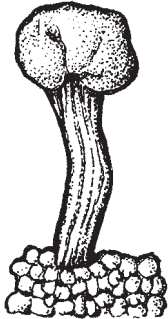
Notes: *Dibaeis* is a predominantly tropical genus comprising 14 species worldwide. Only one of these has been reported for North America. Though technically a crustose genus, *Dibaeis* is included here owing to its stalked apothecia. For points of distinction with similar species in other genera, see the key under *Baeomyces*.

Dibaeis baeomyces (L.f.) Rambold & Hertel
(Syn. *Baeomyces roseus* Pers.)

Map 67

Pink earth

x8



Habitat/Range: Rare over soil, especially in moist sites, at present known only from hypermaritime regions at lower forested elevations; circumpolar, N to AK, YU, wNT, S to BC, with outliers in MX.

Reactions: Cortex, medulla, and stalks: K+ yellow, PD+ yellow; Stalks: UV+ ice-blue.

Contents: Baeomycesic, barbatic, and squamatic acids.

Variability: Moderate.

Notes: The local material consists entirely of a sterile basal crust. Stalked fertile material should be carefully searched for, especially along road edges in the northeast corner of the province.

Minute to small nonstratified fruticose (**shrub**) lichens, consisting of **mats** of decumbent to semi-erect branches, these dark brown to **blackish**, round in cross-section, slender to hairlike, to **5–10 (–25) mm long** and 50–100 (–140) μm wide, dull or occasionally shiny, noncorticate, brittle, solid, sparsely branched to **richly branched**, often bearing short, **spinule-like side branches**; branching uneven/anisotomic. Soredia, isidia, and pseudocyphellae absent. **Medulla absent**. Attached by a distinct holdfast. Photobiont a cyanobacterium: *Stigonema*, cells to 22 μm along long axis.

Ascocarp an apothecium, not seen in local material, borne laterally, disc dot-like/punctiform, arising from pycnidia.

Spores 1- to occasionally 2- to 3-celled, ellipsoid, colourless, eight or 16 per ascus. Pycnidia often present.

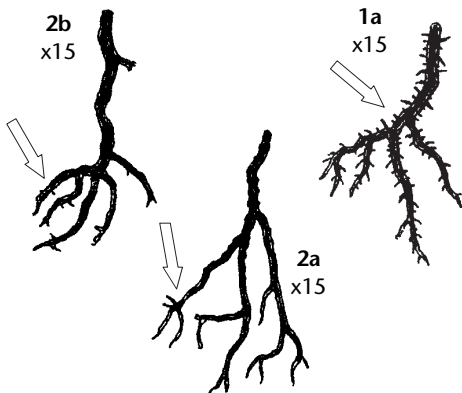
Over **moist rock**.

References: Henssen (1963); Purvis et al. (1992: Gilbert).

Common Name: Descriptive.

Notes: *Ephebe* is a cosmopolitan genus consisting of 12 species. Six species have been reported from North America, but only three are known to occur in British Columbia. No lichen substances have been reported. The following account is preliminary. For points of distinction with similar lichens in other genera, see the key under *Spilonema*.

KEY TO EPHEBE



- 1a** Main branches bearing numerous short, spine-like side branches(←), these much narrower than main branches; over woodland boulders; inland *Ephebe hispidula*
- 1b** Main branches bearing few or no spine-like side branches; generally restricted to moist rocks, especially at seaside and along lake shores and stream margins; distribution various 2
- 2a** Main branches distinctly tapering to the tip(←), rarely whorled; widespread *Ephebe lanata*
- 2b** Main branches often scarcely tapering to the tip(←), in part terminating in a "whorl" of branches; coastal *Ephebe solida* s. lat.

Ephebe hispidula (Ach.) Horwood
(Syn. *Ephebeia hispidula* (Ach.) Nyl.)
Dryside rockshag

Map 68

Habitat/Range: Rare (probably overlooked) over sloping rock in open forested inland localities, but expected also at the edges of lakes and streams, apparently at all forested elevations, local distribution poorly known; possibly incompletely circumpolar, N to wNT, S to CA, CO.

Variability: High.

Notes: Though recently reported as new to British Columbia by Goward et al. (1996), the specimen was collected over dry woodland boulders—a habitat more characteristic of *E. perspinulosa* Nyl. The report must be considered preliminary.

Ephebe lanata (L.) Vainio
Waterside rockshag

Habitat/Range: Frequent over moist, sloping, acid rock in open to sheltered sites at all forested elevations throughout, especially seepage tracks at seaside and at the edges of lakes and streams, but also rarely from rather dry woodland boulders; circumpolar, possibly N to sAK, wNT, S to OR, CA, CO, NM; AB.

Variability: Medium.

Notes: Specimens collected from woodland boulders warrant further study.

Ephebe solida Bornet, s. lat.
Considerable rockshag

Habitat/Range: Rare over moist rock, especially at the margins of streams and lakes, known only from coastal localities at lower elevations, local distribution poorly known; reported in western N Am also from MT, OR, and WY, but the records are suspect.

Variability: Unknown.

Notes: The material comes from Yakoun Lake on Graham Island, and is only tentatively referred to *E. solida*; it may actually represent an undescribed taxon.

Medium-sized to large stratified fruticose or occasionally elongate-foliose (**shrub/leaf**) lichens, consisting of tufts or tresses of semi-erect to pendent branches, these **pale yellowish green** (except **black at branch tips**), **angular in cross-section to flattened**, slender, to **40–150 (–300) mm long** and 1–4 mm wide, dull, broadly “wrinkled,” corticate, pliant, solid, weakly branched to richly branched; branching even/isotomic to uneven/isotomic. Soredia and/or isidia present or absent. Pseudocyphellae present, white. **Medulla white, thick, soft**. Attached to substrate by basal

holdfasts. Photobiont green, chlorococcoid.

Ascocarp an apothecium, unknown in local material, disc reddish brown.

Over trees, also rarely over rocks.

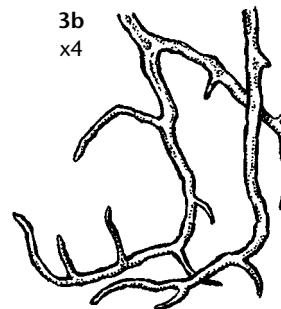
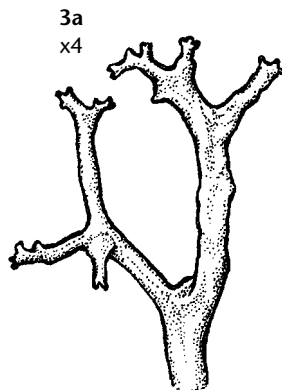
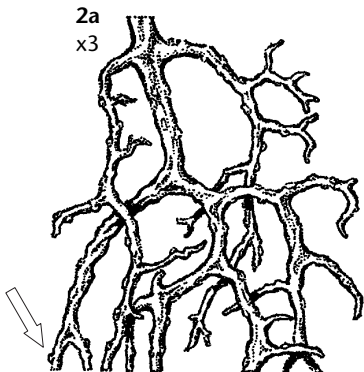
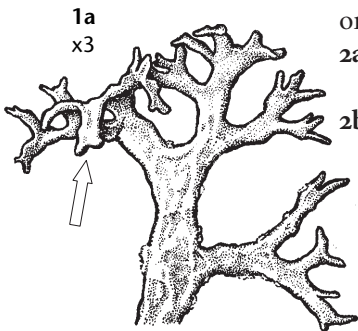
References: Bird (1974).

Common Name: Traditional.

Notes: *Evernia* is a cosmopolitan genus comprising approximately ten species worldwide. Five of these are present in North America, and four in British Columbia. For points of distinction with similar species in other genera, see the key under *Ramalina*.

KEY TO *EVERNIA*

- 1a** Branches distinctly flattened(←), also distinctly paler below than above, bearing soredia; coastal and intermontane. *Evernia prunastri*
- 1b** Branches often somewhat angular, but never distinctly flattened, similarly coloured on all sides, sorediate or not; intermontane and/or boreal 2
- 2a** Branches bearing isidia or soredia, or both(←); primarily boreal; restricted to lower elevations. *Evernia mesomorpha*
- 2b** Branches lacking isidia and soredia; intermontane; from low elevations to alpine. 3
- 3a** Branches hard-corticate, brittle; medulla dense; over soil; alpine; rare *Evernia perfragilis*
- 3b** Branches soft-corticate, supple; medulla lax or dense; over trees at lowland elevations, also occasionally over soil in the alpine; infrequent *Evernia divaricata*



Evernia divaricata (L.) Ach.
Mountain oakmoss (slender evernia)

Map 69

Habitat/Range: Rare over conifers in open, humid, intermontane forests at lower elevations, also rare over ground in exposed alpine sites; western N Am - western Eurasia, N to BC, S to MT, UT, CO, AZ, NM; AB.
Reactions: Cortex KC+ yellow; medulla UV+ ice-blue.
Contents: Usnic and divaricatic acids.
Variability: Low.
Notes: *Evernia divaricata* occurs rather sporadically within its distribution area, perhaps reflecting an inability to disperse effectively.

Evernia mesomorpha Nyl.
Boreal oakmoss (sprucemoss; boreal perfume; tufted evernia)

Habitat/Range: Frequent over conifers in open boreal forests at lower elevations, also rare in similar intermontane localities; incompletely circumpolar, N to AK, YU, wNT, S to WA, MT, WY, CO, MX; AB.
Reactions: Cortex KC+ yellow; medulla UV+ ice-blue.
Contents: Usnic and divaricatic acids.
Variability: Medium.
Notes: In dry intermontane regions, *E. mesomorpha* has been collected over big sagebrush (*Artemisia tridentata*).

Evernia perfragilis Llano
Tundra oakmoss

Map 70

Habitat/Range: Rare over base-rich soils and gravels in open, inland localities at alpine elevations, local distribution poorly known; N Am - eastern Eurasia, N to AK, YU, wNT, S to BC; AB.
Reactions: Cortex KC+ yellow; medulla UV+ ice-blue.
Contents: Usnic and divaricatic acids.
Variability: Medium.
Notes: Recorded in British Columbia from only a single locality.

Evernia prunastri (L.) Ach.

Common oakmoss (antlered perfume; flabby lichen; oakmoss lichen; stag's horn; ragged hoary lichen)

Habitat/Range: Frequent over deciduous and coniferous trees, also over shrubs, in sheltered, maritime and humid intermontane (ICH) forests at lower elevations; incompletely circumpolar, N to BC, S to WA, ID, MT, OR, CA; AB.

Reactions: Cortex K+ yellow, KC+ yellowish or KC-; medulla K+ yellow or K-, UV+ pale blue.

Contents: Atranorin and evernic acid (and usnic acid).

Variability: Medium.

Notes: Specimens in which the lower surface is green, not white, can be confused with *Ramalina farinacea*. In that species, however, the branch tips are predominantly green, versus black in *E. prunastri*.

Minute to small nonstratified “fruticose” (club) microlichens, consisting of a **basal thallus** and (often) **stalked hyphophores**.

Basal crust usually smooth, shiny, thin, greenish, apparently noncorticate. **Isidia**-like structures present in one species, these **colourless and spine-like**. Soredia, pseudocyphellae, and medulla absent. Photobiont green, chlorococcoid.

Conidia-bearing structures often present, consisting of hyphophores, these **brownish to blackish and stalked-scale-like** (ours), 0.1–0.3 mm long and 0.04–0.1 mm wide, erect or “nodding” at maturity, pliant, generally unbranched, in some species bearing a translucent globose “droplet”/conidial mass above, this consisting of threadlike conidial strands.

Ascocarp an apothecium, borne over basal thallus, **disc orangish red to reddish black or black**, weakly concave to plane. Spores multi-celled/muriform, ellipsoid to cylindrical, colourless, one to

eight per ascus. Pycnidia unknown.

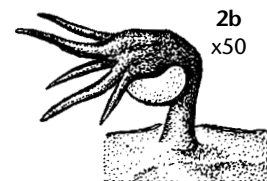
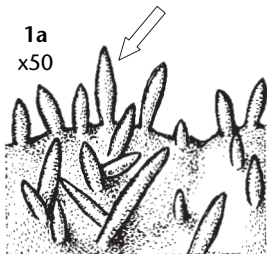
Over bark or moss.

References: Vězda (1979); Tønsberg (1991, 1997); Purvis et al. (1992: Giavarini and P. James); Holien and Tønsberg (1996); T. Tønsberg, University of Bergen, pers. comm., 1999.

Common Name: Fanciful.

Notes: *Gyalideopsis* is a widespread genus of temperate and especially tropical latitudes. It consists of 28 species worldwide, though only five species have been reported from North America, and three from British Columbia. Though technically a crustose genus, *Gyalideopsis* often bears stalked hyphophores, and for this reason is included here. No chemical substances have been reported. Apothecia are often absent in material in which hyphophores occur.

KEY TO *GYALIDEOPSIS*



- 1a** Isidia-like structures present, these spine-like(←), not at all serrated, colourless; scale-like hyphophores absent; over deciduous trees and shrubs; coastal; apothecial spores 20–30 μm x 6–13 μm *Gyalideopsis anastomosans*
- 1b** Isidia-like structures absent; hyphophores present, these stalked, expanding and scale-like above, at maturity with a “serrated” margin; brownish to blackish; habitat various 2
- 2a** Hyphophores bearing distinct outgrowths on the upper or lower surface; over mosses; apparently restricted to hypermaritime regions; apothecial spores 48–55 μm x 2–3 μm *Gyalideopsis muscicola*
- 2b** Hyphophores lacking distinct outgrowths on the upper or lower surface; over deciduous trees and shrubs, as well as over conifer twigs; coastal and humid intermontane; apothecial spores 12–17 μm x 3–5 μm *Gyalideopsis piceicola*

Gyalideopsis anastomosans P. James & Vězda
Shrub mittens

Map 71

Habitat/Range: Rare (overlooked?) over bark of alder (*Alnus*) and willow (*Salix*) in open to more often shaded thickets in coastal localities at lower elevations; western N Am - western Eurasia, N to BC, S to WA.

Variability: Low.

Gyalideopsis muscicola P. James & Vězda
Moss mittens

Map 72

Habitat/Range: Rare over damp mosses, especially *Isoetecium*, in sheltered hypermaritime outcrops at lower elevations, local distribution poorly known; western N Am - western Eurasia; N to BC, S to WA.

Variability: Medium.

Notes: This species is to be searched for in coastal regions over mossy tree trunks and mossy rock faces.

Gyalideopsis piceicola (Nyl.) Vězda
(Syn. *Gyalideopsis alnicola* W. Noble & Vězda)
Twig mittens

Map 73

Habitat/Range: Rare (overlooked?) over twigs of various trees and shrubs in open to somewhat shaded thickets in coastal regions at lower elevations, also known from humid intermontane (ICH) old-growth “rain forests,” local distribution poorly known; western N Am - western Eurasia, N to (sAK), S to WA.

Variability: Medium.

Notes: This species appears to be favoured by enrichment from nearby cottonwood (*Populus*) trees.

Minute weakly stratified fruticose (**shrub**) lichens, consisting of inconspicuous **cushions** of erect branches, these **blackish, oval to cylindrical**, to 0.1–0.5 (–0.8) mm long and 0.1–0.3 mm wide, **dull**, noncorticate, brittle, solid, unbranched or sparsely branched; branching irregular. Soredia, isidia, and pseudocyphellae absent. Medulla sometimes present, white. Attached to substrate by unspecialized holdfasts. Photobiont a cyanobacterium: **Nostoc**, cells 2–6 (–7) μm along long axis.

Ascocarp an apothecium, borne laterally, **disc black**, plane to distinctly convex, **to 0.8 mm wide**. Spores 1-celled, globose to ellipsoid, colourless, eight per ascus. Pycnidia rare.

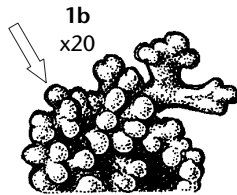
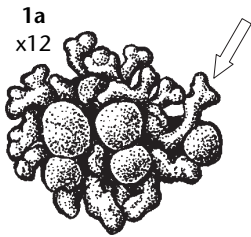
Over plant material, including mosses and other lichens, especially in subalpine and **alpine** localities.

References: Henssen (1965); Thomson (1984).

Common Name: Refers to the blackish colour and the occurrence over plant litter.

Notes: *Leciophysma* occurs mostly at boreal and arctic latitudes, and comprises two species worldwide; both of these occur in British Columbia. No chemical substances have been reported. For points of separation with similar lichens, see the key under *Lempholemma*.

KEY TO *LECIOPHYSMA*



- 1a** Thallus black; branches more or less elongate(←), to 0.5–0.8 mm in length. *Leciophysma finmarkicum*
1b Thallus olivaceous or black; branches at most granular(←), to 0.2 mm in length *Leciophysma furfurascens*

Leciophysma finmarkicum Th. Fr.
Greater litterbear

Map 74

Habitat/Range: Rare (overlooked?) over mosses, lichens, and other plant debris in exposed base-rich sites at subalpine and alpine elevations in inland regions, apparently mostly north of 59°N; probably circumpolar, N to AK, S to WA.
 Variability: Medium.

Leciophysma furfurascens (Nyl.) Gyelnik
Lesser litterbear

Map 75

Habitat/Range: Rare (overlooked?) over mosses, lichens, and other plant debris in exposed base-rich sites at forested and alpine elevations in inland regions; possibly western N Am - western Eurasia, N to AK, S to BC, with outliers in CO.
 Variability: Low.

Small to medium-sized nonstratified foliose and fruticose (**leaf/shrub**) lichens (ours), consisting of mats or rosettes of lobes or branches, these blackish to dark greenish or olivaceous, **gelatinous when wet**, round in cross-section, or else strap-like or leaflike, to 4–5 mm long and 0.2–0.4 mm wide (fruticose species only), **dull**, not distinctly corticate, solid, distinctly swelling when moistened (i.e., **gelatinous**), unbranched or sparsely branched; branching uneven/anisotomic. Soredia, isidia, pseudocyphellae, and medulla absent. Attached to substrate by hairlike rhizoids. Photobiont a cyanobacterium: **Nostoc**, cells 2–6 (–7) μm along long axis.

Ascocarp an apothecium, borne mostly over upper surface, **disc black**, pore-like or occasionally expanding, **to 0.8 mm**

wide. Spores 1-celled, ellipsoid to globose, colourless, eight per ascus. Pycnidia located mostly over upper surface.


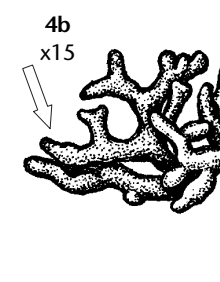
Over rocks, mosses, and base-rich soil.

References: Henssen (1968a); Poelt (1969); Purvis et al. (1992: Coppins, Gilbert, and Jørgensen).

Common Name: Reflects the blackish nonstratified thallus.

Notes: *Lempholemma* is a poorly understood genus occurring primarily at temperate latitudes. As presently circumscribed, it comprises approximately 30 species worldwide, eight of which occur in North America, and three in British Columbia. No chemical substances have been reported. The species included here are heterogeneous.

KEY TO *LEMPHOLEMMA* AND SIMILAR MINUTE, BLACKISH, NONCORTICATE LICHENS OCCURRING OVER ROCK OR GROUND

- | | |
|---|--|
|  <p>3a
x20</p> | <p>1a Thallus essentially fruticose: consisting of distinctly elongate branches, these more or less cylindrical or angular-strap-shaped, to less than 1 mm wide 2</p> <p>2b Photobiont <i>Scytonema</i> or <i>Stigonema</i>: cells to more than 8 μm along long axis, “end cells” rectangular or lens-shaped (check under LM in long-section at tips of well-developed branches) various genera (see key under <i>Spilonema</i>)</p> |
|  <p>4b
x15</p> | <p>2b Photobiont <i>Nostoc</i>: cells to less than 7 μm along long axis, “end cells” globose to oval(←) 3</p> <p>3a Over plant material in exposed base-rich localities; inland <i>Leciophysma</i></p> <p>3b Over rock or soil; coastal; distribution various 4</p> <p>4a Lobes distinctly angular in cross-section(←), to 0.2–0.5 (–0.7) mm wide; isidia often present, globose <i>Lempholemma radiatum</i></p> <p>4b Lobes rounded in cross-section(←), to 0.1–0.2 mm wide; isidia absent or, if present, then not globose <i>Lempholemma fennicum</i></p> |



- 1b Thallus foliose: consisting of short, broad lobes to more than 1 mm wide 5
- 5a Apothecia absent or, if present, appearing as appressed cuplike discs to more than 0.5 mm wide (Note: specimens with 2- to multi-celled spores key here) various genera (see key under *Collema*, Part 1)
- 5b Apothecia present, appearing as tiny, immersed, pore-like discs to 0.2–0.3 mm wide. 6
- 6a Upper surface becoming pruinose; growing directly over rock subject to periodic seepage; semi-arid regions *Thyrea confusa* Henssen [not handled]
- 6b Upper surface not at all pruinose; over mossy base-rich rock subject to periodic seepage; humid regions *Lempholemma polyanthes*

Lempholemma fennicum (Räsänen) Degel. Map 76
(Syn. *Lempholemma intricatum* (Arnold) Zahlbr.)
Waterside tar

Habitat/Range: Rare over base-rich or base-enriched rocks subject to periodic seepage in sheltered coastal and intermontane (ICH) localities at lower elevations, local distribution poorly known; possibly western N Am - western Eurasia; N to BC, S to (MT).
Variability: Medium.
Notes: This species has not previously been reported from continental North America.

Lempholemma polyanthes (Bernh.) Malme Map 77
(Syn. *Lempholemma myriococcum* (Ach.) Th. Fr.)
Chewing-gum tar

Habitat/Range: Rare over mossy base-rich rock subject to periodic seepage in somewhat sheltered inland sites at lower elevations, local distribution poorly known; circumpolar, N to BC, S to WY, CA.
Variability: High.
Notes: Some forms of *L. polyanthes* can be in part crustose.

Lempholemma radiatum (Sommerf.) Henssen Map 78
Winged tar

Habitat/Range: Rare over base-rich rock, soil, or moss in coastal localities at lower elevations, especially in sheltered sites subject to periodic seepage, local distribution poorly known; possibly western N Am - western Eurasia, N to sAK, S to ID; AB.
Variability: Medium.
Notes: At present known in British Columbia only from the Queen Charlotte Islands.

Minute stratified fruticose (**club/shrub**) lichens, consisting of colonies of **erect branches (pseudopodetia)**, these **whitish** to pale yellowish or yellowish green, slender, to 2–4 (–10) mm long and 0.1–0.5 mm wide, dull, soft-textured, **noncorticate**, brittle, **solid**, unbranched to **sparse-ly branched**; branching uneven/anisotomic. **Granular soredia** and/or powdery granules present. Isidia and pseudocyphellae absent. Medulla white. Photobiont green, chlorococcoid.

Ascocarps unknown.

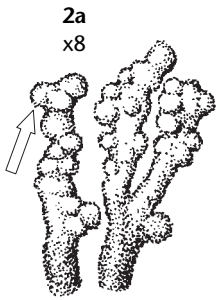
Over soil, humus, and rock crevices.

Reference: Lamb and Ward (1974).

Common Name: Descriptive.

Notes: *Leprocaulon* is a cosmopolitan genus comprising approximately eight species worldwide. Five of these are present in North America, and two in British Columbia. Spot tests are of limited usefulness in this genus, owing to the existence of numerous chemical strains. For points of separation with similar species in other genera, see the key under *Stereocaulon*.

KEY TO *LEPROCAULON*



- 1a Branches distinctly yellowish, KC+ yellowish or apparently KC- (check against white paper), usnic acid present; primarily maritime (CDF) *Leprocaulon microscopicum*
- 1b Branches whitish or creamy, without distinct yellowish overtones, KC-, usnic acid absent; distribution various 2
- 2a Branches bearing poorly defined granules(←), these more or less merging with one another; branch tips PD+ intense yellow to orange (thamnolic acid), or occasionally PD+ pale yellow *Leprocaulon subalbicans*
- 2b Branches bearing well-developed granules, these discrete; branch tips PD- or PD+ pale yellow (atranorin) [*Leprocaulon albicans*]

[*Leprocaulon albicans* (Th. Fr.) Nyl.]
(Syn. *Stereocaulon albicans* Th. Fr.)

Greater cottonthread

Habitat/Range: Expected over soil and thin humus in open, often exposed localities at lower elevations; western N Am - eastern Eurasia, N to AK, S to WA, ID, OR, WY, CA, NV, CO, AZ, NM, MX.

Reactions: K+ yellow, PD+ pale yellow, UV+ ice-blue.

Contents: Atranorin and squamatic and baeomycesic acids, and unidentified fatty acids (ours).

Variability: Unknown.

Notes: *Leprocaulon albicans* is included here based on reports both to the north and south of British Columbia.

Leprocaulon microscopicum (Vill) D. Hawksw.
Yellow cottonthread

Map 79

Habitat/Range: Rare over soil and thin plant debris in open sites, especially vertical rock outcrops, in maritime (CDF) localities at lower elevations; western N Am - western Eurasia, N to BC, S to WA, OR, CA, CO, AZ, NM, MX.
Reactions: KC+ yellowish or apparently KC- (use filter paper).
Contents: Usnic and rangiformic acids and zeorin (ours).
Variability: Unknown.
Notes: At present recorded only from southeast Vancouver Island.

Leprocaulon subalbicans (Lamb) Lamb & Ward
(Syn. *Stereocaulon subalbicans* Lamb)
Lesser cottonthread

Map 80

Habitat/Range: Infrequent (probably overlooked) over soil and thin plant debris, especially mosses, over rock in open somewhat sheltered localities at all elevations throughout, except essentially absent from coastal regions; western N Am, N to sAK, AK, S to WA, ID, MT, OR, CA, CO; AB.
Reactions: Chemotype 1: K+ intense yellow, PD+ intense yellow, orange, or reddish.
Chemotype 2: K+ yellow or K-, PD+ yellow or PD-, UV+ ice-blue.
Contents: Chemotype 1: Thamnic acid (and atranorin and unidentified fatty acids, and rarely fumarprotocetraric acid [= chemotype 3 of Lamb and Ward 1974]). Chemotype 2: squamatic acid (and atranorin, baeomycesic acid, and unidentified fatty acids [= Chemotype 4 of Lamb and Ward 1974]).
Variability: Low.
Notes: Four chemotypes have been accepted for *L. subalbicans* (Lamb and Ward 1974), though only two have been recorded from British Columbia.

Medium-sized to large stratified fruticose (**shrub**) lichens, consisting of tufts of **semi-erect to somewhat pendent branches**, these **vivid greenish yellow**, irregular in cross-section, slender, to 40–80 (–100) mm long and 1–2 mm wide, dull, corticate, pliant, solid, richly branched; branching even/isotomic to uneven/anisotomic. Soredia and isidia present or not. Pseudocyphellae present, yellowish. **Medulla white**. Attached to substrate by basal holdfasts. Photobiont green, chlorococcoid: *Trebouxia*.

Ascomycete an apothecium, borne laterally and at branch tips, disc reddish brown. Spores 1-celled, ellipsoid, colourless/hyaline, eight per ascus.

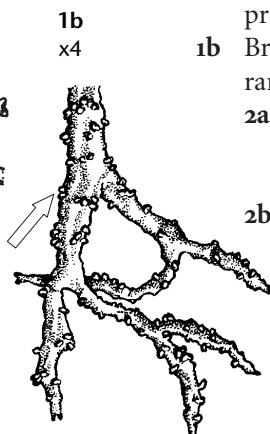
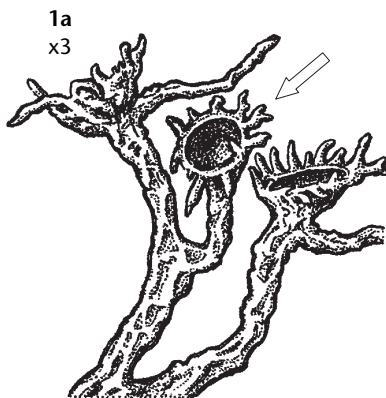
Over trees, also rarely over rocks.

References: Thomson (1969); McCune and Goward (1995); S. Kroken, University of California (Berkeley), pers. comm., 1999.

Common Name: Traditional, referring to the former north European practice of using *L. vulpina* as a poison against foxes and wolves.

Notes: *Letharia* is a cool temperate to middle temperate genus consisting of three species worldwide, two of which are present in North America. Both of these occur in British Columbia. Recent molecular studies, however, suggest that several additional taxa can be recognized; at least one of these occurs in British Columbia.

KEY TO *LETHARIA*



- 1a Branches lacking soredia and isidia; apothecia generally present(←) *Letharia columbiana*
- 1b Branches bearing soredia or isidia (←), or both; apothecia rarely present 2
- 2a Soredia and isidia generally dense; branching copious; thallus tufted, often distinctly greenish yellow; lower and middle forested elevations *Letharia vulpina*
- 2b Soredia and isidia often rather sparse; branching at most moderate; thallus distinctly elongate, generally brilliantly yellow (with only very weak green undertones); middle and upper forested elevations *Letharia* sp. 1 (see *L. vulpina*)

Letharia columbiana (Nutt.) J.W. Thomson
(Syn. *Letharia californica* (Lév.) Hue)
Brown-eyed wolf

Habitat/Range: Frequent (but localized) over conifer bark and wood in open, well-ventilated intermontane forests at middle to upper elevations, north to 53°N, also rare in exposed maritime forests near treeline; western N Am, N to BC, S to WA, ID, MT, OR, WY, CA, MX; AB.

Reactions: All spot tests negative.

Contents: Vulpinic acid and atranorin (and norstictic acid in apothecia).

Variability: Medium.

Notes: *Letharia columbiana* has a rather localized distribution in British Columbia.

Letharia vulpina (L.) Hue
Timber wolf (common wolf)

Habitat/Range: Common over bark and wood, especially conifers, in open, well-ventilated intermontane forests at all forested elevations, mostly north to 54°N, also infrequent in exposed maritime forests; western N Am - western Eurasia, N to BC, with outliers in YU, S to WA, ID, MT, OR, WY, CA, NV, UT, CO, AZ, MX; AB.

Reactions: All spot tests negative.

Contents: Vulpinic acid and atranorin (and norstictic acid in apothecia).

Variability: High.

Notes: Subalpine populations are often more robust, more brilliantly coloured, and less copiously isidiate/sorediate than lowland populations; they appear to warrant separate species recognition, and are recognized here as *L. sp. 1*, or “mountain wolf.”

[The following description is based on *L. stipatula*]. **Minute** nonstratified fruticose (**shrub**) lichen, consisting of **cushions** of dense semi-erect to erect branches, these dark brown to **blackish** (greener when moist), mostly round in cross-section slender to somewhat stout, to **1–3 (–5) mm long** and 50–130 (–180) μm wide, dull, non-corticate, brittle, solid, richly branched; branching even/isotomic to more often uneven/anisotomic. Soredia, isidia, pseudocyphellae, and medulla absent. Attached to substrate by colourless hairlike rhizoids (often inconspicuous). Photobiont a cyanobacterium, Chroococcaceae, **cells globose to oval, to 8–10 (–13) μm along long axis.**

Ascomycete an apothecium, borne at branch tips, unknown in local material, disc convex, reddish brown. Spores 1-celled, ellipsoid, colourless, to 36 (–48) per ascus (ours). Pycnidia lateral or at branch tips.

Over **rock**.

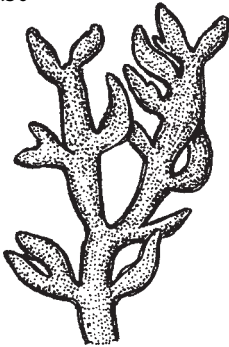
References: Henssen (1963, 1968b);

Moreno and Egea (1992).

Common Name: Describes both the habitat ecology and the minutely tufted habit.

Notes: *Lichinella* is distributed primarily at temperate latitudes. As currently circumscribed, it comprises 11 species worldwide, six of which have been reported from North America, but only two from British Columbia. One of these, *L. nigritella* (Lettau) Moreno and Egea, is foliose, and is not included here; see Part 1, under *Gonohymenia nigritella*. No chemical substances have been reported. For points of separation with similar tiny, blackish, rock-dwelling shrub lichens in other genera, see the key under *Spilonema*.

x30



Lichinella stipatula Nyl.

Shrubby rockcushion

Map 81

Habitat/Range: Rare (probably overlooked) over crevices in acid rock outcrops in sheltered semi-arid intermontane (BG, PP) localities at lower elevations, local distribution poorly known; western N Am - western Eurasia, N to BC, S to CA, CO, AZ, MX.

Variability: Medium.

Notes: The erect habit, copious branching, and presence of a distinctly greenish 1- to few-celled (chroococcoid) photobiont are diagnostic.

Minute nonstratified fruticose (**shrub**) lichens, consisting of **rosettes** of decumbent to semi-erect branches, these **blackish** (translucent when moist), round in cross-section, slender, to **0.4–0.8 (–1.5) mm long** and 40–80 (–150) μm wide, **dull, noncorticate**, brittle, solid, rather sparsely branched; branching irregular. Soredia, isidia, pseudocyphellae, and medulla absent. Attached to substrate by colourless hairlike rhizoids. Photobiont cyanobacterial, *Scytonema*, cells in **two to several rows**, to 9–15 (–17) μm along long axis.

Ascomycete, an apothecium, borne laterally, unknown in local material, disc pale brown, to 0.2–0.8 mm across. Spores 1-celled, ellipsoid to nearly

globose, colourless, to eight per ascus.

Over rock-dwelling lichens and bark of conifers.

References: Henssen (1963, 1968);

Arvidsson (1979).

Common Name: Fanciful.

Notes: *Lichinodium* is a primarily temperate genus consisting of four species worldwide. Three of these have been reported from North America, and two from British Columbia. No chemical substances have been reported.

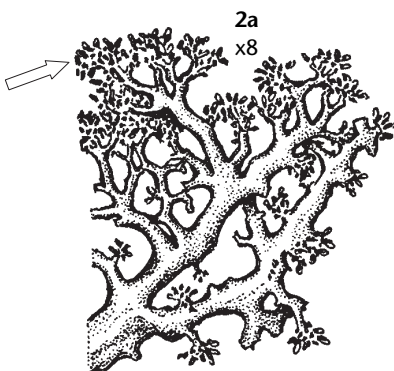
Two keys are provided: the first is to *Lichinodium*, and the second is to *L. canadense* and similar small, blackish, tree-dwelling fruticose lichens.

KEY TO *LICHINODIUM*

- 1a** Over conifer bark in humid old-growth forests; branches to 0.4–0.8 mm long *Lichinodinium canadense*
1b Over rock-dwelling lichens (and mosses), apparently restricted to nonforested sites; branches to 1–2 mm long *Lichinodinium sirosiphoideum*

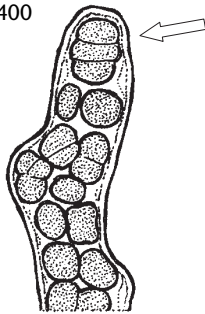
KEY TO *LICHINODIUM* CANADENSE AND SIMILAR SMALL BLACKISH FRUTICOSE LICHENS OCCURRING OVER TREES

- 1a** Conspicuous, to more than 7.0 mm long; medulla present, white, usually distinct; photobiont 1-celled (check under LM); soredia present or absent; distribution various 2
- 2a** Thallus erect-shrublike; branch tips bearing dense isidia-like structures(←), basal portions proportionately broad, often bearing a tomentum of tiny, erect hairs; photobiont distinctly greyish green (check under LM); humid regions *Sticta oroborealis*
- 2b** Thallus pendent to rarely erect-shrublike; branch tips never isidiate; basal portions proportionately slender, never tomentose; photobiont medium green; distribution various *Bryocaulon*, *Bryoria*, *Nodobryoria* (see key under *Bryoria*)

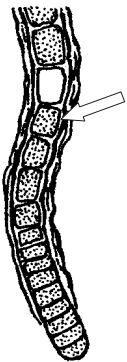


- 1b Inconspicuous, to less than 6 mm long; medulla absent or indistinct; photobiont at least in part in strands or chains (check lobe tips in long-section); humid regions (Note: reliable identification of the following species requires careful study under LM) 3
- 3a Cellular cortex present, distinct; photobiont *Nostoc*; composed entirely of globose to oval cells to less than 7 μm along long axis ***Leptogium***
- 3b Cellular cortex present or absent; photobiont *Scytonema* or *Stigonema*, or at least obviously not *Nostoc*; composed in part of rectangular to lens-shaped cells to more than 8 μm along long axis (check branch tips) 4
- 4a Photobiont *Stigonema*, arranged in an irregular “brickwork” pattern(←); branching “true”; thallus dark above, but often somewhat pale in basal portions, often bearing scattered hairlike rhizoids ***Spilonema* sp. 1**
- 4b Photobiont *Scytonema* or at least not *Stigonema*, arranged in roughly parallel rows, branching “false”; thallus dark throughout; rhizoids present or absent 5
- 5a Photobiont strands arranged mostly in a single row(←); branches bluish grey; over deciduous shrubs Unknown 3
- 5b Photobiont strands arranged mostly in two or more roughly parallel rows; branches variously coloured (including bluish grey); over conifers 6
- 6a Cellular cortex absent (i.e., cross-walls lacking(←)); branches dull, blackish ***Lichinodium canadense***
- 6b Cellular cortex present (cross-walls evident in surface view under LM); branches often somewhat shiny, greyish, bluish, brownish, or occasionally blackish 7
- 7a Branches distinctly constricted at intervals and/or bearing hairlike rhizoids below, these solitary, tufted, or scattered along the length of the branches. 8
- 8a Branches to 0.5 mm long, distinctly constricted at intervals(←); rhizoids mostly scattered Unknown 1
- 8b Branches to 2–4 mm long, not at all distinctly constricted; rhizoids generally in part tufted Unknown 2
- 7b Branches neither distinctly contorted nor bearing hairlike rhizoids. 9
- 9a Photobiont strands to 10–15 μm wide, arranged in two (or occasionally three!) rows in vicinity of branch tips(←) (check in long-section), the rows generally oriented parallel to one another; primarily intermontane in humid regions ***Polychidium dendriscum***
- 9b Photobiont strands to 5–12 μm wide, arranged in more than two rows in vicinity of branch tips(←), the rows generally not oriented parallel to one another; primarily coastal in humid regions ***Polychidium “contortum”***

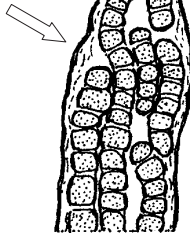
4a
x400



5a



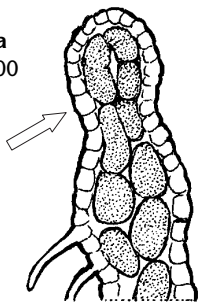
6a
x400



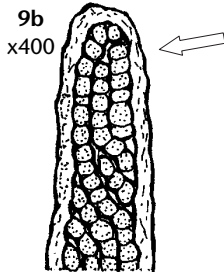
6a
x25



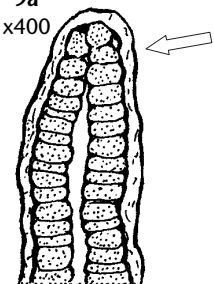
8a
x400



9b
x400



9a
x400



Lichinodium canadense Henssen
Old-growth bearhair

Map 82

Habitat/Range: Rare over conifer branches in humid intermontane (ICH) old-growth
“rain forests” at lower elevations; western N Am, N to (sAK), S to BC.

Variability: Low.

Notes: The holotype specimen was collected from the vicinity of Sicamous.

Lichinodium sirosiphoideum Nyl.
Parasitic bearhair

Map 83

Habitat/Range: Rare over rock-dwelling mosses and lichens, especially *Parmelia*, in
humid intermontane localities at lower to middle elevations; western N Am - eastern
N Am - western Eurasia, N to AK, S to BC.

Variability: Low.

Notes: For points of distinction with tiny, blackish, rock-dwelling fruticose lichens similar to *L. sirosiphoideum*, see the key under *Spilonema*.

Small stratified “fruticose” (club) lichen, consisting of a basal crust and dense assemblages of stalklike isidia. **Basal crust smooth, white**, corticate, often supporting sparse to dense patches of **erect isidia**, these **white**, round in cross-section, slender, to **0.5–2 (–2.5) mm long** and $0.07\text{--}0.15\text{ }\mu\text{m}$ wide, rather dull, corticate, brittle, solid, unbranched, or rather sparsely branched; branching irregular. Soredia and pseudocyphellae absent. Medulla white. Photobiont green, chlorococcoid: *Trebouxia*.

Ascomarp an apothecium, borne over surface of crust, disc brownish, to 0.5–0.8

(–1.0) mm wide. Spores 2- to 6-celled, narrowly spindle-shaped/fusiform, colourless, to eight per ascus. Pycnidia rare.

Over **conifer bark**.

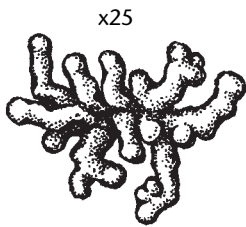
References: Brodo and Henssen (1995).

Common Name: Describes the habitat ecology and the long, white, coralloid isidia.

Notes: *Loxosporopsis* occurs in humid regions at temperate latitudes. It comprises only one species. Though technically crustose, it is included here owing to its conspicuous, elongate, “fruticose” isidia.

Loxosporopsis corallifera Brodo, Henssen & Imshaug

The tree-coral



Habitat/Range: Frequent over conifer bark in open coastal, especially maritime forests at lower elevations, also rare in sheltered old-growth “rain forests” in humid intermontane (ICH) regions; western N Am, N to sAK, S to WA, OR, CA.

Reactions: Cortex UV+ whitish or bluish white.

Contents: Divaricatic acid (and gyrophoric acid and various unidentified substances in the apothecia).

Variability: High.

Notes: The isidia can be sparse in some populations. An isotype specimen of this species comes from Maude Island, in the Queen Charlotte Islands.

Minute “fruticose” microfungi, consisting of **immersed basal threads/hyphae** and **stalked or unstalked apothecia**. Either parasitic (i.e., living off the basal crusts of lichens or free-living algae) or saprobic (i.e., living off dead material). **Photobiont absent**. Basal hyphae immersed in substrate, not readily discernible.

Apothecia stalks, when present, **dark greenish** to blackish or occasionally brownish, to 0.6–1.8 mm long (including apothecial heads) and 150–250 µm wide (excluding heads), scurfy-pruinose, brittle, unbranched. **Apothecial heads/capitula** unstalked/sessile or borne at stalk tips, narrowly cuplike to hemispherical, consisting of an upwardly expanding excipulum and a **powdery spore mass/mazaedium**, this **dark greenish**. Spores 1- to 4-celled, 6–11 µm long, greenish under LM, ornamented with **spirally arranged ridges**, arising from short-lived asci.

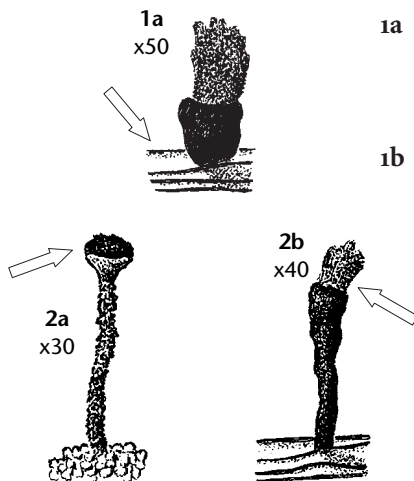
Over bark, wood, and overhanging acid rocks. Also over *Calicium*, *Chaenotheca*, other crust lichens, and free-living algal crusts.

References: Tibell (1975, 1978, 1994), Purvis et al. (1992: Purvis); E.B. Peterson, Oregon State University, pers. comm., 1999.

Common Name: Reflects the resemblance of the extruding greenish mazaedia to the bristles of a broom.

Notes: *Microcalicium* is widely distributed at temperate and cool temperate latitudes, and comprises four species worldwide. Three of these occur in North America, all of which are present in British Columbia. Though not technically a lichen genus, *Microcalicium* is traditionally treated by lichenologists, and is included here owing to its characteristic stalked apothecia.

KEY TO MICROCALICIUM



- 1a Apothecia more or less unstalked(←); spore mass/mazaedium often distinctly extruding from the excipulum; spores to more than 9 µm long; over bark or wood of standing conifers; frequent . . . *Microcalicium disseminatum*
- 1b Apothecia distinctly stalked; mazaedium distinctly extruding or not; spores mostly to 6–8 (–11!) µm long; habitat various; rare . . . 2
- 2a Apothecia (including stalks) generally to more than 1.0 mm long; excipulum well developed; mazaedium not at all extruding(←); over crustose lichens or free-living algae on rock or roots of upturned trees. *Microcalicium arenarium*
- 2b Apothecia generally to less than 1.0 mm long; excipulum poorly developed; mazaedium often distinctly extruding(←); growing directly over soft wood of standing snags . . . *Microcalicium ahlneri*

Microcalicium ahlneri Tibell
Witch's broom

Map 84

Habitat/Range: Rare over wood of standing conifers in humid intermontane (ICH) old-growth forests at lower elevations, local distribution poorly known; possibly incompletely circumpolar, N to BC, S to WA, OR, CA.

Reactions: All spot tests negative.

Contents: No lichen substances reported.

Variability: Medium.

Notes: The distinctly stalked apothecia, the extruding dark greenish spore mass/mazaedium, and the occurrence directly over wood are diagnostic. See also the notes under *M. disseminatum*.

Microcalicium arenarium (A. Massal.) Tibell
(Syn. *Coniocybopsis arenaria* (A. Massal.) Vainio)
Rock broom

Map 85

Habitat/Range: Rare over crustose lichens or free-living algae on the upturned roots of conifers, also in similar habitats over acid rock on the lower surfaces of overhangs, in humid intermontane forests at lower to middle elevations, local distribution poorly known; probably incompletely circumpolar, N to AK, S to WA, OR, CA.

Reactions: Excipulum H+ greenish; stalk and spore mass K+ brownish.

Contents: No lichen substances reported.

Variability: High.

Notes: Diagnostic characters include the distinctly stalked apothecia, the nonextruding dark greenish spore mass/ mazaedium, and the occurrence over crustose lichens on rock or upturned roots. See also the notes under *M. disseminatum*.

Microcalicium disseminatum (Ach.) Vainio
(Syn. *Microcalicium subpedicellatum* (Ach.) Tibell)
Whisk broom

Habitat/Range: Frequent over bark and wood of conifers in sheltered maritime and intermontane (ICH) forests at lower to middle elevations; incompletely circumpolar, N to BC, S to WA, OR, CA.

Reactions: Excipulum K+ brownish.

Contents: No lichen substances reported.

Variability: High.

Notes: Diagnostic characters include the unstalked apothecia, the dark greenish spore mass/mazaedium, and the rather cylindrical spores to more than 9 μm long. Some specimens are distinctly stalked, and must carefully be distinguished from *M. ahlneri* and *M. arenarium*. In the latter two species, however, the spores are ellipsoid and 6–8 (–11) μm long. In *M. arenarium*, moreover, the spore mass is scarcely extruded above the excipulum.

Minute to small nonstratified “fruticose” (club) microlichen, consisting of a **basal crust** and stalked hyphophores. Basal crust smooth, thin, greenish, apparently noncorticate. Soredia, isidia, pseudocyphellae, and medulla absent. Photobiont green, chlorococcoid, cells to 5–8 μm along long axis.

Conidia-bearing fruiting bodies often present, consisting of **stalked hyphophores**, these dark brown, round in cross-section, hairlike, to **0.9–2.1 mm long** (including conidial head) and 60–150 μm wide (stalk base only), shiny, nonlichenized (i.e., lacking algae), pliant, solid, **unbranched** to sparsely branched, terminating upwards in a **conidial head**, this **brown**, to 60–115 μm across, **shiny**, roughly cone-shaped, “nodding” at maturity. **Conidia thread-shaped/filiform**, 10- to 30-celled, sinuous, colourless, 60–120 \times 1.5–2.0 μm .

Ascocarps apparently unknown.
Over conifer bark.

References: Funk (1973); Sérusiaux and De Sloover (1986); T. Tønsberg, University of Bergen, Norway, pers. comm., 1998.

Common Name: Reflects the stalked fruiting structures, and the tendency of the conidial head to “glow” when illuminated.

Notes: As currently circumscribed, *Microlychnus* consists of a single species worldwide; it is known only from the temperate west coast of North America. The material, however, is close to *Tricharia*, and may warrant inclusion in that genus. Though technically crustose, *Microlychnus* is included here owing to its stalked hyphophores. No chemical substances have been reported.

x20



Microlychnus epicorticis A. Funk Map 86
Pacific lamppost

Habitat/Range: Rare (probably overlooked) over conifers and especially red alder (*Alnus rubra*) in sheltered forest openings at lower elevations in coastal regions, local distribution poorly known; western N Am, N to (sAK), S to (WA).

Variability: Medium.

Minute “fruticose” microfungi, consisting of **basal fungal threads/hyphae** and **stalked apothecia**. Saprobic (i.e., living off dead wood and other organic matter). **Photobiont absent**. Basal hyphae immersed in substrate, not readily discernible.

Apothecial **stalks nonlichenized, blackish, hairlike, to 0.6–1.5 mm long** (including heads) and 50–120 μm wide (excluding heads), smooth, brittle, **unbranched**. **Apothecial heads/capitula** borne at stalk tips, broadly top-shaped/turbinate to hemispherical, consisting of an upwardly expanding excipulum, and a **compact black spore surface** (i.e., lacking a powdery mazaedium). **Spores 1-celled**, ellipsoid, to 5–8 μm long (ours), smooth to minutely ornamented, brownish under LM, arising within persistent vial-shaped **asci (to more than 35 μm long)** (ours), eight spores per ascus. Ascus tip evenly thickened, not penetrated by a “canal.”

Over **conifer wood** (ours).

References: Tibell (1975, 1994).

Common Name: Alludes to the stalked apothecia that terminate in a “pin head.”

Notes: *Mycocalicium* occurs at cool temperate to tropical latitudes, and comprises approximately 11 species worldwide. Nine of these have been reported from North America, but only one from British Columbia.

Mycocalicium is technically not a lichen genus, but is traditionally treated by lichenologists; it is included here owing to its stalked apothecia. No chemical substances have been reported. The ascus tips are best examined in a squash mount stained with lactophenol cotton blue, and viewed using phase-contrast microscopy at 1000x. For points of distinction with similar species in other genera, see the key under *Chaenothecopsis*.

Mycocalicium subtile (Pers.) Szat.

(Syn. *Mycocalicium parietinum* (Ach.) D. Hawksw.)

Snag pin

Habitat/Range: Frequent over wood of conifers in open coastal and humid intermontane forests at lower to middle elevations, western N Am - western Eurasia - eastern Eurasia, N to AK, wNT, S to WA, OR, CA, UT, CO, AZ, MX; AB.

Variability: High.

Notes: The material assigned here is highly variable, and may include two distinct taxa.

Diagnostic characters include the stalked apothecia, the blackish stalk (check under LM), the 1-celled, typically dark brownish spores, the large asci to more than 35 μm long, the evenly thickened ascus tips, and the occurrence over conifer wood.

Chaenothecopsis nana is a similar species occurring over conifer bark, but in that species the asci are less than 33 μm long (check asci in which a full complement of eight spores is present), and the ascus tip is penetrated by an apical “canal.”

x30



Medium-sized stratified fruticose or semi-foliose (**shrub**/leaf) lichens, consisting of **tufts** of semi-erect to pendent branches, these **pale greenish** to yellowish green, **coloured alike above and below, flattened** in cross-section to occasionally round, to **30–80 mm long** and 0.5–10 (–25) mm wide, dull to shiny, corticate, pliant, solid, sparsely branched to occasionally richly branched; branching uneven/anisotomic. Soredia present or absent. Isidia and pseudocyphellae absent (ours). Medulla white, **loose** (ours) or in part longitudinally gristly/chondroid. Attached to substrate by basal holdfasts. Photobiont green, chlorococcoid: *Trebouxia*.

Ascocarp an apothecium, borne laterally or at branch tips, disc pale greenish. Spores 2-celled, colourless/hyaline, eight per ascus. **Pycnidia black, dotlike, conspicuous.**

Over seashore trees (ours).

References: Bowler et al. (1994); Spjut (1996).

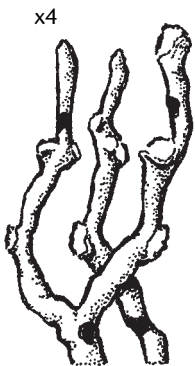
Common Name: Reflects the restricted occurrence in maritime localities subject to fog.

Notes: *Niebla* is a genus primarily of temperate latitudes in regions of mediterranean climate. Many of its species (including *N. cephalota*) have recently been transferred to *Vermilacinia*. As many as 71 species are recognized for North America (including 29 species currently placed in *Vermilacinia*), but only one is expected to occur in British Columbia. For points of distinction with similar species in other genera, see the key under *Ramalina*.

[*Niebla cephalota* (Tuck.) Rundel and Bowler]

(Syn. *Desmazieria cephalota* (Tuck.) Follmann & Huneck; *Ramalina cephalota* Tuck., *Vermilacinia cephalota* (Tuck.) Spjut & Hale)

Northern seafog (powdery fog lichen)



Habitat/Range: Expected over conifers, shrubs, or rock in exposed seaside localities in extreme southern coastal British Columbia; western N Am, N to WA, S to WA, OR, CA, MX.

Reactions: Cortex KC+ yellow.

Contents: Usnic acid and various unidentified fatty acids.

Variability: High.

Notes: *Niebla cephalota* occurs northwards to northern Washington (J. Marsh, University of Northern British Columbia, pers. comm., 1997). The distinctly lax medulla and scattered black pycnidia serve to distinguish this lichen from *Ramalina*. *Evernia mesomorpha* is also similar, but has black branch tips, and is absent from coastal regions.

Small to medium-sized stratified fruticose (**hair**) lichens, consisting of tufts or tresses of semi-erect to decumbent branches, these **dark reddish brown**, somewhat angular or flattened in cross-section, slender, to **2.5–10 (–17) cm long** and 0.3–1.0 mm wide, often bearing short, **pointed side branches, dull**, corticate (cortex consisting of distinctly **knobby cells**), **brittle**, solid, richly branched; branching uneven/anisotomic. Soredia, isidia, and pseudocyphellae absent. Medulla white. Typically attached to substrate by basal holdfasts. Photobiont green, chlorococcoid: *Trebouxia*.

Ascocarp an apothecium, borne later-
ly, disc reddish brown, concave to convex.

Spores 1-celled, ellipsoid, colourless, eight per ascus. Pycnidia rare.

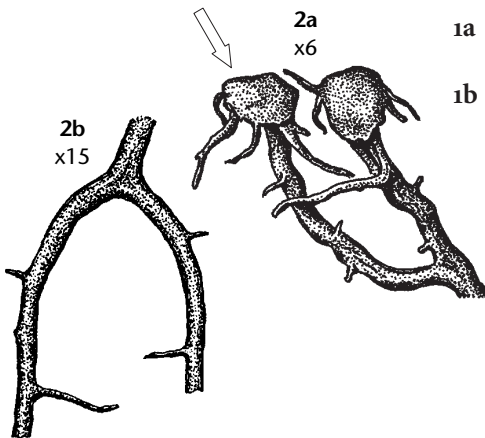
Mostly over **conifer bark**, also over ground in exposed sites.

References: Brodo and Hawksworth (1977); Brodo and Alstrup (1981); Common and Brodo (1995).

Common Name: Refers to the reddish hairlike branches.

Notes: *Nodobryoria* is restricted to cool temperate latitudes. It comprises three species, all of which are present in British Columbia. Chemistry is of no diagnostic value. For points of distinction with similar species in other genera, see the key under *Bryoria*.

KEY TO *NODOBRYORIA*



- 1a Over rock or soil; alpine; thallus prostrate . . .
 *Nodobryoria subdivergens*
- 1b Over conifers; all forested elevations; thallus tufted or pendent . . . 2
- 2a Thallus tufted, to 2–3 cm long; apothecia present(←), generally
 with “spiny” margins; inland *Nodobryoria abbreviata*
- 2b Thallus tufted to more often pendent, to 3–10 (–18) cm long;
 apothecia generally absent or, when present, not at all spiny-
 margined; widespread in southern regions . . .
 *Nodobryoria oregana*

Nodobryoria abbreviata (Müll. Arg.) Common & Brodo

(Syn. *Alectoria abbreviata* (Müll. Arg.) R. Howe; *Bryoria abbreviata* (Müll. Arg.) Brodo & D. Hawksw.)

Tufted foxtail (abbreviated horsehair)

Habitat/Range: Frequent over conifers, especially pine, in open to exposed dry intermontane sites at all forested elevations, mostly south of 53°N; western N Am, N to BC, S to WA, ID, MT, OR, WY, CA, MX.

Variability: Medium.

Notes: The tufted habit, reddish brown colour, and “spiny” apothecial margins are diagnostic.

Nodobryoria oregana (Tuck.) Common & Brodo

(Syn. *Alectoria oregana* Tuck.; *Bryoria oregana* (Tuck.) Brodo & D. Hawksw.)

Pendent foxtail

Habitat/Range: Common over conifers in open to sheltered maritime and humid intermontane localities at all forested elevations; western N Am, N to sAK, S to WA, ID, MT, OR, CA; AB.

Variability: Medium.

Notes: *Nodobryoria oregana* can occasionally be difficult to distinguish from reddish forms of *Bryoria fremontii*, though that species is generally much larger (to more than 20 cm long), and has shiny, pliant branches.

Nodobryoria subdivergens (E. Dahl) Common & Brodo

Map 87

(Syn. *Alectoria subdivergens* E. Dahl; *Bryoria subdivergens* (E. Dahl) Brodo & D. Hawksw.)

Alpine foxtail

Habitat/Range: Rare (overlooked?) over rocks and debris in exposed inland localities at treeline, also rare over conifers at treeline; western N Am, N to BC, S to WA, (ID), MT, OR, (CA); AB.

Variability: High.

Notes: Goward and Ahti (1992) have suggested that North American material of *N. subdivergens* might actually represent a ground-dwelling form of *N. oregana*; further studies are required.

Minute “fruticose” microfungi, consisting of **basal fungal threads/hyphae** and **stalked apothecia**. Either parasitic (i.e., living off lichens or free-living algae) or saprobic (i.e., living off dead bark, wood, and other organic matter). **Photobiont absent**. Basal hyphae immersed in substrate, not readily discernible.

Apothecial stalks nonlichenized, black or brownish, hairlike, to 0.3–0.5 mm long (including heads) and 40–60 µm wide (excluding heads), smooth, brittle, unbranched. **Apothecial heads/capitula** borne at stalk tips, lens-shaped or strongly flattened and fan-shaped, consisting of an upwardly expanding excipulum, and a **compact black spore surface** (i.e., lacking a powdery mazaedium). **Spores 1- or 2-celled**, ellipsoid, to 10–15 (–20) µm long (ours), smooth to minutely ornamented, brown under LM, arising within persistent vial-shaped asci, eight spores per ascus.

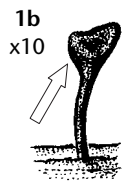
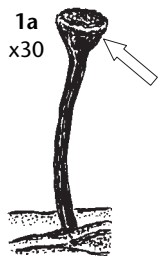
Over **bark** of deciduous trees and shrubs.

References: Schmidt (1970); Tibell (1975, 1984, 1994); S. Selva, University of Maine, pers. comm., 1996; E.B. Peterson, Oregon State University, pers. comm. 1999.

Common Name: Descriptive.

Notes: *Phaeocalicium* is a widespread genus occurring primarily at temperate latitudes. It comprises 10 species worldwide, five of which have been reported from North America, and two from British Columbia. Though technically not a lichen genus, *Phaeocalicium* is traditionally treated by lichenologists; it is included here owing to its stalked apothecia. No chemical substances have been reported. See the key under *Chaenothecopsis* for points of distinction with similar species.

KEY TO PHAEOCALICIUM



- 1a Over aspen or cottonwood (*Populus*); apothecial heads round in cross-section(←); spores 2-celled at maturity *Phaeocalicium populneum*
- 1b Over alder (*Alnus*) or birch (*Betula*); apothecial heads strongly flattened in cross-section(←); spores 1-celled at maturity 2
- 2a Over birch; spores pale brown *Phaeocalicium betulinum*
- 2b Over alder; spores dark brown. *Phaeocalicium compressulum*

Phaeocalicium betulinum (Nyl.) Tibell
Birch needles

Map 88

Habitat/Range: Rare over branches of paper birch (*Betula papyrifera*) in humid intermontane (ICH) forests at lower elevations; western N Am - eastern N Am - western Eurasia, in western N Am known only from BC.
Variability: Low.

Phaeocalicium compressulum (Vainio) A. Schmidt
Alder needles

Map 89

Habitat/Range: Rare (probably overlooked) over thin, dead twigs of Sitka alder (*Alnus crispa*) or paper birch (*Betula papyrifera*) in humid intermontane (ICH) forests at lower elevations; incompletely circumpolar, N to BC, S to WA, MT, OR.
Variability: Low.
Notes: The stalked apothecia, the laterally compressed apothecial heads, and the occurrence over alder or birch are diagnostic.

Phaeocalicium populneum (Duby) A. Schmidt
(Syn. *Calicium populneum* Duby)
Poplar needles

Habitat/Range: Frequent over dead twigs of aspen and cottonwood (*Populus*) in sheltered maritime and intermontane forests at lower and middle elevations, also known from the bark of fir (*Abies*); incompletely circumpolar, N to BC, S to WA, MT, OR, CA, UT, AZ; AB.
Variability: Medium.
Notes: Diagnostic characters include the stalked apothecia, the apothecial heads that are round in cross-section, the 2-celled spores to 10–13 µm long, and the occurrence over aspen or cottonwood. In some specimens the spores are considerably longer than previously reported, at 15–20 µm in length. Such material has been assigned to a separate (unnamed) species by Callan and Ring (1994); further work is needed.

Small to medium-sized stratified fruticose (**club**) lichens (see notes, below) consisting of a **basal crust** and/or **stalks/pseudopodetia**. Basal crust granular to tile-like/areolate, whitish to pale greyish or greyish green, corticate, continuous to scattered, often bearing scattered cephalodia (see below). **Pseudopodetia erect**, round in cross-section, pale whitish or greyish, to **5–30 mm long** and 0.4–1.0 mm wide, corticate (at least in part), sorediate or not, brittle, **solid, unbranched** to occasionally sparsely branched above, often terminating upwards in an apothecium (see below). Photobiont green, chlorococcoid; accompanied by cyanobacterial colonies, these localized as minute, wartlike, brownish to blackish cephalodia, and borne on basal crust, also on pseudopodetia.

Ascocarp an **apothecium**, generally **borne on tips of pseudopodetia**, disc **black**, generally globose. Spores 1-celled, ellipsoid, colourless, eight per ascus.

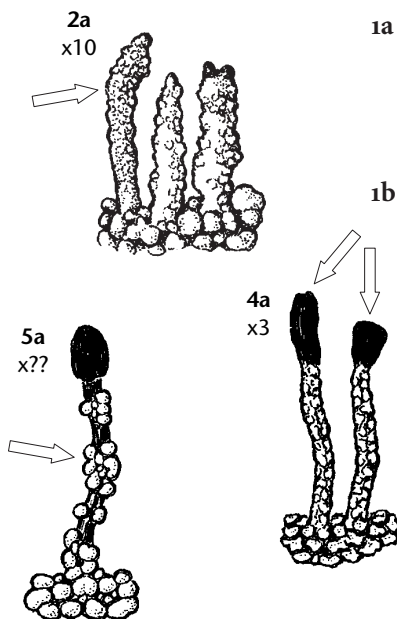
Over rock.

References: Jahns (1981); Brodo (1995).

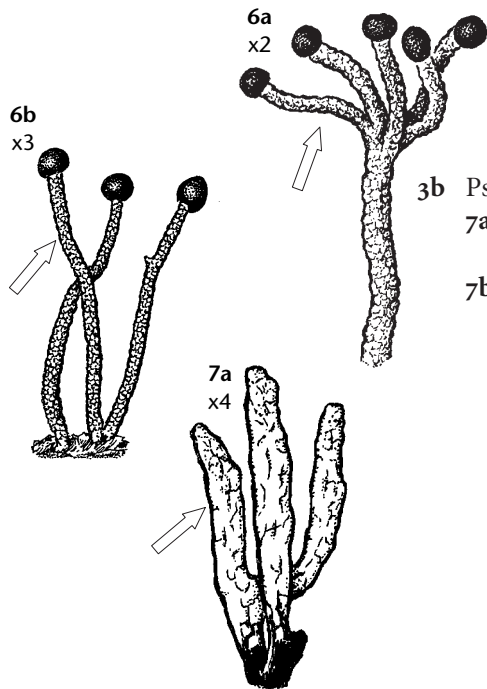
Common Name: Describes the long narrow stalks that terminate upwards in black, generally rounded apothecia.

Notes: *Pilophorus* occurs primarily at temperate latitudes. It consists of 11 species worldwide, eight of which have been reported from North America, and seven from British Columbia. In addition to the stalked species listed below, the strictly crustose species *P. dovrensis* (Nyl.) Timdal, Hertel & Rambold has also been reported for British Columbia (Brodo 1995).

KEY TO *PILOPHORUS*



- 1a Collected east of coast ranges (Note: sorediate specimens key here) 2
- 2a Pseudopodetia and basal crust bearing granular soredia(←); rare *Pilophorus cereolus*
- 2b Pseudopodetia and basal crust smooth or lumpy, but lacking soredia; frequent *Pilophorus acicularis* (see 6b)
- 1b Collected west of coast ranges 3
- 3a At least some stalks/pseudopodetia terminating upwards in (black) apothecia 4
- 4a Apothecia triangular (tapering gradually downwards) or cylindrical(←), at least twice as long as wide. . . *Pilophorus clavatus*
- 4b Apothecia globose or at least not triangular or cylindrical, not much longer than wide; distribution various 5
- 5a Pseudopodetia and basal crust distinctly lumpy-areolate(←), the areoles peltate (i.e., centrally attached); inner portions of pseudopodetia black throughout *Pilophorus nigricaulis*
- 5b Pseudopodetia and basal crust smooth or lumpy, but never peltate; inner portions of pseudopodetia pale 6



- 6a Pseudopodetia fork-branched to radially branched above(←), at least in part; hypermaritime; rare *Pilophorus robustus*
- 6b Pseudopodetia unbranched(←) or sparsely fork-branched above; widespread; frequent *Pilophorus acicularis*
- 3b Pseudopodetia lacking apothecia 7
- 7a Pseudopodetia more or less smooth, white-corticate(←), except black in basal portions and within *Pilophorus vegae*
- 7b Pseudopodetia lumpy, white to pale greyish, never black within. . . 8
- 8a Basal crust consisting of closely packed “tiles”/areoles; pseudopodetia generally to less than 1.5 mm tall *Pilophorus clavatus*
- 8b Basal crust consisting of scattered “tiles”/areoles; pseudopodetia often to more than 1.5 cm tall. 9
- 9a Pseudopodetia fork-branched to radially branched above, at least in part; hypermaritime; exposed seaside sites; rare *Pilophorus robustus*
- 9b Pseudopodetia unbranched or at most fork-branched above; widespread; generally restricted to sheltered sites; frequent. *Pilophorus acicularis*

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

Devil’s matchstick

Habitat/Range: Frequent over acid rocks in sheltered, humid forests at lower elevations throughout, except absent from boreal regions; western N Am (rare east to Ontario) - eastern Eurasia, N to sAK, S to WA, ID, OR, CA.

Reactions: Cortex K+ yellow.

Contents: Atranorin and zeorin.

Variability: Low.

Notes: This is the only widely distributed species of *Pilophorus* occurring in British Columbia.

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

Map 90

Powdered matchstick (miner’s matchstick)

Habitat/Range: Rare over recently disturbed rock surfaces in humid, sheltered intermontane (ICH) forests at lower elevations; incompletely circumpolar, in western N Am known only from BC.

Reactions: Cortex and soredia K+ yellow.

Contents: Atranorin and zeorin.

Variability: Medium.

Notes: *Pilophorus cereolus* has a highly scattered distribution.

***Pilophorus clavatus* Th. Fr.**

Tapered matchstick

Habitat/Range: Frequent over acid rock in humid, generally sheltered coastal forests at lower to middle elevations; western N Am - eastern Eurasia, N to sAK, S to WA, OR.

Reactions: Cortex K+ yellow or occasionally K-.

Contents: Atranorin (trace) and zeorin.

Variability: Low.

Notes: The holotype specimen is from “Mt. Mark” on Vancouver Island.

***Pilophorus nigricaule* Satô**

Charred matchstick

Habitat/Range: Frequent over acid rock in humid, sheltered coastal forests at lower elevations; western N Am - eastern Eurasia, N to sAK, S to WA, OR.

Reactions: Cortex K+ yellow; medulla K+ yellow, PD- or PD+ yellow to orange.

Contents: Atranorin and zeorin (and stictic acid).

Variability: Medium.

***Pilophorus robustus* Th. Fr.**

Map 91

Octopus' matchstick

Habitat/Range: Rare over rock in open hypermaritime localities at lower to presumably subalpine elevations; circumpolar, N to sAK, AK, wNT, S to BC.

Reactions: Cortex K+ yellow.

Contents: Atranorin and zeorin.

Variability: High.

Notes: *Pilophorus robustus* has an arctic-alpine distribution in most of its range, but in British Columbia is known only from coastal regions near sea level. Sparsely branched forms can be difficult to distinguish from *P. acicularis*.

***Pilophorus vegae* Krog**

Map 92

Headless matchstick

Habitat/Range: Rare over acid rock open in hypermaritime localities at lower elevations; western N Am - eastern Eurasia, N to sAK, S to BC.

Reactions: Cortex K+ yellow; medulla K+ yellow, PD+ yellow to orange.

Contents: Atranorin, zeorin, and stictic acid.

Variability: High.

Notes: The sterile, nonsorediate pseudopodetia with a black interior are distinctive for the species.

Minute to small nonstratified fruticose (**shrub**) lichens, consisting of **cushions** or mats of decumbent to semi-erect branches, these **greyish to brownish** or brownish black, round in cross-section, slender, to 1.5–5 mm long and (40–) 50–125 (–140) μm wide, rather shiny, **cor-ticate**, brittle, solid, **sparsely branched** to rather richly branched; branching mostly even/isotomic. Soredia, isidia, and pseudocyphellae absent. Well-developed medulla absent. Attached to substrate by basal holdfasts. Photobiont a cyanobacterium, either *Scytonema* (cells to (5–) 8–15 μm along long axis) or *Nostoc* (cells to 5–7 μm along long axis).

Ascocarp an apothecium, borne laterally, disc brown, to 1.5–2 (–2.5) mm wide. Spores 1- to 2-celled, ellipsoid to spindle-shaped/fusiform, colourless, eight per ascus.

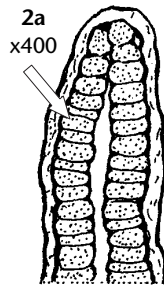
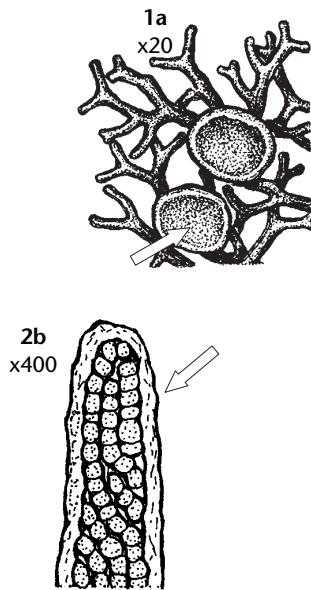
Over **conifer bark or mossy outcrops**.

References: Henssen (1963).

Common Name: Describes the dark, “fur-like” appearance.

Notes: *Polychidium* is a primarily temperate genus consisting of five species worldwide. Three of these have been reported from North America, and all occur in British Columbia. No chemical substances have been reported.

KEY TO *POLYCHIDIUM*



- 1a** Over mossy rock; apothecia common(←); photobiont *Nostoc* (i.e., cells greyish green, to 5–7 [–8] μm along long axis: check in long-section under LM); widespread . . .
 *Polychidium muscicola*
- 1b** Over conifer bark; apothecia unknown; photobiont *Scytonema* (i.e., cells medium greenish, to [5–] 8–15 μm along long axis (check lengthwise squash mount under LM); humid regions . . . 2
- 2a** Algal strands to 10–15 μm wide, arranged in two rows in vicinity of branch tips(←), the rows generally oriented parallel to one another; primarily intermontane . . .
 *Polychidium dendriscum*
- 2b** Algal strands to 5–12 μm wide, arranged in more than two rows in vicinity of branch tips(←), the rows generally not oriented parallel to one another; primarily coastal . . .
 *Polychidium “contortum”*

Polychidium contortum auct., non Henssen
Maritime woollybear

Habitat/Range: Frequent over conifer branches in sheltered coastal old-growth “rain forests” at lower elevations; western N Am, possibly N to BC, S to OR.

Variability: Medium.

Notes: This species has hitherto been assigned to *P. contortum* Henssen (from New Zealand), but apparently belongs to another, possibly unnamed taxon (T. Tønsberg, University of Bergen, Norway, pers. comm., 1998). For points of distinction with similar epiphytic lichens in other genera, see the key under *Lichinodium*.

Polychidium dendriscum (Nyl.) Henssen
Inland woollybear

Map 93

Habitat/Range: Infrequent over conifer branches in sheltered humid intermontane (ICH) regions at lower elevations; probably incompletely circumpolar, N to sAK, S to OR.

Variability: Medium.

Notes: For points of contrast with similar epiphytic lichens in other genera, see the key under *Lichinodium*.

Polychidium muscicola (Sw.) Gray
Eyed mossthorns

Habitat/Range: Frequent over mossy acid outcrops in open coastal and intermontane localities at lower to middle forested elevations, also rare at the base of mossy trees; possibly circumpolar, N to sAK, AK, YU, wNT, S to WA, ID, MT, OR, WY, CA, CO, (AZ).

Variability: Medium.

Notes: For points of separation with similar ground-dwelling lichens in other genera, see the key under *Spilonema*.

Small stratified fruticose (**hair**) lichens, consisting of loose to dense mats of decumbent to weakly ascending branches, these dark brown to **blackish**, round in cross-section to in part somewhat flattened, slender, to **4–10 (–15) mm long** and 0.1–0.5 (–1.0) mm wide, dull to occasionally shiny, smooth, corticate, pliant or brittle, solid, richly branched, lacking spine-like side branches; branching even/isotomic to uneven/anisotomic. Soredia, isidia, and pseudocyphellae absent. **Medulla white**. Attached to substrate by expanded basal holdfasts and by unspecialized attachment points along the length of the branches. Photobiont green, chlorococcoid.

Ascocarp an apothecium, disc blackish, concave to convex, borne laterally. Spores 1-celled, ellipsoid, colourless, eight per ascus. Pycnidia common.

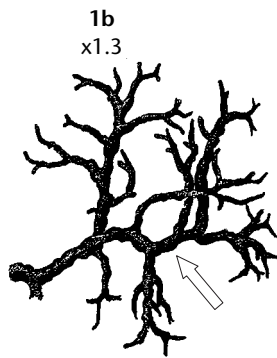
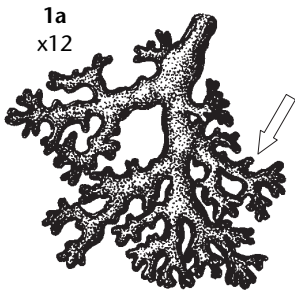
Over rock.

References: Brodo and Hawksworth (1977).

Common Name: Descriptive.

Notes: *Pseudephebe* is a cool-temperate to arctic genus consisting of two species worldwide. Both occur in British Columbia. Chemistry is of no diagnostic value. For points of separation with similar lichens in other genera, see the key under *Bryoria*.

KEY TO *PSEUDEPHEBE*



- 1a** Branches in part flattened in cross-section, uneven; internodes short(←), 0.2–0.5 (–1.0) mm; thallus closely appressed (to nearly crustose) toward thallus centre; alpine . . .
 *Pseudephebe minuscula*
- 1b** Branches generally round in cross-section, more or less even; internodes longer(←) (0.6–) 1–3 (–5) mm; thallus often semi-erect toward thallus centre; alpine to temperate. *Pseudephebe pubescens*

Pseudephebe minuscula (Arnold) Brodo & D. Hawksw.

(Syn. *Alectoria minuscula* (Arnold) Degel.)

Coarse rockwool

Habitat/Range: Frequent over acid or occasionally base-rich rock in exposed alpine localities throughout, except apparently absent from hypermaritime regions; circumpolar, N to sAK, AK, YU, wNT, S to WA, ID, MT, OR, WY, CA, UT, CO, AZ, NM; AB.

Variability: High.

Notes: Some specimens are difficult to distinguish from *P. pubescens*, but can usually be separated by the partly flattened branches.

Pseudephebe pubescens (L.) Choisy

(Syn. *Alectoria pubescens* (L.) R. Howe; *Parmelia lanata* (L.) Wallr.)

Fine rockwool

Habitat/Range: Frequent over acid rock or stony ground in exposed temperate to alpine localities throughout; circumpolar, N to sAK, AK, YU, wNT, S to WA, ID, MT, OR, WY, CA, NV, UT, CO, MX; AB.

Variability: Medium.

Small nonstratified fruticose (**hair**) lichen, consisting of **mats** of decumbent to weakly ascending **cyanobacterial strands**, these dark brown to **blackish**, round in cross-section, gossamery, to **2–5 mm long and 10–15 µm wide**, weakly shiny, noncorticate, brittle, solid, moderately branched, closely **ensheathed in fungal threads**/hyphae, these elongate, and with thick, **sinuous hyphal walls**, conspicuous under LM. Soredia, isidia, pseudocyphellae, and medulla absent.

Attached to substrate by basal holdfasts. Photobiont appearing dark brown: *Trentepohlia*, cells to 15–18 µm along long axis (cell walls often difficult to discern). Ascocarps and pycnidia unknown. Over **vertical rock**.

References: Purvis et al. (1992: Dalby).
Common Name: Describes the habitat and the appearance of the branches.
Notes: *Racodium* is a cool-temperate genus consisting of only one species.

x500



Racodium rupestre Pers.

Map 94

The rockhair

Habitat/Range: Infrequent (probably overlooked) over undersides of acid rock outcrops in humid localities at low to middle elevations throughout, except perhaps absent from boreal regions, local distribution poorly known; possibly western N Am - western Eurasia, N to BC, S to WA.

Reactions: All spot tests negative.

Contents: No lichen substances reported.

Variability: Low.

Notes: This species apparently often grows intermixed with *Cystocoleus ebeneus*. For points of separation with similar lichens in other genera, see the key under *Cystocoleus*.

Medium-sized to large stratified fruticose or semi-foliose (**shrub**/leaf) lichens, consisting of tufts or tresses of semi-erect to pendent branches, these **pale greenish** to yellowish green, generally coloured alike above and below, **green also at tips, flattened** in cross-section to occasionally oval or round, smooth to more or less “gristly”/chondroid, slender to broad, to **20–150 (–300) mm long** and (0.5–) 1–3 (–15) mm wide (ours), dull to shiny, smooth, corticate, pliant (but rather **stiff**), solid or hollow, sparsely branched to richly branched; branching even/isotomic to uneven/anisotomic. Soredia present or absent. Isidia absent. Pseudocyphellae often present. **Medulla white, compact**. Attached to substrate by basal holdfasts. Photobiont green, chlorococcoid.

Ascocarp an apothecium, disc pale greenish to pinkish orange. Spores 2-celled.

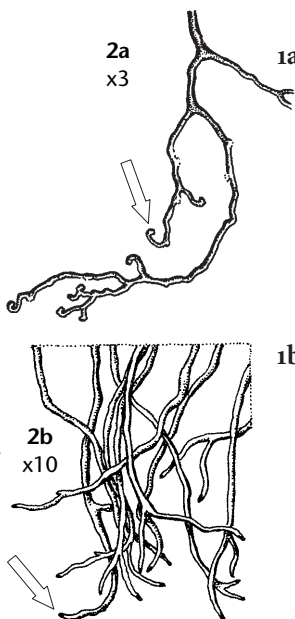
Over trees, shrubs, and occasionally rocks, generally in sheltered sites.

References: Bowler and Rundel (1974, 1977, 1978); Rundel and Bowler (1976); Bowler (1977); Krog and James (1977); Wylie (1977); Thomson (1984); McCune and Goward (1995).

Common Name: Describes the shrublike appearance of most species.

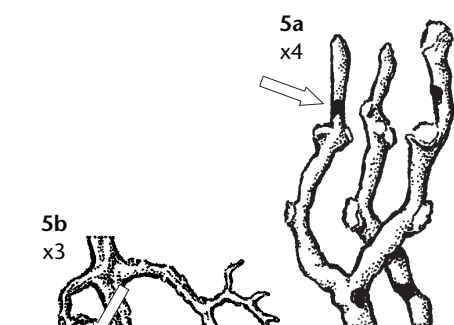
Notes: *Ramalina* is a cosmopolitan genus comprised of approximately 200 species worldwide. Forty-four of these have been recorded for North America, though only 12 species (including two unnamed taxa) are currently recognized for British Columbia. Usnic acid is present in the cortex of all local species; accordingly, the resulting KC+ yellowish reaction will be omitted from the following accounts.

KEY TO *RAMALINA* AND SIMILAR LICHENS

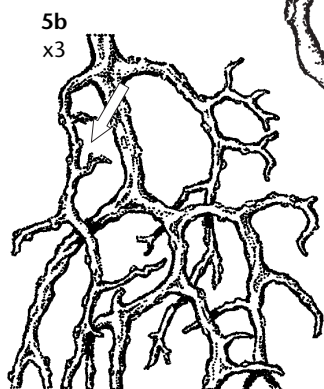


- 1a Branches threadlike more or less throughout, essentially round in cross-section; thallus often to more than 7 cm long 2
- 2a Extreme branch tips pale green, at least in part bearing minute fiddlehead-like “hooks”(←) (check under hand lens), these often minutely sorediate; pseudocyphellae generally inconspicuous (check surface of main branches); medulla KC- *Ramalina thrausta*
- 2b Extreme branch tips black (at least in part), not at all hooked(←), lacking soredia; pseudocyphellae generally conspicuous; medulla KC+ red or KC- *Alectoria sarmentosa*
- 1b Branches fine or more often coarse, but never threadlike throughout, generally distinctly flattened in cross-section; thallus generally less than 6 cm long (Note: specimens bearing netlike branches key here, regardless of thallus length) 3
- 3a Thallus bearing powdery soredia (check lobe tips); apothecia generally absent (Note: specimens with hollow lobes key here: check basal portions) 4
- 4a Medulla distinctly thick, “fluffy,” branches soft to the touch, rather flaccid (Note: specimens having predominantly black branch tips key here) 5

⁷ Prepared by Trevor Goward and Hiroyuki Kashiwadani.



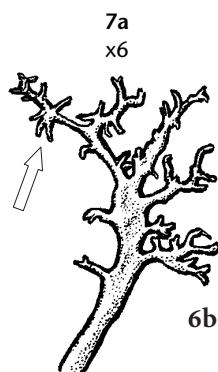
5a Branch tips mostly green; cortex coloured alike above and below, often black-spotted(←), at least in part; in herbarium often minutely covered in fine crystalline “hairs”; medulla UV-; divaricatic and evernic acids absent; seaside localities; expected in extreme southern regions [*Niebla cephalota*]



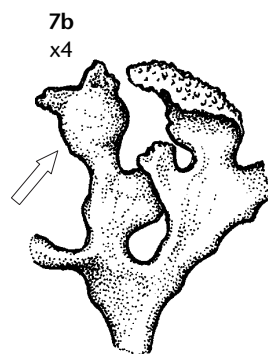
5b Branch tips mostly black(←); cortex generally green above, paler below, not at all black-spotted, never producing crystalline hairs, medulla UV+ distinctly blue; divaricatic or evernic acid present; absent from seaside localities; frequent . . . *Evernia*

4b Medulla thin, generally rather compact; branches hard to the touch, not at all flaccid 6

6a Main branches hollow, often perforate; soredia more or less restricted to vicinity of branch tips; thalli small, generally less than 3 cm long. 7



7a Branches slender, less than 1.3 mm wide (check sterile branches), terminating upwards in short, fine, delicate branchlets(←); branch tips at most sparsely sorediate; sekikaic acid present; mostly west of coast ranges *Ramalina roesleri*

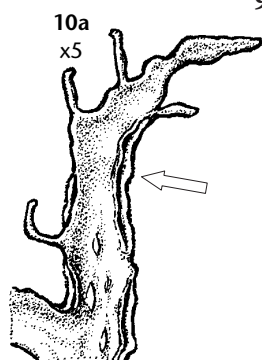


7b Branches coarser, generally 1–4 mm wide, terminating upwards in proportionately broad, hoodlike flaps(←), these covered below in copious soredia; evernic acid present; east of coast ranges *Ramalina obtusata*

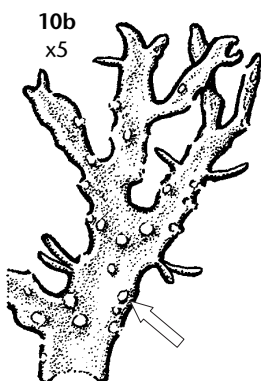
6b Main branches solid, not at all translucent; soredia not confined to branch tips, present at least in part along lobe margins and/or over upper or lower surface of lobes; thalli small to large 8

8a Soredia borne in well-delimited soralia, these oval to somewhat elongate, positioned at least in part along lobe margins 9

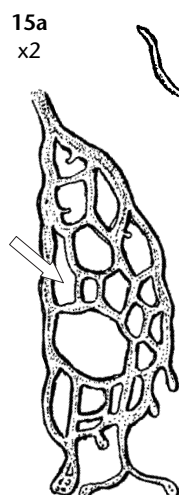
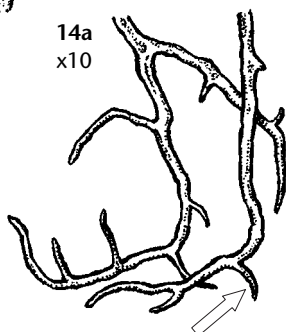
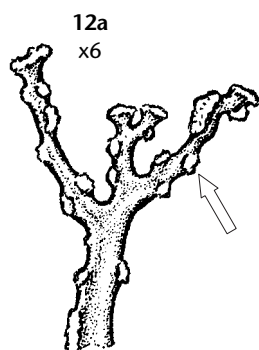
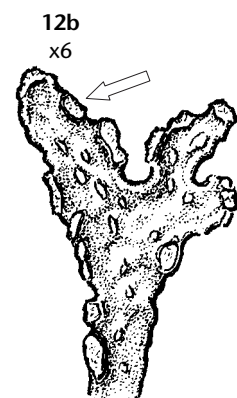
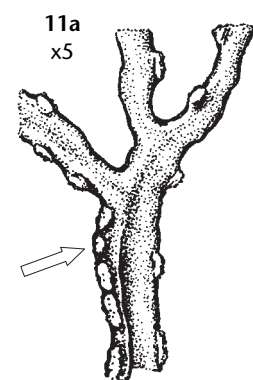
9a Main branches generally to 2–8 (–15) mm wide, bearing at least some small, perpendicular side branches (these forming at edges of marginal soralia); soralia present both along lobe margins and (often sparsely) over upper surface; coastal 10



10a Marginal soralia predominantly slitlike(←), elongate; medulla PD-; zeorin present or occasionally absent; protocetraric and hypoprotocetraric acids absent *Ramalina subleptocarpha*



10b Marginal soralia predominantly oval to round(←); medulla PD+ orange (rarely PD-); zeorin absent; protocetraric or hypoprotocetraric acid generally present. *Ramalina* sp. 2



9b Main branches generally to 0.5–2 (–3) mm wide; small perpendicular side branches present or absent; distribution various (Note: specimens collected from east of the coast ranges key here, regardless of branch width) 11

11a Soralia present exclusively along lobe margins(←); thallus often to more than 4 cm in length; main branches lacking small, perpendicular side branches; evernic acid absent, sekikaic and homosekikaic acids also absent (except occasionally present in material collected from boreal regions); over trees and shrubs; widespread, frequent, but less common in boreal regions *Ramalina farinacea*

11b Soralia present along lobe margins and often also at lobe tips and upper surface; thallus generally to less than 4 cm in length; main branches often bearing at least some small, perpendicular side branches; evernic acid or sekikaic and homosekikaic acids present; over rock and conifers; east of coast ranges, especially in boreal regions 12

12a Terminal branches generally long and narrow(←), often almost threadlike, not at all expanded-flaplike at tips; sekikaic and homosekikaic acids present

. *Ramalina intermedia*

12b Terminal branches generally rather coarse(←), not at all threadlike, often in part expanded-flaplike at tips; evernic acid present *Ramalina pollinaria*

8b Soredia more or less diffuse, or at least not borne in well-delimited soralia, positioned over lower surface or in vicinity of lobe tips. . . 13

13a Main branches terminating in broad, hoodlike flaps (see 7a), these more or less covered below in soredia; lower surface otherwise generally lacking soredia; evernic acid present; east of coast ranges. *Ramalina obtusata*

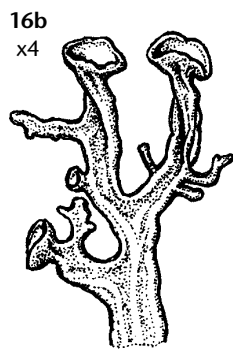
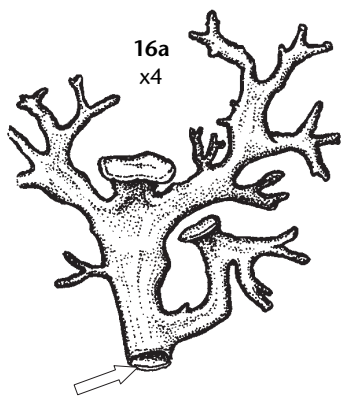
13b Main branches terminating in narrow, delicate branchlets, these not at all hoodlike, bearing at most sparse soredia; lower surface of lobes also generally sorediate; evernic acid absent; northern *Ramalina* sp. 1

3b Thallus lacking powdery soredia (Note: take care to distinguish between powdery soredia and the compact, often partly exposed medulla of *R. sinensis* s. lat.); apothecia often present 14

14a Branch tips mostly black(←); branches soft to the touch, flaccid; medulla also soft, rather loose *Evernia*

14b Branch tips mostly green; branches hard to the touch, not at all flaccid; medulla distinctly compact. 15

15a Thallus long-pendulous, to 30 cm in length; branches at least in part with netlike perforations(←) (check tips); apothecia rare; coastal *Ramalina menziesii*



- 15b Thallus short or tufted, or both, to 3–4 cm long; branches not at all netlike; apothecia common; distribution various 16
- 16a Main branches hollow(←), more or less semi-translucent, to less than 2.5 mm wide; widespread; frequent *Ramalina dilacerata*
- 16b Main branches solid, opaque, to more than 3 mm wide; boreal; rare *Ramalina sinensis* s. lat.

***Ramalina dilacerata* (Hoffm.) Hoffm.**

(Syn. *Fistulariella minuscula* (Nyl.) Bowler & Rundel; *R. minuscula* (Nyl.) Nyl.; *R. geniculata* auct., non Hook. f. & Taylor; *R. inflata* auct, non (Hook. f. & Taylor) Hook. f. & Taylor)

Punctured bush (perforated ramalina; punctured gristle; ragged twig)

Habitat/Range: Frequent over coniferous and especially deciduous trees and shrubs in open maritime and humid intermontane (ICH) localities at lower elevations; probably incompletely circumpolar, N to sAK, (YU), S to WA, ID, OR, CA, NM, MX; AB.

Reactions: All spot tests negative.

Contents: Divaricatic and usnic acids.

Variability: Medium.

Notes: Robust specimens here interpreted as belonging to *R. dilacerata* are sometimes attributed to the southern hemisphere species *R. geniculata* or *R. inflata*. Further work is needed.

***Ramalina farinacea* (L.) Ach.**

The dotted line (powdery ramalina; rimmed gristle; dotted twig lichen)

Habitat/Range: Frequent over trees and shrubs in open to somewhat sheltered localities at lower elevations throughout, except rare in boreal and dry intermontane regions, also occasionally over rock; circumpolar, N to sAK, AK, S to WA, ID, OR, CA, AZ, NM, MX; AB.

Reactions: Chemotype 1: Medulla PD+ orangish red. Chemotype 3: Medulla CK+ yellow to orange, or CK-; PD+ orange. Chemotype 5: Medulla PD+ orange.

Contents: Chemotype 1: Usnic and protocetraric acids. Chemotype 2: Usnic and hypoprotocetraric acids. Chemotype 3: Usnic and salazinic acids (and norstictic acid). Chemotype 4: Usnic acid. Chemotype 5: Usnic and norstictic acids. Chemotype 6: Usnic, homosekikaic, and sekikaic acids.

Variability: Low.

Notes: Diagnostic characters include the well-delimited marginal soralia and the long, narrow branches to less than 2 (–3) mm wide. Homosekikaic and sekikaic acids have not previously been reported from *R. farinacea*, and are currently known only from specimens collected in boreal regions. See also notes under *Ramalina* sp. 2 and *Evernia prunastri*.

Ramalina intermedia (Nyl.) Nyl.
Rock bush

Map 95

Habitat/Range: Rare (probably overlooked) over rock and conifers in open to somewhat sheltered inland forests, especially in boreal regions, at lower elevations, local distribution poorly known; probably incompletely circumpolar, N to YU, wNT, S to CA, (CO), AZ, NM; AB.

Reactions: All spot tests negative.

Contents: Usnic, homosekikaic, and sekikaic acids (and atranorin and 4'-o-methylnorhomosekikaic acid).

Variability: High.

Notes: This species can be recognized by: (1) its narrow, often tapered branches that bear "loose" soredia in scattered, irregular soralia located especially near the tips; (2) its production of homosekikaic and sekikaic acids; and (3) its characteristic occurrence over sheltered rock faces. Some forms of *R. farinacea* are similar, but is often more than 4 cm long, whereas *R. intermedia* is generally smaller.

Ramalina menziesii Taylor
(Syn. *Ramalina reticulata* (Nöhden) Kremp.)
The fishnet (lace lichen)

Habitat/Range: Frequent (localized) over trees and shrubs in open coastal localities at lower elevations, generally in close proximity to the ocean; western N Am, N to sAK, AK, S to WA, OR, CA, MX.

Reactions: All spot tests negative.

Contents: Usnic acid.

Variability: High.

Notes: Occasionally the characteristic netlike branching is poorly developed, and must be carefully checked for near the branch tips.

Ramalina obtusata (Arnold) Bitter
Hooded bush (hooded ramalina)

Habitat/Range: Frequent over trees and shrubs (occasionally over rock) in open to somewhat sheltered, humid intermontane (ICH) forests at lower elevations, also rare in boreal regions; probably circumpolar, N to wNT, S to (WA), (ID), MT, CA, UT, CO, AZ; AB.

Reactions: All spot tests negative.

Contents: Evernic, obtusatic, and usnic acids.

Variability: High.

Notes: The expanded, hoodlike branch tips covered below in diffuse soredia are diagnostic.

Ramalina pollinaria (Westr.) Ach. Map 96
Chalk bush (dusty gristle; dusty ramalina; powdery twig lichen; dusty cartilage lichen)

Habitat/Range: Infrequent (overlooked?) over trees and shrubs in sheltered, humid inland forests at lower elevations; probably circumpolar, N to AK, S to WA, MT, OR, WY, CA, CO, AZ, NM, MX; AB.

Reactions: All spot tests negative.

Contents: Evernic, obtusatic, and usnic acids.

Variability: Medium.

Notes: Diagnostic characters include: (1) the presence of diffuse soredia over the lobe margins, lobe tips, and often the upper surface; (2) the expanded, flaplike lobe tips; and (3) the production of evernic acid.

Ramalina roesleri (Schaerer) Hue
(Syn. *Fistulariella roesleri* (Schaerer) Bowler & Rundel)
Frayed bush (perforated ramalina)

Habitat/Range: Frequent over trees and shrubs in open hypermaritime forests at lower elevations; probably incompletely circumpolar, N to sAK, AK, wNT, S to WA, ID, OR, CA, NM; AB.

Reactions: All spot tests negative.

Contents: Chemotype 1: Usnic and divaricatic acids. Chemotype 2: Usnic, sekikaic, and homosekikaic acids. Chemotype 3: Usnic acid.

Variability: Medium.

Notes: Diagnostic characters include: (1) the slender, partly hollow branches that become “frayed” above into short, fine branchlets; and (2) in British Columbia, the predominantly hypermaritime distribution. Chemotype 2 is restricted to western coastal North America; it has been recognized as a separate species, *R. bonsaia* Wylie, ined.

Ramalina sinensis Jatta, s. lat. Map 97
Burning bush (fan ramalina)

Habitat/Range: Rare over trees and shrubs in open boreal forests at lower elevations; incompletely circumpolar, N to BC, S to CA, UT, CO, AZ, NM, (MX); AB.

Reactions: All spot tests negative.

Contents: Usnic acid.

Variability: High.

Notes: This species can be recognized by its broad, fan-shaped habit, and by the presence of numerous pale pink apothecia. The British Columbia material appears to be heterogeneous; at least some specimens may more appropriately be included in *R. americana* Hale. Further studies are needed.

Ramalina subleptocarpa Rundel & Bowler
Slit-rimmed bush (powdery strap lichen)

Map 98

Habitat/Range: Rare over deciduous trees and shrubs in open maritime (CDF) forests at lower elevations, mostly south of 49°N; western N Am, N to BC, S to WA, OR, CA, (MX).

Reactions: All spot tests negative.

Contents: Chemotype 1: Usnic acid and zeorin. Chemotype 2: Usnic acid.

Variability: Medium.

Notes: The rather broad lobes (to more than 2 mm wide), slitlike marginal soralia, and PD- medulla are diagnostic.

Ramalina thrausta (Ach.) Nyl.
(Syn. *Alectoria thrausta* Ach.)
Angelhair (angel's hair)

Habitat/Range: Frequent over conifers in open to sheltered maritime and especially inter-montane (ICH) localities at lower elevations, also rare in boreal regions; circumpolar, N to sAK, S to WA, ID, MT, OR, CA; AB.

Reactions: All spot tests negative.

Contents: Usnic acid (trace), stenosporic acid, and one unknown.

Variability: Medium.

Notes: The delicate, pale green, hairlike branches with green tips (check under hand lens!) are distinctive. This is a hygrophytic species best developed when growing in close proximity to standing water or wetlands.

***Ramalina* sp. 1**
Lacerated bush

Map 99

Habitat/Range: Rare (localized) over trees and shrubs in open coastal forests at lower elevations, mostly north of 59°N; global distribution unknown.

Reactions: All spot tests negative.

Contents: Usnic acid.

Variability: Unknown.

Notes: The species is undescribed, and may correspond to *R. filigrana* Wylie, ined. (Wylie 1977). Diagnostic characteristics include the “shredded” habit and the generally broad, flattened branches that bear scattered, diffuse soredia over the lower surface.

***Ramalina* sp. 2.**

Maritime bush

Habitat/Range: Frequent over deciduous trees and shrubs in open maritime forests at lower elevations, south of 54°N; western N Am - western Eurasia, N to BC, S to WA, OR, CA.

Reactions: Chemotype 1: Medulla PD+ orangish red.

Contents: Chemotype 1: Usnic and protocetraric acids. Chemotype 2: Usnic and hypoprotocetraric acids.

Variability: Medium.

Notes: *Ramalina* sp. 2 is similar to *R. farinacea*, but differs in its broader lobes (to more than 2 mm wide), its habitual production of small, perpendicular side branches, and its strictly coastal distribution. Additional chemotypes may exist; further work is needed.

Minute “fruticose” (club) microlichens, consisting of a **basal crust** and **stalked apothecia**. Basal crust immersed in substrate, not readily discernible. Photobiont yellowish green: *Trentepohlia*, cells to 15–18 μm along long axis.

Apothecial stalks nonlichenized, pale brownish, pruinose or more often lacking pruina, generally **pale-translucent within**, hairlike, **to 0.5–1.0 mm long** (including heads) and 50–150 (–200) μm wide (excluding heads), smooth, brittle, unbranched. **Apothecial heads/capitula borne at stalk tips, top-shaped/turbinate to hemispherical**, consisting of an upwardly expanding excipulum and a powdery spore mass/mazaedium, this pinkish brown or rusty brown, but often **obscured by a white, yellow, or violet pruina**. Spores 1-celled, globose, at maturity minutely net-ridged/reticulate (at 1000x) or apparently smooth, colourless/hyaline under LM, minutely

warted at maturity, arising from short-lived asci, later extruded as a loose, dry spore mass/mazaedium.

Over dry, sheltered bark of deciduous trees in humid sites.

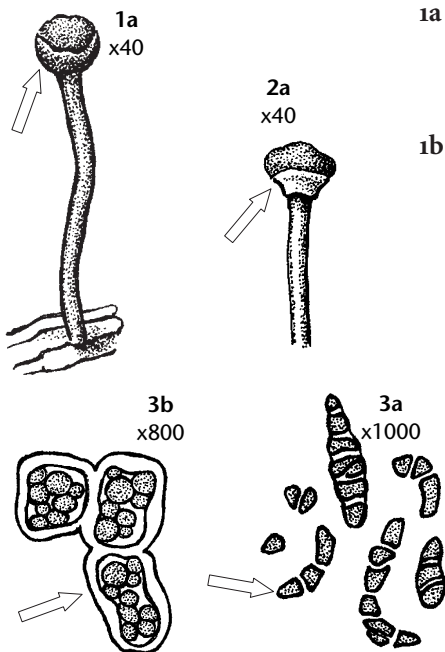
References: Tibell (1984, 1994),

Middelborg and Mattsson (1987).

Common name: Refers to the often semi-translucent or “glassy” appearance of the stalks.

Notes: *Sclerophora* is restricted primarily to temperate latitudes. It consists of six species worldwide, three of which have been reported for North America, including British Columbia. Though usually characterized as a crustose genus, *Sclerophora* is included here owing to its stalked apothecia. For points of distinction with similar species in other genera, see the key under *Chaenotheca*.

KEY TO *SCLEROPHORA* AND SIMILAR LICHENS



- 1a Young apothecial heads appearing bright rusty brown under hand lens; excipulum conspicuously cupping the spore mass/mazaedium at maturity(←), but not at all collarlike; spores 5–6 μm diameter . . . *Sclerophora coniophaea*
- 1b Young apothecial heads appearing strong yellow, violet, or white under hand lens, becoming bright rusty brown only at maturity, if at all; excipulum either not conspicuously cupping the spore mass at maturity or soon becoming distinctly collarlike; spores often larger or smaller than above . . . 2
- 2a Excipulum conspicuous, distinctly collarlike at maturity(←); spores to 5–6 (–7) μm diameter. *Sclerophora amabilis*
- 2b Excipulum inconspicuous, not at all collarlike at maturity; spores to 3–5 μm diameter 3
- 3a Stalks distinctly yellow-pruinose (check young apothecia), dull as viewed under hand lens, blackish within (check broken stalks under LM); basal thallus bearing *Stichococcus*(←) . . . *Chaenotheca brachypoda*
- 3b Stalks lacking pruina, more or less shiny as viewed under hand lens, pale within; basal thallus bearing *Trentepohlia*(←) . . . *Sclerophora peronella*

Sclerophora amabilis (Tibell) Tibell
Collared glass-whiskers

Map 100

Habitat/Range: Rare over cottonwood (*Populus*) in sheltered intermontane (ICH) forests at lower elevations; western N Am, N to BC, S to (OR).

Reactions: Pruina: K+ violet.

Contents: Unknown pigments.

Variability: High.

Notes: The collar-forming excipulum and spores to 5–7 µm in diameter are diagnostic.

The spores in the original New Zealand populations are much smaller, at 3.2–4.1 µm.

Sclerophora coniophaea (Norman) J. Mattsson & Middelb.
Cinnamon whiskers

Map 101

Habitat/Range: Infrequent (overlooked?) over bark of deciduous trees, especially cottonwood (*Populus*), in humid, sheltered intermontane (ICH) old-growth forests at lower elevations; western N Am - eastern N Am - western Eurasia, in western N Am known only from BC.

Reactions: Pruina K+ reddish (flash) or apparently K-.

Contents: Unknown pigments.

Variability: Medium.

Notes: Diagnostic characters include the presence of a rusty brownish pruina over the heads of young apothecia, and the association with *Trentepohlia*.

Sclerophora peronella (Ach.) Tibell
Frosted glass-whiskers

Map 102

Habitat/Range: Rare over wood of deciduous trees, especially cottonwood (*Populus*), in sheltered intermontane (ICH) forests at lower elevations, local distribution poorly known; western N Am - western Eurasia, N to BC, S to American Pacific Northwest (E.B. Peterson, Oregon State University, pers. comm., 1998).

Reactions: All spot tests negative.

Contents: Unknown yellow pigment.

Variability: High.

Notes: The small globose spores to 3–5 µm diameter, the nonpruinose stalks, and the association with *Trentepohlia* are diagnostic.

Medium-sized to large stratified fruticose (**club**) lichens, consisting of clusters of semi-erect to **erect** branches, these **whitish**, more or less round in cross-section, but weakly longitudinally furrowed/striate, slender, to **20–30 (–70) mm long** and 1.5–2 mm wide, dull, corticate, brittle, **solid**, unbranched to **sparse-ly branched**, terminating upwards in **blunt tips**; branching even/isotomic to more often uneven/anisotomic. Soredia, isidia, and pseudocyphellae absent. Medulla white. Attached to substrate by “rootlike” basal holdfasts. Photobiont

green, chlorococcoid: *Trebouxia*.

Ascocarps unknown. Pycnidia also unknown.

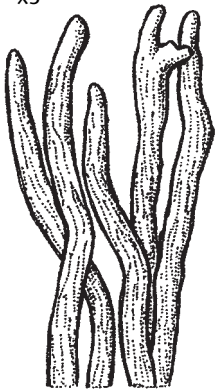
Over ground in **shallow standing water** (ours).

References: Thomson (1984).

Common Name: Describes the habitat and general appearance.

Notes: *Siphula* is an essentially cosmopolitan genus comprising 25 species. Only two of these, however, have been reported for North America, and only one occurs in British Columbia.

x3



Siphula ceratites (Wahlenb.) Fr.

(Syn. *Siphula simplex* (Taylor) Nyl.)

Northern waterfingers (waterworm)

Habitat/Range: Frequent (localized) over mud at margins of shallow pools in open peatlands in hypermaritime regions at lower elevations; circumpolar (in the high arctic), N to sAK, AK, wNT, S to BC.

Reactions: Cortex K+ orangish.

Contents: Siphulin and siphulitol.

Variability: Medium.

Notes: *Thamnolia vermicularis* is similar, but has hollow branches and grows in exposed sites, usually at alpine elevations.

Medium to large stratified fruticose (**shrub**) lichens, consisting of tufts or cushions of semi-erect to decumbent branches, these **whitish**, pale greenish, brownish, or occasionally becoming blackened, round to somewhat irregular in cross-section, slender, to **10–50 (–60) mm long** and 1–2 mm wide, dull to shiny, smooth or “dimpled”/foveolate, corticate, pliant to brittle, **solid** (ours), sparsely branched to richly branched, in some species divisible into primary, secondary, and tertiary branches; branching even/isotomic to uneven/anisotomic, often **terminating in fruiting bodies** (see below). Soredia, isidia, and pseudocyphellae absent. Medulla white. Attached to substrate by basal holdfasts. Photobiont green, chlorococcoid.

Ascocarp an apothecium, **ball-shaped**,

borne at branch tips, apothecial surface **powdery**/mazaediate, **black**, opening from tips. Spores 1-celled, broadly ellipsoid, dark violet (but appearing blackish owing to a thick ornamentation/secondary spore wall within the ascus), 8–12 µm in diameter, arising within short-lived asci.

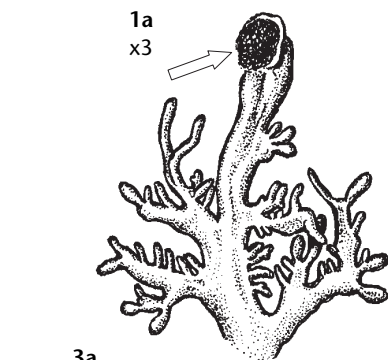
Over conifers, rocks, or moss.

References: Tibell (1975, 1984), Wedin (1993a, 1993b).

Common Name: Descriptive.

Notes: *Sphaerophorus* occurs predominantly at temperate latitudes. As treated here, five species are recognized worldwide (i.e., including at least one unnamed taxon), four of which occur in British Columbia. Further work is needed.

KEY TO SPHAEROPHORUS AND SIMILAR LICHENS



1a Branches in part distinctly flattened, especially toward tips; apothecia generally present, opening downwards at lobe tips(←); medulla I-; hypermaritime. *Bunodophoron melanocarpum*

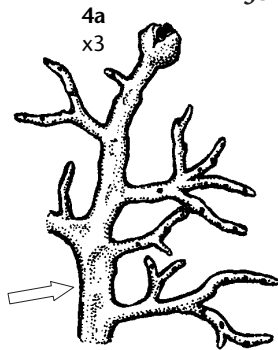
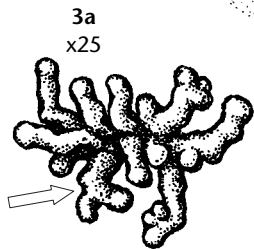
1b Branches circular in cross-section, or at least not distinctly flattened; apothecia present or absent, opening outwards at lobe tips; medulla I+ purple or I-; coastal and intermontane in humid localities. 2

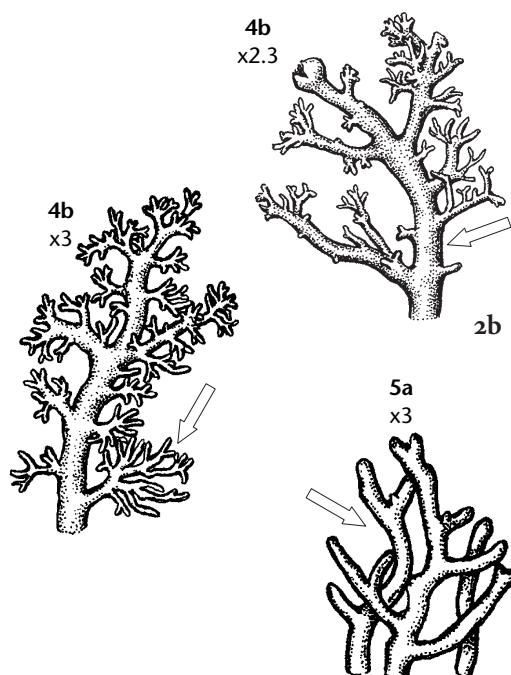
2a Over (mossy) conifer bark at lowland elevations 3

3a Thallus less than 2 mm tall, without distinct main stems(←), arising from a basal crust (often difficult to see: check margins of thallus); medulla I-; coastal. *Loxosporopsis corallifera*

3b Thallus more than 2 mm tall, with distinct main stems; basal crust absent; medulla I+ purple; distribution various 4

4a Main stems often in part irregular in cross-section, “dimpled”/foveolate below(←), not bearing dense clusters of brittle third-order branchlets; branchlets, if present, mostly confined to basal portions of thallus; black, dotlike pycnidia abundant over branches; apothecia frequent; medulla K-; present in humid intermontane regions and in maritime regions, but essentially absent from hypermaritime regions *Sphaerophorus tuckermanii*





- 4b Main stems round in cross-section throughout(←), or at most only weakly “dimpled”/foveolate, bearing dense clusters of brittle third-order branchlets(←), these most copious in basal portions of thallus, but extending also into upper portions; black, dotlike pycnidia absent or rarely sparse over branches; apothecia uncommon; medulla K+ yellowish or orange, or K-; present in humid intermontane regions, as well as in maritime and hypermaritime regions *Sphaerophorus globosus*
- 2b Over rocks and (mossy) ground, often at subalpine and alpine elevations 5
- 5a Thallus without distinct main stems(←) (check sterile branches); branches pale grey, except in part blackening where exposed; medulla I-; inland; northern *Sphaerophorus fragilis*
- 5b Thallus with distinct main stems; branches often in part becoming orangish brown, or at least not blackish; medulla I+ purple (occasionally weak); variously distributed, but not strictly northern 6
- 6a Main branches matte to weakly shiny, either distinctly “dimpled” or bearing dense clusters of third-order branchlets; lower elevations; coastal 4
- 6b Main branches distinctly lustrous, neither strongly “dimpled” nor bearing dense clusters of third-order branchlets; middle and upper elevations; widespread *Sphaerophorus* sp. 1

***Sphaerophorus fragilis* (L.) Pers.**

Map 103

Fragile coral (pygmy coral; ball-tip lichen)

Habitat/Range: Infrequent (overlooked?) over acid rock in open inland alpine localities, especially north of 57°N; circumpolar, N to sAK, AK, YU, wNT, S to BC.

Reactions: Medulla PD+ strong yellow or PD-, UV+ purple or UV-.

Contents: Fragilin and sphaerophorin (and squamatic acid or thamnolic acid, or both).

Variability: Low.

Notes: Diagnostic characters include: (1) the short, clustered, pale greyish branches that lack a main stem (at least when sterile); (2) the ground-dwelling habitat ecology; and (3) the alpine distribution. The occurrence of blackish, rather than pale greyish branches may reflect the presence of a parasitic fungus.

Sphaerophorus globosus (Hudson) Vainio

(Syn. *Sphaerophorus globosus* (Hudson) Vainio var. *gracilis* (Müll. Arg.) Zahlbr.)
Clustered coral (common christmas tree; common coral; coral lichen; denser ball-tip lichen; tree coral)

Habitat/Range: Common over conifers, also occasionally over mossy outcrops, in open to shady coastal forests at lower to middle elevations, also rare in humid intermontane (ICH) old-growth forests at lower elevations; apparently western N Am, N to sAK, S to WA, OR, CA.

Reactions: Medulla K+ yellow, orange, or brownish, or K-, PD+ yellow or PD-, I+ purple, UV+ blue or UV-.

Contents: Fragilin and sphaerophorin (and hypothamnolic, thamnolic, and squamatic acids, and other unknown substances).

Variability: High.

Notes: The taxonomic delimitation of this species requires further study. See notes under *Sphaerophorus tuckermanii*.

Sphaerophorus tuckermanii Räsänen

(Syn. *Sphaerophorus globosus* (Hudson) Vainio var. *lacunosus* Tuck.)
Ball-headed coral

Habitat/Range: Frequent over conifers in sheltered maritime and humid intermontane (ICH) old-growth forests at lower elevations; apparently circumpolar, N to sAK, S to WA, ID, (OR), (CA).

Reactions: Medulla I+ purple, UV+ blue.

Contents: Fragilin and sphaerophorin (and thamnolic or squamatic acids and other unknown substances).

Variability: Medium.

Notes: Some authors include *S. tuckermanii* within *S. globosus*, though the two species are clearly distinct. Besides the obvious morphological differences (e.g., branches “dimpled”/foveolate versus round in cross-section, respectively), *S. globosus* appears to reproduce vegetatively (i.e., through fragmentation of its copious third-order branchlets), whereas *S. tuckermanii* reproduces via the production of sexual spores. *S. tuckermanii* is also less widespread than *S. globosus*, and is essentially absent from hypermaritime regions.

Sphaerophorus sp. 1
Outcrop coral

Habitat/Range: Infrequent over mossy outcrops in coastal localities at subalpine and alpine elevations, also apparently extending to inland regions in northern portions of the province; global distribution unknown.

Reactions: Medulla I+ purple, or apparently I-.

Contents: Fragilin and sphaerophorin (and squamatic acid).

Variability: High.

Notes: Diagnostic characters include the glossy, “undimpled” branches, the lack of copious third-order branchlets, the ground-dwelling habitat ecology, and the occurrence at subalpine and alpine elevations. Ground-dwelling forms of *S. tuckermanii* are similar, but have distinctly “dimpled” main branches that are generally heavily pycnidiate and rather matte. As defined here, *S. tuckermanii* also appears to be restricted to lowland localities. Further work is needed.

Minute nonstratified fruticose (**shrub**) lichens, consisting of **cushions** of more or less **upright, densely clustered cyanobacterial branches**, these **blackish**, mostly round in cross-section, slender, to **0.3–3 (–6) mm long** and 40–60 (–100) μm wide, dull, smooth, noncorticate, brittle, solid, richly branched; branching mostly lateral, **side branches numerous**, remaining short, often knoblike. Soredia, isidia, pseudocyphellae, and medulla absent. Attached to substrate by colourless or **dark bluish hairlike rhizoids**.

Photobiont a cyanobacterium:

Hyphomorpha or *Stigonema*, cells to 12–20 (–25) μm along long axis.

Ascocarp an apothecium, borne laterally (below the surface of the thallus cushion), not seen in local material, disc convex, brownish to blackish. Spores 1-celled, narrowly ellipsoid, colourless, eight per ascus. Pycnidia terminal or lateral.

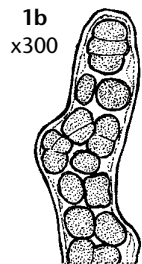
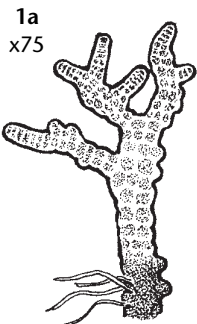
Over rock and conifer bark.

References: Henssen (1963, 1981); Purvis et al. (1992: Coppins, Gilbert, and Jørgensen).

Common Name: Descriptive.

Notes: *Spilonema* is a genus primarily of temperate latitudes. It consists of four species worldwide, three of which have been reported from North America, but only one from British Columbia. Recently, however, a second, apparently undescribed species has been detected in the province (Brodo and Tønsberg 1994), and is included here. No chemical substances have been reported.

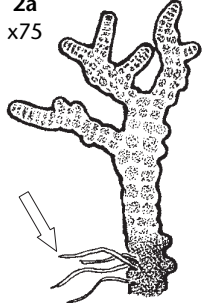
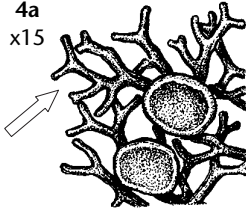
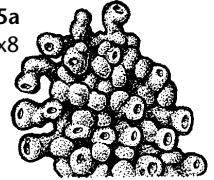
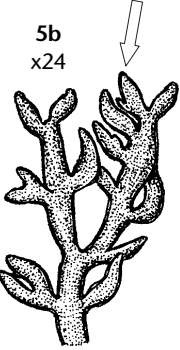
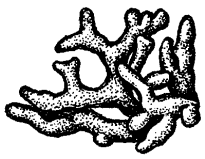
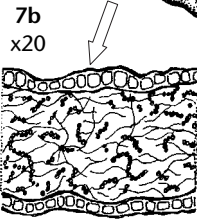
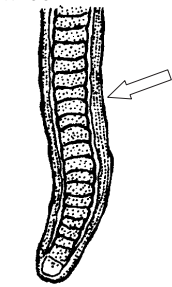
Two keys are provided: the first is to *Spilonema*, and the second is to *S. revertens* and other tiny, blackish, fruticose, rock-dwelling lichens that lack a medulla. For points of separation with tiny, blackish bark-dwelling lichens similar to *S. sp. 1*, see the key under *Lichinodium*. For a key to tiny, blackish, pendent, fruticose, rock-dwelling lichens with gossamer-like branches, see *Cystocoleus*.

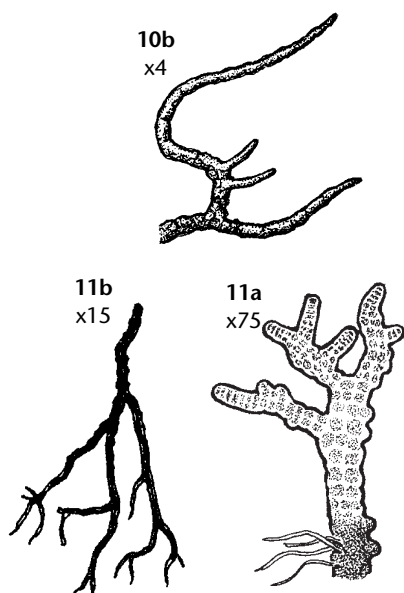


KEY TO SPILONEMA

- 1a Over rock; widespread at lower elevations *Spilonema revertens*
1b Over conifer bark; humid coastal regions at lower elevations *Spilonema* sp. 1

KEY TO *SPILONEMA REVERTENS* AND SIMILAR TINY, BLACKISH, FRUTICOSE,
ROCK-DWELLING LICHENS LACKING A MEDULLA

- 2a** x75 
- 1a** Hairlike rhizoids numerous and conspicuous in basal portions of thallus, distinctly visible under LM(←), often bluish black (Note: specimens having a bluish black lower surface key here) 2
- 2a** Thallus erect and shrublike throughout (hypermaritime specimens may be flattened at the thallus margin); photobiont cells to 15–20 µm along long axis *Spilonema revertens*
- 2b** Thallus at least in part appressed and flattened; photobiont cells to 10–12 µm along long axis. *Placynthium* (see Part 1)
- 1b** Hairlike rhizoids absent or at most inconspicuous, never bluish 3
- 3a** Photobiont 1-celled or arranged in clusters of two or three, cells globose to distinctly oval (check in long-section under LM at 1000x) 4
- 4a** Among moss over rock; branching rather loose(←); thallus distinctly shiny; photobiont *Nostoc*: cells to 5–7 µm along long axis, not at all enveloped in a distinct gelatinous sheath *Polychidium muscicola*
- 4b** Attached directly to rock; branching compact; thallus more or less dull; photobiont Chroococcales: cells to 8–12 (–15) µm along long axis, often enveloped by a distinct gelatinous sheath 5
- 5a** Branches to more than 200 µm wide, terminating in coarse, blunt tips, these in part bearing sunken, pore-like apothecia(←) *Synalissa symphorea*
- 5b** Branches to less than 150 µm wide, terminating in tapering, often pointed tips(←); apothecia unknown in local material *Lichinella stipatula*
- 3b** Photobiont at least in part arranged in obvious strands or chains (check near tips of young, well-developed branches). 6
- 6a** Photobiont *Nostoc*: cells mostly 5–7 µm along long axis, “end cells” globose or at most oval (check in cross-section near tips of well-developed branches). 7
- 7a** Branches dull; cellular cortex absent; directly attached to rock *Lempholemma fennicum*
- 7b** Branches shiny; cellular cortex well developed, readily discernible in cross-section(←); usually indirectly attached to rock (i.e., over thin soil or plant material). *Leptogium*
- 6b** Photobiont *Scytonema* or *Stigonema*: cells to more than 8 µm along long axis, “end cells” rectangular or lens-shaped (check for both characters in long-section at tips of well-developed branches). 8
- 8a** Photobiont *Scytonema*: remaining strandlike throughout; branching “false” (i.e., arising through terminal growth of photobiont strands). 9
- 9a** Branches shiny, often difficult to distinguish from free-living/unlichenized algae; photobiont strands arranged throughout in a single row(←) [*Thermutis velutina*]
- 9b** Branches dull, obviously consisting of photobiont strands embedded in a fungal matrix (check under LM); photobiont strands at least partly arranged in two parallel rows (check near tips of well-developed branches). 10
- 4a** x15 
- 5a** x8 
- 5b** x24 
- 7a** x12 
- 7b** x20 
- 9a** x400 



- 10a Collected over acid rock, generally colonizing *Parmelia* or other rock-dwelling lichens; main branches bearing numerous side branches; photobiont strands often in part arranged in three or four parallel rows *Lichinodium sirosiphoideum*
- 10b Collected over base-rich rock, directly attached; main branches bearing few if any side branches; photobiont strands mostly arranged in two parallel rows *Zahlbrucknerella calacarea*
- 8b Photobiont *Stigonema*: strands soon disassociating into irregular cell clusters; branching “true” (i.e., not arising through terminal growth of photobiont strands) 11
- 11a Thallus erect, strongly cushion-forming, generally to less than 5 mm long, attached below by at least some hairlike basal rhizoids (Note: specimens supporting a brownish squamulose lichen with dark bluish margins key here) *Spilonema revertens*
- 11b Thallus prostrate to occasionally in part erect, but not distinctly cushion-forming, to more than 5 mm long, lacking rhizoids *Ephebe*

***Spilonema revertens* Nyl.**

Rock hairball

Habitat/Range: Frequent over acid rock subject to periodic seepage in exposed coastal and intermontane localities at lower to middle elevations, in coastal regions present especially at seaside; possibly incompletely circumpolar, N to BC, S to WA, (ID), (MT), CA, CO, AZ, (NM); AB.

Variability: High.

Notes: Material collected from hypermaritime regions grows appressed and flattened at the thallus margins; this material possibly represents a separate taxon. In semi-arid regions, *S. revertens* often supports *Psorula rufonigra* (Tuck.) Gotth. Schneider: a small greyish brown squamulose lichen with dark bluish grey margins.

***Spilonema* sp. 1**

Map 104

Arboreal hairball (black hairball)

Habitat/Range: Rare over conifer bark in open humid coastal forests at lower elevations, possibly associated with the spray zones of waterfalls, local distribution poorly known; possibly western N Am, N to sAK, S to BC.

Variability: Unknown.

Notes: The material forms densely branched, shrublike colonies. The branches measure 50–100 µm wide by 1–2 µm long, are brownish black (except often paler in basal portions), lack a cortex, and bear scattered hairlike rhizoids. It is close to the Australasian *S. dendroides* Henssen, though in that species the branches are shorter.

Minute “fruticose” microfungi, consisting of **basal fungal threads/hyphae** and **stalked apothecia**. Either parasitic (i.e., living off lichens or free-living algae) or saprobic (i.e., living off dead bark, wood, and other organic matter). **Photobiont absent**. Basal hyphae immersed in substrate, not readily discernible.

Apothecial stalks nonlichenized, black, hairlike, to **0.3–1.5 (–2) mm long** (including apothecial heads) and 60–80 µm wide (excluding heads), smooth, brittle, unbranched to weakly branched; branching irregular. **Apothecial heads/capitula** borne at stalk tips, consisting of a narrow, cup-shaped excipulum with a somewhat **incurved excipular rim**, and a **compact black spore surface** (i.e., lacking a powdery mazaedium). **Spores (2-)4- to 8-celled**, spindle-shaped/fusiform, 12–55 µm long (ours), brown under LM, minutely ornamented, arising within persistent vial-

shaped asci, eight spores per ascus.

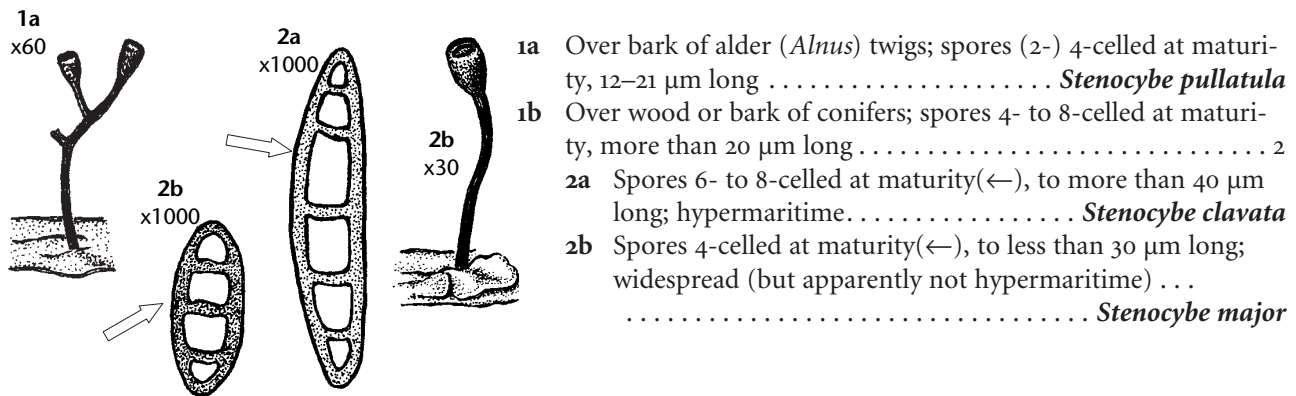
Over **bark**.

References: Tibell (1975, 1991); S. Selva, University of Maine, pers. comm., 1996; E.B. Peterson, Oregon State University, pers. comm. 1998.

Common Name: Refers to the stalked, pinlike fruiting bodies.

Notes: *Stenocybe* is a widespread genus of temperate latitudes, consisting of seven species worldwide. Five of these have been reported for North America, and three from British Columbia. Though *Stenocybe* is technically not a lichen genus, it is nevertheless traditionally treated by lichenologists; it is included here owing to its stalked apothecia. No chemical substances have been reported. For points of distinction with similar species in other genera, see the key under *Chaenothecopsis*.

KEY TO *STENOCYBE*



Stenocybe clavata Tibell
Pacific stickpin

Map 105

Habitat/Range: Infrequent (overlooked?) over bark of conifers in humid, sheltered coastal forests at lower elevations; western N Am, N to sAK, S to WA, OR.
Variability: Low.

Stenocybe major Körber
Greater stickpin

Habitat/Range: Frequent over bark of conifers, especially fir (*Abies*) in open to shady maritime and intermontane localities at all forested elevations; incompletely circumpolar, N to wNT, S to WA, OR, CA, UT.
Variability: Low.
Notes: In addition to colonizing fir, *S. major* also occurs occasionally over the (young) bark of Douglas-fir (*Pseudotsuga*), redcedar (*Thuja*), and spruce (*Picea*). In some material, the stalks are very long and flexuous, measuring to more than 1.5 mm tall. Such specimens may represent a separate taxon; further work is needed.

Stenocybe pullatula (Ach.) B. Stein
(Syn. *Stenocybe byssacea* (Fr.) Körber)
Alder stickpin

Map 106

Habitat/Range: Rare (probably overlooked) over bark of mountain alder (*Alnus incana*) twigs in humid, sheltered coastal and intermontane forests and thickets at lower to middle elevations, local distribution poorly known; incompletely circumpolar, N to YU, S to WA, MT, OR, CA, AZ.
Variability: High.

Small to **medium-sized** or large stratified fruticose (**shrub**) lichens, consisting of a basal crust and/or upright stalks/pseudopodetia. **Basal crust** short-lived or persistent, consisting of tiny whitish granules or scales/squamules. **Pseudopodetia erect** or decumbent, **whitish** to greyish or pale rose, round in cross-section, to (5–) 20–40 (–90) mm long and 1–4 mm wide, dull, smooth to more often roughened or covered in a fine woolly tomentum, generally ecorticate, brittle, **solid**, unbranched to more often **richly branched**; branches generally bearing a copious “foliage” of phyllocladia, these whitish to greyish or pale bluish, corticate, wartlike, coral-like/coralloid or flattened and scale-like/squamulose, distributed on all sides, or else massed on the “upper” side only; pseudopodetia also generally supporting sparse to numerous wartlike **cephalodia**, these tiny, blackish, brownish, or greyish, granular to hemispherical, occasionally concealed in a woolly tomentum. Soredia present or absent. Isidia and pseudocyphellae absent. Medulla white. Attached to substrate by basal holdfasts, but often becoming unattached. **Photobiont** green, chlorococcoid (*Trebouxia*), except blue-green/cyanobacterial (*Nostoc* or *Stigonema*) in cephalodia.

Ascarp an apothecium, disc brownish or blackish, plane to strongly convex, borne along branches or at pseudopodetial tips. Spores transversely septate and 4- to multi-celled, narrow-ellipsoid to somewhat spindle-shaped/fusiform, colourless, eight per ascus. Pycnidia inconspicuous.

Over acid soil, rock, or thin soil over rock.

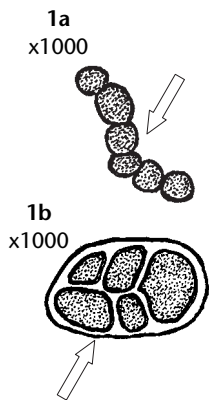
References: Lamb (1977, 1978).

Common Name: Descriptive of most of the species when viewed at a distance.

Notes: *Stereocaulon* is a nearly cosmopolitan genus consisting of approximately 125 species worldwide. Thirty-one species are known to occur in North America, and 16 are accepted for British Columbia. This is a taxonomically difficult genus, in which some material will prove difficult to identify with certainty. Identification is made easier, however, by a detailed knowledge of: (1) substrate (i.e., soil, rock, crevice); (2) degree of attachment (i.e., tightly attached versus loosely attached); and (3) orientation of the pseudopodetia (i.e., erect versus decumbent). Spot tests are of limited value in this genus, but can be used to distinguish specimens in which stictic acid is present (PD+ orange) from those in which it is lacking (PD+ pale yellow or PD-). The reagent should be fresh, and should be applied to the tips of the phyllocladia; allow up to 60 seconds for development. The PD+ orange reaction is occasionally difficult to discern, but the phyllocladia should at least not appear PD+ uniformly pale yellow after one minute. Thin-layer chromatography is required to confirm the identity of species in which porphyrilic acid or bourgeanic acid is diagnostic.

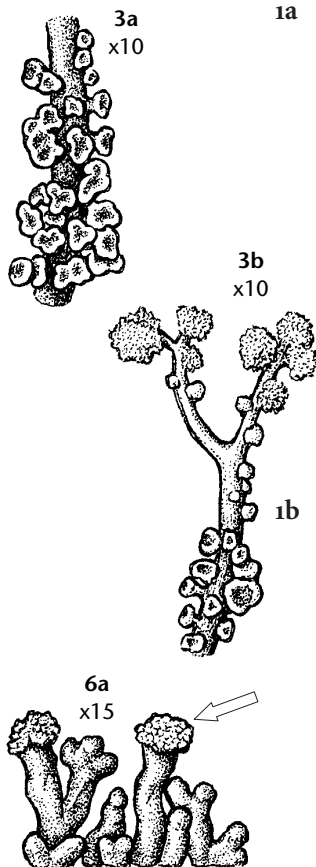
Two keys are provided: the first is to cyanobacteria, and the second is to *Stereocaulon* and similar lichens.

KEY TO CEPHALODIAL PHOTOBIONTS IN *STEREOCAULON* (OURS)

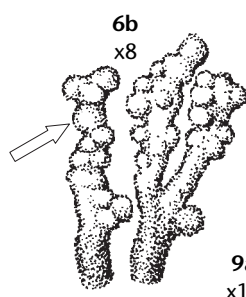


- 1a** Photobiont forming unbranched filaments, these one cell in width and resembling strings of beads (←) (check under LM); gelatinous sheath inconspicuous or apparently absent, colourless; cells 3–5 (–6) μm along long axis, more or less uniform in shape, spherical to short-ellipsoid, to 3–5 (–6) μm along long axis, the walls of adjoining cells not flattened; cell contents bluish green to greyish green *Nostoc*
- 1b** Photobiont forming either: (1) branched or unbranched filaments, these in part two or more cells in width, not resembling strings of beads, or (2) irregular, nonfilamentous packets of cells(←); gelatinous sheath conspicuous, often tinted yellowish to orangish brown; cells mostly 6–12 μm along long axis, variable in shape, often in part angular, the walls of adjoining cells often flattened; cell contents olivaceous green to bluish green *Stigonema*

KEY TO *STEREOCAULON* AND SIMILAR LICHENS



- 1a** At least some phyllocladia distinctly peltate (i.e., attached to pseudopodetia by the central portion of the lower surface) and two-toned (i.e., with pale, often somewhat raised margins, and darker centres) 2
- 2a** Thallus forming compact cushions on sandy or gravelly ground, PD+ pale yellow; porphyritic acid present (thin-layer chromatography required); soredia absent; alpine *Stereocaulon arenarium*
- 2b** Pseudopodetia tightly attached to rock, PD+ orange, PD+ pale yellow or PD-; stictic acid or lobaric acid present; often bearing soredia near tips; distribution various 3
- 3a** Phyllocladia PD+ orange; stictic acid present; pseudopodetia usually erect, with phyllocladia located on all sides; soredia present or absent; widespread *Stereocaulon vesuvianum*
- 3b** Phyllocladia PD+ pale yellow or PD-; lobaric acid present; pseudopodetia decumbent, with phyllocladia concentrated on upper side; soredia present; rare, northern *Stereocaulon symphycheilum*
- 1b** Phyllocladia not both peltate and distinctly two-toned (Note: specimens in which pseudopodetia are covered in a thick woolly tomentum key here) 4
- 4a** Phyllocladia sorediate or noncorticate or at least becoming distinctly soft-corticate (i.e., cortex thin and readily scraped away: check carefully, especially near branch tips) 5
- 5a** Pseudopodetia less than 10 mm long, arising from a persistent crustose basal thallus (not always readily seen) 6
- 6a** Pseudopodetia bearing corticate phyllocladia or not, terminating in conspicuous globose soralia(←); cephalodia present, brownish, containing *Stigonema*; lobaric acid present; over rock *Stereocaulon pileatum*



6b Pseudopodetia lacking a cortex, bearing minute lumps or granules(←), these appearing “soft”; cephalodia absent; lobaric acid absent; over soil or humus, or in rock crevices *Leprocaulon*

5b Pseudopodetia to more than 10 mm long, generally not arising from a persistent crustose basal thallus 7

7a Phyllocladia generally soon replaced by spreading/diffuse soredia, these powdery. *Stereocaulon* cfr. *capitellatum*

7b Phyllocladia at least in part remaining distinctly corticate; soredia, if present, rather granular 8

8a Nonsorediate phyllocladia in part “lumpy”/nodulose and short-stalked; PD+ orange (Note: specimens key here in which at least a few obscurely two-toned phyllocladia are present) *Stereocaulon vesuvianum*

8b Nonsorediate phyllocladia granular, wartlike or scale-like/squamulose, but not short-stalked; PD+ orange, PD+ pale yellow, or PD-. 9

9a Phyllocladia granular to wartlike, the granules soft-corticate, often in part resembling coarsely granular soredia, PD+ pale yellow or PD-; porphyritic acid present; cephalodia containing *Nostoc* *Stereocaulon botryosum*

9b Phyllocladia granular to scale-like/squamulose, distinctly sorediate, soredia diffuse or clustered or located on the undersides of flattened phyllocladia or branch tips; PD+ orange; stictic acid present; cephalodia containing *Stigonema* (ours) 10

10a Phyllocladia chalky white, in part granular, in part flattened and either closely appressed (in places merging to form a corticate mantle on the upper side of the pseudopodetia [←]) or spatula-like (with upturned edges); pseudopodetia often to more than 3 cm long, smooth; soredia developing mainly on undersides of branch tips and spatula-like phyllocladia, rarely also on all sides of branch tips *Stereocaulon spathuliferum*

10b Phyllocladia ashy grey, mainly granular or, if flattened, then not merging to form a corticate mantle on the upper side of the pseudopodetia; pseudopodetia mostly to less than 2.5 cm long, often minutely roughened; soredia usually spreading over all sides of branch tips, rarely confined to underside of branch tips or flattened phyllocladia *Stereocaulon* cfr. *spathuliferum*

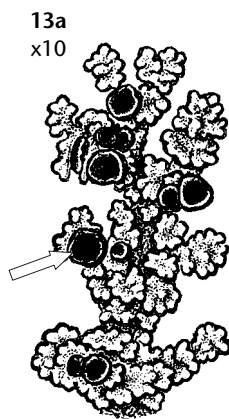
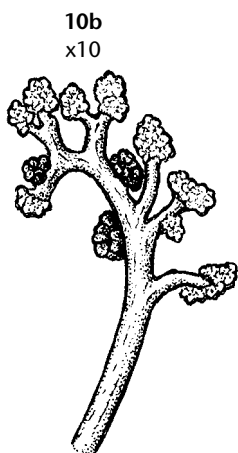
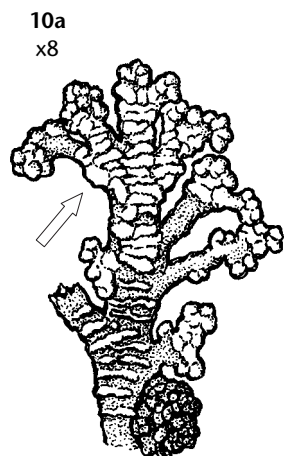
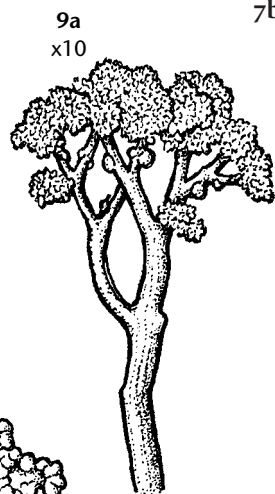
4b Phyllocladia nonsorediate, remaining firmly corticate throughout 11

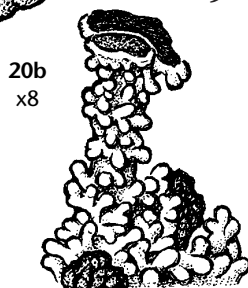
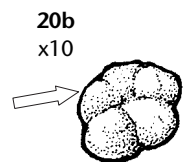
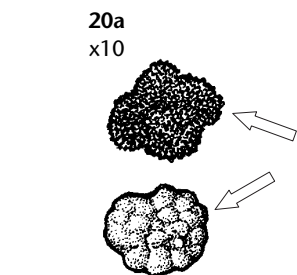
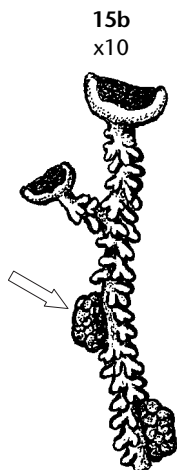
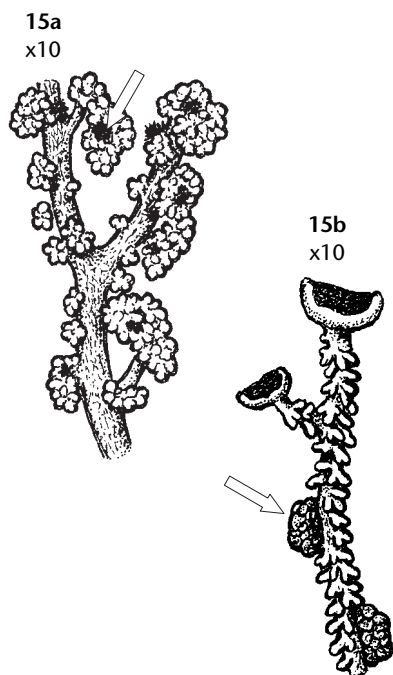
11a Over rock; pseudopodetia tightly attached and not easily removed intact 12

12a Basal crust persistent and conspicuous; pseudopodetia simple to sparsely branched *Pilophorus*

12b Basal crust not persistent, or at least never conspicuous; pseudopodetia sparsely to richly branched 13

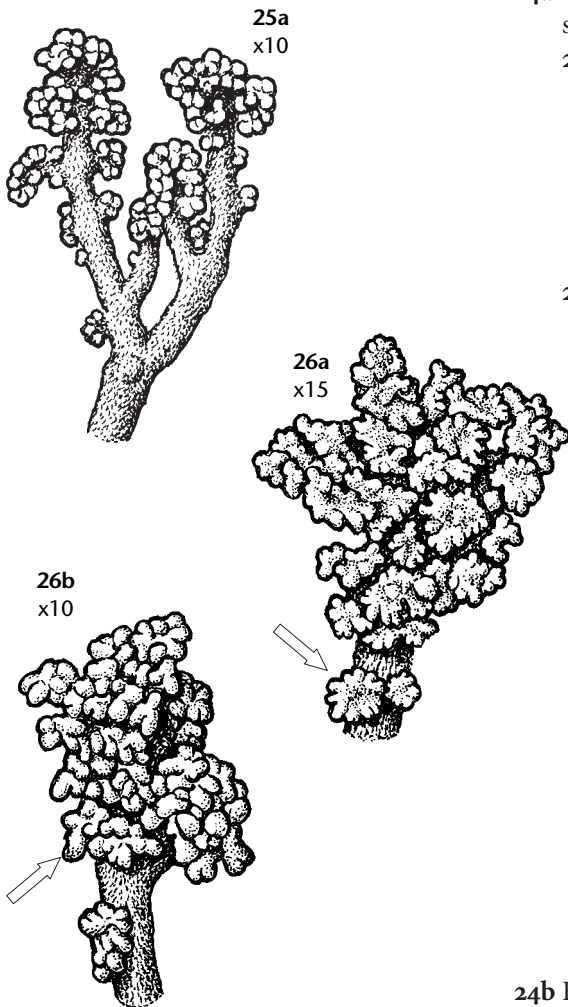
13a Pseudopodetia bearing a thick woolly tomentum, especially on underside; apothecia, if present, mostly lateral (i.e., located along sides [not at tips!] of main branches and side branches)(←) *Stereocaulon tomentosum* s. lat. (rock-dwelling form)





- 13b Pseudopodetia smooth to at most thinly tomentose; apothecia, if present, mostly terminal (i.e., located at tips of main branches and side branches) 14
- 14a Phyllocladia partly to entirely cylindrical or branched-cylindrical/coralloid 15
- 15a Cephalodia dark reddish brown to black(←), often “smudge-like,” the surface often roughened by minute projecting filaments; phyllocladia mostly granular and in compact clusters, sometimes becoming cylindrical or coralloid; inland *Stereocaulon paschale* (rare rock-dwelling form)
- 15b Cephalodia bluish grey to brown(←) (not blackish), never “smudge-like,” the surface minutely warty, but not at all roughened by minute projecting filaments; phyllocladia not forming compact granular clusters; mostly coastal *Stereocaulon intermedium* s. lat.
- 14b Phyllocladia granular to scale-like/squamulose, but not cylindrical or coralloid 16
- 16a Phyllocladia PD+ orange; stictic acid present 17
- 17a Phyllocladia in part flattened and closely appressed, often forming a corticate mantle on upper side of pseudopodetia (see 10a) *Stereocaulon spathuliferum* (rare, indistinctly soresiate)
- 17b Phyllocladia, if flattened, peltate and at least weakly two-toned (see 1a), not at all forming a corticate mantle on upper side of pseudopodetia. *Stereocaulon vesuvianum* (see 3a)
- 16b Phyllocladia PD+ pale yellow or PD-; stictic acid absent 18
- 18a Pseudopodetia prostrate-decumbent; phyllocladia in part wart-like, but mostly flattened and scale-like/squamulose and often somewhat elongate and incised; only bourgeanic acid present in addition to atranorin (thin-layer chromatography required) (Note: *S. rivulorum* may key here, but lacks bourgeanic acid, and occurs on sand or gravel, or in rock crevices, not directly on rock). *Stereocaulon depressum*
- 18b Pseudopodetia more or less erect; phyllocladia granular to wartlike, scarcely flattened, not elongate; only porphyritic acid present in addition to atranorin (thin-layer chromatography required) *Stereocaulon botryosum* (see 9a)
- 11b Over sandy or gravelly ground, among mosses, on thin duff over rock, or in rock crevices; pseudopodetia never tightly attached to rock, and usually easily removed from or with substrate 19
- 19a Basal phyllocladia and cephalodia present, forming a compact, soil-binding mat; pseudopodetia present or absent 20
- 20a Cephalodia containing *Stigonema*, dark reddish brown to black, with a rough surface(←), lacking tomentum; lower to middle elevations; mostly boreal. *Stereocaulon condensatum*
- 20b Cephalodia containing *Nostoc*, medium reddish brown to bluish grey, except often covered in a thin appressed tomentum and then appearing paler, with a smooth (although sometimes fissured) surface(←); subalpine-alpine; widespread in maritime and intermontane regions *Stereocaulon glareosum*

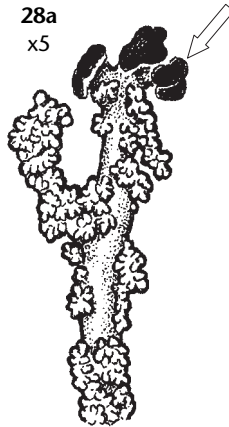
- 19b Basal phyllocladia and cephalodia absent, or at least not persistent; pseudopodetia present 21
- 21a Cephalodia dark reddish brown to black (see 15a), often “smudge-like,” the surface often roughened by minute projecting filaments, containing *Stigonema* ***Stereocaulon paschale***
- 21b Cephalodia greenish, bluish grey, or medium brown, never “smudge-like,” the surface often minutely warty, but not roughened by minute projecting filaments, containing *Nostoc* or (in some specimens of *S. grande*) *Stigonema* 22
- 22a Apothecia present, mostly lateral (i.e., located along sides [not at tips!] of main branches and side branches [see 13a]), to 1 mm in diameter ***Stereocaulon tomentosum* s. lat.**
- 22b Apothecia absent or, if present, then mostly terminal (i.e., located at tips of main branches and side branches), to more than 1 mm in diameter. 23
- 23a Phyllocladia PD+ orange; stictic acid present ***Stereocaulon tomentosum* s. lat.**
- 23b Phyllocladia PD+ pale yellow or PD-; stictic acid absent 24
- 24a Pseudopodetia decumbent, with distinct upper and lower sides 25
- 25a Phyllocladia granular to weakly flattened, often somewhat elongated, usually not concealing the pseudopodetial branches as viewed from above; pseudopodetia very brittle (finer branches tending to break off in herbarium packets), often branched from near base, lacking a well-defined main stem; on unstable soil in wet, seepy sites, especially near late snow beds; alpine. ***Stereocaulon rivulorum***
- 25b Phyllocladia granular to (mostly) distinctly flattened, usually crowded and largely concealing pseudopodetial branches as viewed from above; pseudopodetia not especially brittle (remaining more or less intact in herbarium packets), usually with a well-defined main stem; generally in drier sites (Note: sterile specimens of the following species cannot always be reliably distinguished) 26
- 26a Phyllocladia at least in part plane and scale-like/squamulose(←), bearing marginal rounded to medium fingerlike outgrowths, these numerous, rather delicate, often paler than the central portions; widespread, but most common at lower elevations ***Stereocaulon tomentosum* s. lat. (Chemotype 2) (sterile forms)**
- 26b Phyllocladia not both plane and scale-like/squamulose, usually wartlike and weakly convex to strongly convex(←), bearing marginal rounded to weakly elongate outgrowths, these sparse, rather coarse, not distinctly fingerlike, coloured alike with central portions; mostly restricted to subalpine and alpine elevations ***Stereocaulon alpinum***
- 24b Pseudopodetia ascending to erect, without distinct upper and lower sides 27



27a Pseudopodetia mostly to less than 20 (–25 mm) long; tomentum thin, feltlike, whitish; phyllocladia granular to stoutly cylindric or short fingerlike/coralloid, not flattened; cephalodia conspicuous, more or less globose, not concealed in pseudopodetial tomentum . . .

..... *Stereocaulon glareosum*

27b Pseudopodetia mostly to more than 20 mm long; tomentum thin to rather thick, feltlike to woolly, pinkish, greyish, or whitish; phyllocladia at least in part flattened and scale-like/squamulose; cephalodia inconspicuous, granular to wartlike and clustered, often more or less concealed in pseudopodetial tomentum 28



28a Phyllocladia wartlike and arranged in globular clusters or, if convex and scale-like/squamulose, then margins of the squamules usually with fingerlike projections mostly aligned in a single plane; cephalodia usually scarce, partly concealed in tomentum, partly exposed and then brown and more or less globose; apothecia, if present, becoming subdivided into groups of secondary discs(←) *Stereocaulon grande*

28b Phyllocladia not forming globular clusters, mostly convex and scale-like/squamulose, the squamules with wavy margins, generally not in a single plane, lacking distinct fingerlike projections; cephalodia granular, frequent, but mostly concealed in tomentum; apothecia, if present, mostly not subdivided . . .

..... *Stereocaulon alpinum* (see **26b**)

***Stereocaulon alpinum* Laurer**

Alpine foam (alpine easter lichen; piluraq)

Habitat/Range: Frequent over sandy or gravelly soil in open to exposed inland sites at alpine elevations; circumpolar, N to sAK, AK, YU, wNT, S to WA, MT, OR, WY, CO; AB.

Reactions: Phyllocladia K+ pale yellow, PD+ pale yellow (or apparently PD-).

Contents: Atranorin and lobaric acid.

Variability: High.

Notes: The cephalodia contain *Nostoc*. Diagnostic characters include: (1) the loosely attached, dorsiventral pseudopodetia that have a distinct main stem, and that often bear large terminal apothecia; (2) the granular cephalodia; (3) the PD+ pale yellow or PD- reaction; and (4) the primarily alpine distribution. Sterile specimens can be difficult to distinguish from chemotype 2 of *S. tomentosum* (see the key under that species). Specimens lacking the characteristic dorsiventral habit must be carefully distinguished from *S. grande* by the presence, in the latter species, of at least some phyllocladia having fingerlike projections along the margins.

Stereocaulon arenarium (Savicz) Lamb
Sand foam

Map 107

Habitat/Range: Rare over sand in open to exposed sites at alpine elevations, local distribution poorly known; probably circumpolar, N to sAK, AK, wNT, S to BC.

Reactions: Phyllocladia K+ pale yellow, PD+ pale yellow.

Contents: Atranorin and porphyrilic acid.

Variability: High.

Notes: The cephalodia contain *Nostoc* or *Stigonema*. The partly peltate phyllocladia, the occurrence over sandy ground, the alpine distribution, and the presence of porphyrilic acid are diagnostic.

Stereocaulon botryosum Ach.
Cauliflower foam

Map 108

Habitat/Range: Rare over rock (tightly attached!) in exposed inland localities at alpine elevations, local distribution poorly known; circumpolar, N to sAK, AK, YU, wNT, S to WA, OR; AB.

Reactions: Phyllocladia K+ pale yellow, PD+ pale yellow (or apparently PD-).

Contents: Atranorin and porphyrilic acid.

Variability: High.

Notes: The cephalodia contain *Nostoc*. Diagnostic characters include the “soft-corticate” phyllocladia (in part), the medium-sized pseudopodetia (to more than 10 mm long), the firm attachment to rock, and the PD+ pale yellow or PD- reaction. Some forms of *S. spathuliferum* can be similar, but that species contains stictic acid, and contains *Stigonema* in the cephalodia (ours). See also the notes under *S. depressum*.

Stereocaulon* cfr. *capitellatum H. Magn.
Dissolving foam

Map 109

Habitat/Range: Rare over rock (tightly attached) in open inland sites at alpine elevations, local distribution poorly known; western N Am - eastern N Am (Greenland) - western Eurasia, N to sAK?, S to BC.

Reactions: Phyllocladia K+ pale yellow, PD+ pale yellow.

Contents: Atranorin alone (ours).

Notes: The cephalodia contain *Nostoc*. This is a distinctive rock-dwelling species, in which the phyllocladia typically soon dissolve into soredia. It is known in British Columbia from a single locality.

Stereocaulon condensatum Hoffm.
Granular soil-foam

Map 110

Habitat/Range: Rare over sandy soil in open inland sites at lower to middle elevations, local distribution poorly known; circumpolar, N to AK, wNT, S to BC; AB.

Reactions: Phyllocladia K+ pale yellow, PD+ pale yellow.

Contents: Atranorin and lobaric acid.

Variability: Medium.

Notes: Diagnostic characters include the low stature (to 1.5 cm tall), the occurrence over soil, and the presence of basal cephalodia containing *Stigonema*. Some forms of *S. glareosum* are similar, but the cephalodia in that species contain *Nostoc*.

Stereocaulon depressum (Frey) Lamb
Creeping foam

Map 111

Habitat/Range: Rare over rock (tightly attached) in open inland sites at alpine elevations, local distribution poorly known; incompletely circumpolar, in N Am known only from BC.

Reactions: Phyllocladia K+ pale yellow, PD+ pale yellow.

Contents: Atranorin and bourgeanic acid.

Notes: The cephalodia contain *Nostoc*. Diagnostic for this species are: (1) the decumbent habit; (2) the tight attachment to rock; (3) the flattened, noncoralloid phyllocladia; (4) the alpine distribution; and (5) the presence of bourgeanic acid. Some forms of *S. rivulorum* are similar, but that species has loosely attached pseudopodetia, which lack bourgeanic acid. *S. botryosum*, while also sometimes similar, has more erect pseudopodetia, has more granular or wartlike phyllocladia, and contains porphyritic, not bourgeanic, acid.

Stereocaulon glareosum (Savicz) H. Magn.
Alpine soil-foam

Map 112

Habitat/Range: Rare (overlooked?) over sandy or gravelly soil in open sites at all elevations, in maritime and intermontane regions; circumpolar, N to sAK, AK, YU, wNT, S to WA, MT, OR, WY, (CA), UT, CO, (MX); AB.

Reactions: Phyllocladia K+ pale yellow, PD+ pale yellow.

Contents: Atranorin and lobaric acid (or atranorin alone).

Variability: High.

Notes: The cephalodia contain *Nostoc*. The low stature (generally to less than 20 mm tall), the occurrence over soil, and the presence of large (to 1.5 mm across), often smooth and nearly globose basal cephalodia are diagnostic. Well-developed specimens in which the basal thallus has disintegrated can be difficult to distinguish from small specimens of *S. rivulorum*. In that species, however, the cephalodia are smaller (to less than 0.5 mm across) and have a finely warty surface, and the pseudopodetia are distinctly fragile. See also the notes under *S. condensatum*.

Stereocaulon grande (H. Magn.) H. Magn.
Grand foam

Habitat/Range: Frequent over sandy soil, thin duff, or occasionally directly attached to rock, in open inland sites at middle to upper elevations, also present at lower elevations in inner coastal localities; circumpolar, N to sAK, AK, YU, wNT, S to WA, MT, OR; AB.

Reactions: Phyllocladia K+ pale yellow, PD+ pale yellow (or apparently PD-).

Contents: Atranorin and lobaric acid.

Variability: Medium.

Notes: The cephalodia contain either *Nostoc* or *Stigonema*. Diagnostic for *S. grande* are:

(1) the more or less erect, loosely attached habit; (2) the partly flattened phyllocladia that bear fingerlike projections; (3) the terminal apothecia that often become “subdivided”; and (4) the PD+ pale yellow or PD- reaction. Sterile specimens in which the pseudopodetia are not distinctly erect can be difficult to distinguish from *S. alpinum*. In that species, however, the phyllocladial margins, though “wavy,” lack distinct fingerlike projections. Further work is needed.

Stereocaulon intermedium (Savicz) H. Magn., s. lat.

(Syn. *Stereocaulon intermedium* f. *compactum* Lamb; ?*Stereocaulon sterile* (Savicz) Krog)

Pacific foam

Habitat/Range: Frequent over rock (tightly attached!) in sheltered to open coastal sites at lower to middle elevations, especially common on seaside rocks, also infrequent over low alpine ridges in coastal regions; western N Am - eastern N Am (rare) - eastern Eurasia, N to sAK, AK, S to WA, OR, CA.

Reactions: Phyllocladia K+ pale yellow, PD+ pale yellow.

Contents: Atranorin and lobaric acid.

Variability: High.

Notes: The cephalodia contain *Stigonema*. Diagnostic for this species are: (1) the large, often bluish cephalodia; (2) the predominantly cylindrical to branched-coralloid phyllocladia; (3) the tight attachment to rock; and (4) the coastal distribution. As defined here, *S. intermedium* includes *S. sterile*, thus reflecting the frequent occurrence of intermediate material (at least in British Columbia). Other authors have separated these taxa as follows:

- 1a Pseudopodetia erect, to 75 mm long, bearing a thin woolly tomentum; phyllocladia not flattened, at first granular, later becoming cylindrical to coralloid; cephalodia bluish grey to brown; apothecia frequent, to 5 mm broad (Note: specimens in which the pseudopodetia form dense cushions to less than 15 mm in height are referable to f. ***compactum*** Lamb). ***Stereocaulon intermedium***
- 1b Pseudopodetia at first decumbent, later becoming more erect, to 25 mm long, lacking tomentum; phyllocladia at first flattened and bearing fingerlike outgrowths, later becoming branched-coralloid; cephalodia brown; apothecia rare, to 3 mm broad ***Stereocaulon sterile***

***Stereocaulon paschale* (L.) Hoffm.**

Cottontail foam (easter lichen; cottontail coral; common coral)

Habitat/Range: Common over mossy soil or rock in sheltered to open or exposed inland localities at all elevations, also rare in inner coastal regions at lower forested elevations; circumpolar, N to sAK, AK, YU, wNT, S to WA, MT, OR; AB.

Reactions: Phyllocladia K+ pale yellow, PD+ pale yellow.

Contents: Atranorin and lobaric acid.

Variability: Medium.

Notes: This is a distinctive species in which the phyllocladia form globose clusters, and in which the cephalodia are blackish and rough, and contain *Stigonema*. In some specimens, the cephalodia are poorly developed; check carefully for blackish “smudges” at the bases of the phyllocladial clusters.

***Stereocaulon pileatum* Ach.**

Map 113

Pixie foam

Habitat/Range: Rare over rock (tightly attached!) in open maritime sites at lower elevations, local distribution poorly known; incompletely circumpolar, in western N Am known only from BC; AB.

Reactions: Soredia and phyllocladia K+ yellow, PD+ pale yellow.

Contents: Atranorin and lobaric acid.

Variability: Low.

Notes: The cephalodia contain *Stigonema*. This is a distinctive species. Diagnostic characters include: (1) the persistent, crustose, basal crust that grows tightly attached to rock; (2) the short pseudopodetia (to less than 10 mm long); and (3) the conspicuous terminal soredia. This species is common in eastern North America, though in British Columbia it is known from a single locality.

***Stereocaulon rivulorum* H. Magn.**

Snow foam

Habitat/Range: Frequent over unstable sandy or gravelly ground, also in rock crevices in inland localities, mostly at alpine and upper forested elevations, especially in sites subject to water seepage, including stream banks or late-lying snow beds; circumpolar, N to sAK, AK, YU, wNT, S to WA, MT, OR, WY, CA, UT, CO; AB.

Reactions: [All chemotypes] Phyllocladia K+ pale yellow, PD+ pale yellow.

Contents: Chemotype 1: Atranorin and lobaric acid. Chemotype 2: Atranorin and perlatolic and anziaic acids. Chemotype 3: Atranorin.

Variability: High.

Notes: The cephalodia contain *Nostoc*. This can be a difficult species. Diagnostic characters include: (1) the fragile, decumbent, dorsiventral pseudopodetia that lack a distinct main stem and are rather loosely attached; (2) the rather delicate, uncrowded phyllocladia that fail to entirely obscure the pseudopodetia as viewed from above; and (3) the occurrence at alpine elevations in late snow beds and other sites subject to seepage. Some forms of *S. alpinum* are similar, but in that species the pseudopodetia are less fragile, and tend to have a distinct main stem. See also the notes under *S. glareosum*.

Stereocaulon spathuliferum Vainio, s. lat.
Chalk foam

Map 114

Habitat/Range: Infrequent over rock (tightly attached!) in open localities in humid sites at lower to upper forested elevations throughout, except apparently absent in boreal regions; incompletely circumpolar, N to sAK, AK, S to WA, OR.

Reactions: Phyllocladia and soredia K+ yellow, PD+ orange.

Contents: Atranorin and stictic and norstictic acids.

Variability: High.

Notes: Diagnostic characters include: (1) the partly sorediate and partly corticate phyllocladia; (2) the PD+ orange reaction; (3) the tight attachment to rock; (4) the presence of *Stigonema* in the cephalodia (ours); and (5) the coastal distribution. Nonsorediate forms can resemble *S. vesuvianum*, but lack the peltate, two-toned phyllocladia characteristic of that species. *Stereocaulon botryosum* is also similar, but bears *Nostoc* in the cephalodia, contains porphyritic acid, and appears to have an inland distribution. The material assigned here exhibits a wide range of morphological variability, and possibly includes two taxa; see leads 10a, 10b, above. However, intermediate specimens exist; further study is needed.

Stereocaulon symphycheilum Lamb
Two-toned foam

Habitat/Range: Rare over rock (tightly attached!) in open intermontane localities; incompletely circumpolar, N to AK, S to BC.

Reactions: Phyllocladia K+ yellow, PD+ pale yellow (or apparently PD-).

Contents: Atranorin and lobaric acid.

Variability: Medium.

Notes: The cephalodia contain *Stigonema*. This is a distinctive species, in which the pseudopodetia are dorsiventral and tightly attached to rock, and in which the phyllocladia are sorediate, distinctly peltate, and two-toned, and give a PD+ pale yellow or PD- reaction. *Stereocaulon vesuvianum* is similar, but gives a PD+ orange reaction.

***Stereocaulon tomentosum* Fr., s. lat.**

(Syn. *Stereocaulon myriocarpum* Th. Fr.; *Stereocaulon sasakii* Zahlbr.; *Stereocaulon tomentosum* Fr. var. *alpestre* Flotow)

Eyed foam (woolly coral; woolly foam; downy froth; downy easter lichen)

Habitat/Range: [Chemotype 1] Common over soil, rock, or moss in sheltered to rather open inland localities at all elevations; circumpolar, N to sAK, AK, YU, wNT, S to WA, ID, MT, OR, WY, CA, CO, (NM); AB. [Chemotype 2] Frequent over rock or moss in sheltered to rather open coastal and mostly humid intermontane localities, except rare in hypermaritime regions; western N Am - eastern N Am - eastern Eurasia, N to sAK, S to WA, OR, CA.

Reactions: Chemotype 1: Phyllocladia K+ yellow, PD+ orange. Chemotype 2: Phyllocladia K+ yellow, PD+ yellow.

Contents: Chemotype 1: Atranorin and stictic acid and norstictic acid. Chemotype 2: Atranorin and lobaric acid.

Variability: High.

Notes: The cephalodia contain *Nostoc*. *Stereocaulon tomentosum* can be recognized by its predominantly lateral apothecia, as well as by its dorsiventral, thickly tomentose pseudopodetia, which are generally weakly attached. As defined here, it contains two chemotypes, each of which exhibits a similar suite of morphological forms. Some of these forms have been accorded species rank, while some have not; for the present we prefer to unite them within a single species. The following key incorporates a narrower species concept:

- 1a Phyllocladia PD+ orange; stictic acid present. 2
 - 2a Pseudopodetia erect, with a thin tomentum; cephalodia wartlike to clustered-hemispherical, often to more than 0.5 mm across, not concealed in tomentum, bluish grey to brown; phyllocladia in part coralloid. . . ***Stereocaulon myriocarpum***
 - 2b Pseudopodetia decumbent to erect, with a thick tomentum; cephalodia grainlike, mostly to less than 0.5 mm across, concealed in tomentum, but appearing bright bluish green where the tomentum has eroded; phyllocladia not coralloid, although sometimes flattened and bearing fingerlike marginal projections. 3
 - 3a Phyllocladia distinctly greyish, dull to weakly shiny, mostly 0.1–0.25 mm thick, wartlike to squamulose, and then with the margins bearing rounded to fingerlike outgrowths, which are often paler than the central portions; tomentum grey to whitish; cephalodia frequent; widespread at all forested elevations. ***Stereocaulon tomentosum* s. str.**
 - 3b Phyllocladia white, often shiny, mostly to 0.3–0.5 mm thick, in part weakly flattened and with slightly wavy margins, but lacking rounded to fingerlike outgrowths, often wartlike and fusing into nodulose clusters, these becoming short-stalked and broadly attached to pseudopodetia; tomentum pale pink; cephalodia scarce; alpine . . .
. (= ***Stereocaulon* cfr. *tomentosum* var. *alpestre***)
- 1b Phyllocladia PD+ pale yellow; lobaric acid present (*S. sasakii* s. lat.) 4
 - 4a Pseudopodetia and phyllocladia as in 2a, above . . .
. ***Stereocaulon* cfr. *sasakii* s.str**
 - 4b Pseudopodetia and phyllocladia as in 2b, above 5

- 5a Phyllocladia, tomentum, and cephalodia as in 3a, above . . .
 *Stereocaulon sasakii* var. *tomentosoides* Lamb
- 5b Phyllocladia, tomentum, and cephalodia as in 3b, above (Note: sterile forms of the following taxa cannot always reliably be distinguished) 6
- 6a Phyllocladia at least in part plane and scale-like/squamulose, bearing marginal rounded to medium fingerlike outgrowths, these numerous, rather delicate, often paler than the central portions; widespread, but most common at lower elevations . . .
 *Stereocaulon sasakii* (unnamed form)
- 6b Phyllocladia not both plane and scale-like/squamulose, usually wartlike and weakly convex to strongly convex, bearing marginal rounded to weakly elongate outgrowths, these sparse, rather coarse, coloured alike with central portions; mostly restricted to subalpine and alpine elevations *Stereocaulon alpinum*

***Stereocaulon vesuvianum* Pers.**

(Syn. *Stereocaulon denudatum* Flörke; *Stereocaulon vesuvianum* var. *nodulosum* (Wallr.) Lamb)

Variegated foam

Habitat/Range: Frequent over rock (tightly attached!) in open coastal localities at lower elevations, also rare in similar habitats in humid intermontane regions; circumpolar, N to sAK, AK, wNT, S to WA, MT, (OR), CA.

Reactions: Phyllocladia K+ yellow, PD+ orange.

Contents: Atranorin and stictic and norstictic acids.

Variability: High.

Notes: The cephalodia contain *Stigonema*. Diagnostic characters include the tight attachment to rock, and the peltate, two-toned phyllocladia that give a PD+ orange reaction. This species is represented in British Columbia by var. *nodulosum*, in which the pseudopodetia lack a distinct woolly tomentum. Some specimens are difficult to distinguish from *S. spathuliferum*, but careful searching usually yields at least some weakly peltate or two-toned phyllocladia, or both. See also *S. symphycheilum*.

[The following description applies only to *Sticta oroborealis*; other local species of this primarily foliose genus are handled in Part 1] Small stratified lichen, consisting of two forms/phototypes: a fruticose (**shrub**) form, and a foliose (leaf) form. Fruticose form: consisting of dense to loose tufts of **erect branches**, these **whitish** to pale tan, round in cross-section to irregular, often stout below, to **7–12 (–15) mm long** and 0.7–1. (–1.5) mm wide, dull, in part covered in a fine nap of **erect tomentum**, corticate, brittle, solid, **richly branched**, branches divided into primary branches and secondary branches; branching irregular. **Isidia-like outgrowths developing at branch tips**, these minute, numerous, **dark greyish** or greyish brown, brittle. Soredia and pseudocyphellae absent. **Medulla white**. Attached to substrate by a single holdfast. Photobiont a cyanobacterium: *Nostoc*,

cells to 5–7 (–8) μm along long axis.

Foliose form: consisting of broad lobes to 6–14 mm long and 4–10 mm wide, these pale green, dull, and broadly “wrinkled” above, and pale creamy, erect-tomentose, cratered/cyphellate, and tufted-rhizinate below. Medulla white.

Ascocarps unknown. Pycnidia over upper surface.

Mostly over **conifer bark**.

References: Tønsberg and Goward [2000].

Common Name: Refers to the shrubby habit of the fruticose form, and the “cratered” lobes of the foliose form.

Notes: With about 200 species worldwide, *Sticta* is predominantly a tropical and temperate genus of the southern hemisphere. Only nine species are present in North America; seven of these occur in British Columbia (see Goward et al. 1994).

Sticta oroborealis Goward & Tønsberg, ined.

Map 115

(Syn. *Dendroscocaulon intricatulum* auct., non (Nyl.) Henssen)

Northern moonshrub; green moon

x6



Habitat/Range: Infrequent over tree bark in humid intermontane (ICH) old-growth forests at lower elevations, also rare in maritime regions; western N Am, N to sAK, S to WA, OR.

Reactions: Fruticose form: All spot tests negative. Foliose form: Cortex K+ yellow.

Contents: Fruticose form: No lichen substances present.

Variability: Medium.

Notes: The foliose form of *S. oroborealis* is known only from the lower Kispiox Valley of west-central British Columbia. For points of distinction with similar small, dark, bark-dwelling fruticose lichens in other genera, see the key under *Lichinodium*.

Small nonstratified fruticose (**shrub**) lichen, consisting of **dense cushions** of decumbent to erect branches, these **blackish** to dark reddish brown, gelatinous when wet, round to oval in cross-section, stout, **to 2–3 (–5) mm long** and 0.2–0.4 mm wide, dull, **noncorticate**, tough, solid, richly branched; branching irregular. Soredia, isidia, pseudocyphellae, and medulla absent. Attached to substrate by unspecialized basal holdfasts. Photobiont a cyanobacterium: Chroococcales (*Gloeocapsa*), individual cells to 10–15 µm along long axis (cell “packets” to 50–70 µm).

Ascocarp an apothecium, borne at **branch tips**, somewhat immersed in thallus, opening by an **enlarged pore**, disc

dark reddish brown, **0.1–0.2 mm wide**. Spores 1-celled, more or less ellipsoid, colourless, eight per ascus or many per ascus.

Over **vertical base-rich rock**.

Reference: Purvis et al. (1992: Gilbert and Coppins).

Common Name: Refers to the habitat and the resemblance (under the microscope) to the head of Medusa, with its serpentine “locks.”

Notes: *Synalissa* is primarily a warm temperate genus apparently comprising five species worldwide. Only one of these has been reported from North America. For points of separation with similar lichens in other genera, see the key under *Spilonema*.

Synalissa symphorea (Ach.) Nyl.
Eyed rockgorgon

Map 116

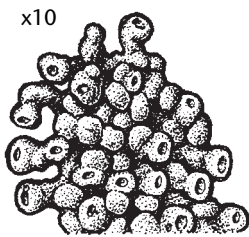
Habitat/Range: Rare over vertical base-rich rock subject to occasional seepage, at present known only from sheltered hypermaritime localities at lower elevations; incompletely circumpolar, N to BC, S to CA; AB.

Reactions: All spot tests negative.

Contents: No lichen substances reported.

Variability: Unknown.

Notes: *Synalissa symphorea* might be confused with *Collema ceraniscum*, but in that species the photobiont is *Nostoc* (cells to 5–7[–8] µm along long axis), not Chroococcales (cells to 10–15 µm along long axis). A specimen collected from a limestone outcrop in the south Okanagan Valley also keys here, but apparently belongs to a separate, undescribed species (A. Henssen, Philipps University, Marburg, Germany, pers. comm., 1995); further work is needed.



Minute nonstratified “fruticose” (club) microlichen, consisting of a **basal crust** and stalked hyphophores. Basal crust granular, pale greenish, apparently non-corticate. Photobiont green, “micareoid” (cells to 3–6 μm along long axis), but intermixed with a few cyanobacterial strands (probably *Stigonema*).

Conidia-bearing structures present, consisting of **stalked hyphophores**, these **brown** (often paler in upper portions), round in cross-section, hairlike, to **0.7–0.8 mm long** (including conidial head) and 0.1–0.15 mm wide (stalk only), dull to somewhat shiny, lacking algae (i.e., unlichenized), rather pliant, solid, unbranched to often weakly branched, terminating upwards in a **conidial head**, this **black, club-shaped/clavate, to 0.2–0.3 mm long**. Conidia hairlike/fili-form, 10- to 17-celled, colourless,

95–125 μm x 1.5–2.5 μm , extruded from conidial head in a thick, white “mucus” (check in squash mount).

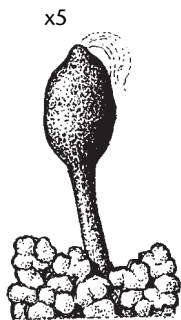
Ascocarps unknown.

Over **bark**.

References: Funk (1983); Brodo and Tønsberg (1994: as “*Micarea clavopycnidata*”); T. Tønsberg, University of Bergen, Norway, pers. comm., 1998.

Common Name: Refers to the minute size and the appearance of the stalked hyphophores.

Notes: *Szczawinskia* consists of a single species worldwide, and is currently known only from temperate latitudes. Though technically a crustose genus, it is included here owing to its stalked hyphophores. No chemical substances have been reported.



Szczawinskia tsugae A. Funk
Pacific elfclub

Map 117

Habitat/Range: Rare (probably overlooked) over twigs of alder (*Alnus*) and occasionally conifers, in sheltered but open forests at lower elevations in humid coastal regions; western N Am - western Eurasia, N to (sAK), S to WA.

Variability: Low.

Small (ours) to medium-sized fruticose (**shrub**) or weakly foliose (**leaf**) lichens, consisting of tufts of erect or semi-erect **branches**, these yellowish to **orange** or whitish grey, round in cross-section to irregular, slender to in part rather stout, branches to 3–5 (–8) mm long and 0.4–1.1 mm wide (ours), dull, often covered in a thin nap of erect tomentum, corticate, brittle, solid or in part hollow, richly branched, branches often divisible into primary branches and secondary branches, **bearing cilia**; branching irregular, terminating in minute, **globose, isidia-like outgrowths** (ours), these numerous, pale yellowish to orangish, brittle. Soredia and isidia otherwise present or absent. Pseudocyphellae present or absent (ours). **Medulla white**. Attached to substrate by pale rhizine-like holdfasts. Photobiont green, chlorococcoid: *Trebouxia*.

Ascocarp an apothecium, borne laterally at the branch tips, disc yellowish or orange, margins often bearing cilia. Spores distantly 2-celled/polarilocular or occasionally 3- to 4-celled, ellipsoid, colourless, eight per ascus. Pycnidia reddish orange to dark brown, often wartlike.

Over **vertical rocks** (ours) or trees.

References: Kärnefelt (1989); Rosentreter and McCune (1996).

Common Name: Descriptive.

Notes: *Teloschistes* is a widespread genus consisting of about 30 species worldwide. It is confined primarily to tropical and subtropical regions, but extends also into temperate and even arctic latitudes. Six species occur in North America, but only one has been reported from British Columbia.



Teloschistes contortuplicatus (Ach.) Vězda
Crannied orangebush

Map 118

Habitat/Range: Rare in sheltered crevices over vertical, base-rich rock faces in dry intermontane (IDF) localities at lower elevations; western N Am - western Eurasia - eastern Eurasia, N to wNT, S to ID, MT, NV, UT, CO, AZ, NM.

Reactions: Cortex K+ purple or in part K-.

Contents: Parietin, and traces of emodin, erythroglaucon, fallacinal, parietinic acid, teloschistin, and xanthorin.

Variability: High.

Notes: The local species is intermediate in appearance between *Teloschistes* and *Xanthoria*.

Medium-sized to large stratified fruticose (**club**) lichen, consisting of loose to dense clusters of **decumbent** to partly ascending branches, these **whitish**, more or less round in cross-section, slender, to **(15–) 30–45 (–70) mm long** and 0.8–1.2 (–1.5) mm wide, dull, often frosted/pruinose (especially at tips), corticate, brittle, **hollow**, unbranched to **sparsely branched**, terminating in pointed tips; branching mostly irregular. Soredia, isidia, and pseudocyphellae absent. Medulla white. Attached to substrate by unspecialized lateral holdfasts, or often unattached. Photobiont green, chlorococcoid: *Trebouxia*.

Ascocarps unknown. Pycnidia also apparently unknown.

Over rock and gravelly soil in **exposed sites**, mostly at **alpine** elevations.

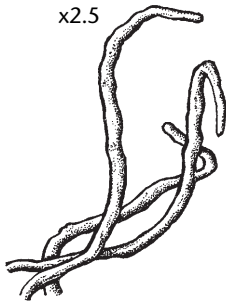
References: Thomson (1984); Kärnefelt and Thell (1996).

Common Name: Refers to habitat and appearance.

Notes: *Thamnolia* is a widespread arctic-alpine genus traditionally regarded as comprising two species: *T. vermicularis* and *T. subuliformis*. Based on recent molecular evidence, however, these taxa can be united as chemotypes of a single species (V. Miao, TerraGen, Vancouver, pers. comm., 1998). For points of separation with similar species in other genera, see *Siphula*.

***Thamnolia vermicularis* (Sw.) Ach.**

(Syn. *Thamnolia subuliformis* (Ehrh.) Culb.)
The whiteworm (rockworm; worm lichen)



Habitat/Range: [Both chemotypes] Frequent over acid rock in exposed sites at alpine elevations throughout, also rare in coastal regions at lower elevations; circumpolar, N to sAK, AK, YU, wNT, S to WA, ID, MT, OR, WY, CA, CO, NM; AB.

Reactions: Chemotype 1: Medulla K+ strong yellow; PD+ strong yellow to orange.

Chemotype 2: Cortex K+ pale yellow to medium yellow, UV+ yellow; medulla UV+ strikingly ice-blue.

Contents: Chemotype 1: Thamnic acid. Chemotype 2: Squamatic and baeomycesic acids.

Variability: High.

Notes: Chemotype 2 (*T. "subuliformis"*) predominates east of the coast ranges, whereas Chemotype 1 is more common west of the coast ranges.

Small nonstratified fruticose (**hair**) lichen, consisting of **mats** of decumbent to semi-erect **cyanobacterial filaments**, these dark brown to **blackish**, round in cross-section, gossamery, to **3–5 mm long and 15–20 (–25) µm wide** (including sheath), **glossy**, noncorticate, brittle, solid, unbranched to sparsely branched, often sinuous near tips, **interwoven with fungal threads**/hyphae, these elongate, colonizing the gelatinous sheath of the cyanobacterium (see below), **inconspicuous** under LM. Soredia, isidia, pseudocyphellae, and medulla absent. Attached to substrate by basal holdfasts. Photobiont a cyanobacterium: *Scytonema*, cells to 10–13 (–15) µm wide.

Ascocarp an apothecium, borne lateral-

ly, unknown in local material, visible from above, disc reddish brown, to 0.3–0.6 mm wide, asci 8 (–12)-spored. Spores 1-celled, colourless, ellipsoid. Pycnidia lateral.

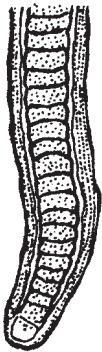
Over **rock**.

References: Henssen (1963); Purvis et al. (1992: Giavarini).

Common Name: Describes the habitat ecology and general appearance of the species.

Notes: *Thermutis* is a cool-temperate genus consisting of only one species. No chemical substances have been reported. For points of separation with similar lichens, see the key under *Cystocoleus*.

x500



[*Thermutis velutina* (Ach.) Flotow]

The rockvelvet

Habitat/Range: Expected over acidic or base-rich outcrops in sheltered, humid sites subject to periodic wetting; probably incompletely circumpolar, western N Am distribution unknown, S to CA.

Variability: Low.

Notes: *Thermutis velutina* is only weakly lichenized; in the absence of apothecia, it is often difficult to distinguish from unlichenized colonies of the cyanobacterium genus *Scytonema*. Though this species has been reported for British Columbia by Noble et al. (1987), no authentic material could be found.

Small stratified fruticose (**club**) lichen, consisting of **dense cushions** of **erect podetia**, these brownish **grey** to greenish brown, longitudinally folded and ridged, **stout**, to **1–3 (–5) mm long** and 1.5–2 mm wide, dull, smooth, corticate, pliant (except often brittle below), **hollow**, sparsely branched below, **terminating in fruiting bodies** (see below); branching irregular. Soredia, isidia, and pseudocyphellae absent. Medulla white. Attached to substrate by basal holdfasts. Photobiont green, chlorococcoid.

Ascocarp an apothecium, **cup-shaped**, borne at branch tips, apothecial surface

powdery/mazaediate, **black**. Spores 2-celled, ellipsoid, brownish, spirally ridged, 8–10 µm in diameter, arising within short-lived asci.

Over **conifer branches**.

References: Østhaugen (1974); Otto (1983); Tibell (1984).

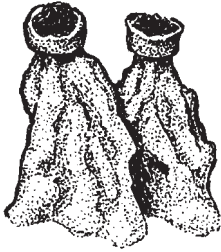
Common Name: Describes the inflated, upright, urn-like podetia.

Notes: *Tholurna* occurs at cool-temperate to boreal latitudes, and comprises only one species. No lichen substances have been reported.

Tholurna dissimilis (Norman) Norman

The tree-urns (urn lichen; the bottle collection)

x10



Habitat/Range: Frequent over upper twigs of conifers in exposed maritime and intermontane forests at subalpine elevations, also rare in the crowns of conifers in lowland maritime old-growth forests; western N Am - western Eurasia, N to YU, wNT, S to WA, OR, (CA).

Notes: The tiny, “urn-shaped” podetia that terminate in powdery black spores are easily recognized. *Tholurna dissimilis* appears to be restricted to conifer branches enriched by bird droppings.

Medium to large stratified fruticose (**shrub/hair**) lichens, consisting of tufts or tresses of semi-erect or pendent branches, these pale yellowish green to **pale greenish** (rarely reddish), except often becoming blackish at base, round in cross-section to occasionally angular, hair-like to slender, to 25–300 (–3000 or more!) mm long and 0.5–2.0 (–2.5) mm wide, dull, **papillate or not**, tuberculate or not (Note: tubercles are slightly larger than papillae and bear apical pseudocyphellae), **corticate**, pliant, solid, sparsely to densely branched, branches even/isotomic to more often uneven/anisotomic, often divisible into primary and secondary branches, often bearing short, perpendicular side-branches/**fibrils**. Soredia and/or isidia present or absent. Pseudocyphellae present or absent. Medulla white to occasionally yellow or pinkish, thin to thick, loose to compact, encircling a dense, cartilaginous **central cord**, this whitish or occasionally yellow or pinkish. Photobiont green, chlorococcoid: *Trebouxia*.

Ascocarp an apothecium, borne lateral-

ly or near branch tips, disc tan, plane to concave. Spores 1-celled, ellipsoid, colourless, eight per ascus.

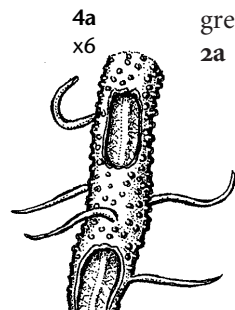
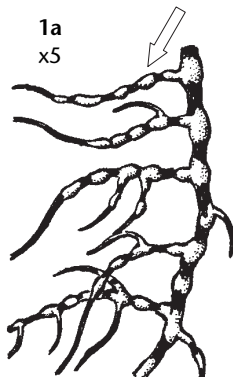
Over **bark or wood**, also rarely over rock (ours).

References: Clerc (1984, 1987, 1991, 1997); Clerc and Diederich (1991); Halonen et al. (1998); Herrera-Campos et al. (1998).

Common Name: Traditional.

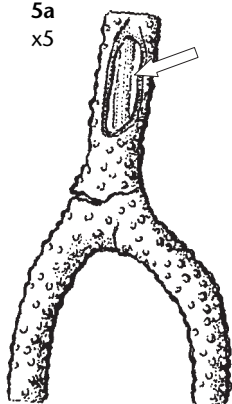
Notes: *Usnea* is a poorly understood cosmopolitan genus possibly comprising as many as 450 species worldwide (Motyka 1936, 1938), though probably much smaller. Approximately 80 species have been reported from North America, and 23 are currently accepted for British Columbia. Usnic acid is present in the cortex of all local species; accordingly, the resulting KC+ yellowish reaction will be omitted from the following accounts. The western North American and especially global distributions of several species are at present unclear.

KEY TO *USNEA*

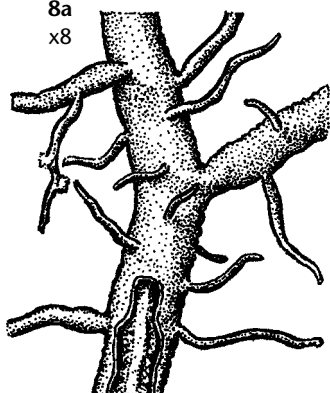


- 1a Over rock; alpine; sorediate; ultimate branches at least in part banded black and green(←) [*Usnea sphacelata*]
- 1b Over bark or wood (very rarely over rock); forested elevations; sorediate or not; ultimate branches greenish, or at least not banded black and green 2
- 2a Central cord distinctly reddish, pinkish, orangish, and/or yellowish, at least in part; coastal 3
- 3a Central cord pale yellowish or orangish; cortex often bearing tiny reddish or purplish spots. 4
- 4a Soralia generally exclusively sorediate, only rarely bearing isidia; thallus to less than 4 (–5) cm long at maturity; cortex generally reddish- to purple-spotted *Usnea wirthii*

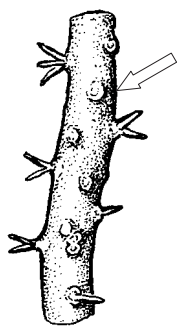
5a
x5



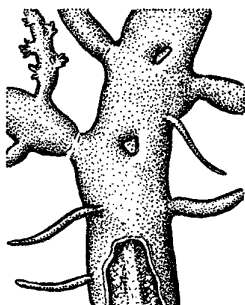
8a
x8



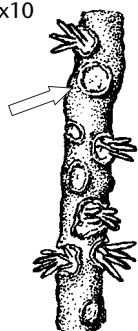
9a
x10



9a
x6



9b
x10



4b Soralia generally bearing isidia, at least in part; thallus to more than 4–5 cm long at maturity; cortex only occasionally reddish- to purple-spotted. 9

3b Central cord reddish or pinkish; cortex lacking tiny reddish or purplish spots 5

5a Medulla dense(←), K- and CK+ yellowish or yellowish orange; diffractaic acid present; secondary branches not at all constricted . . . *Usnea ceratina*

5b Medulla loose, never both K- and CK+ yellowish orange; diffractaic acid absent; secondary branches somewhat constricted at point of attachment 9

2b Central cord white, or at least not reddish, pinkish, orangish, or yellowish; distribution various 6

6a Secondary branches distinctly and more or less consistently constricted at point of attachment, and/or central cord one-third or less of total branch diameter (check main stem); mostly coastal (only the sorediate *Usnea glabrata* extends east of coast ranges) 7

7a Soralia present, these generally bearing soredia, but not at all isidiate. . . . 8

8a Main branches smooth or at most weakly papillate; thallus generally less than 4 cm long at maturity; medulla K-; salazinic and bourgeanic acids absent; widespread in humid regions, but absent from hypermaritime localities; locally frequent *Usnea glabrata*

8b Main branches densely covered in conspicuous papillae; thallus generally 4–6 cm long at maturity; medulla K+ yellow, orange, or red; salazinic and bourgeanic acids present; hypermaritime; rare *Usnea esperantiana*

7b Soralia absent or, if present, then at least in part bearing isidia 9

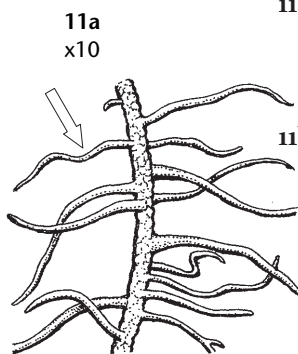
9a Isidiate soralia often restricted to upper portions of thallus, generally minute at maturity(←), except often in part “coalescing” into large soralia nearly the width of the supporting branch; upper branches often unevenly/anisotomically branched, readily divisible into main stems and (sparse or numerous) secondary lateral branches; medulla K- or more often K+ yellow becoming orangish or blood-red; salazinic, protocetraric, or psoromic acids present *Usnea cornuta* s. lat.

9b Isidiate soralia scattered over upper and/or mid-portions of thallus, at maturity often more than one-third the width of the supporting branches(←), remaining discrete; upper branches often more or less evenly/isotomically branched, generally not readily divisible into main stems and secondary branches; medulla K-, K+ pale yellow or rarely K+ yellow becoming orangish or blood-red; norstictic, stictic, squamatic, or rarely salazinic acids present *Usnea fragilesceus* var. *mollis*

6b Secondary branches not at all constricted at point of attachment; central cord more than one-third of branch diameter; distribution various 10

10a Cortex distinctly reddish or reddish-mottled (check main branches); thallus pendent at maturity; hypermaritime; rare. *Usnea rubicunda*

10b Cortex greenish or yellowish green, not at all reddish (except occasionally turning dull reddish after long storage in herbarium); thallus pendent or tufted at maturity; distribution and frequency status various 11



11a Cortex absent or distinctly eroding over main stems, often in part revealing the white underlying central cord; thallus consisting of unbranched or sparsely branched stems, bearing numerous perpendicular fibrils(←), these to 1–2 (–4) cm long; central cord I+ blue; coastal *Usnea longissima*

11b Cortex well developed over main stems, never eroding or decorticate; thallus consisting of distinctly branching stems; fibrils, if present, to less than 1 cm long; central cord I–; distribution various. 12

12a Medulla K– and CK+ yellow to yellowish orange; hypermaritime (Note: specimens containing diffractaic acid key here, regardless of spot test reactions) *Usnea ceratina* (see 5a) (nonroseate form)

12b Medulla not both K– and CK+ yellow to yellowish orange; distribution various (Note: specimens collected from intermontane localities key here, regardless of chemistry and spot test reactions). 13

13a Thallus distinctly long pendulous, at maturity often more than 15 cm long (Note: specimens in which a majority of the secondary branches hang parallel to the main branches key here). 14

14a Papillae absent or at most very inconspicuous (Take care to distinguish between tubercles [= raised pseudocyphellae] and papillae: the former are whitish, whereas the latter are coloured alike with the rest of the cortex) 15

15a Central cord distinctly and uniformly brown; transverse stress cracks numerous, conspicuous throughout; rare 16

16a East of coast ranges *Usnea trichodea*

16b Hypermaritime 18

15b Central cord white or at least not distinctly and uniformly brown; transverse stress cracks sparse or numerous, conspicuous or not; frequency status various 17

17a Main stems becoming distinctly angular(←); isidia and soralia absent; holdfasts often lacking; transverse stress cracks absent or at most inconspicuous; widespread *Usnea cavernosa*

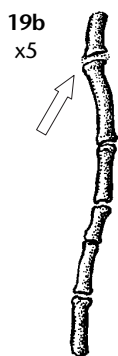
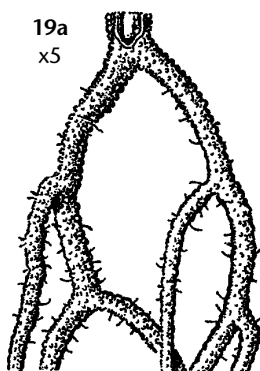
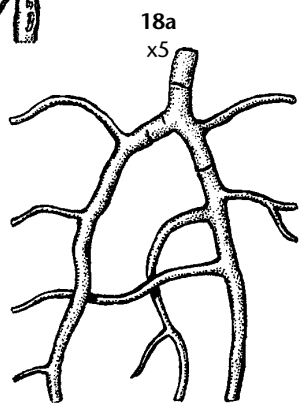
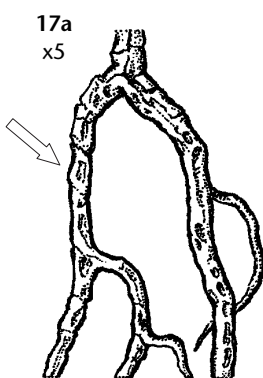
17b Main stems more or less round in cross-section (Note: terminal branches may, however, be somewhat angular); pseudocyphellae often bearing minute isidia or soralia, or both, the isidia often arising singly; holdfasts generally present; transverse stress cracks present, conspicuous or not; coastal 18

18a Cortex greenish in basal portions, or at least generally not distinctly blackening; medulla K–; protocetraric acid present; salazinic acid absent; hypermaritime *Usnea hesperina*

18b Cortex distinctly blackening in basal portions; medulla K+ yellow, orange, or red; protocetraric acid absent; salazinic acid present; widespread in coastal regions 19

19a Main branches generally bearing few transverse stress cracks; terminal branches often at least in part distinctly ridged in cross-section *Usnea scabrata* s. lat.

19b Main branches bearing copious stress cracks(←), these often extending into the middle and upper portions of the thallus; terminal branches generally not distinctly ridged in cross-section *Usnea chaetophora*



14b Papillae abundant, especially on main stems (check basal portions of thallus). 20

20a Main stems bearing numerous, conspicuous transverse stress cracks, these often extending into the middle and upper portions of the thallus; soralia absent or, if sparsely present, then generally lacking isidia; fibrils absent or sparse; coastal . . .

. *Usnea chaetophora* (papillate form)

20b Main stems lacking conspicuous transverse stress cracks, or stress cracks at most predominantly confined to basal portions of thallus; soralia present, often abundant, generally bearing isidia; fibrils absent to numerous; widespread (Note: specimens in which the terminal branches are in part distinctly angular in cross-section key here, regardless of other characters). 21

21a Terminal branches more or less uniformly round in cross-section; cortex of main branches distinctly dark or blackening (check basal portions), often with a “soiled” appearance into mid-portions of thallus; fibrils generally copious over main branches, often evenly arranged in a “fishbone” pattern(←); medulla generally dense, K+ yellow, orange, or red . . .

. *Usnea filipendula* s. lat.

21b Terminal branches often in part distinctly angular in cross-section; cortex of main stems pale or occasionally somewhat darkening, but not distinctly so, except occasionally black at point of attachment; fibrils absent to occasionally numerous over main branches, but generally not in a “fishbone” pattern; medulla loose to occasionally dense, K- or (especially in coastal forms) K+ yellow, orange, or red . . .

. *Usnea scabrata* s. lat. (see **19a**)

13b Thallus erect-tufted to somewhat pendulous, generally less than 12 cm in length; main stems more or less divergent, especially in basal half of thallus. 22

22a Apothecia present(←), numerous (occasionally small and inconspicuous: check carefully); soredia and isidia absent; medulla K- and PD+ yellow, orange, or red; protocetraric acid present; maritime . . .

. *Usnea rigida* s. lat.

22b Apothecia absent or, if present, then soredia and isidia also present; medullary reactions not as above (exception: *U. hesperina*, see **27b**); distribution various 23

23a Soredia and isidia absent . . .

. (nonregenerating forms of various species)

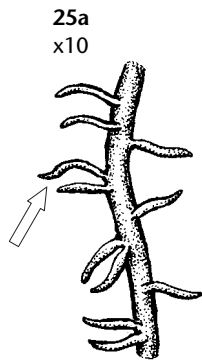
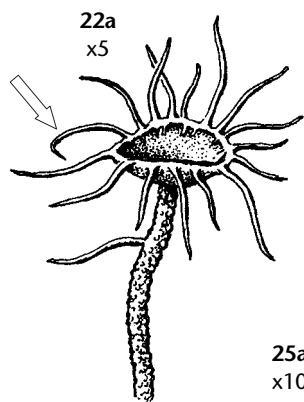
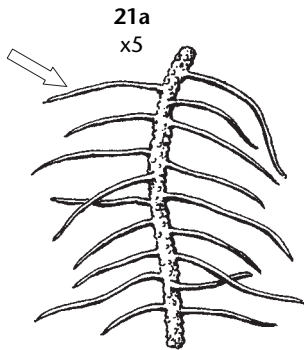
23b Soredia and/or isidia present, or at least apparently present. 24

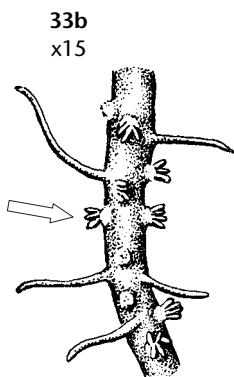
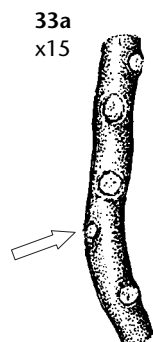
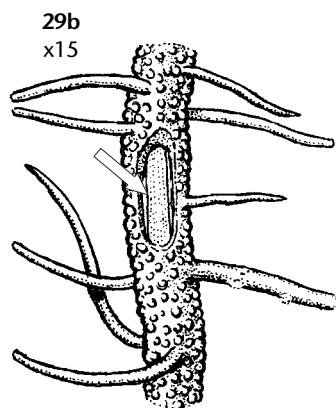
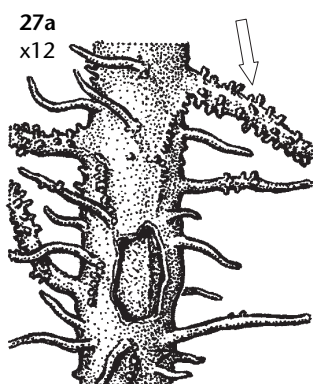
24a Thallus either strictly isidiate or, if soralia present, then at least some soralia bearing isidia, these often rather spinulose 25

25a Fibrils generally in part clustered in groupings of two to several(←); hypermaritime; rare . . . *Usnea nidulans* s. lat.

25b Fibrils solitary or absent (except rarely clustered in stressed forms!); distribution and frequency status various. 26

26a Primary branches more or less smooth, lacking papillae; cortex generally pale (rarely blackening!) in basal portions of thallus 27





27a Isidia generally copious(←), densely clustered, at least in part; medulla loose, K-, PD-; inland *Usnea hirta*

27b Isidia sparse throughout, developing singly; medulla compact, K- and PD+ yellow, orange, or red; hypermaritime *Usnea hesperina* (see 18a) (tufted form)

26b Primary branches more or less distinctly papillate; cortex pale or more often blackening in basal portions of thallus 28

28a Soralia rather large at maturity, in part encircling the branches 29

29a Medulla loose, thick, generally comprising more than 15% of branch width (see 38a) (check main stems); east of coast ranges *Usnea lapponica* ("isidiate" form)

29b Medulla distinctly compact, thin, comprising less than 15% of branch width(←); hypermaritime *Usnea madeirensis*

28b Soralia small to large at maturity, but never encircling the branches 30

30a "Soralia" (actually raised, compact scars or pseudocyphellae!) minute, the largest to less than 0.1 mm in diameter, bearing at most a few spinulose isidia; secondary branches usually densely fibrillose, the fibrils arranged in a tidy "fishbone" pattern (see 21a)

. *Usnea filipendula* s. lat (coastal form)

30b Soralia minute to medium-sized or large, the largest to more than 0.2 mm in diameter, bearing few to several isidia; secondary branches densely fibrillose or not 31

31a Basal portion of main stems often bearing numerous transverse stress cracks, these often numbering to 6–9 per 5 mm; coastal (Note: specimens in which the main stems darken upward into the mid-portions of the thallus key here) 32

32a Medulla dense, generally very thin (check in several places); central cord proportionately thick, generally accounting for much more than one-half of total branch width; cortex tough, often not readily cut with a razor blade; soralia circular in outline or often in part transversely ellipsoid (check upper branches); salazinic acid present. *Usnea madeirensis* (see 29b)

32b Medulla generally loose, rather thick; central cord proportionately thick or not, seldom accounting for much more than half the total branch width; cortex readily cut with a razor blade; soralia circular or often in part longitudinally ellipsoid; salazinic acid present or absent (Note: specimens bearing copious soralia and/or isidia more or less throughout the upper two-thirds of the thallus key here) 33

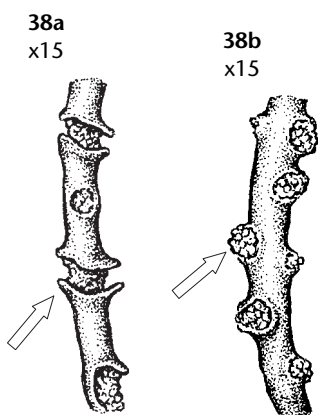
33a Soralia mostly with a plane or weakly concave upper surface(←); isidia very sparse, restricted to young soralia; norstictic acid present or absent; infrequent

. *Usnea glabrescens* s. lat.

33b Soralia distinctly convex to tuberculate; isidia sparse to more often abundant(←), occurring more or less throughout upper two-thirds of the thallus, present in young and old soralia alike (but often disappearing through abrasion in old specimens); norstictic acid absent; frequent

. *Usnea subfloridana*

- 31b Basal portion of main stems generally bearing at most only a few transverse stress cracks; main stems generally pale in mid-portions of thallus; distribution various. 34
- 34a Soralia generally bearing copious isidia at maturity (check sheltered inner portions of thallus); coastal (Note: specimens in which the medulla is UV+ ice-blue key here) 35
- 35a Ultimate branches not tapering, mostly unevenly/anisotomically branched, readily divisible into main branches and secondary lateral branches, often sinuous; cortex pale or blackened in basal portions of thallus; medulla either: (1) K+ medium yellow, orange, or red and PD+ yellow or orange; or (2) K+ medium yellow and PD+ sulphur yellow; or (3) K- and PD-; baeomycesic or salazinic acid present. *Usnea diplotypus*
- 35b Ultimate branches tapering, mostly evenly/isotomically branched, generally not readily divisible into main stems and secondary branches, not sinuous; cortex blackened in basal portions of thallus; medulla either: (1) K+ strong yellow and PD+ strong yellow or orange; or (2) K- and PD-; baeomycesic and salazinic acids absent *Usnea subfloridana*
- 34b Soralia at most bearing sparse isidia at maturity; inland (rare in coastal regions). 36
- 36a Main stems even, more or less round in cross-section; isidia minute, not readily discerned at 15x, sparse, confined to soralia; common. *Usnea substerilis* (see 38a)
- 36b Main stems often in part uneven, irregular in cross-section; isidia large, readily discerned at 15x, numerous, not always associated with soralia; infrequent *Usnea scabrata* s. lat. (see 19a) (shrubby form)
- 24b Soralia present, strictly sorediate; isidia absent 37
- 37a Soralia mostly circular in outline, and at maturity with a plane to weakly concave upper surface (see 33a); norstictic acid present; essentially coastal (rarely intermontane in humid regions) *Usnea glabrescens* s. lat.
- 37b Soralia circular to becoming elongate or irregular, generally tuberculate to deeply concave at maturity, but rarely plane; norstictic acid absent; essentially inland (rare in maritime regions) 38
- 38a Soredia finely powdery; soralia strongly concave at maturity, often merging and then occasionally revealing central cord, frequently rimmed in part by loose cortical "flaps" (←) *Usnea lapponica*
- 38b Soredia coarsely powdery to distinctly granular; soralia tubercular (←) or at most weakly concave at maturity, never revealing central cord, not rimmed by loose cortical flaps. *Usnea substerilis* (nonisidiate form)



***Usnea cavernosa* Tuck.**

(Syn. *Usnea cavernosa* ssp. *sibirica* (Räsänen) Mot.)

Pitted beard (angled beard; pitted beard lichen; pitted old man's beard)

Habitat/Range: [Both chemotypes] Locally frequent over conifers in open to somewhat sheltered forests at lower elevations throughout, except essentially absent from hypermaritime regions; incompletely circumpolar, N to sAK, AK, wNT, S to WA, OR, WY, CA, CO, AZ, NM, MX; AB.

Reactions: Chemotype 1: Medulla K+ yellow, orange, or red, CK- or CK+ yellow or orange, PD+ yellow or orange. Chemotype 2: All spot tests negative.

Contents: Chemotype 1: Usnic and salazinic acids. Chemotype 2: Usnic acid.

Variability: Low.

Notes: *Usnea cavernosa* is a distinctive species, owing to the pendulous habit and the distinctly angular or "dimpled"/foveolate branches, which have a smooth/nonpapillate cortex. Specimens containing salazinic acid are referred by some authors to ssp. *sibirica*. Chemotype 2 appears to be rather infrequent in British Columbia.

***Usnea ceratina* Ach.**

Map 119

Warted beard (warty beard lichen)

Habitat/Range: Rare over conifers and shrubs in open, somewhat exposed hypermaritime forests at lower elevations; incompletely circumpolar, N to BC, S to WA, OR, CA, AZ, NM, MX; AB.

Reactions: Medulla C+ yellow, CK+ yellow or yellowish orange.

Contents: Usnic, barbatic, 4-o-demethylbarbatic, and diffractaic acids (and various unidentified substances).

Variability: Medium.

Notes: The more or less pendulous habit, hypermaritime distribution, compact medulla, and pink central cord are diagnostic. Anomalous forms in which the central cord is white can usually be recognized by the medullary spot test reactions: K- and CK+ yellow to yellowish orange. Unfortunately, specimens in which 4-o-demethylbarbatic acid is in low concentration yield a CK- reaction; confident identification of such material requires thin-layer chromatography.

***Usnea chaetophora* Stirton**
Articulated beard

Habitat/Range: [Both chemotypes] Frequent over conifer branches in open to sheltered coastal localities at lower elevations; apparently western N Am - western Eurasia, N to sAK, S to (WA), (OR).

Reactions: Chemotype 1: Medulla K+ yellow, orange, or red, CK- or CK+ yellow or orange, PD+ yellow or orange. Chemotype 2: All spot tests negative.

Contents: Chemotype 1: Usnic and salazinic acids. Chemotype 2: Usnic acid.

Variability: High.

Notes: *Usnea chaetophora* is readily confused with several other pendulous sorediate species.

Distinctly papillate forms, for example, are close to *U. filipendula* s. lat. and *U. scabrata* s. lat. In *U. filipendula*, however, the soralia are more abundant and more often isidiate, and copious fibrils are often present, giving a characteristic “fishbone” pattern; fibrils are never abundant in *U. chaetophora*. *Usnea scabrata* s. lat., an equally variable species, differs in having a more generally loose medulla, a paler base, typically more abundant and more isidiate soralia, and a tendency toward more “angular” terminal branches. Chemotype 2 is very rare in British Columbia.

***Usnea cornuta* Körber, s. lat.**

(Syn. *Usnea inflata* (Duby) Mot.; including *Usnea occidentalis* Mot.)

Crab’s beard (inflated beard lichen)

Habitat/Range: [All chemotypes] Frequent over conifers and shrubs in open, often somewhat exposed hypermaritime forests at lower elevations; N to BC, S to WA, OR, CA, AZ, MX.

Reactions: Chemotype 1: Medulla K+ yellow, orange, or red, CK- or CK+ yellow or orange, PD+ sulphur yellow. Chemotype 2: Medulla: K+ yellow, orange, or red, PD+ yellow to orange. Chemotype 3: Medulla PD+ orange. Chemotype 4: Medulla PD+ yellow to sulphur yellow.

Contents: Chemotype 1: Usnic and salazinic acids (and constictic, stictic, and norstictic acids, and trace of protocetraric acid). Chemotype 2: Usnic, norstictic, and stictic acids (and constictic, cryptostictic, and menegazziaic acids). Chemotype 3: Usnic, protocetraric, and psoromic acids (and 2¹-o-demethylpsoromic acid). Chemotype 4: Usnic and psoromic acids (and 2¹-o-demethylpsoromic acid).

Variability: High.

Notes: The inflated lobes, the “coalescing” isidiate soralia, and the hypermaritime distribution are diagnostic. Some forms, however, are difficult to distinguish from *U. fragiles* var. *mollis*, though that species typically has a more pendent habit, a more distinctly blackened base, and larger, rather scattered (i.e., not coalescing) soralia that arise not only among the terminal branches, as in *U. cornuta*, but also among the secondary branches. Included in chemotypes 1 and 3 is a form in which the primary branches are very coarse; this material may represent a distinct species: *U. occidentalis* Mot. See also the comments under *U. glabrata*.

Usnea diplotypus Vainio, s. lat.
Ragged beard

Habitat/Range: Frequent over trees and shrubs in open coastal forests at lower elevations; western N Am - western Eurasia, possibly N to BC, S to (WA), (OR).

Reactions: Chemotype 1: Medulla K- or K+ yellow, PD- or PD+ sulphur yellow, UV+ ice-blue. Chemotype 2: Medulla K+ yellow, orange, or red, CK- or CK+ yellow or yellowish orange, PD+ yellow or orange.

Contents: Chemotype 1: Usnic, baeomycesic, squamatic, and barbatic acids (and 4-o-demethylbarbatic acid). Chemotype 2: Usnic and salazinic acids (and barbatic and 4-o-demethylbarbatic acids).

Variability: Medium.

Notes: *Usnea diplotypus* closely resembles *U. subfloridana*, but has uniformly small, dot-like/punctiform soralia, and unevenly branched terminal branches that do not taper and are readily divisible into main stems and secondary branches. By contrast, the soredia in *U. subfloridana* vary from small to enlarged, and the branches are more evenly branched. Chemotype 2 of *U. diplotypus* (with salazinic acid) has a distinctive spot test signature (i.e., K+ medium yellow, orange, or red and PD+ yellow or orange). Similarly, chemotype 2 of *U. subfloridana* (with thamnolic acid) can be recognized by its combined K+ strong yellow and PD+ strong yellow or orange reactions. Specimens yielding a K+ medium yellow and PD+ sulphur yellow reaction can be assigned to chemotype 1 of *U. diplotypus* (with baeomycesic acid in high concentration), although the identity of specimens giving a K- and PD- reaction must be confirmed using thin-layer chromatography. The material assigned here to chemotype 1 of *U. diplotypus* was formerly included in *U. subfloridana* (Halonen et al. 1998). More recent studies, however, suggest that it is more closely allied with *U. diplotypus* or, alternatively, that it warrants recognition as a distinct species (P. Halonen, University of Oulu, Finland, pers. comm., 1999).

Usnea esperantiana Clerc
Seaside beard

Map 120

Habitat/Range: Rare over conifers in open hypermaritime localities at lower elevations, local distribution poorly known; western N Am - western Eurasia, N to BC, S to CA.

Reactions: Medulla K+ yellow, orange, or red, CK- or possibly CK+ yellow or orange, PD+ orange, or red.

Contents: Usnic, bourgeanic, and salazinic acids (and constictic acid).

Variability: Medium.

Notes: Diagnostic characters include the inflated branches, the (often) recurved branch tips, the white or orangish central cord, the nonisidiate soralia, the densely papillate main branches, and the hypermaritime distribution. *Usnea glabrata* is similar, but has a K- medullary reaction, and is apparently absent from hypermaritime regions.

Usnea filipendula Stirton, s. lat.
Fishbone beard (forest beard lichen)

Habitat/Range: Frequent over conifers and shrubs in open forests and forest edges at lower elevations throughout, except possibly rare in boreal regions; probably circum-polar, N to sAK, AK, S to WA, ID, OR, CA, AZ, NM, MX; AB.

Reactions: Medulla K+ yellow, orange, or red, CK- or CK+ yellow or orange, PD+ yellow or orange.

Contents: Usnic and salazinic acids (and trace of protocetraric acid).

Variability: High.

Notes: Typical forms of *U. filipendula* s. lat. can be recognized by their pendulous, noninflated branches that bear abundant papillae and copious fibrils arranged in a tidy “fishbone” pattern. Some specimens, however, are difficult to reliably distinguish from K+ yellow (i.e., salazinic-containing) forms of *U. scabrata* s. lat., whereas others apparently intergrade with papillate forms of *U. chaetophora*. For points of distinction, see the comments under that species.

Usnea fragilesceus Lynge var. *mollis* (Vainio) Clerc
(Syn. *Usnea mollis* Stirton)

Inflated beard

Habitat/Range: [All chemotypes] Frequent over conifers and shrubs in open, generally somewhat exposed hypermaritime forests at lower elevations; western N Am - eastern N Am - western Eurasia, N to sAK, S to WA, OR, CA, AZ, NM, MX.

Reactions: Chemotype 1: Medulla K+ yellow, orange, or red, PD+ orange. Chemotype 2: Medulla K- orange, or red, CK- or CK+ yellow or orange, PD+ yellow or orange.

Chemotype 3: Medulla UV+ ice-blue. Chemotype 4: PD+ sulphur yellow.

Chemotype 5: All spot tests negative.

Contents: Chemotype 1: Usnic, norstictic, and stictic acids (and menegazziaic, constictic, and cryptostictic acids). Chemotype 2: Usnic and salazinic acids (and atranorin, norstictic, stictic, constictic, and/or cryptostictic acids). Chemotype 3: Usnic and squamatic acids. Chemotype 4: Usnic, psoromic, and 2¹-o-demethylpsoromic acids.

Chemotype 5: Usnic acid.

Variability: High.

Notes: Diagnostic characters include the inflated habit, the isidiate soralia, the evenly branching upper branches, and the hypermaritime distribution. Some forms of *U. cornuta* and *U. wirthii* are similar; see the comments under those species.

Usnea glabrata (Ach.) Vainio
(Syn. *Usnea kujalae* Räsänen)
Lustrous beard

Habitat/Range: [All chemotypes] Frequent (localized) over deciduous trees and shrubs (also occasionally over conifers) in open maritime and especially humid inland forests at lower elevations; incompletely circumpolar, N to sAK, S to WA, ID, OR, CA, UT, CO, AZ, NM, MX; AB.

Reactions: Chemotype 1: Medulla PD+ yellow, orange, or red. Chemotypes 2 and 3: All spot tests negative.

Contents: Medulla: Chemotype 1: Usnic and protocetraric acids (and fumarprotocetraric and barbatic acids, and Cph-1 and Cph-2). Chemotype 2: Usnic acid. Chemotype 3: Usnic and barbatic acids (and 4-o-demethylbarbatic acid).

Variability: Medium.

Notes: Diagnostic characters include the small stature (mostly to less than 4–5 cm long), the inflated branches, the copious soralia bearing abundant soredia, and the smooth or at most sparsely papillate main branches. Rarely, the soredia are intermingled with isidia-like fibrils, leading to possible confusion with *U. cornuta* and *U. fragilescens*. Those species, however, are somewhat larger (to more than 4–5 cm long at maturity), and are in any case restricted to hypermaritime localities outside the range of *U. glabrata*. They also often yield K+ yellow, orange, or red medullary reactions. In maritime portions of its range, *U. glabrata* must be carefully distinguished from anomalous specimens of *U. wirthii* in which the central cord is white, rather than yellowish. That species, however, generally contains norstictic or psoromic acid, and thus yields a K+ yellow, orange, or red medullary reaction or a PD+ sulphur medullary reaction, respectively. See also the comments under *U. esperantiana*.

Usnea glabrescens (Vainio) Vainio, s. lat.
(Syn. including *Usnea fulvoreagens* (Räsänen) Räsänen)
Speckled beard

Habitat/Range: [Both chemotypes] Frequent over trees in open, humid maritime forests at lower elevations, also rare in similar habitats in humid intermontane (ICH) regions; incompletely circumpolar, N to sAK, S to WA, ID, OR, NM; AB.

Reactions: Medulla K+ yellow, orange, or red, CK- or CK+ yellow or orange, PD+ yellow or orange.

Contents: Chemotype 1: Usnic and norstictic acids (and constictic, cryptostictic, and stictic acids). Chemotype 2: Usnic and salazinic acids (and norstictic and stictic acids).

Variability: Medium.

Notes: Diagnostic characters include the tufted, noninflated branches that bear large, plane (or often partly raised), more or less circular, nonisidiate soralia. Some forms of *U. subfloridana* are similar, but in that species the soralia contain isidia, and are invariably distinctly raised. Another similar species, *U. fulvoreagens*, is also probably present in British Columbia. It can be distinguished by its more fibrillose branches, and especially by its irregular soralia that typically become deeply concave at maturity.

Usnea hesperina Mot.
Silken beard (rough beard lichen)

Map 121

Habitat/Range: Rare over conifers in open hypermaritime forests, especially at shoreline; incompletely circumpolar, also widespread at tropical latitudes, N to BC, S to OR, CA, MX.

Reactions: Medulla PD+ yellow, orange, or red.

Contents: Usnic and protocetraric acids.

Variability: Medium.

Notes: The long, pendulous, nonpapillate branches, the K- and PD+ yellow, orange, or red medullary reactions (i.e., protocetraric acid present), and the strictly hypermaritime distribution are diagnostic.

Usnea hirta (L.) F.H. Wigg.
(Syn. *Usnea variolosa* Mot.)

Bristly beard (sugar-coated beard; sugared beard; sugary beard; speckled flowering lichen; shaggy old man's beard)

Habitat/Range: Common over conifers and deciduous trees and shrubs in open to somewhat sheltered intermontane (BG, PP, IDF) localities at lower elevations, especially in semi-arid and dry regions; circumpolar, N to BC, S to WA, MT, OR, WY, CA, UT, CO, AZ, NM, MX; AB.

Reactions: All spot tests negative.

Contents: Usnic acid (and fatty acids in the murolic acid complex, rarely also diffractaic acid).

Variability: Medium.

Notes: In British Columbia, *U. hirta* is an intermontane species usually readily recognized by its noninflated, nonpapillate, densely isidiate, and often somewhat irregularly angular branches, as well as by its pale greenish or brownish, not blackish, basal portions.

***Usnea lapponica* Vainio**

(Syn. *Usnea laricina* auct., non Räsänen)

Powdered beard (powdery beard; powdery old man's beard)

Habitat/Range: [All chemotypes] Common over conifers and deciduous trees and shrubs in open to somewhat sheltered inland localities at lower to middle elevations, also rare in maritime (CDF) regions; circumpolar, N to sAK, AK, YU, wNT, S to WA, ID, MT, OR, WY, CA, UT, CO, AZ, NM; AB.

Reactions: Chemotype 1: Medulla: All spot tests negative. Chemotype 2: Medulla K+ yellow, orange, or red, CK- or CK+ yellow or orange, PD+ yellow or orange. Chemotype 3: Medulla C+ yellowish, CK- or CK+ yellowish orange. Chemotype 4: Medulla PD+ sulphur yellow.

Contents: Chemotype 1: Usnic acid. Chemotype 2: Usnic and salazinic acids. Chemotype 3: Usnic, barbatic, 4-o-demethylbarbatic, and salazinic acids. Chemotype 4: Usnic and psoromic acids (and 2¹-o-demethylpsoromic acid).

Variability: Medium.

Notes: *Usnea lapponica* can be characterized by its predominantly inland distribution, its tufted habit, its noninflated branches, and its distinctive concave soralia, which at maturity tend to encircle the branches, often bordered by loose cortical "flaps." *Usnea substerilis* is somewhat similar, but in that species the soralia are generally minutely isidiate when young, and soon become raised, rarely encircling the branches.

***Usnea longissima* Ach.**

(Syn. *Usnea longissima* Ach. var. *corticata* R. Howe; *Usnea longissima* Ach. var. *perciliata* Mot.)

Methuselah's beard (long beard lichen)

Habitat/Range: [All chemotypes] Frequent (localized) over conifers and secondarily over deciduous trees and shrubs in open, humid coastal localities, especially in old-growth forests at lower elevations; incompletely circumpolar, also widespread in southern hemisphere, N to sAK, S to WA, OR, CA.

Reactions: Chemotype 1: Medulla: all spot tests negative. Chemotype 2: Medulla C+ yellow, CK+ yellow or yellowish orange. Chemotypes 3 and 4: All spot tests negative. Chemotype 5: Medulla K+ yellow, orange, or red, CK- or CK+ yellow or orange, PD+ yellow or orange.

Contents: Chemotype 1: Usnic and evernic acids. Chemotype 2: Usnic and diffractaic acids (and barbatic, 4-o-demethylbarbatic, and evernic acids). Chemotype 3: Usnic and barbatic acid (and 4-o-demethylbarbatic acid). Chemotype 4: Usnic acid. Chemotype 5: Usnic and salazinic acids and atranorin (and barbatic, 4-o-demethylbarbatic, and constictic acids).

Variability: Medium.

Notes: This is the longest of all lichens, occasionally unravelling to lengths of 3 m or more. In no other local species are the main stems essentially decorticate. Chemotype 5 is anomalously robust, and is usually also reddish at the tips of the fibrils; it may represent a distinct taxon; more work is needed.

***Usnea madeirensis* Mot.**

(Syn. *Usnea silesiaca* Mot.)

Neptune's beard

Habitat/Range: Frequent over conifers and deciduous trees and shrubs in open hyper-maritime forests at lower elevations, especially at shoreline, also rare in maritime regions; western N Am - western Eurasia, N to BC, S to CA.

Reactions: Medulla K+ orange, or red, CK- or CK+ yellow or orange, PD+ yellow or orange.

Contents: Usnic and salazinic acids (and constictic and protocetraric acids, rarely also with barbatic and 4-o-demethylbarbatic acids).

Variability: High.

Notes: Typical forms can be recognized by the presence of divergent, noninflated branches, copious papillae, numerous transverse stress cracks, large, isidiate soralia, and especially a very thin, highly compact medulla and correspondingly thick central cord.

Specimens lacking soredia are readily confused with *U. filipendula*, in which, however, the medulla is not distinctly thin, and stress cracks are less numerous.

***Usnea nidulans* Mot., s. lat.**

Map 122

Nested beard

Habitat/Range: [Both chemotypes] Infrequent over trees in open hypermaritime forests at lower elevations; western N Am, possibly N to BC, S to OR.

Reactions: Chemotype 1: Medulla K+ yellow, orange, or red, CK- or possibly CK+ yellow or orange, PD+ yellow or orange. Chemotype 2: Medulla PD+ strong yellow.

Contents: Chemotype 1: Usnic and norstictic acids (and protocetraric, salazinic, and stictic acids). Chemotype 2: Usnic and psoromic acids (and 2'-o-demethylpsoromic acid).

Variability: Medium.

Notes: Diagnostic characters include the noninflated branches, the hypermaritime distribution, and especially the presence of clustered fibrils. The British Columbia material is closely related to *U. nidulans*, from southern South America, but may represent an undescribed taxon.

***Usnea rigida* (Ach.) Mot., s. lat.**

Map 123

(Syn. *Usnea florida* auct., non (L.) F.H. Wigg.; including *Usnea arizonica* Mot.)

Eyed beard

Habitat/Range: Rare over deciduous trees in sheltered maritime forests at lower elevations; western N Am - western Eurasia, N to BC, S to CA, AZ, NM, MX.

Reactions: Medulla PD+ yellow, orange, or red.

Contents: Usnic and protocetraric acids (and various unknown substances).

Variability: Low.

Notes: *Usnea rigida* is the only local *Usnea* in which apothecia are invariably present.

Also diagnostic are the K- and PD+ yellow, orange, or red medullary reactions. In some specimens, the apothecia are small and are easily overlooked. The British Columbia material is chemically distinct from *U. arizonica*, as well as from European races of *U. rigida*, and may represent a distinct taxon.

Habitat/Range: Rare over deciduous shrubs in open hypermaritime forests at shoreline, local distribution poorly known; western N Am - eastern N Am - western Eurasia, also widespread at tropical latitudes, N to BC, S to ?WA, ?OR, CA, MX.

Reactions: Medulla K+ yellow, orange, or red, CK- or CK+ yellow or orange, PD+ yellow or orange.

Contents: Usnic, salazinic, norstictic, constictic, cryptostictic, norstictic, and protocetraric acids.

Variability: Medium.

Notes: Only in *U. rubicunda* does the cortex have a reddish colour in the field, though several other species eventually acquire a reddish cast in the herbarium. Other diagnostic characters include the hypermaritime distribution, the pendulous habit (mature specimens only!), the pale basal portions, the thin, compact medulla, and the noninflated branches that bear abundant soralia containing isidia in addition to soredia.

Known in British Columbia from a single locality on Vancouver Island.

Usnea scabrata Nyl., s. lat.

(Including *Usnea barbata* (L.) F.H. Wigg., *Usnea prostrata* Räsänen, *Usnea rugulosa* Vainio, *Usnea scabiosa* Mot.)

Straw beard (scruffy beard)

Habitat/Range: [Both chemotypes] Frequent over conifers and deciduous trees and shrubs in open to somewhat sheltered forests at lower elevations throughout; probably incompletely circumpolar, N to sAK, wNT, S to WA, ID, MT, (OR), CA, AZ, (NM), MX; AB.

Reactions: Chemotype 1: Medulla: all spot tests negative. Chemotype 2: Medulla K+ yellow, orange, or red, CK- or CK+ yellow or orange, PD+ yellow or orange.

Contents: Chemotype 1: Usnic acid. Chemotype 2: Usnic and salazinic acids.

Variability: High.

Notes: Typical forms can be recognized by the rather pendulous habit, the noninflated branches, the thin, rather papery cortex, the loose medulla, and the often rather ridged or angular terminal branches. Some forms are difficult to distinguish from *U. chaetophora*, whereas others appear to intergrade with *U. filipendula*. For points of distinction, see the comments under *U. chaetophora*. Coastal localities invariably support Chemotype 2, whereas Chemotype 1 predominates in inland regions.

[*Usnea sphacelata* R. Br.]

(Syn. *Neuropogon lambii* Imsh.; *Neuropogon sulphureus* (J. König) Hellbom)
Zebra beard (banded beard)

Habitat/Range: Expected over exposed acid rock outcrops at alpine elevations in the coast ranges; incompletely circumpolar, N to wNT, S to WA, OR.

Reactions: Medulla: All spot tests negative.

Contents: Usnic acid.

Variability: Medium.

Notes: No other western *Usnea* species is known to occur over rock at alpine elevations.

Usnea sphacelata has recently been reported from the Cascade Mountains of Washington State, and should be looked for in adjacent portions of British Columbia. In North America, this species has a predominantly high-arctic distribution.

Usnea subfloridana Stirton

(Syn. *Usnea comosa* (Ach.) Vainio, non Pers.; *Usnea similis* (Mot.) Räsänen)
Nit beard

Habitat/Range: Probably frequent over conifers and occasionally also deciduous trees in open coastal forests at lower elevations; incompletely circumpolar, N to ?AK, ?YU, S to WA, MT, OR, CA, UT, CO, AZ, NM, (MX); AB.

Reactions: Chemotype 1: Medulla UV+ ice-blue. Chemotype 2: Medulla K+ strong yellow, PD+ yellowish orange.

Contents: Chemotype 1: Usnic and squamatic acids. Chemotype 2: Usnic and thamnolic acids.

Variability: High.

Notes: Diagnostic characters include the maritime distribution, the distinctly blackened base, and the noninflated branches that bear copious papillae and produce small to enlarged soralia, which often contain abundant isidia (check sheltered branches). Specimens of *U. ceratina* in which the medulla and central cord are white, not pinkish, also closely resemble *U. subfloridana*, but typically yield K- and CK+ yellow or yellowish orange medullary reactions (4-o-demethylbarbatic acid in high concentration!). *Usnea wasmuthii* Räsänen is also similar, but typically has more concave and elongated soralia, and is often longitudinally cracked at the base; it has recently been detected in Washington and Oregon (P. Halonen, University of Oulu, Finland, pers. comm., 1999). See also the notes under *U. diplotypus*.

***Usnea substerilis* Mot.**

(Syn. *Usnea stuppea* (Räsänen) Mot.)

Embossed beard

Habitat/Range: [All chemotypes] Common over conifers and especially deciduous trees and shrubs in open to occasionally sheltered inland forests and steppe at lower to middle elevations, also rare in coastal regions; probably circumpolar, N to sAK, AK, YU, wNT, S to WA, MT, WY, CA, (AZ); AB.

Reactions: Chemotypes 1 and 2: Medulla K+ yellow, orange, or red, CK- or CK+ yellow or orange, PD+ orange. Chemotype 3: Medulla: All spot tests negative.

Contents: Chemotype 1: Usnic and salazinic acids. Chemotype 2: Usnic, barbatic, 4-o-demethylbarbatic, and salazinic acids. Chemotype 3: Usnic, barbatic, and 4-o-demethylbarbatic acids.

Variability: High.

Notes: This is an essentially inland species in which the branches are rather tufted, non-inflated, and distinctly papillate, and bear copious, raised, isidiate or coarsely sorediate soralia, or both. *Usnea lapponica* is similar, but has more powdery soredia that lack isidia, and that at maturity often encircle the branches as eroding “rings.”

***Usnea trichodea* Ach.**

Map 125

Bony beard (smooth bony beard lichen)

Habitat/Range: Rare over conifers in open intermontane forests at lower elevations, local distribution poorly known; western N Am - eastern N Am, N to BC, S to ?WA, AZ.

Reactions: (ours): Medulla K+ yellow or orange, CK+ orangish, PD+ yellow or orange.

Contents: (ours): Usnic and constictic acids, and traces of diffractaic and salazinic acids.

Variability: Medium.

Notes: Diagnostic characters include the inland distribution, the pendulous habit, and especially the uniformly brown central cord. Possibly extirpated in British Columbia: the only known locality, at Finlay Forks, has apparently been obliterated by the Williston Lake reservoir. In other parts of its range, *U. trichodea* sometimes contains usnic acid alone.

Usnea wirthii Clerc
Blood-spattered beard

Habitat/Range: [All chemotypes] Frequent over conifers and deciduous trees and shrubs in open hypermaritime forests at lower elevations, especially at forest edges, also infrequent in maritime regions; western N Am - western Eurasia - eastern Eurasia, also in southern hemisphere, probably N to sAK, S to WA, OR, CA, MX.

Reactions: Chemotype 1: Medulla K- or more often K+ yellow, orange, or red, PD+ yellow or orange. Chemotype 2: Medulla PD+ sulphur yellow. Chemotype 3: All spot tests negative.

Contents: Chemotype 1: Usnic and norstictic acids, and various unknowns (and stictic and constictic acids, and various unknowns). Chemotype 2: Usnic and psoromic acids. Chemotype 3: Usnic acid (and various unknowns).

Variability: Medium.

Notes: The coastal distribution, small stature (mostly to less than 4 [–5] cm long), inflated branches, strictly sorediate soralia, and yellow central cord are diagnostic. In this species the branches are also often sparsely speckled with tiny reddish dots.

Anomalous specimens in which the central cord is white, not yellow, must be carefully distinguished from *U. cornuta* and *U. fragilesce* var. *mollis*. Both of these species tend to be larger than *U. wirthii* (generally to more than 4–5 cm long at maturity), and often bear weakly isidiate soralia. See also the comments under *U. glabrata*.

Minute nonstratified fruticose (**shrub**) lichens, consisting of **rosettes** of loosely decumbent branches, these olive brown to **dark brown or blackish**, round in cross-section, slender, to 1–2 mm long (ours) and 50–100 (–110) μm wide, dull or occasionally shiny, smooth, noncorticate, brittle, solid, **rather sparsely branched**, often bearing short, **spinule-like side branches**; branching irregular to often in part **in pairs** (reflecting paired photobiont: see below). Soredia, isidia, pseudocyphellae, and medulla absent. Attached to substrate by basal holdfasts. **Photobiont** a cyanobacterium: *Scytonema*, cells **arranged in two parallel rows**, to 12–15 (–20) μm along long axis.

Ascocarp an apothecium, borne laterally, disc brown (ours) to dark greenish, to 0.4 mm wide. Spores 1-celled, ellipsoid (ours) to bean-shaped, colourless, to 24 or more per ascus.

Over **base-rich rock**.

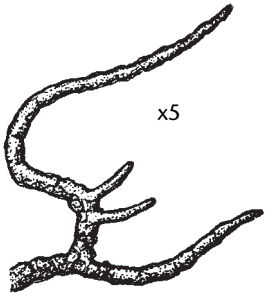
References: Henssen (1977).

Common Name: Describes the habitat and the often sinuous branches.

Notes: *Zahlbrucknerella* is a primarily temperate genus consisting of seven species worldwide. Three of these have been reported from North America, but only one from British Columbia. For points of separation with similar lichens, see the key under *Spilonema*.

Zahlbrucknerella calcarea (Herre) Herre
Frosted rockserpent

Map 126



Habitat/Range: Rare over base-rich rock in open to somewhat sheltered inland localities at lower elevations, local distribution poorly known; possibly incompletely circumpolar, N to wNT, S to WY, CA, CO; AB.

Reactions: All spot tests negative.

Contents: No lichen substances reported.

Variability: Medium.

Notes: Under LM, *Z. calcarea* exhibits “false branching,” in which the branches arise not as a result of lateral outgrowth, but as a result of terminal growth by the internal *Scytonema* colonies.

A **minute** nonstratified fruticose (**shrub**) lichen consisting of cushions of **semi-erect branches**, these **dark brownish green** to occasionally dark bluish green (semi-translucent when moist), round in cross-section, but **constricted at intervals**, stout, to **0.1–0.4 mm long** and 40–60 μm wide, rather shiny, **corticate**, brittle, solid, sparsely branched; branching irregular. Soredia, isidia, pseudocyphellae, and **medulla absent**. Attached to substrate by scattered colourless **hairlike rhizoids**. Photobiont an unknown cyanobacterium, resembling *Scytonema*: consisting of rounded cells to 15 μm across.

Ascocarp an apothecium, borne laterally, attached in central portions of thallus

by radiating fungal threads/hyphae, these often clearly visible from above as an **encircling “corona”**; disc more or less pale pinkish, to 0.4–0.6 mm across. Spores 1-celled, ellipsoid, colourless, to eight per ascus.

References: T. Tønsberg, University of Bergen, Norway, pers. comm., 1999.

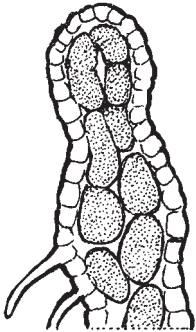
Common Name: Describes the habitat and the nodular, “prickly-pear” appearance.

Notes: The material belongs to an undescribed genus (= *Spilonemella* Henssen, ined.) consisting of two species. For points of distinction with similar minute, dark, shrubby, bark-dwelling lichens, see the key under *Lichinodium*.

Unknown 1
Pacific barkcholla

Map 127

x400



Habitat/Range: Rare (overlooked?) over twigs, and rarely trunks, of conifers and deciduous shrubs in coastal and humid intermontane (ICH) old-growth forests at lower elevations; probably western N Am, N to (sAK), S to (WA).

Reactions: None.

Contents: No lichen substances expected.

Variability: Medium.

Notes: This diminutive species (= *Spilonemella americana* Henssen & Tønsberg, ined.) often grows in company with the slightly larger *Lichinodium canadense*, in which the branches can attain 0.4–0.8 (–1.5) mm in length. Some species of *Leptogium* (e.g., *L. teretiusculum* (Wallr.) Arnold and other diminutive species: see Part 1) can also be similar, but are distinguished by the presence of *Nostoc*, in which the cells measure 5–7 (–8) μm along long axis, versus to 15 μm in Unknown 1.

A **minute** nonstratified fruticose (**shrub**) lichen consisting of **cushions** of decumbent to semi-erect branches, these **bluish green** to brownish (semi-translucent when moist), round in cross-section throughout, slender, to **2–4 mm long** and **50–75 µm wide**, rather shiny, apparently corticate, brittle, solid, richly branched; branching consisting mostly of numerous short, **budlike side-branches**. Soredia, isidia, pseudocyphellae, and medulla absent. Attached to substrate by tufted, colourless **hairlike rhizoids**. Photobiont a cyanobacterium: resembling *Scytonema*: consisting of **strandlike** chains, these often in part arranged in **two or more rows**, each row 10–15 µm

wide: check young branches under LM).

Ascocarps unknown.

Over **conifer branches**.

References: I.M. Brodo, Museum of Nature, Ottawa, pers. comm., 1998.

Common Name: Describes the habitat and the characteristic hairlike rhizoids.

Notes: The material included here was recently reported for British Columbia as *Dictyonema moorei* (Nyl.) Henssen by Brodo (1995), though the identification appears to be erroneous; it may represent an undescribed genus. For points of separation with similar tree-dwelling species in other genera, see the key under *Lichinodium*.

Unknown 2
Pacific barktassel

Map 128

Habitat/Range: Rare over conifers at forest edges in humid coastal localities at lower elevations, local distribution poorly known; global distribution unknown, in N Am known only from BC.

Reactions: All spot tests negative.

Contents: No lichen substances reported.

Variability: Unknown.

Notes: Diagnostic for this species are: (1) the tiny, appressed thallus to 2–4 mm across; (2) the slender, bluish grey branches to 50–75 µm wide; (3) the tufted hairlike rhizoids; (4) the budlike side-branches; and (5) the strandlike photobiont (*Scytonema*) to more than 8 µm wide.

A **minute** nonstratified fruticose (**hair**) lichen consisting of cushions of **loosely appressed branches**, these **pale bluish grey** (semi-translucent when moist), round in cross-section, slender, to **0.2–0.3 mm long** and 10–15 µm wide, rather shiny, apparently **noncorticate**, brittle, solid, very sparsely branched; branching “false” (i.e., in which the branches arise not as a result of lateral outgrowth, but as a result of terminal growth by the internal *Scytonema* colonies). Soredia, isidia, pseudocyphellae, and **medulla absent**. Attached to substrate by basal holdfasts.

Photobiont a cyanobacterium: *Scytonema*, cells to more than 8 µm along long axis. Ascocarps unknown.

References: T. Tønsberg, University of Bergen, Norway, pers. comm., 1998. Common Name: Describes both the habitat and the appearance.

Notes: The material appears to belong to an undescribed genus. For points of distinction with similar minute, dark, shrubby, bark-dwelling lichens, see the key under *Lichinodium*.

x500



Unknown 3
Pacific barkvelvet

Habitat/Range: Expected over deciduous shrubs in humid coastal forests at lower elevations, local distribution unknown; global distribution unknown, known at present only from northern WA.

Reactions: None.

Contents: No lichen substances expected.

Variability: Low.

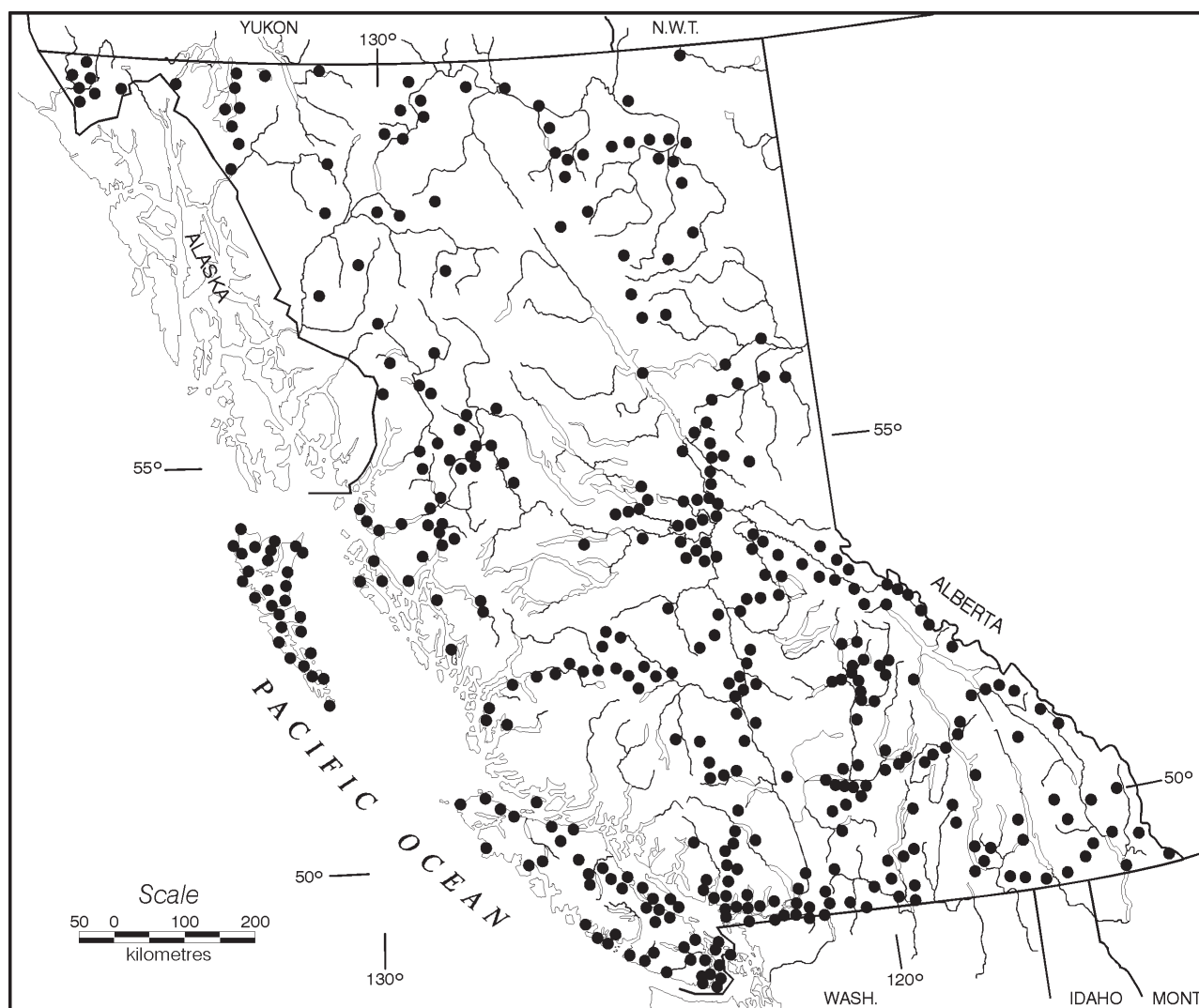
Notes: Diagnostic characters include the tiny, appressed thallus to 1–2 mm across, the threadlike, bluish grey branches to 10–15 µm wide, and the strandlike photobiont (*Scytonema*) that is loosely enveloped by fungal threads/hyphae. Under LM, this species somewhat resembles *Thermutis velutina*.

Distribution maps are presented for 127 fruticose lichen species known in British Columbia from fewer than eight to 10 localities. The following additional species are also rather localized in occurrence, but have not been mapped, owing to taxonomic and other problems: *Chaenotheca sphaerocephala*, *C. sp. 1*, *Chaenothecopsis* spp. 1–9, *Ephebe solida*, and *Stereocaulon symphycheilum*.

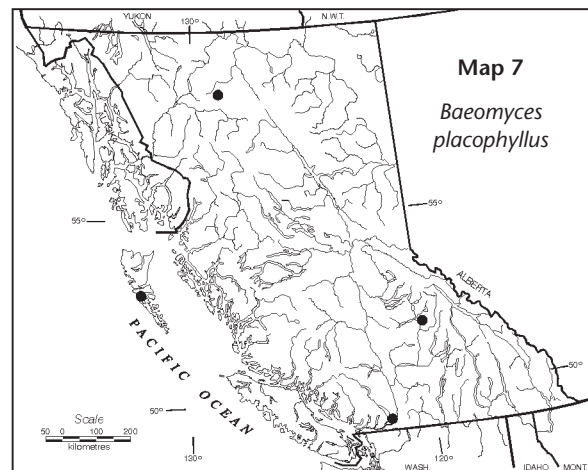
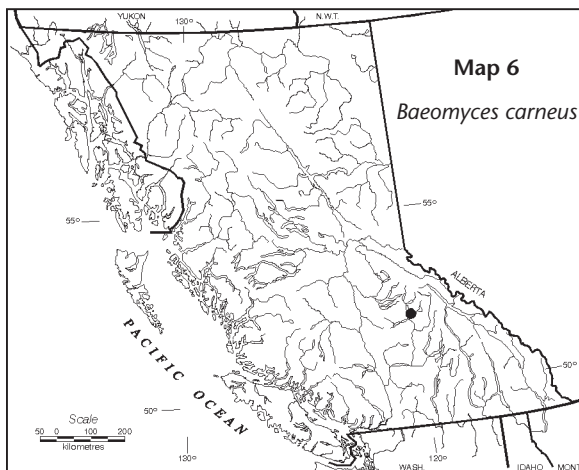
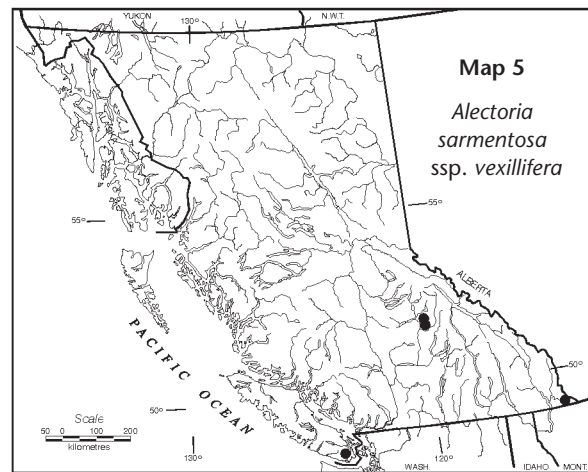
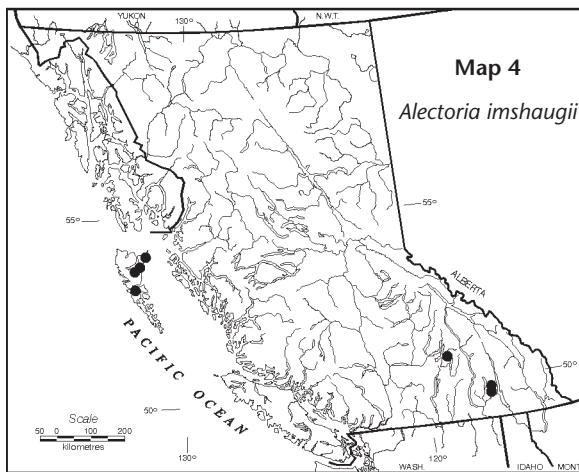
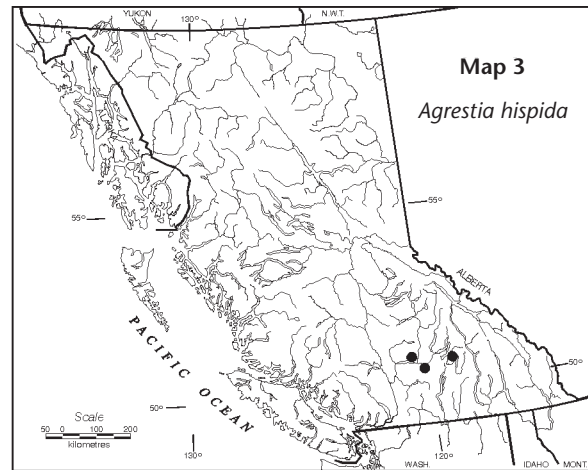
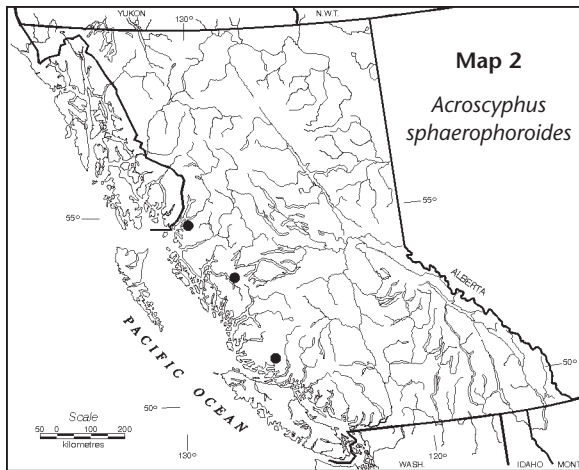
The maps are based on a study of approximately 20 000 specimens housed at

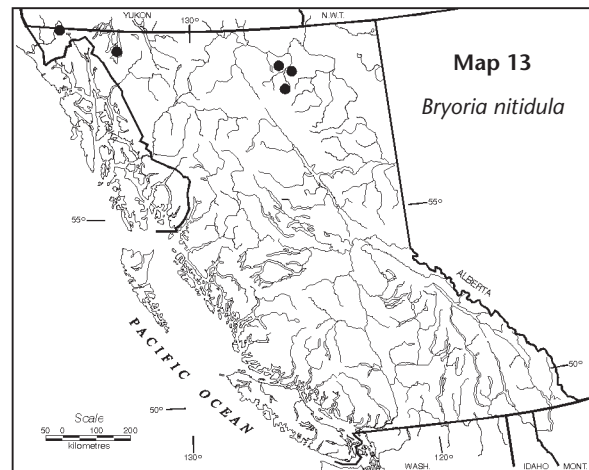
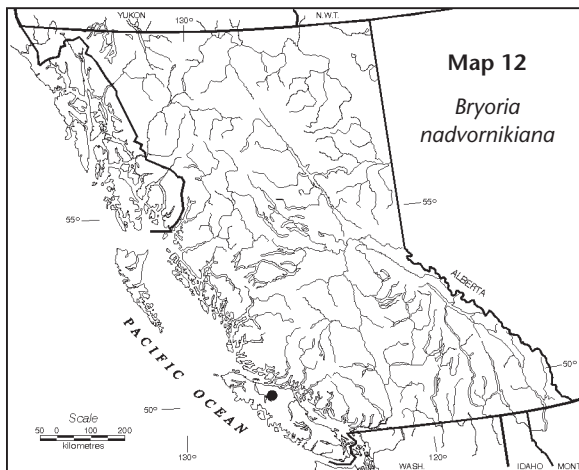
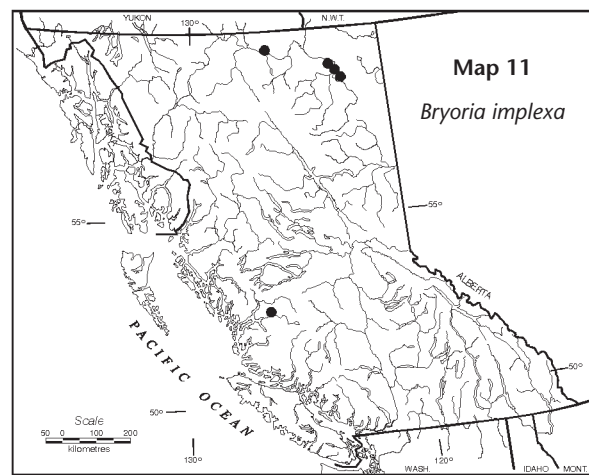
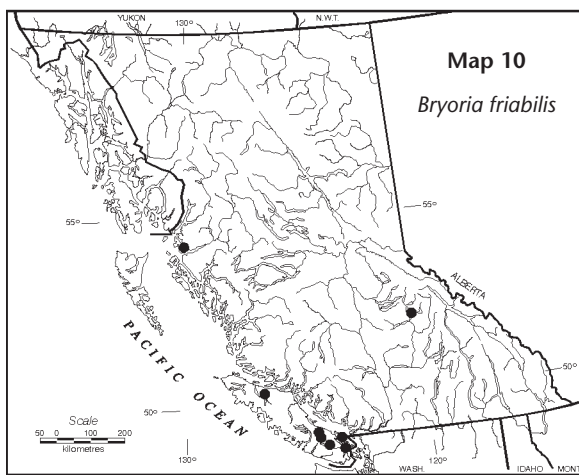
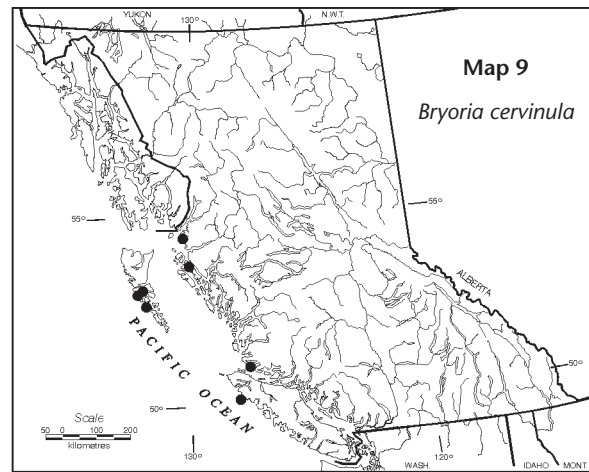
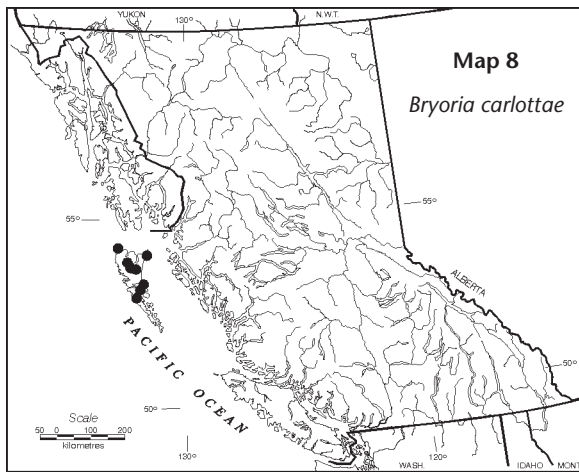
the University of British Columbia (UBC) in Vancouver, the Canadian Museum of Nature (CANL) in Ottawa, and the Royal British Columbia Museum (VC) in Victoria. Reliable literature reports have also been included. The exsiccated collections of John Macoun (1831–1920) have been excluded owing to errors in labelling (Brodo and Hawksworth 1978).

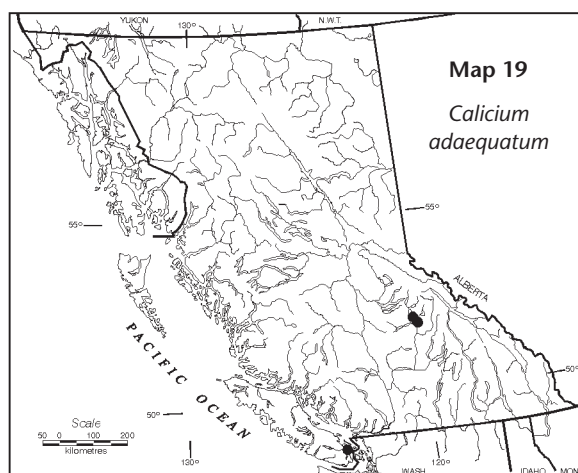
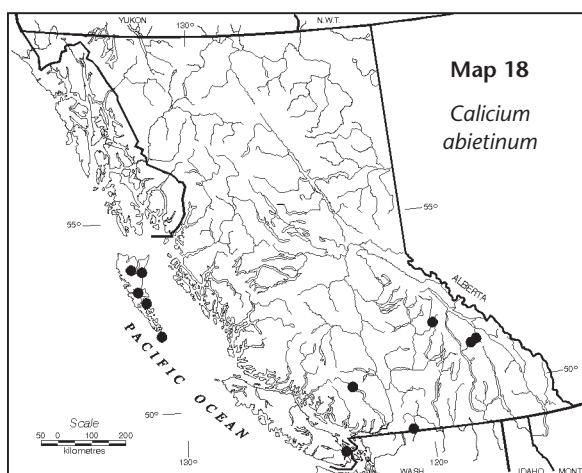
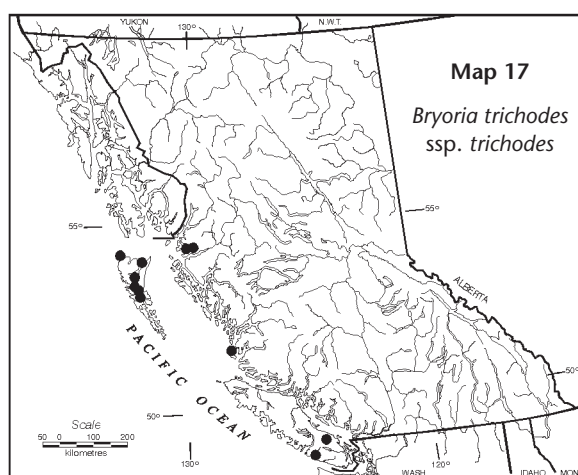
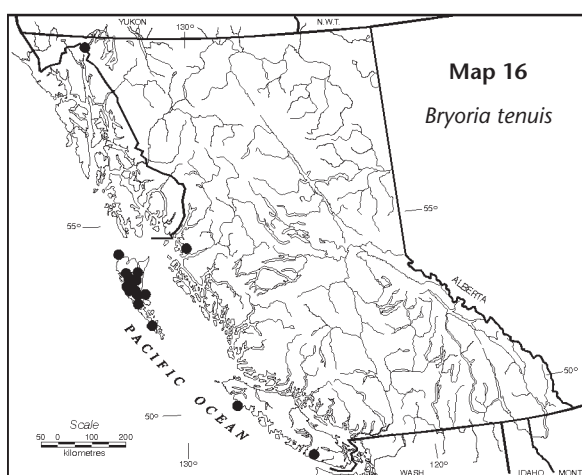
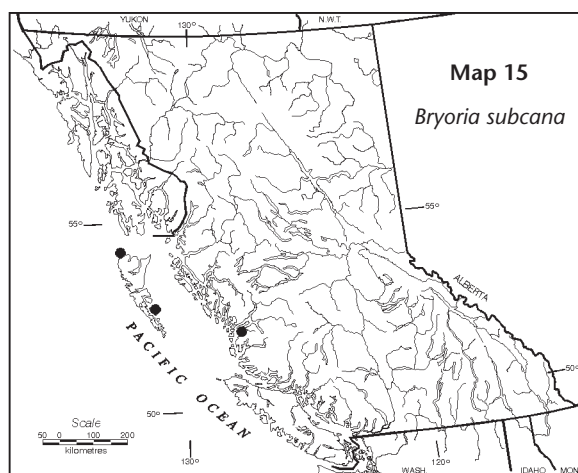
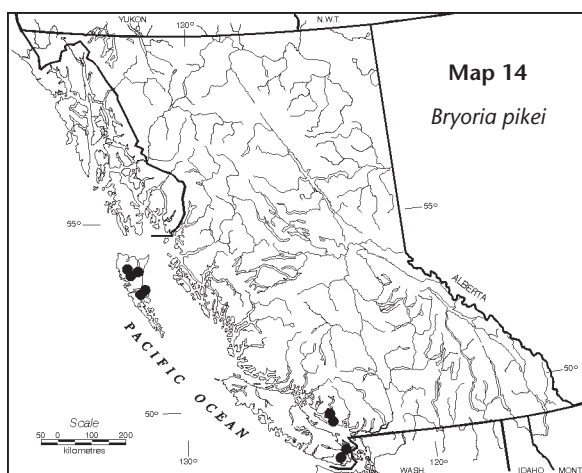
Map 1 summarizes lichen collecting localities to 1998. See also Figure 1 (page 1).

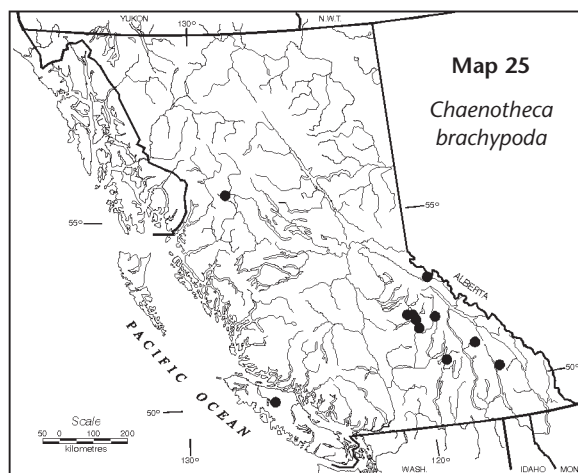
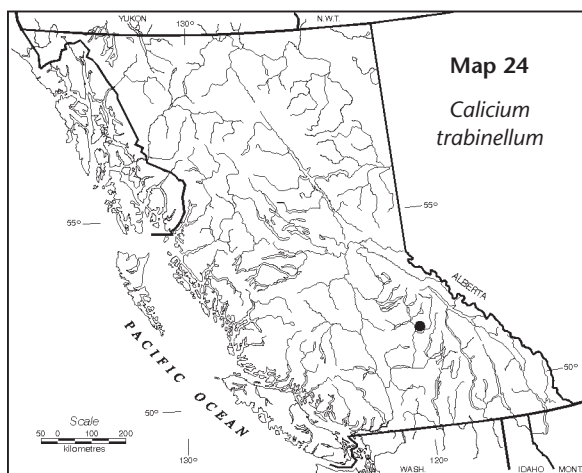
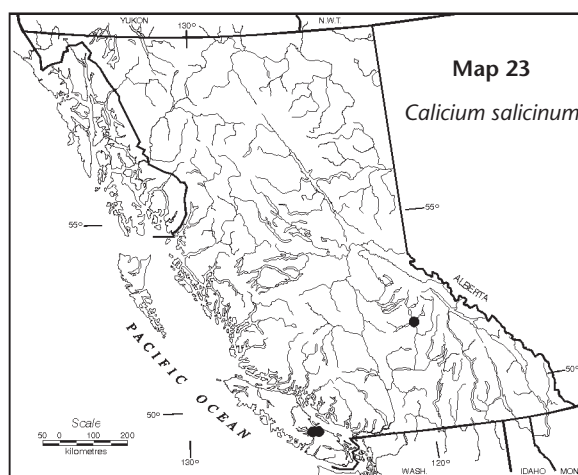
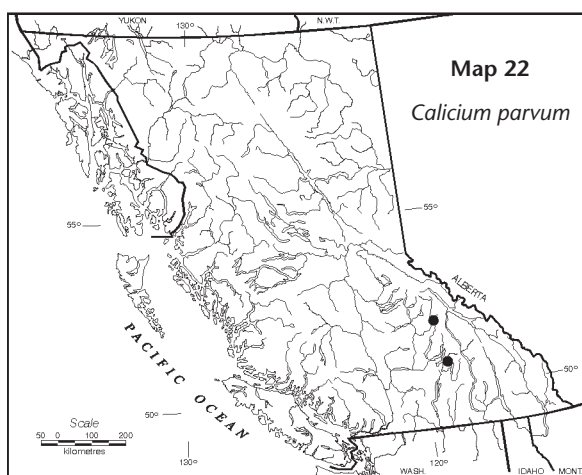
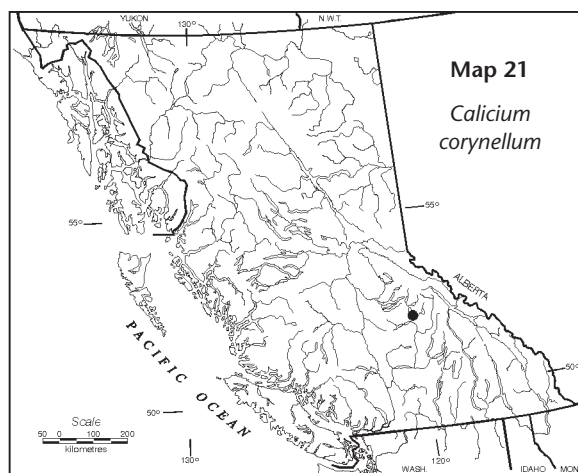
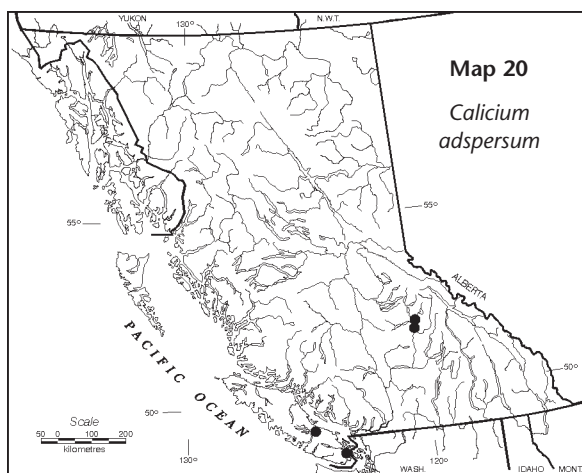


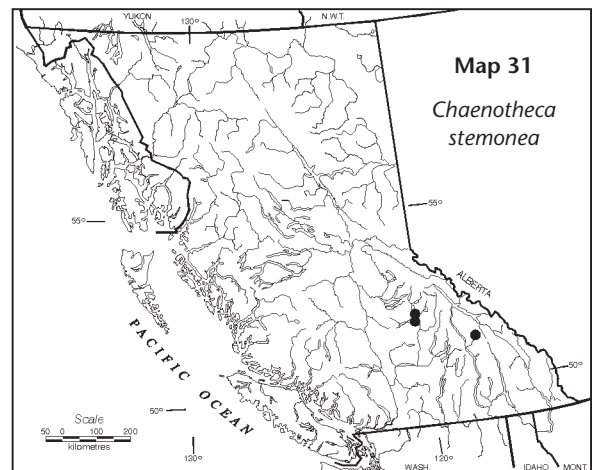
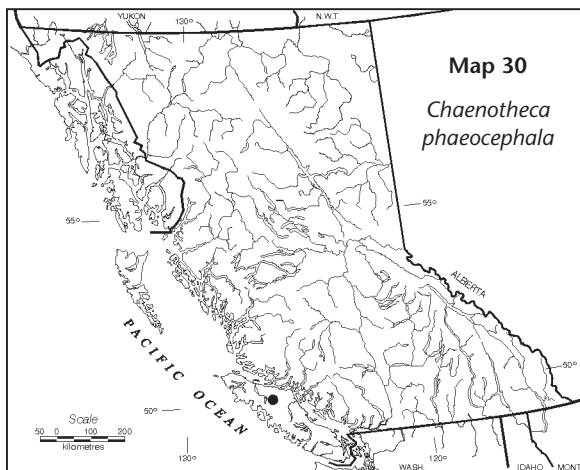
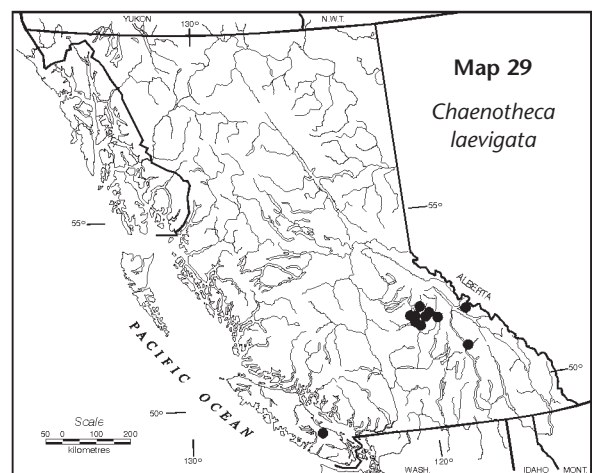
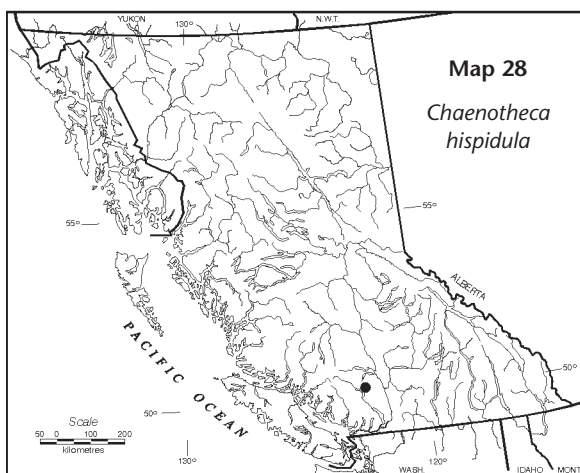
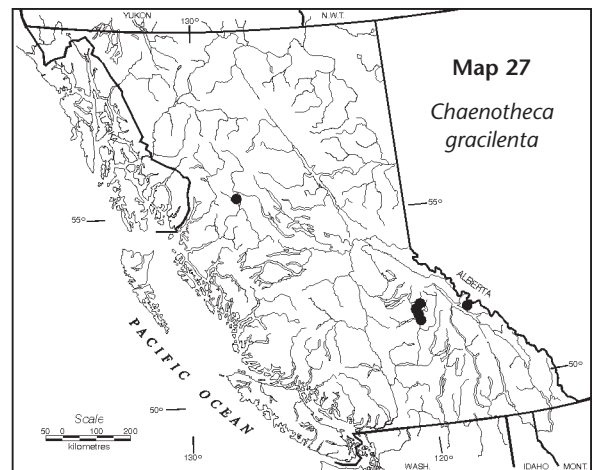
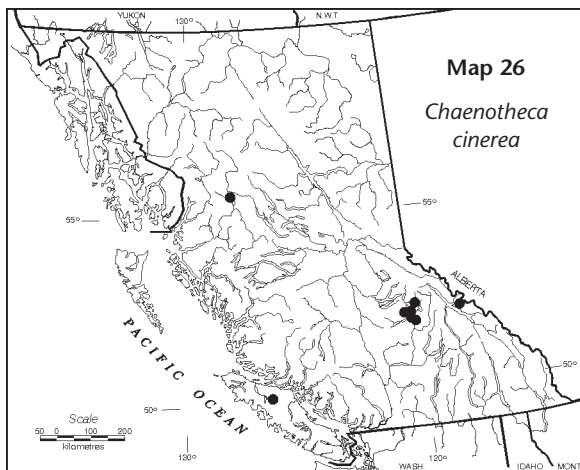
MAP 1 Lichen collection localities in British Columbia to 1998.

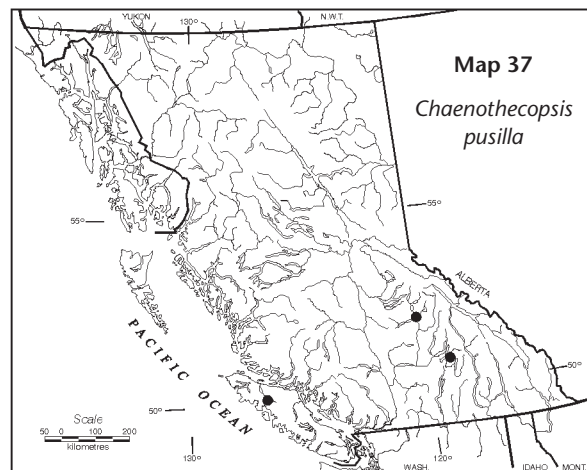
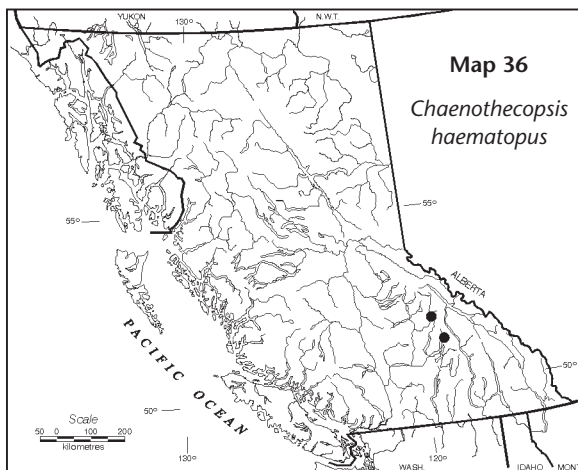
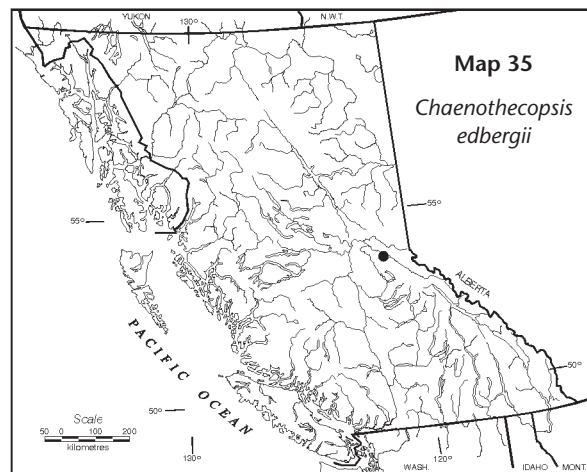
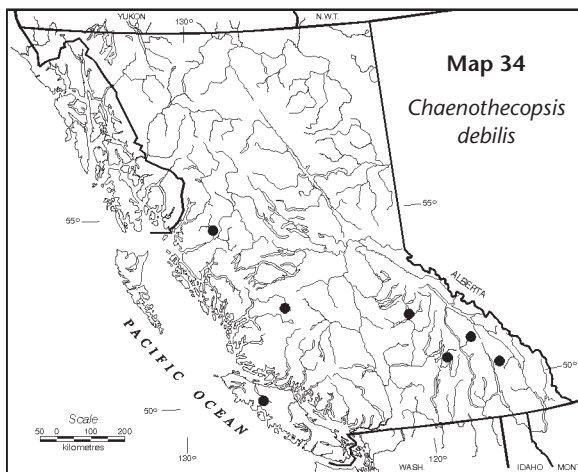
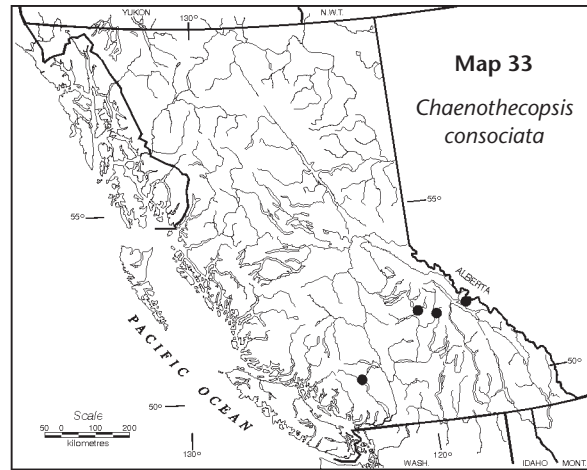
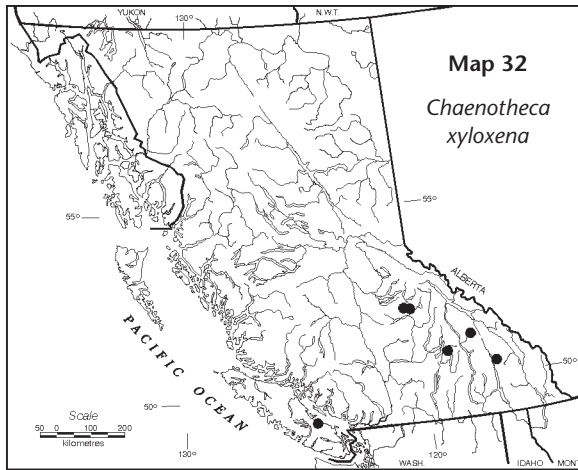


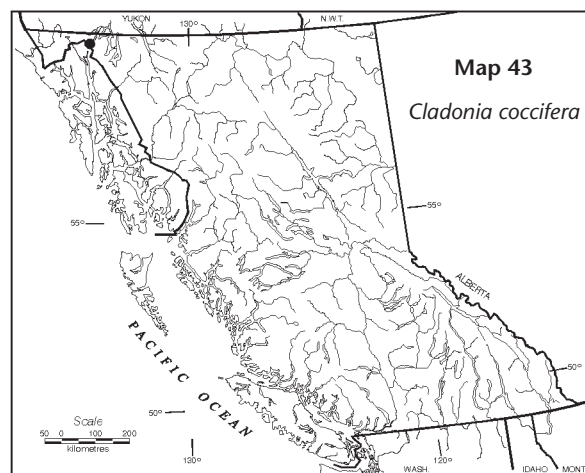
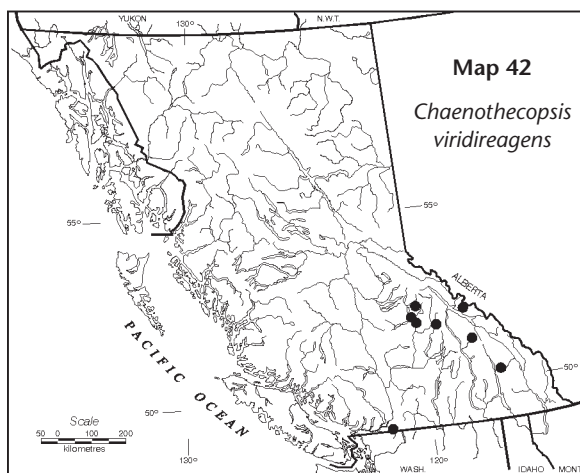
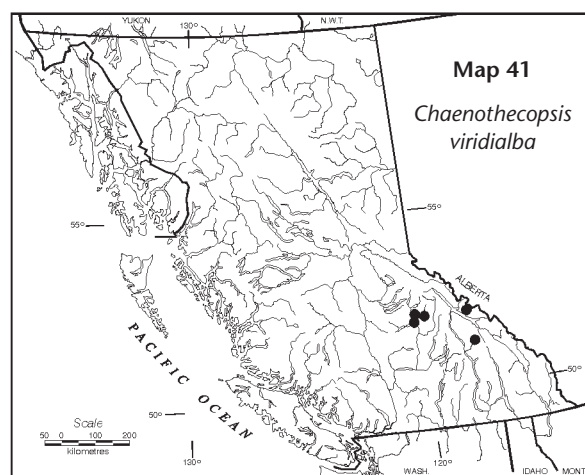
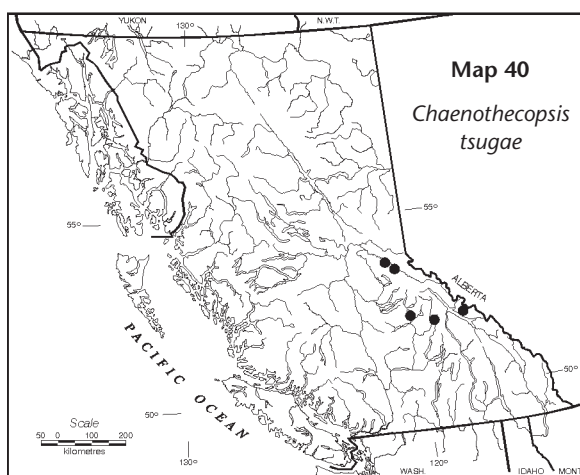
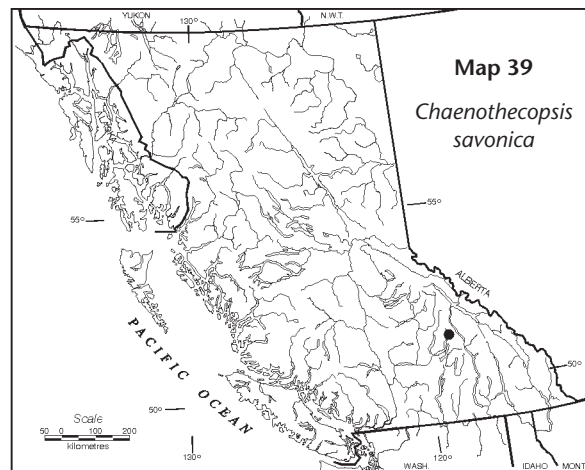
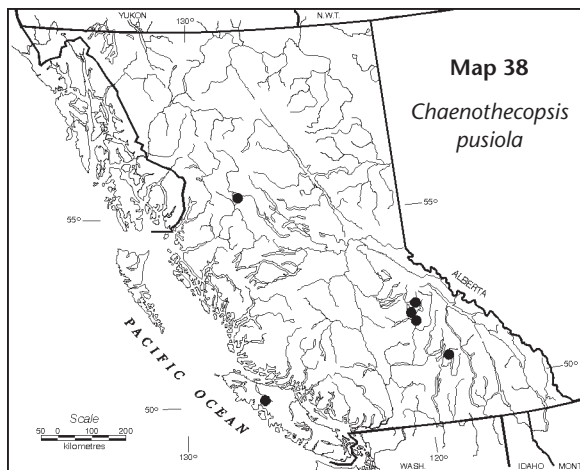


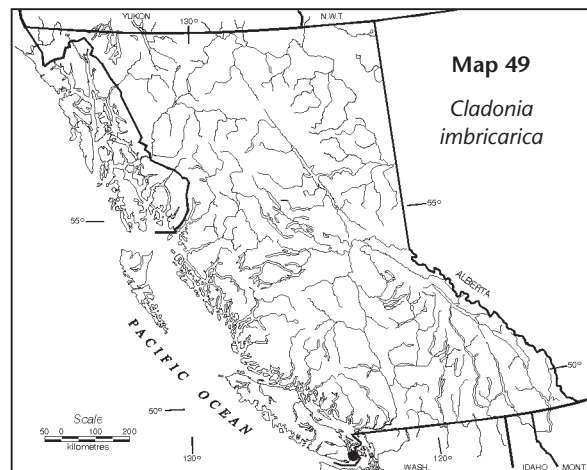
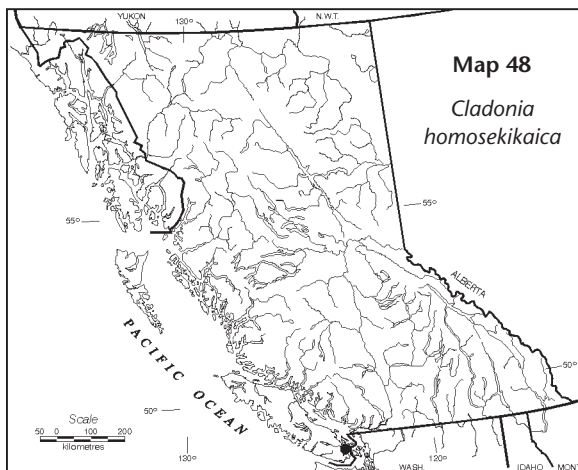
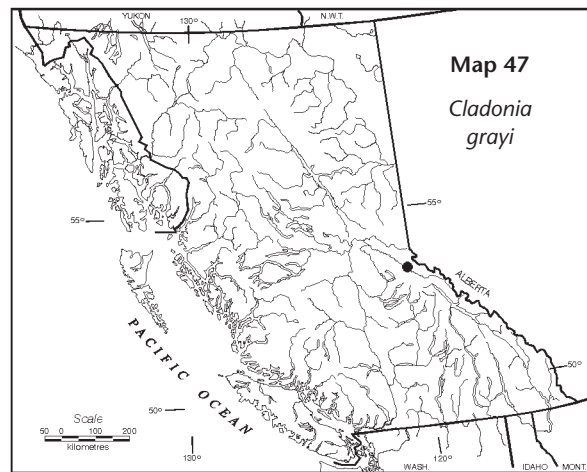
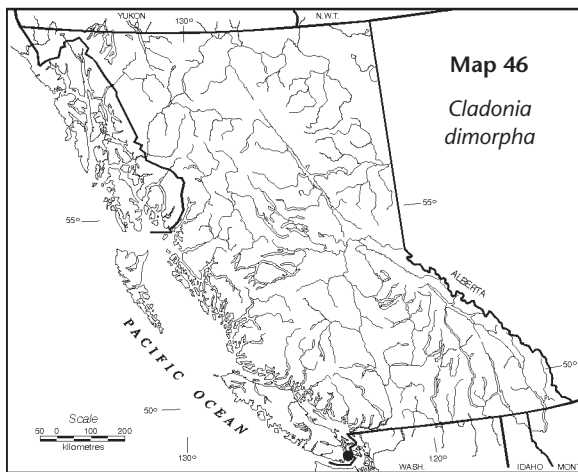
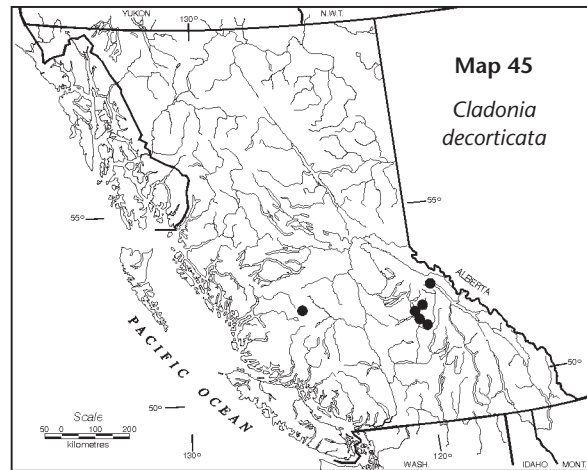
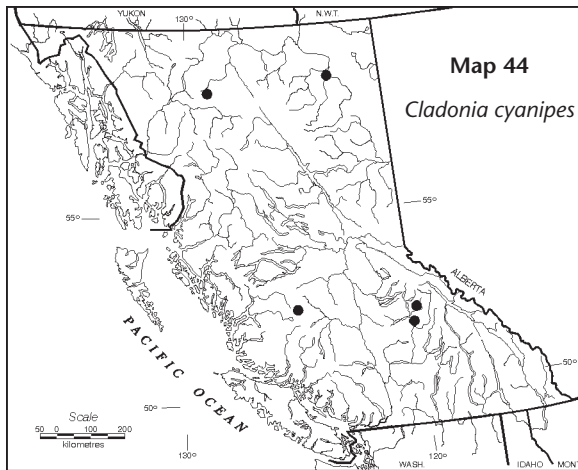


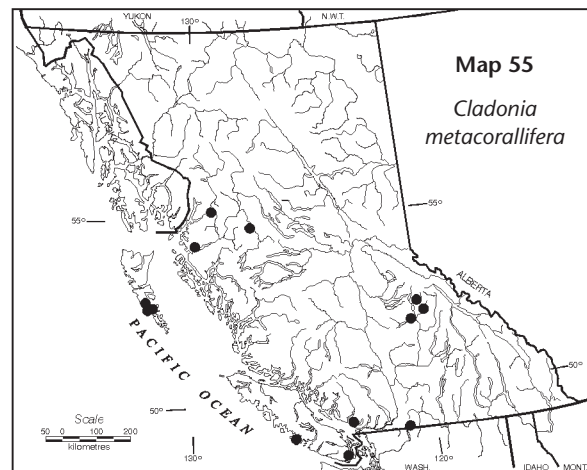
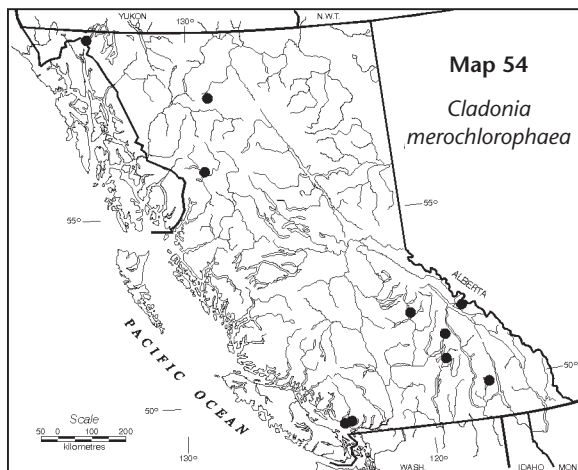
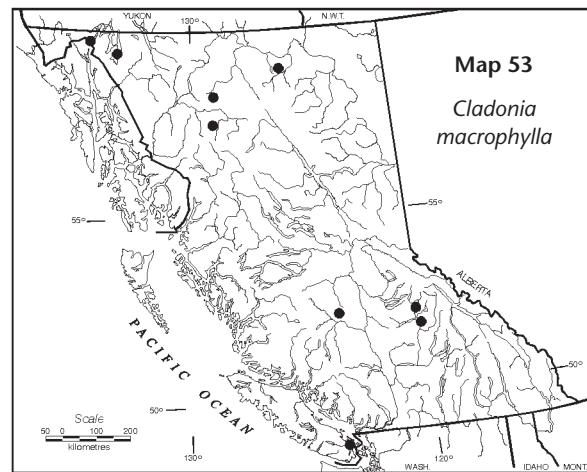
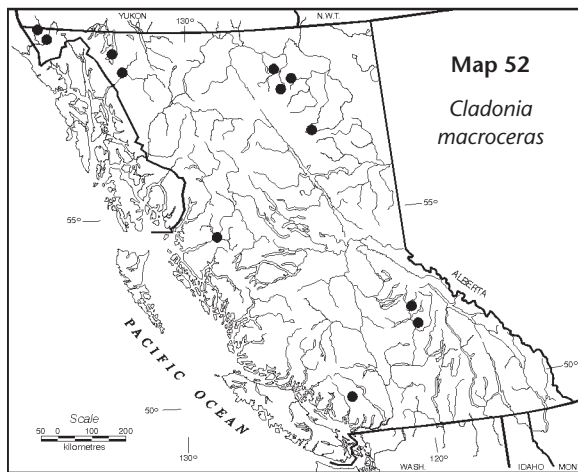
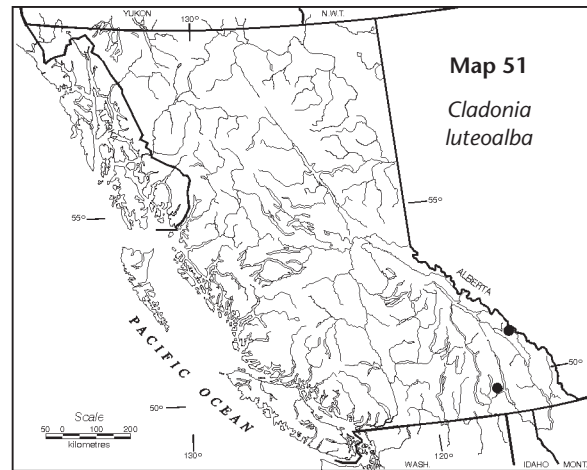
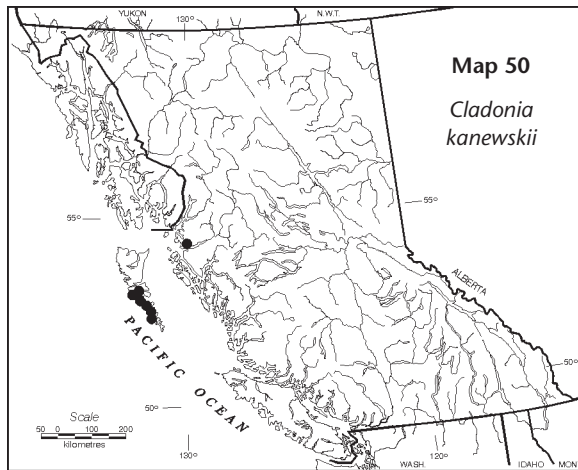


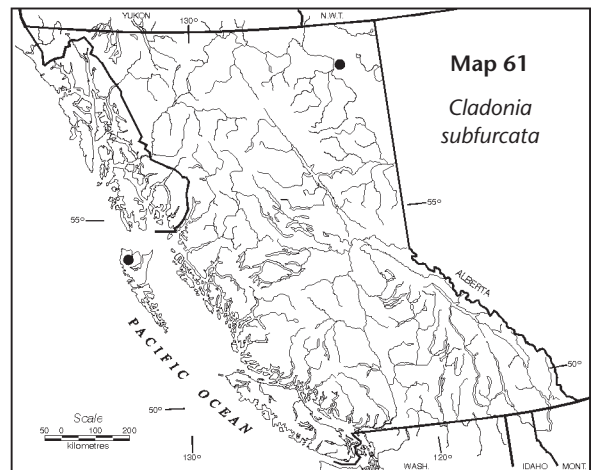
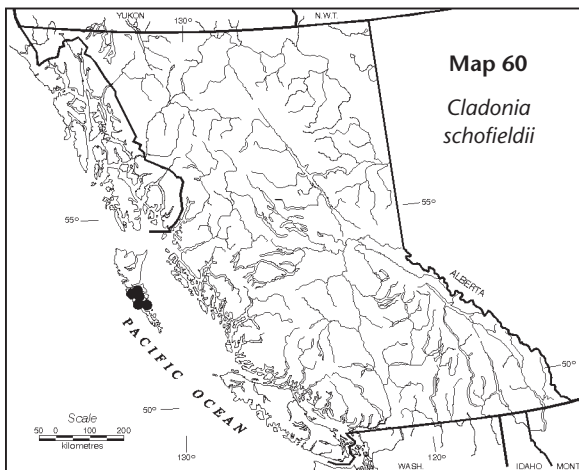
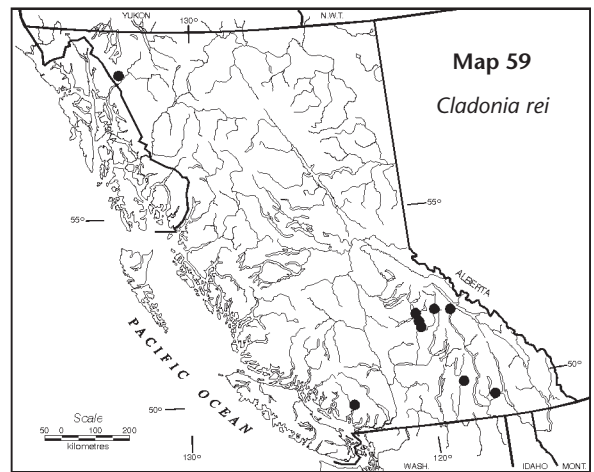
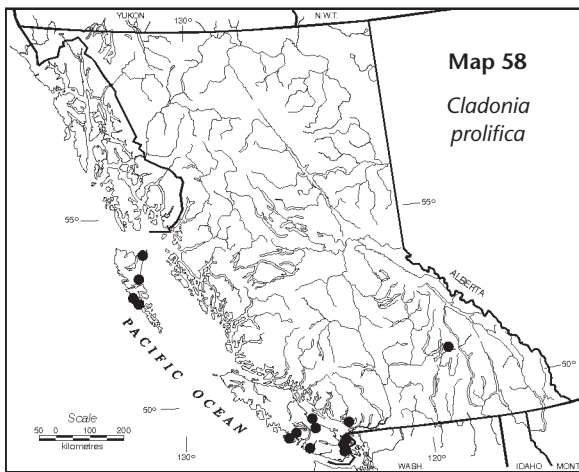
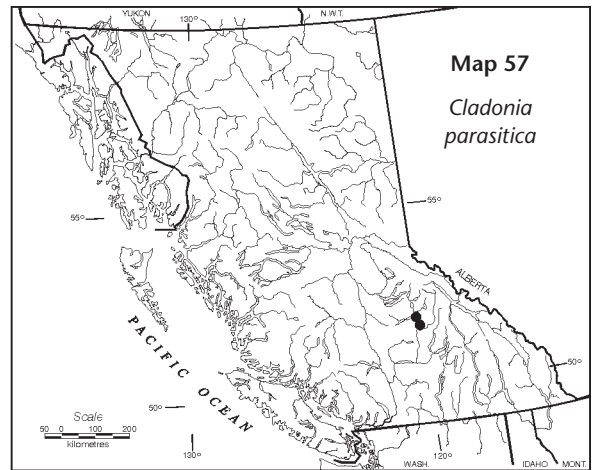
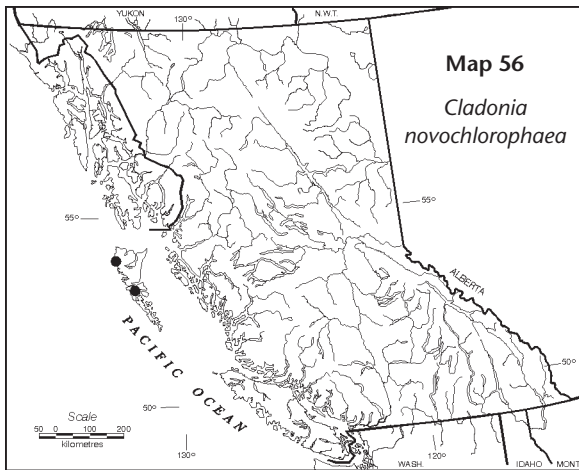


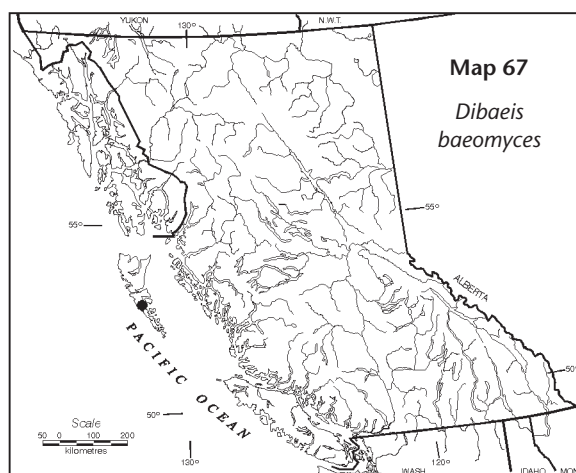
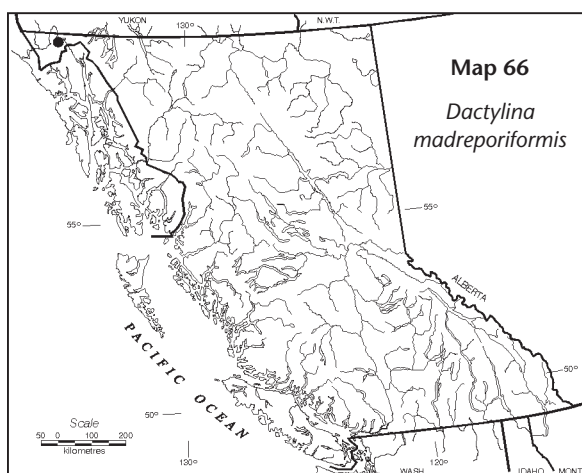
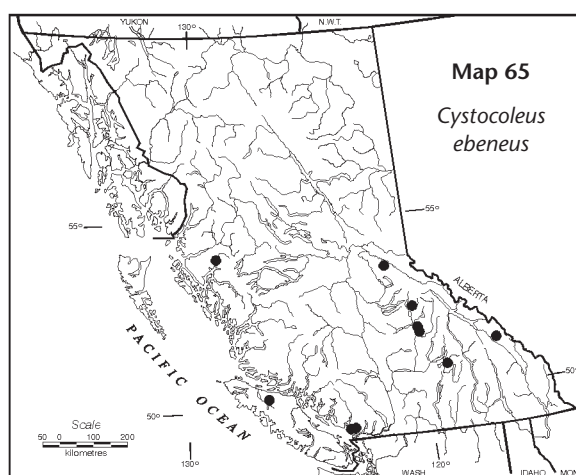
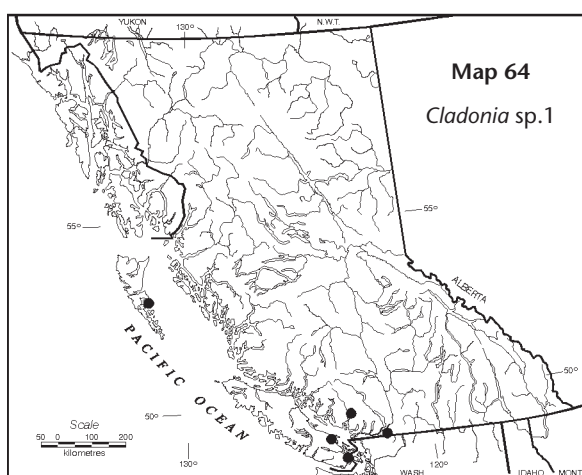
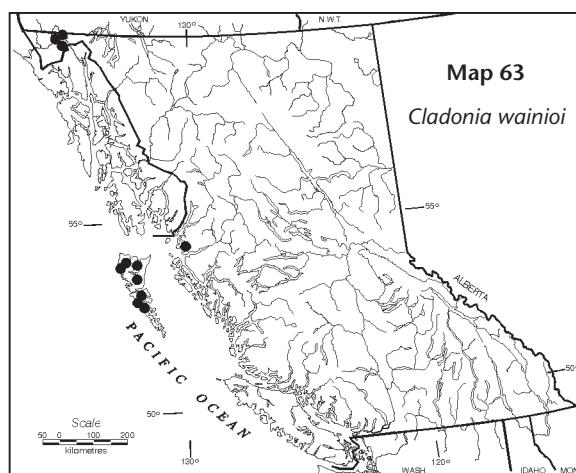
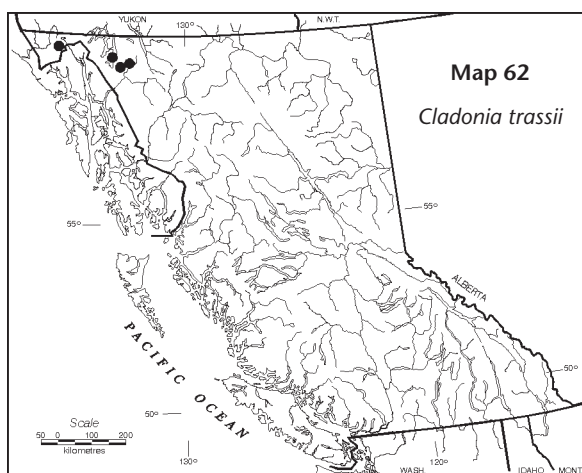


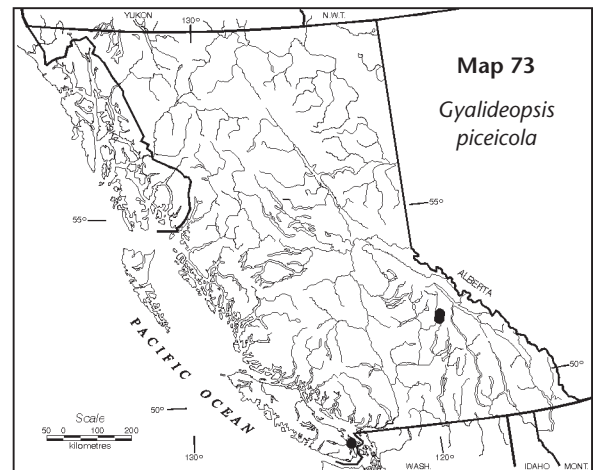
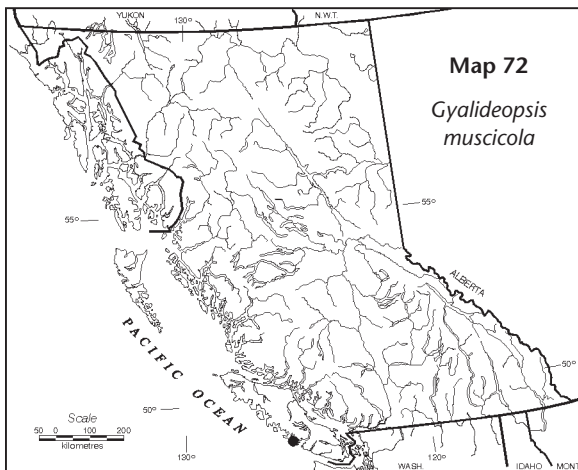
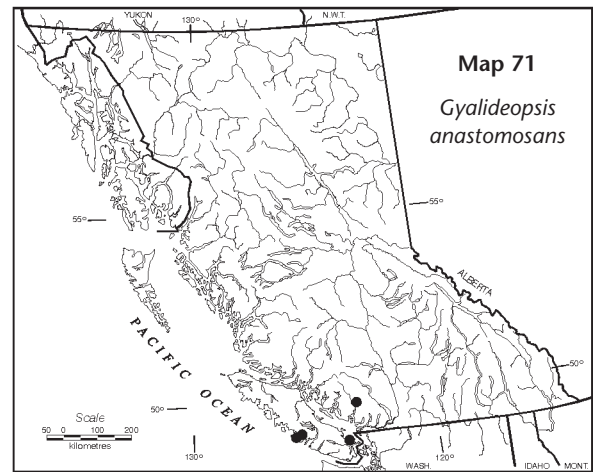
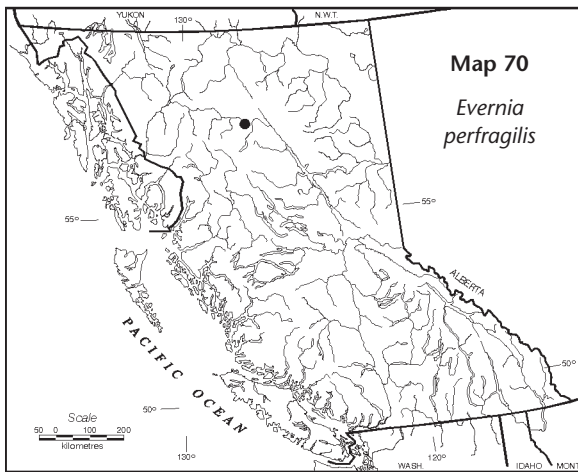
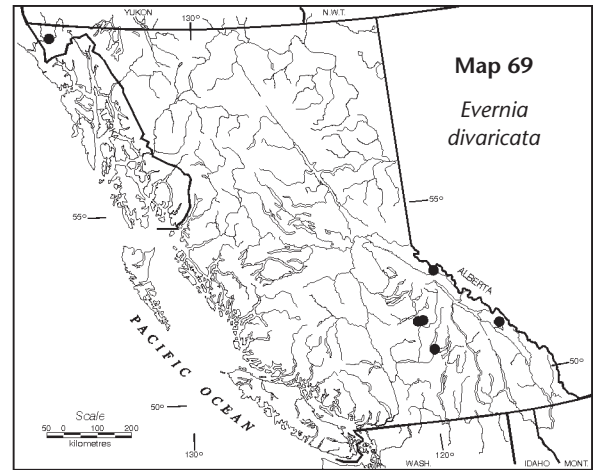
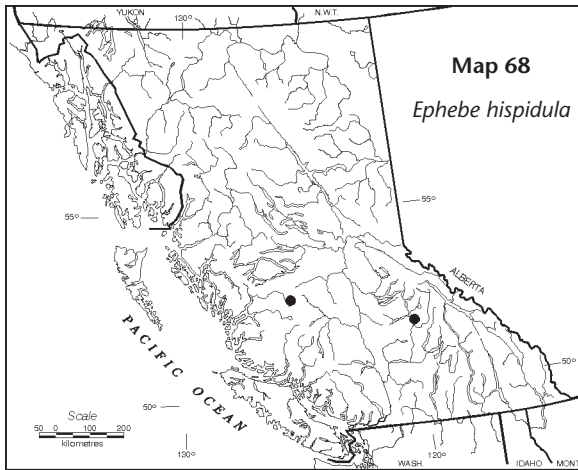


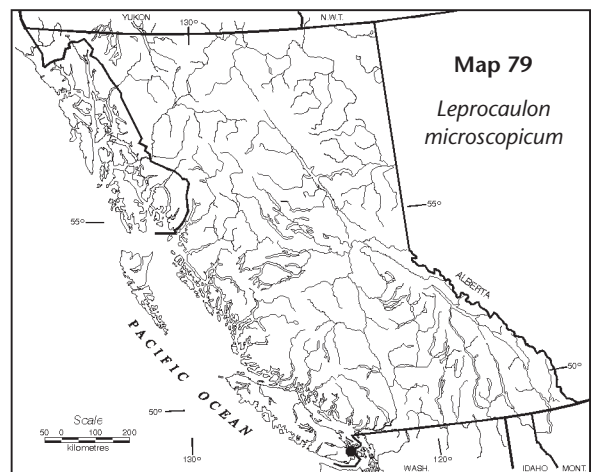
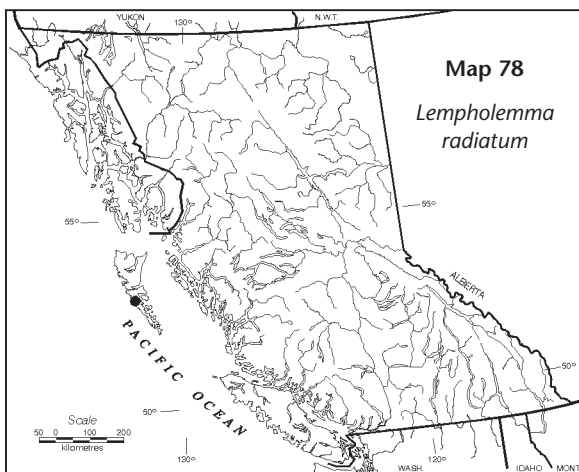
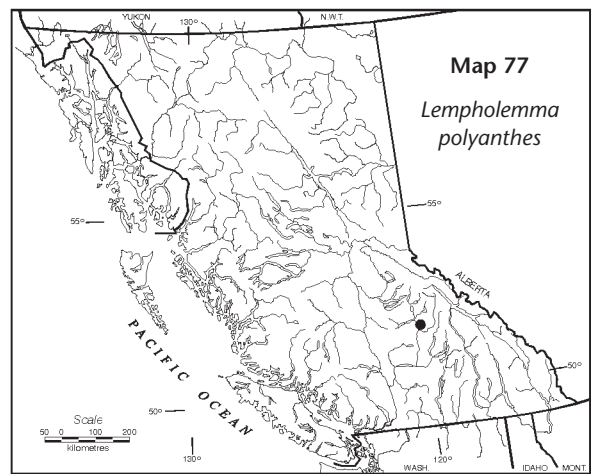
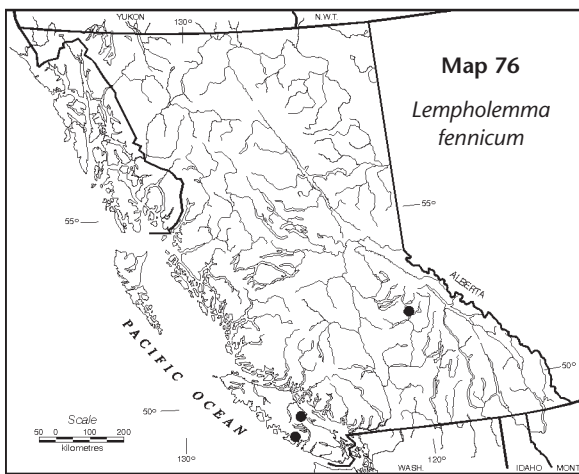
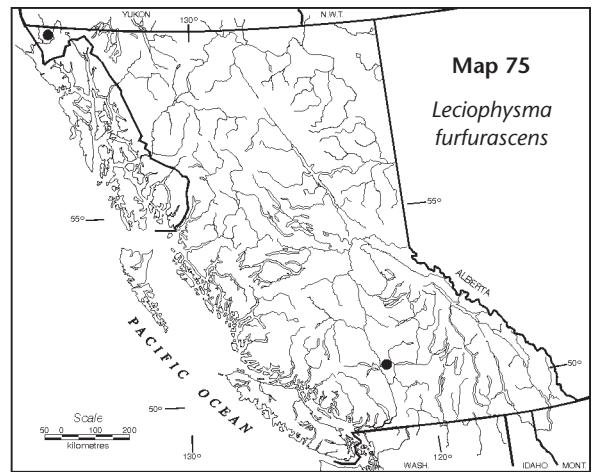
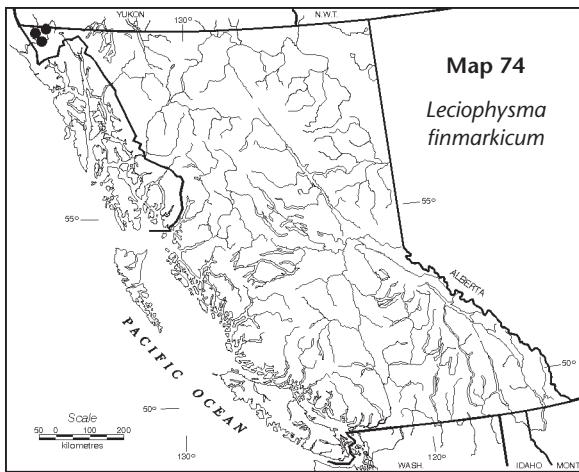


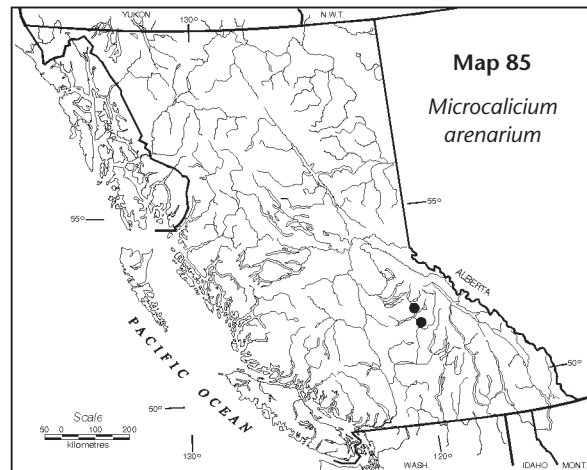
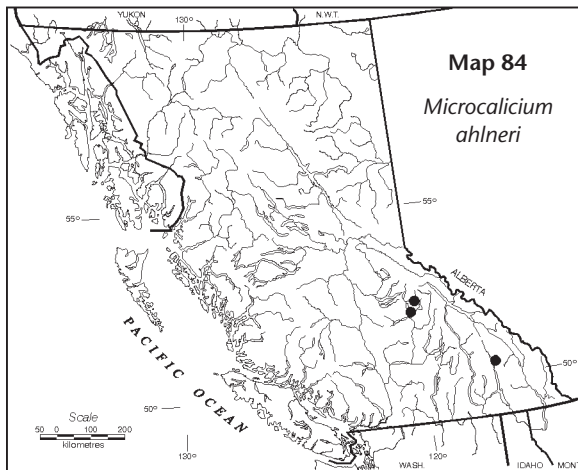
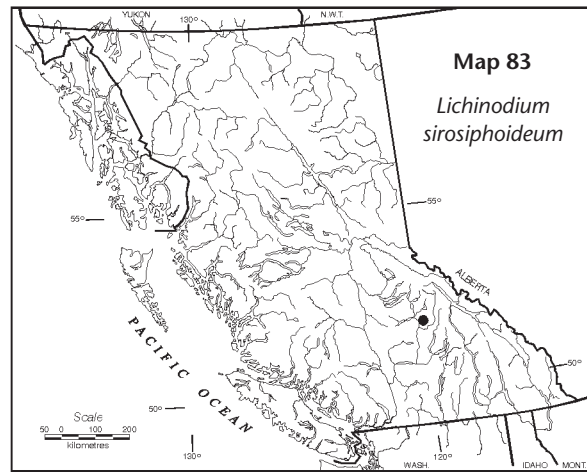
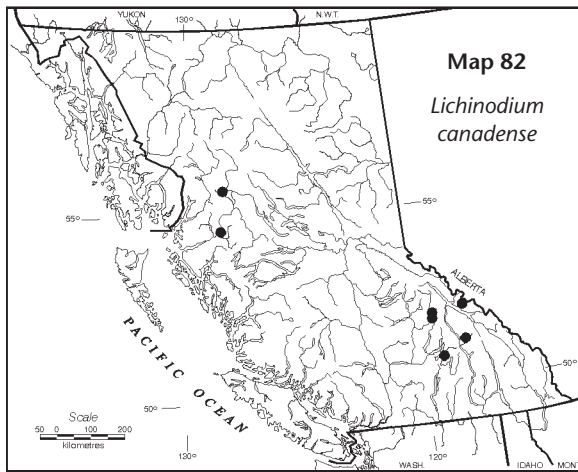
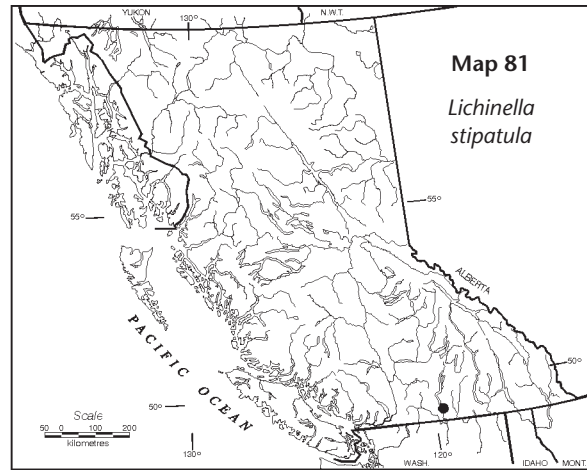
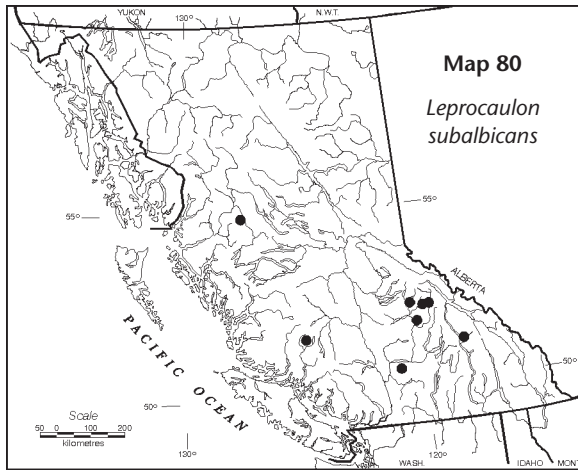


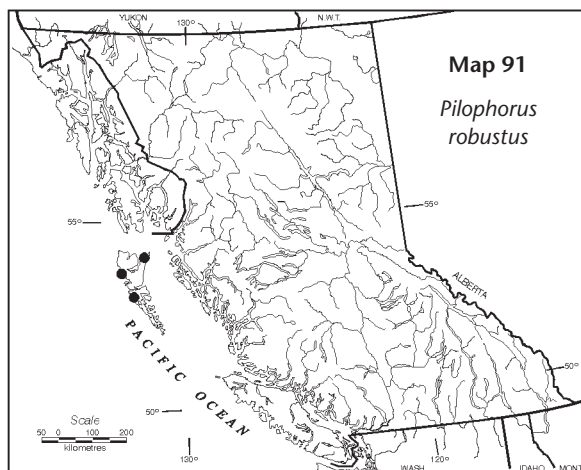
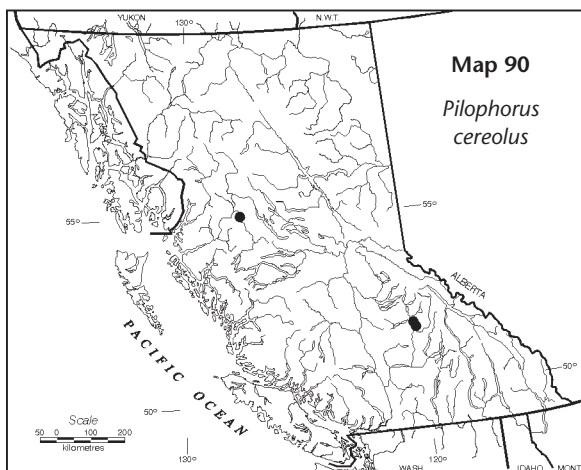
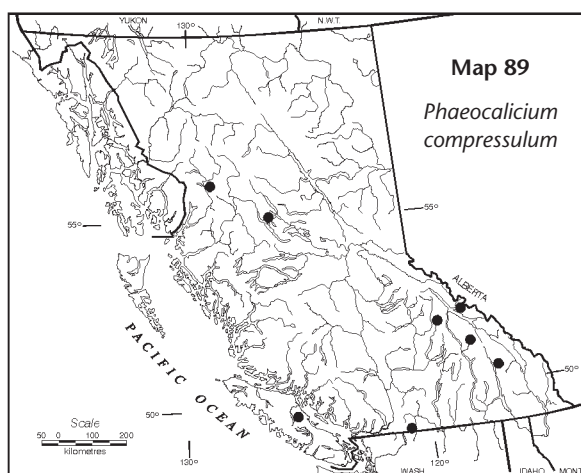
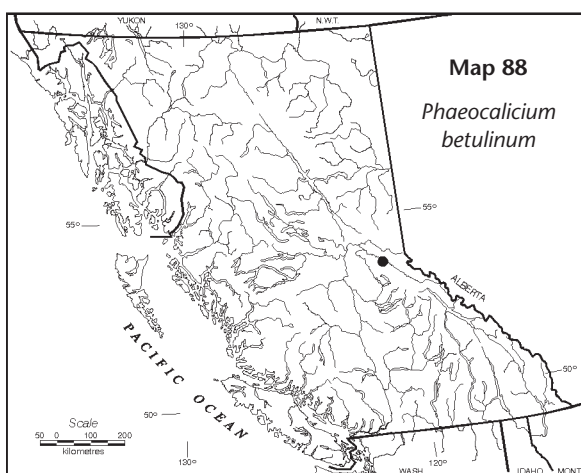
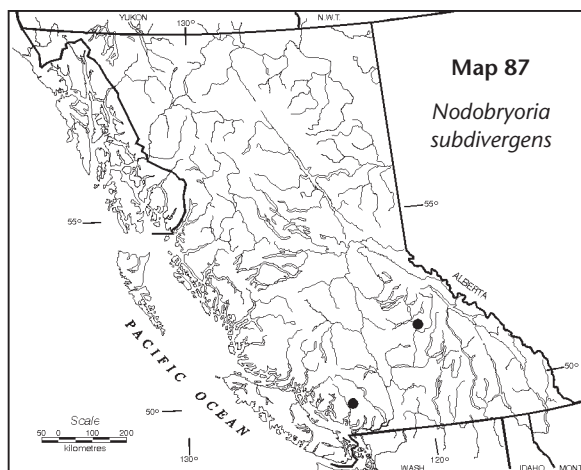
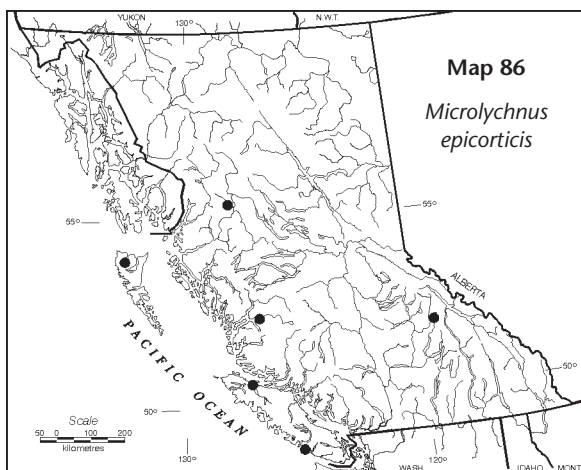


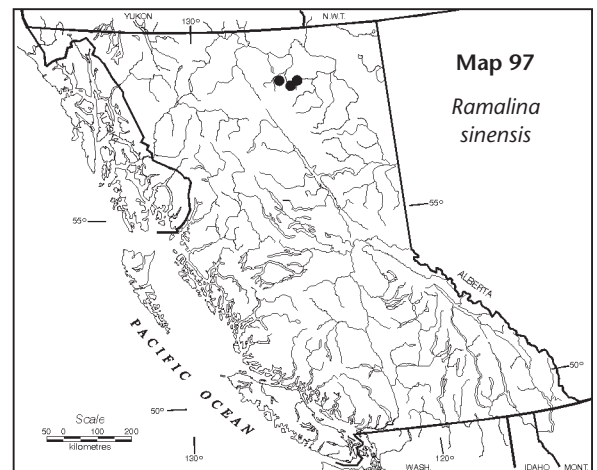
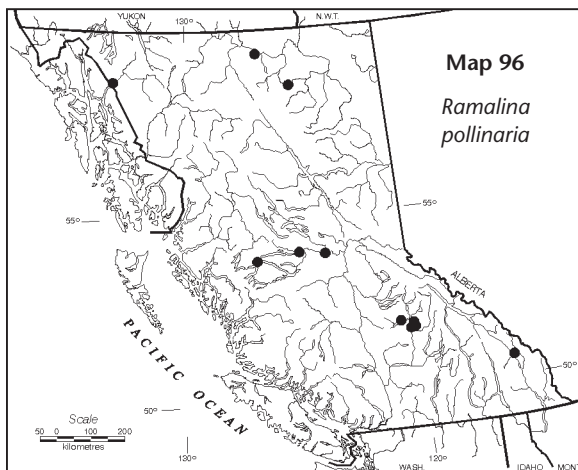
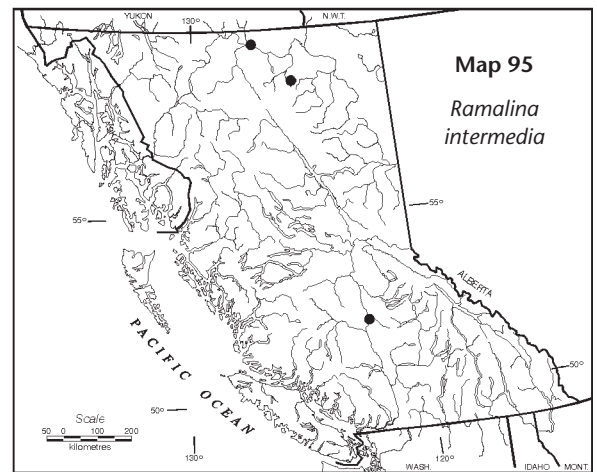
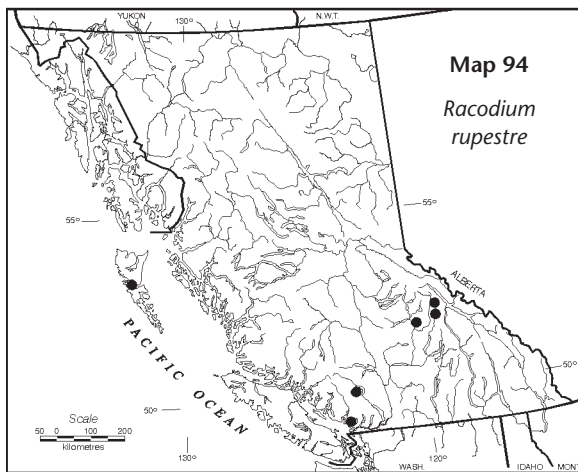
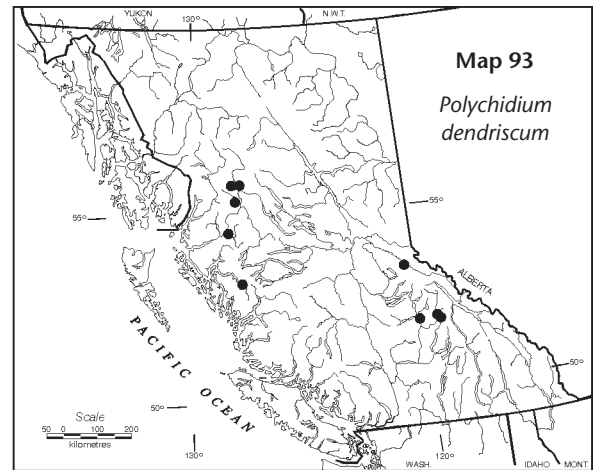
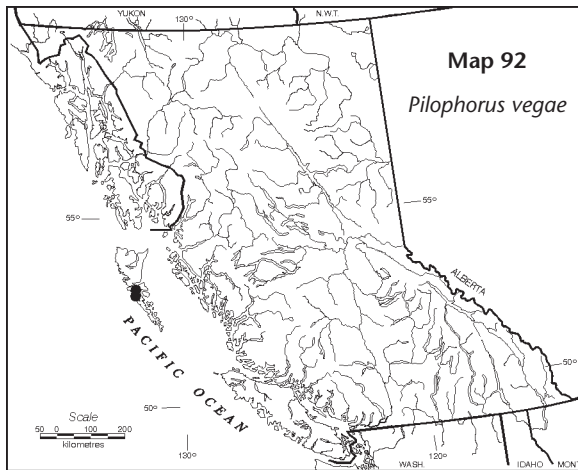


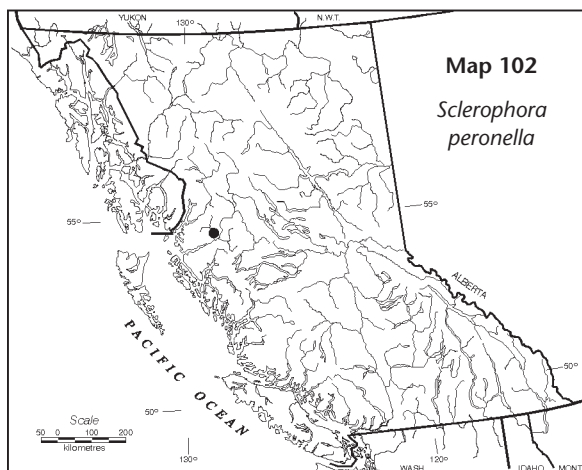
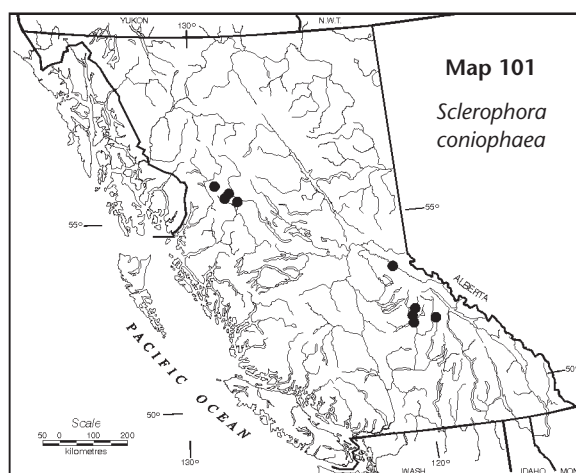
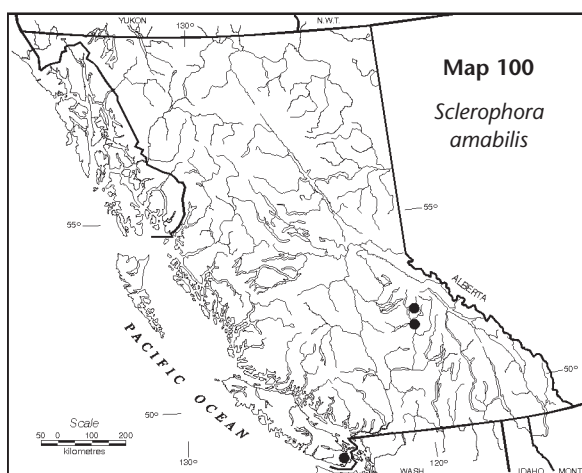
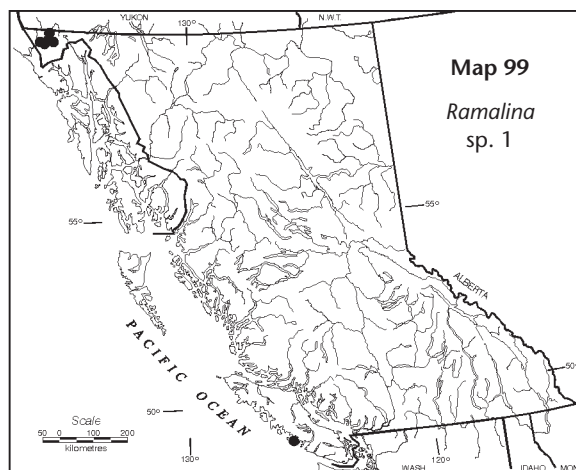
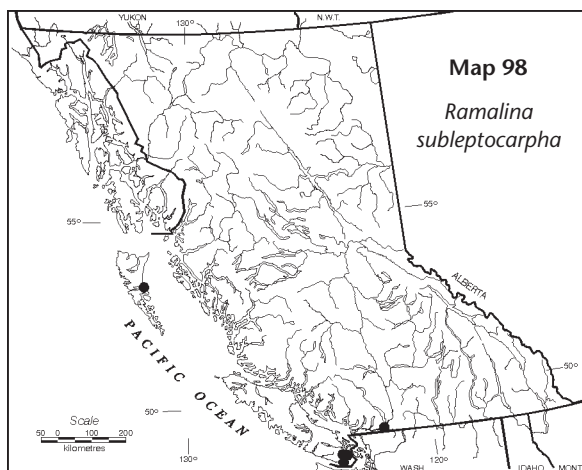


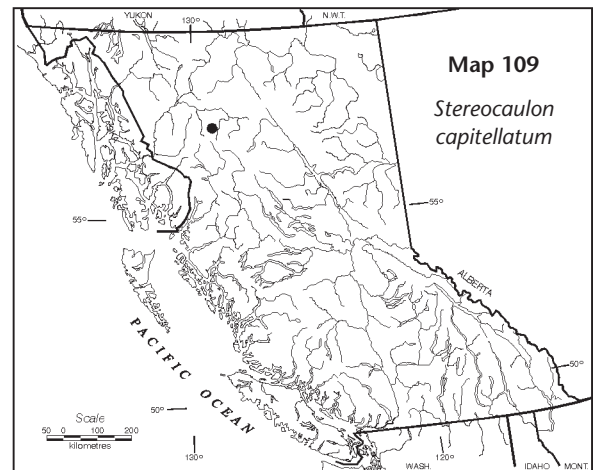
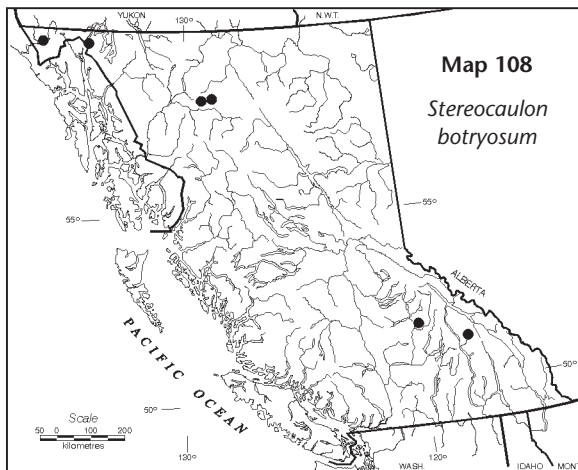
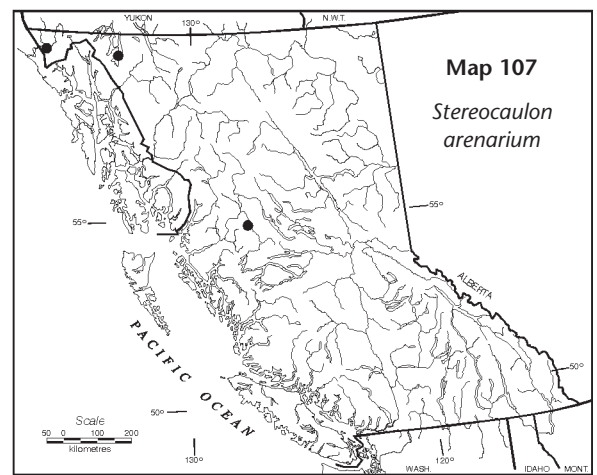
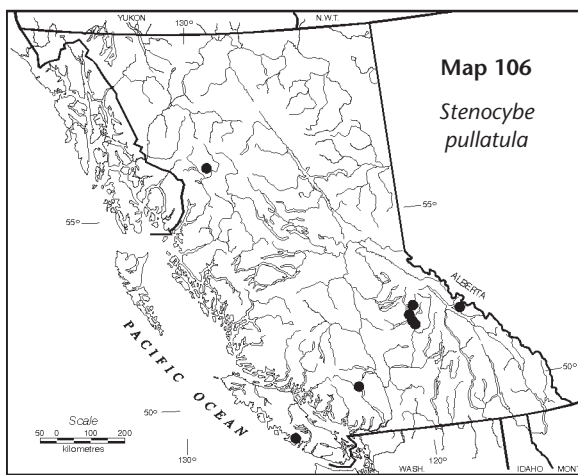
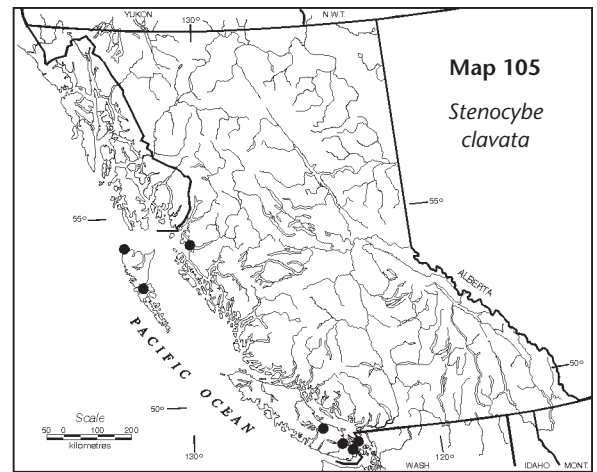
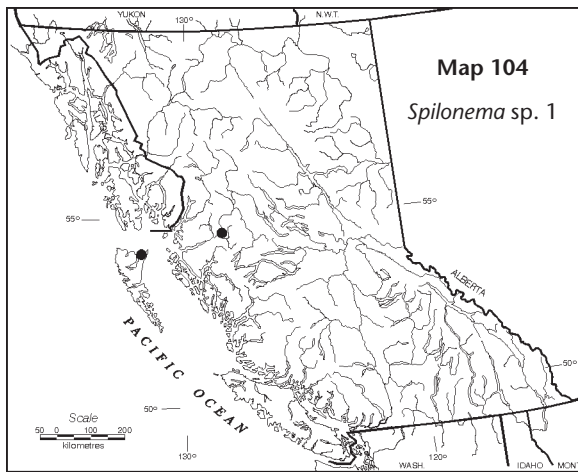


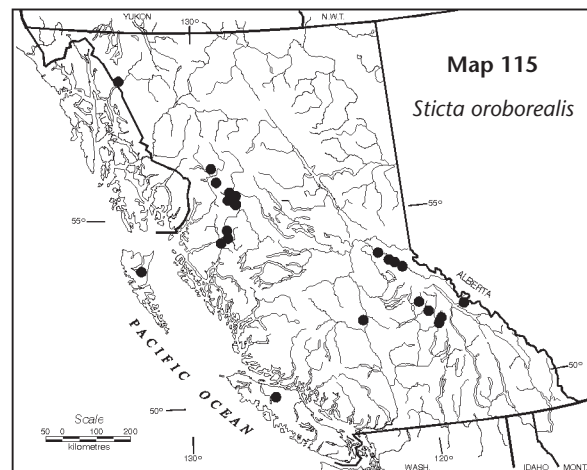
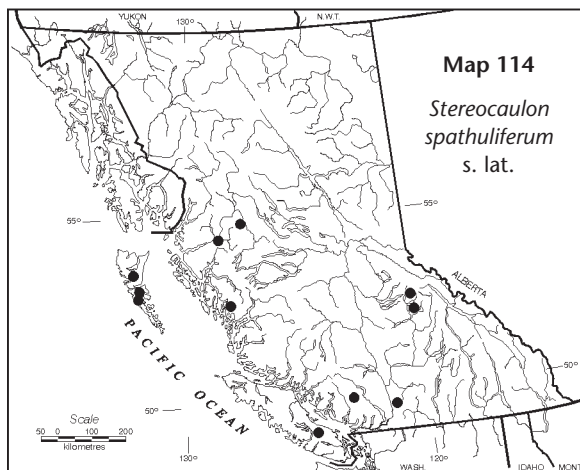
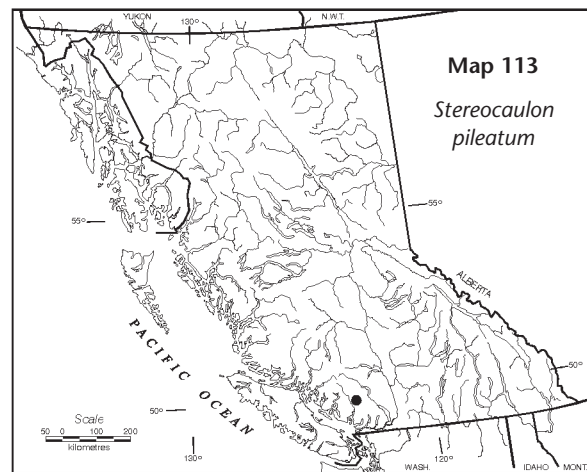
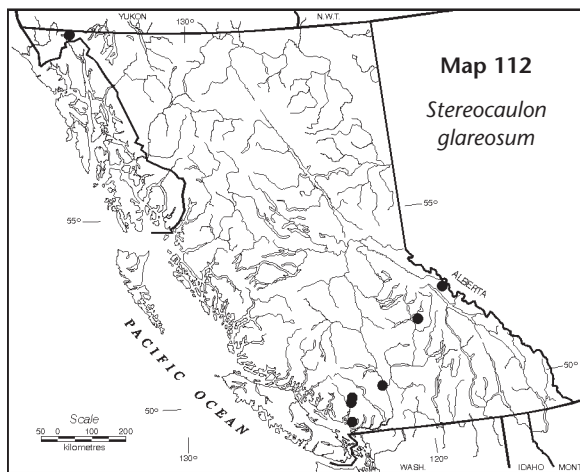
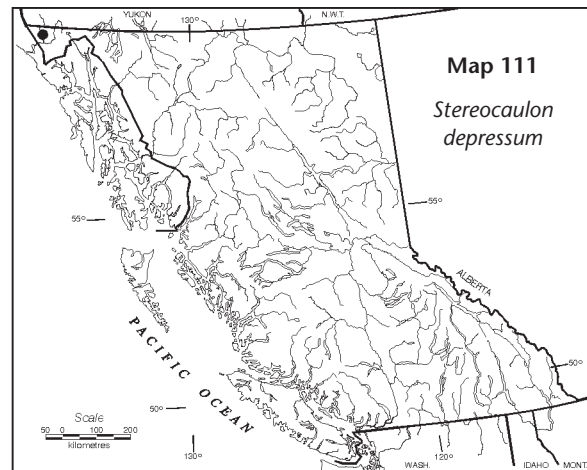
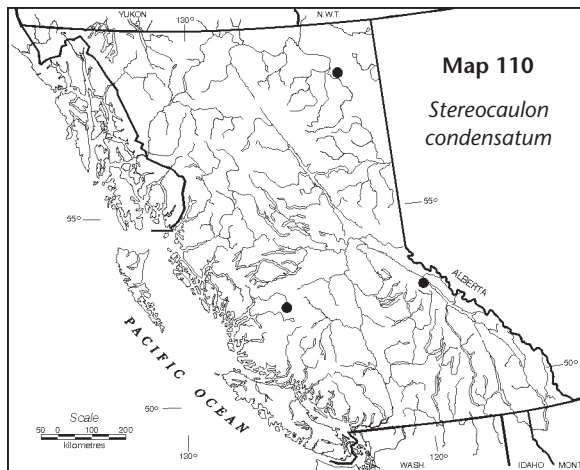


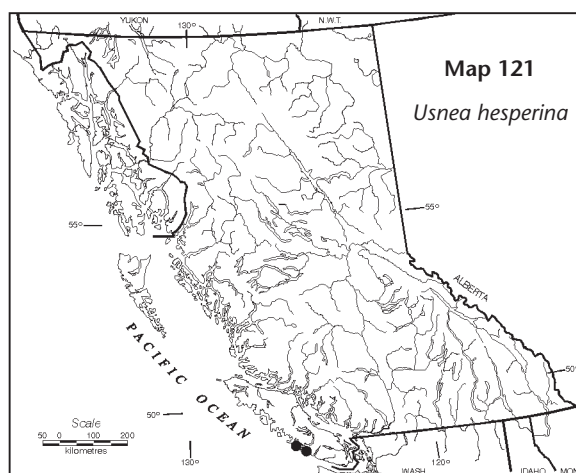
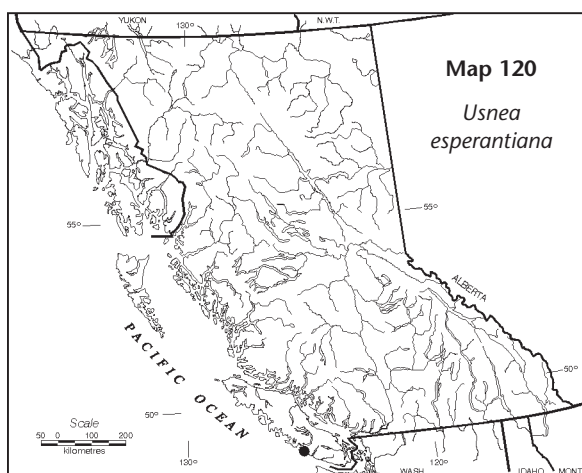
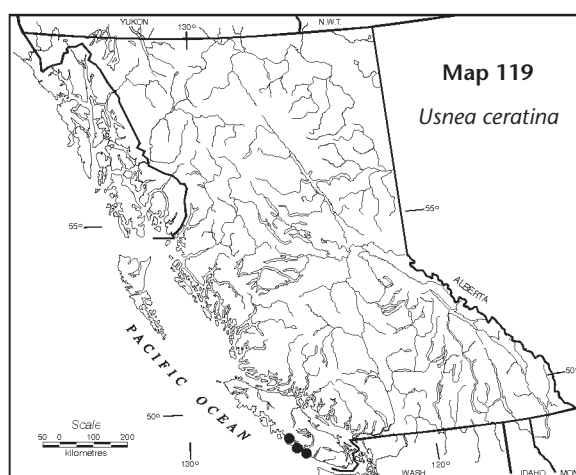
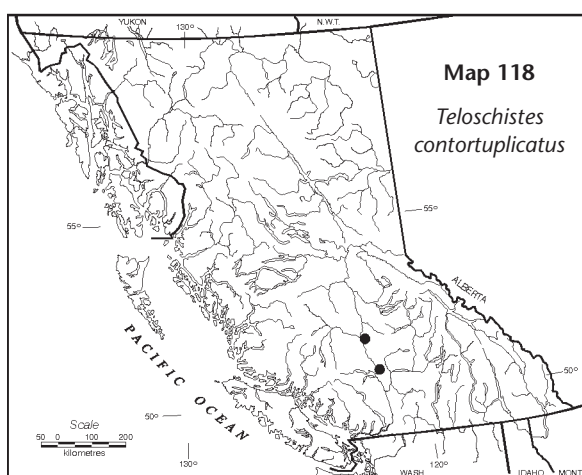
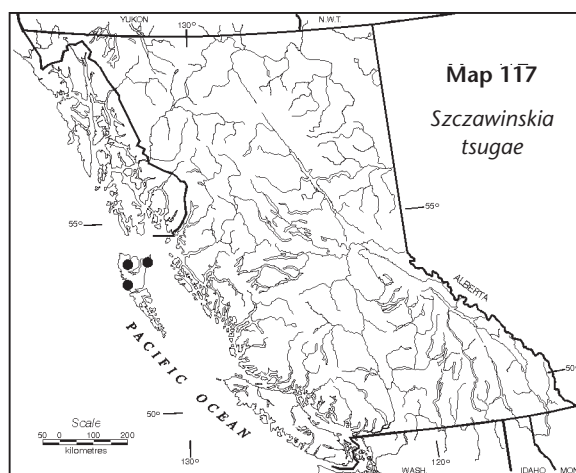
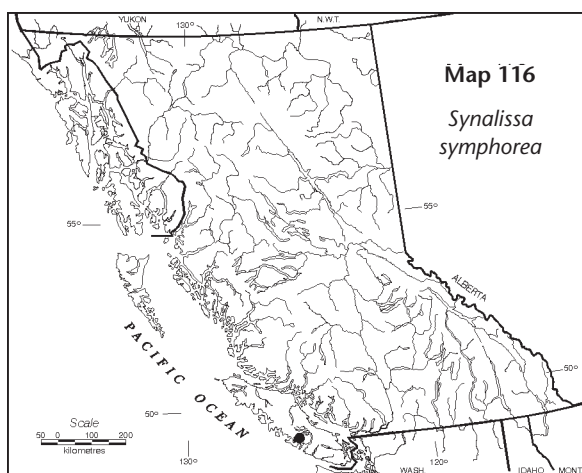


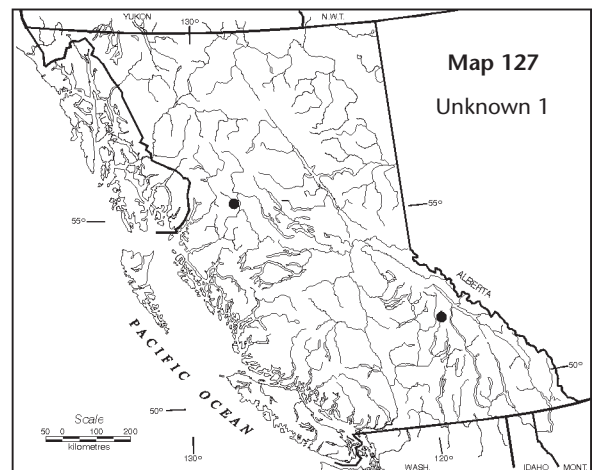
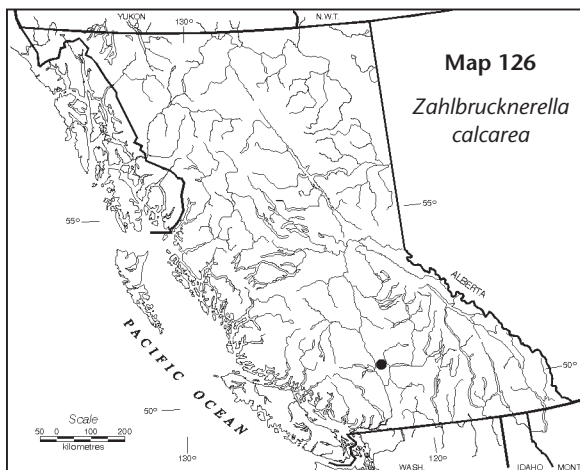
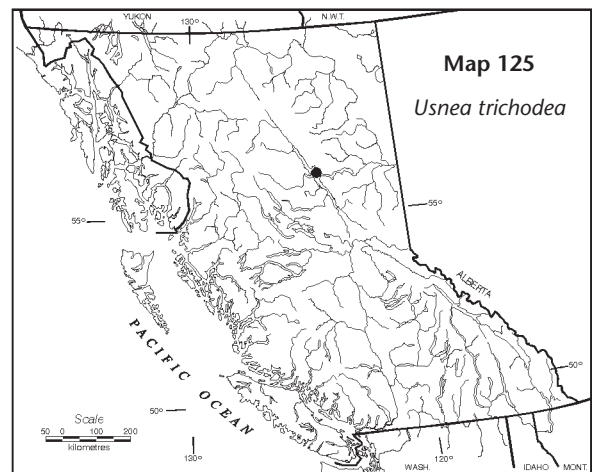
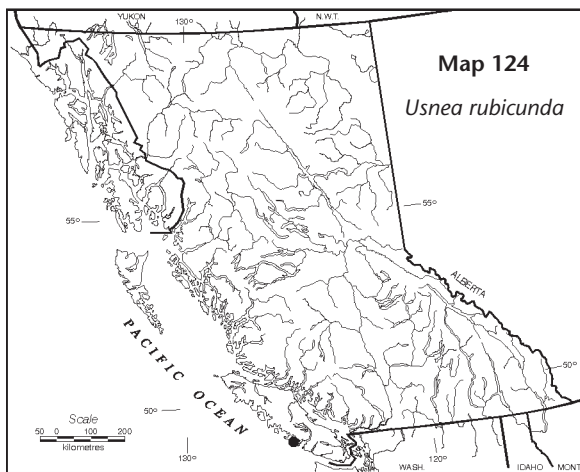
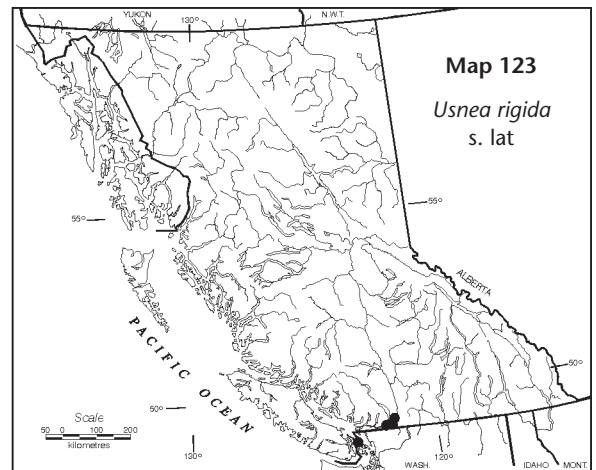
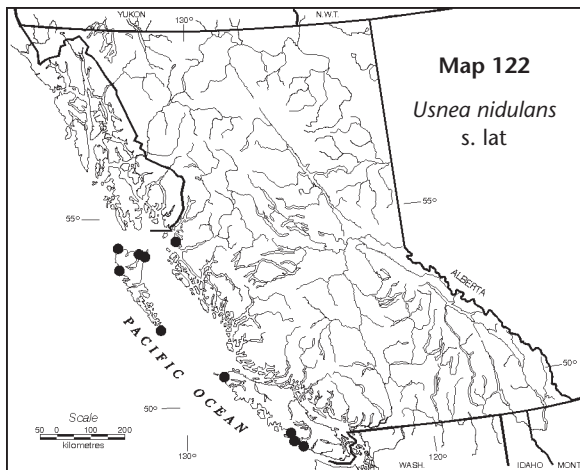


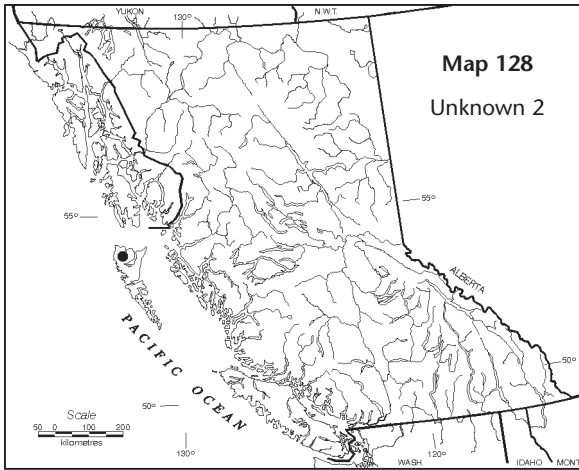












Cladonia apodocarpa Robbins was reported for British Columbia by Klinka et al. (1989), but no specimens have been seen. This eastern North American species is not expected to occur in the west.

Cladonia caespiticia (Pers.) Flörke was first reported for British Columbia by Otto (1968) and was later confirmed by Noble et al. (1987). Both reports are apparently based on a specimen in J. Macoun's "Canadian Lichens" series (No. 495), on deposit at CANL. According to the label data, this collection was made "On rocks at Deer Park, Columbia River. June 6th, 1890." The record, however, is suspect: *C. caespiticia* has an essentially eastern distribution in North America.

Cladonia carassensis Vainio was reported for British Columbia by Noble (1982) and Goward and Schofield (1983) and was later included in the checklist of Noble et al. (1987). This species, however, has not been reliably reported from North America; the local material is apparently referable to the thamnolic strain of *C. crispata* (Ach.) Flotow. ssp. *crispata*.

Cladonia cryptochlorophaea Asah. was first reported for the province by Thomson (1984) and was later included in the checklist of Noble et al. (1987). Apparently both reports were based on a single specimen (Scotter 1973) on deposit at CANL. The material has now been examined using thin-layer chromatography, and was found to contain fumarprotocetraric acid alone; it can be referred to *C. chlorophaea* (Sommerf.) Sprengel.

Cladonia gracilis (L.) Willd. ssp. *gracilis* is a European and eastern North American taxon first reported for British Columbia by Otto and Ahti (1967) and later by Thomson (1984) and Thomson and Ahti (1994). The specimens on which

these reports are based are referable to other species (T. Ahti, University of Helsinki, pers. comm., 1998).

Cladonia humilis (With.) J.R. Laundon was included in the British Columbia checklist of Noble et al. (1987), though no specimens were found at CANL, UBC, or VC. However, *C. humilis* has been reliably documented from northern portions of the American Pacific Northwest (Hammer 1995), and should be searched for in adjacent portions of British Columbia.

Cladonia maxima (Asah.) Ahti was recorded for the province by Ahti (1980) and was later included in the checklist of Noble et al. (1987). However, the material is abundantly perforate, and can thus be referred to *C. gracilis* (L.) Willd. ssp. *vulnerata* Ahti. *Cladonia maxima* s. str. may eventually be found in coastal Alaska (T. Ahti, University of Helsinki, pers. comm., 1998).

Cladonia nipponica Asah. has been recorded for British Columbia on several occasions, including Otto and Ahti (1967), Thomson (1984), and Noble et al. (1987). However, all specimens examined in connection with this manual gave a PD-reaction, and are thus referable to *C. kanewskii* Oksner. Authentic material of *C. nipponica* is known from coastal Alaska (T. Ahti, University of Helsinki, pers. comm., 1998), and might yet be found in north coastal British Columbia.

Cladonia polydactyla (Flörke) Sprengel was recently reported for British Columbia by Aptroot (1996). However, this species is not currently accepted as occurring in North America (Esslinger and Egan 1995); the local material can probably be referred to *C. umbricola* Tønsberg and Ahti.

Cladonia pseudomacilenta Asah. was first reported for British Columbia by Otto and Ahti (1967), and has been reported several times since then, most recently by Goward and Ahti (1992). However, *C. pseudomacilenta* is an eastern Eurasian species not known to occur in North America (Esslinger and Egan 1995); the local material is referable to *C. umbricola* Tønsberg and Ahti.

Cladonia thomsonii Ahti is a North American arctic species first reported for British Columbia by Thomson and Ahti (1994); the record, however, is probably referable to *C. kanewskii* (T. Ahti, University of Helsinki, pers. comm., 1998).

Cladonia vulcani Savicz was first recorded for British Columbia by Bird and Bird (1973; as *C. theiophila* Asah.), and has appeared in the literature several times since then, including Noble et al. (1987). This species, however, is not currently accepted as occurring in North America; the local material is probably referable to *C. umbricola* Tønsberg and Ahti.

Coelocaulon muricatum (Ach.) J.R. Laundon (Syn. *Cetraria muricata* (Ach.) Eckfeldt) has been reported for the province on several occasions, most notably by Kärnefelt (1986), who provided a map of its distribution. However, no consistent points of separation with *C. aculeatum* (Schreber) Link could be discerned in the British Columbia material; see also the notes under that species.

Dictyonema moorei was reported for British Columbia by Brodo (1995), based on a specimen from the Queen Charlotte Islands. The report, however, was in error (I.M. Brodo, Canadian Museum of

Nature, Ottawa, pers. comm., 1998). The material probably represents an undescribed taxon; it is included in this manual as "Unknown 2."

Lempholemma isidioides (Nyl.) H. Magn. was provisionally reported as new for North America by Brodo et al. (1987), based on a specimen from the Liard River basin (Brodo 21610), on deposit at CANL. The specimen has subsequently been examined, and appears to be referable to *Collema subparvum* Degel.

Stereocaulon coniophyllum Lamb was reported for British Columbia by Noble et al. (1987) on the basis of a single specimen collected in northern British Columbia (Otto 5502). The specimen is on deposit at CANL. It has been re-examined, and appears to be referable to *S. capitellatum* H. Magn; see the notes under that species.

Stereocaulon dactylophyllum Flörke was first recorded for the province by Tuckerman (1882: as *S. coralloides* Fr.), and has been reported many times since then, most recently by Noble et al. (1987). However, no authentic specimens have been seen; the local material can probably be referred to *S. intermedium* (Savicz) H. Magn.

Stereocaulon saxatile H. Magn. was first reported for British Columbia by Ahti (1962: as *S. evolutoides* (H. Hagn.) Frey), and has been recorded on several occasions since then, including Bird and Bird (1973), Thomson (1984), and Noble et al. (1987). However, no authentic material has been seen.

Stereocaulon subcoralloides (Nyl.) Nyl. was first reported for British Columbia by

Noble et al. (1987), though no authentic material has been seen. Several specimens labelled under this name at CANL are referable to *S. intermedium* (Savicz) H. Magn.

Usnea capitata Mot. was recently reported for the province by Thomson and Ahti (1994)—apparently on the basis of a

misidentification (P. Halonen, University of Oulu, Finland, pers. comm., 1998).

Usnea merrillii Mot. was first reported for British Columbia by Motyka (1936), and has more recently appeared in the checklist of Noble et al. (1987). Most of the local material, however, is probably referable to *U. chaetophora* Stirton.

Note: Some of the terms included below appear only in Part 1 of this series.

AB: Alberta.

acicular (= needle-like): long, very slender, and pointed.

acid: referring to rock or bark lacking free calcium carbonates. Most quartzites are acidic (= siliceous) and most conifers have acid bark. See also **base-rich**.

aeruginose: dull bluish green.

AK: inland Alaska.

algae: (sing.: alga): in lichens, tiny photosynthetic cells (also called the **photobiont**), usually grass-green in colour, from which the lichen fungus derives its carbohydrate requirements. In some lichens the photobiont is a **cyanobacterium**. See page 23 [28].

anisotomic (= uneven): branching unequally, with the side-branches narrower than the main stem.

apothecia (sing.: -ium): in lichens, the saucerlike or buttonlike fruiting bodies (**ascocarps**) in which the sexual **spores** of the fungal partner are borne. Macroscopically, a typical apothecium comprises a **disc** and an **excipulum**, or “rim” (see Figure 13, page 18). See also **mazaedia** and **perithecia**.

apothecial rim: see **excipulum**.

apotheciate: bearing **apothecia**.

arachnoid: in lichens, sparsely covered in a delicate mesh of fine fungal threads.

areolate (= platy): bearing **areoles**.

areoles: in lichens, tiny, tile-like patches of cortex, each minutely separated from the others adjacent by narrow cracks (see Figure 11c, page 16).

asci (sing.: ascus): microscopic, saclike structures within the **ascocarp** of an **ascomycete**, in which sexually produced spores are borne (see Figure 13d, e, i, page 18).

ascocarp: general term for the sexual fruiting body of an **ascomycete** (i.e., the class of fungi to which most lichens belong). **Apothecia**, **mazaedia**, and **perithecia** are ascocarps (see Figure 13, page 18).

ascomycete: a fungal species belonging to the Class Ascomycetes, in which the spores are produced in saclike **asci**.

AT: Alpine Tundra biogeoclimatic zone: a cold, often snowy, upland zone occurring at and above treeline throughout British Columbia (see Table 2, page 7).

AZ: Arizona.

base-rich: referring to rock or bark containing free calcium carbonates or giving rise to such. Limestone and peralkaline basalt are base-rich rocks, whereas maple and cottonwood are base-rich trees. See also **acid**.

BC: British Columbia.

BG: Bunchgrass biogeoclimatic zone: a treeless lowland zone of semi-arid **intermontane** regions (see Table 2, page 7).

boreal: in British Columbia, pertaining to **inland** regions lying to the east of the Rocky Mountains, and having a cool, rather continental climate (see Figure 2, page 4).

buttoned: see **omphalodisc**.

C: in lichenology, an abbreviation for calcium hypochlorite (in water): a **reagent** used to perform **spot tests**. Such tests reveal the presence of specified chemical substances. See page 20.

CA: California.

capitulum (pl.: -a): a **nonlichenized**, often stalked, roughly headlike sexual fruiting body, consisting of a cuplike **excipulum** and a powdery **mazaedium** (see Figure 13f, g, page 18). Present in *Calicium*, *Chaenotheca*, *Chaenothecopsis*, *Microcalicium*, *Mycocalicium*, *Phaeocalicium*, *Sclerophora*, and *Stenocybe*.

catenulate: chainlike: arranged in a linear, repeating pattern.

CDF: Coastal Douglas-fir biogeoclimatic zone: a lowland zone of dry **maritime** regions (see Table 2, page 7).

central axis: see **central cord**.

central cord (= central axis): a tough, reinforcing fungal “thread” present within the branches of all *Usnea* species (see Figure 11g, k, page 16).

cephalodia (sing.: -ium): small, localized colonies of **cyanobacteria** occurring within or over the upper or lower surface of lichens in which the primary **photobiont** is an **alga** (see Figures 4e, 10d, pages 11, 15).

cephalodiate: bearing **cephalodia**.

chondroid: consisting of one or more cartilage-like strands.

cilia (sing.: -ium): thin, hairlike appendages usually occurring along the margins of **lobes** or **apothecia** (see Figure 10i, page 15).

ciliate: bearing **cilia**.

circumpolar: in the northern hemisphere, distributed more or less continuously around the north pole at arctic, boreal, or temperate latitudes.

CK: in lichenology, an abbreviation for a **spot test** procedure in which **C** (calcium hypochlorite) is applied to a **thallus** fragment, followed by **K** (potassium hydroxide). Such tests reveal the presence of specified chemical substances. See page 20.

clavate (= clublike): resembling a club: gradually enlarging upwards (see Figure 12d, page 17).

clublike: see **clavate**.

CO: Colorado.

coast: as used here, pertaining to regions lying to the west of the coast ranges (i.e., including **maritime** and **hypermaritime** regions) (see Figure 2, page 4). See also **inland**.

conidia (sing.: -ium): asexual fungal spores generally borne within flasklike **pycnidia**, but also produced in some species at the tips of stalked **hyphophores** (see Figure 13k, page 18). See also **thalloconidia**.

conidial head: as used here, the **conidia**-bearing portion of a stalked **hyphophore** (see Figure 13l, m, page 18).

coralloid: resembling coral: elongate and much-branched; often used in reference to **isidia** and **phyllocladia** (see Figure 14h, page 19).

cortex: in lichens, the dense, hardened outer “skin” of a **thallus**, consisting of closely packed fungal **hyphae** (see Figure 4, page 11).

corticate: having a **cortex**.

cross-wall: see **septum**.

crustose: in lichens, pertaining to **thalli** that lack a lower **cortex** and **rhizines** and are so closely applied to the **substrate** as to be virtually inseparable from it (see Figure 9b, page 14).

CWH: Coastal Western Hemlock biogeoclimatic zone: a lowland zone of humid **maritime** and **hypermaritime** regions (see Table 2, page 7).

cyanobacteria (sing.: -ium): in lichens, tiny photosynthetic cells or filaments (also collectively termed the **photobiont**), usually bluish green to bluish grey, from which the lichen fungus derives its carbohydrate requirements. In many lichens the

photobiont is an **alga**, not a cyanobacterium. Cyanobacteria were formerly referred to as “blue-green algae.” See page 23.

cyphellae (sing.: -a): rimmed, craterlike pores that open into the medulla via the lower surface; characteristic of the genus *Sticta* (see Figure 10f, page 15). See also **pseudocyphellae**.

cyphellate: producing **cyphellae**.

decorticate: formerly **corticate**, but now lacking a **cortex**.

decumbent: lying loosely parallel to the substrate, but with more or less upturned tips.

dentate: bearing pointed, “tooth-like” projections at regular intervals along the margins.

disc: in lichens, the fertile central portion of an **apothecium** (i.e., excluding the **excipulum**) (see Figure 13a–j, page 18).

dorsiventral: having an obvious upper and lower surface.

ellipsoid: narrowly oval; in lichens, usually pertaining to **spores** (see Figure 12c, page 17).

ESSF: Engelmann Spruce–Subalpine Fir biogeoclimatic zone: a subalpine zone of **intermontane** regions (see Table 2, page 7).

even: see **isotomic**.

excipulum (pl. -a): the sterile outer rim of an **ascocarp**, whether an **apothecium**, a **mazaedium**, or a **perithecium**. The excipulum is said to be **lichenized** when it contains **photobiont** cells (and is of the same colour as the rest of the cortex), and **non-lichenized** when it does not (see Figure 13d–g, page 18).

farinose: powdery, like flour; in lichens, pertaining to **soredia** (see Figure 14b, page 19).

fibrillose: bearing **fibrils**.

fibrils: short unbranched side branches,

occurring more or less at right angles to the main branch (see Figure 11h, page 16).

filiform (threadlike): long and very slender; in lichens, often pertaining to **spores** (see Figure 12a, page 17).

fissured: see **gyrodisc**.

flocculent: delicately interwoven, and resembling loose tufts of wool; in lichens, generally pertaining to **rhizines** (see Figure 7e, page 13).

foliose: in lichens, having a **dorsiventral thallus**, the lower surface of which is usually **corticate**, and more or less readily separable from the **substrate** (see Figure 9d, page 14).

foveolate: bearing **foveoles**.

foveoles: broad and irregular pits or depressions; in lichens, usually pertaining to the **cortex** (see Figure 11a, page 16).

fruticose: in lichens, pertaining to club-like, shrublike, or hairlike **thalli**, the branches of which are more or less round in cross-section (see Figures 9e–g, page 14).

fusiform (= spindle-like): wide in the middle portions, and narrow at either end (see Figure 12b, page 17).

gelatinous: becoming swollen and “jelly-like” or rubbery when moist; in lichens, usually pertaining to *Collema*, *Lempholemma*, and *Leptogium*.

globose: more or less spherical (see Figure 14e, page 19).

gyrodisc (= fissured): referring to an **apothecium** (of the genus *Umbilicaria*) in which the surface of the **disc** is more or less concentrically fissured (see Figure 13c, page 18).

H (= HNO_3): nitric acid (in water); a **reagent** used to perform **spot tests** in lichens. Such tests reveal the presence of specified chemical substances. See page 20.

hemispherical: half a sphere.

heteromerous (= stratified): in lichens, pertaining to **thalli** in which the **photobiont** and **medulla** are organized in distinct layers. Such species have a pale **medulla** (see Figure 4, page 11). See also **homoiomorous**.

HNO₃: see **H**.

holdfast: in lichens, a general term for that portion of a **thallus** that attaches to the **substrate** (see Figure 7f, page 13). As used here, the term denotes an unspecialized organ of attachment.

homoiomorous (= nonstratified): in lichens, pertaining to **thalli** in which the **photobiont** and **medulla** are not organized in distinct layers. Such species lack a pale **medulla**, and can be **gelatinous** when wet (see Figure 5, page 11). See also **heteromerous**.

hyaline: colourless and more or less transparent.

hymenium: within the **ascocarps** of fungi, the fertile layer in which the **asci** arise.

hypermaritime: as used here, pertaining to highly oceanic portions of the **coast** lying adjacent to the open Pacific Ocean (see Figure 2, page 4), and excluding **maritime** regions.

hyphae (sing. -a): fungal threads.

hyphophore: as used here, a stalked **pycnidium** that bears asexual spores (**conidia**) (see Figure 13l, m, page 18). Present in *Gyalideopsis*, *Microlychnus*, and *Szczawinskia*.

hypothallus (= prothallus): in lichens, a thin, typically dark, tightly appressed web of fungal threads that in some species develops on the underside of the **thallus**, and can even extend beyond it (see Figure 7g, page 13).

I: in lichenology, an abbreviation for iodine (in potassium iodide solution); a **reagent** used to perform **spot tests** in

lichens. A positive reaction indicates the presence of certain kinds of starch. See page 20.

ICH: Interior Cedar–Hemlock biogeoclimatic zone: a lowland zone of humid **inland** regions (see Table 2, page 7).

ID: Idaho.

IDF: Interior Douglas-fir biogeoclimatic zone: a lowland zone of dry **inland** regions (see Table 2, page 7).

imbricate: overlapping, as in the manner of shingles.

immersed: in lichenology, embedded within the **thallus** or **substrate**, and scarcely visible from above.

inland: as used here, pertaining to regions lying to the east of the coast ranges (i.e., including **intermontane** and **boreal** regions) (see Figure 2, page 4). See also **coast**.

intermontane: as used here, pertaining to **inland** regions situated between the coast ranges and the Rocky Mountains (see Figure 2, page 4).

isidia (sing.: -ium): tiny **corticate** outgrowths of the **cortex** that readily become detached, and behave as asexual reproductive structures. In form, isidia can be wartlike, **globose**, fingerlike, or **coralloid** (see Figure 14e–i, page 19). See also **soredia**.

isidiate: bearing **isidia**.

isodiametric: more or less equal in length and width.

isotomic (= even): branching into two or more branches of more or less equal diameter (see Figure 8a, page 13).

K (= KOH): in lichenology, an abbreviation for potassium hydroxide (in water): a **reagent** used to perform **spot tests**. Such tests reveal the presence of specified chemical substances. See page 20.

KC: in lichenology, an abbreviation for a **spot test** procedure in which **K**

(potassium hydroxide) is applied to a **thallus** fragment, followed by **C** (calcium hypochlorite). Such tests reveal the presence of specified chemical substances. See page 20.

KOH: see **K**.

laminal: located on the (upper) surface of **lobes**. See also **lateral**.

lateral (= marginal): located along the margins of **lobes**, branches, **apothecia**, or other structures.

leiodisc: an **apothecium** (of the genus *Umbilicaria*) in which the surface of the **disc** is smooth.

leprose: in lichens, having a loose, powdery surface that lacks a **cortex** at all stages of development (see Figure 9a, page 14).

lichenized: referring to fungi, algae, and/or cyanobacteria that have entered into a stable, enduring relationship with one another, thereby forming a lichen **thallus**. Lichenized fungi, algae, and cyanobacteria often differ in appearance from their unlichenized relatives. See also **unlichenized**.

LM: light (or compound) microscope.

lobes: flattened branches or projections, characteristic of **foliose** lichens (see Figure 9d, page 14).

lobulate: bearing **lobules**.

lobule: tiny **lobe**-like, **dorsiventral** outgrowths, often occurring along the margins of **lobes** or stress cracks.

maculae: (sing.: -a): small, pale spots in the upper **cortex** of some lichen species, often caused by an uneven distribution of **algae** or **cyanobacteria** below (see Figure 10e, page 15).

maculate: bearing **maculae**.

marginal: see **lateral**.

maritime: as used here, pertaining to the British Columbia **coast**, but excluding

hypermaritime regions. See Figure 2, page 4.

mazaedia (sing.: -ium): sexual fruiting bodies (**ascocarps**) in which the **spores** of the fungal partner are borne in a soft, powdery mass, which is often surrounded by a cuplike **excipulum** (see Figure 13g, page 18). Present in *Acroscyphus*, *Bunodophoron*, *Calicium*, *Chaenotheca*, *Sclerophora*, *Sphaerophorus*, and *Tholurna*.

mazaediate: bearing **mazaedia**.

medulla: in lichens, the pale, usually white interior portion of a **thallus**, composed mostly of loose fungal threads (see Figure 4c, page 11). Nonstratified (**homoiomorous**) lichens lack a medulla.

MH: Mountain Hemlock biogeoclimatic zone: a forested subalpine zone of **coast** regions. See Table 2, page 7.

microsquamules: tiny, readily detachable **squamules** that typically form on the sides of a **podetium** (see Figure 11f, page 16).

MT: Montana.

muriform: pertaining to **spores** in which both longitudinal/lengthwise and transverse/crosswise **septa** are present (see Figure 12l, page 17).

MX: Mexico.

mycobiont: the fungal partner of a lichen. See also **photobiont**.

needle-like: see **acicular**.

NM: New Mexico.

nonlichenized: referring to free-living fungi, algae, and/or cyanobacteria (i.e., occurring outside of the lichen symbiosis). In lichenology, also referring to lichen tissues in which a fungal partner (**mycobiont**) is present, but an algal/cyanobacterial partner (**photobiont**) is lacking; such tissues are **nonthalline**.

nonstratified: see **homoiomorous**.

nonthalline: lacking a **thallus**.

NV: Nevada.

omphalodisc (= buttoned): referring to an **apothecium** (of the genus *Umbilicaria*) in which the surface of the **disc** is interrupted by a central, buttonlike knob of sterile material (see Figure 13b, page 18).

OR: Oregon.

P: see **PD**.

papillae (sing.: -a): tiny rounded or cylindrical **corticate** lumps or “warts” occurring over the **cortex** of some lichens, especially *Usnea* (see Figure 11g, page 16). Unlike **isidia**, papillae do not become detached.

papillate: bearing **papillae**.

parasitic: as used here, deriving nutrients from living organic material.

PD (= **P**): in lichenology, an abbreviation for paraphenylenediamine (in alcohol), a **reagent** used to perform **spot tests**. Such tests reveal the presence of specified chemical substances. See page 21.

peltate: in lichenology, pertaining to a roughly plate-like **thallus** (or thallus segment) that is attached by a short stalk arising from the centre of the lower surface (see Figure 11d, page 16).

pendent: hanging suspended.

perforate: in lichens, referring to a **cortex** interrupted by one or several tiny holes.

perithecia (sing.: -ium): sexual fruiting bodies (**ascocarps**) in which the **spores** of the fungal partner are borne in minute, flasklike structures that are often immersed in the thallus (see Figure 13i, page 18). Viewed from above, perithecia resembles tiny dots (see Figure 13h, page 18). See also **apothecia**, **hyphophore**, and **pycnidia**.

peritheciate: bearing **perithecia**.

photobiont: the photosynthetic partner in a lichen, consisting of a green **alga** or a blue-green **cyanobacterium** or both. The

lichen fungus derives its carbohydrate requirements from the photobiont.

photomorph (= phototype): a general term designating one of two possible states in lichens in which both an **alga** and a **cyanobacterium** are present as **photobionts**: “green” (when the algal partner dominates); or “blue-green” (when the cyanobacterium dominates). The green and blue-green photomorphs of a single lichen species are often dissimilar in form and colour.

phototype: see **photomorph**.

phyllocladia: tiny **corticate**, foliage-like outgrowths occurring over the **pseudopodetia** of *Stereocaulon* (see Figure 11j, page 16).

platy: see **areolate**.

podetia (sing.: -ium): as used here, the more or less erect, stemlike, usually hollow, **lichenized** portion of some lichens (i.e., *Cladina*, *Cladonia*, and *Tholurna*). Podetia often terminate in **apothecia** or **pycnidia**, and can be branched or unbranched, and cuplike or pointed-tipped. See also **pseudopodetia**.

podetiate: bearing **podetia**.

polarilocular: 2-celled, but with the cells well separated from one another by a broad **septum**; pertaining to the sexual **spores** of some species (see Figure 12j, page 17).

PP: Ponderosa Pine biogeoclimatic zone: a sparsely forested lowland zone of semi-arid **intermontane** regions (see Table 2, page 7).

prothallus = see **hypothallus**.

pruina: in lichens, a thin, white frosting of minute crystals, especially calcium oxalate.

pruinose: covered in **pruina**.

pseudocyphellae (sing.: -a): tiny, pale, unrimmed pores in the upper or lower **cortex** through which the **medulla** is exposed. In form, pseudocyphellae can

be dotlike, angular, or irregular (see Figures 10g, 11e, pages 15 and 16).

pseudocyphellate: bearing **pseudocyphellae**.

pseudopodetia (sing.: -ium): as used here, the more or less erect, stemlike, solid, **lichenized** portion of some lichens (i.e., *Leprocaulon*, *Pilophorus*, and *Stereocaulon*). Pseudopodetia often terminate in **apothecia**, and can be branched or unbranched. See also **podetia**.

pubescent: covered in minute, soft, usually woolly, hairs.

pulvinate: densely cushionlike.

punctiform: very small and dotlike, but visible without a hand lens; in lichens, often pertaining to **soralia** and **pseudocyphellae**.

pustulate: bearing **pustules**.

pustule: a blisterlike swelling, as on the upper surface of a lichen (see Figure 10a, page 15).

pycnidia (sing.: -ium): in lichens, minute, flasklike asexual spore-producing structures of the fungus, usually **immersed** in the **thallus** and visible from above as tiny black dots that occasionally protrude from the surface (see Figure 13j, page 18). Pycnidia are similar in outward appearance to perithecia, but do not contain **asci** (see Figure 13k, page 18).

pycniolate: bearing **pycnidia**.

reagent: a liquid chemical that, when applied to lichen **thalli**, can cause a colour change. Such changes reveal the presence of specified chemical substances. **K**, **C**, **PD**, **H**, and **I** are reagents. See page 20. See also **spot test**.

reticulate: bearing a **reticulum**.

reticulum: a ridged, netlike pattern (see Figure 10b, page 15).

rhizinate: bearing **rhizines**.

rhizines: in lichens, macroscopic rootlike

bundles of fungal threads by which the **thallus** attaches to the **substrate** (see Figure 7a–e, page 13).

rhizoids: as used here, tiny hairlike fungal threads, usually only one cell wide, emerging from the basal portions of some lichens, and often attaching the **thallus** to the **substrate** (see Figure 5c, page 11).

rim: see **excipulum**.

sAK: Pacific coastal Alaska.

saprobic: deriving nutrients from dead organic material.

scabrid (= scabrous): bearing scabers (i.e., minutely rough-textured); in lichens, usually pertaining to the **cortex**.

scabrous: see **scabrid**.

scales: see **squamules**.

septate: bearing one or more **septa**; in lichens, said of spores.

septum (pl: -a) (= cross-wall): a cell wall that separates two adjacent cells (see Figure 12h, i, page 17).

sessile: unstalked: in lichens, growing directly attached to the underlying thallus.

simple: unbranched, usually pertaining to **rhizines** (see Figure 7a, page 13).

s. lat.: *sensu lato* (“in the broad sense”): referring to species or genus concepts assumed to embrace more than one taxon. See also **s. str.**

solid: as used here, not hollow.

soralia (sing.: -ium): the specialized region of a **thallus** in which **soredia** are produced (see Figure 14a, page 19).

soredia (sing.: -ium): tiny powdery or granular asexual reproductive structures. Soredia contain both fungal **hyphae** and **photobiont** cells, but lack a **cortex**; they often protrude from the upper or lower surface of the lichens on which they occur (see Figure 14a–d, page 19).

spindle-like: see **fusiform**.

spinules: short **fibril** or spine-like outgrowths, often somewhat constricted at the base.

spore: in lichens, a general term for the microscopic sexual or asexual reproductive units of the fungal partner (**mycobiont**) (see Figure 12, page 17). The sexual spores of most lichens are produced in **apothecia**, whereas asexual spores (**conidia**) are borne in **pycnidia** or **hyphophores**. See also **thalloconidia**.

spot test: any of several chemical tests for colour reactions obtained by applying a liquid **reagent** (**K, C, KC, PD, H, I**) to a lichen tissue. Such tests reveal the presence of specified chemical substances (see page 20).

squamules (= scales): small, often somewhat overlapping “scales” that typically lack a lower **cortex** (see Figure 9c, page 14). Squamules often form a basal mat, but in some lichens they can occur also over the **podetia**.

squamulose: bearing **squamules**.

squarrose: brushlike: bearing numerous short perpendicular side branches; usually referring to **rhizines** (see Figure 7c, page 13).

s. str.: *sensu stricto*: (“in the narrow sense”): referring to species (or genera) assumed to consist of only a single taxon. See also **s. lat.**

stratified: see **heteromerous**.

striae (sing. -a): parallel lines, grooves, or ridges; in lichens, usually oriented lengthwise (see Figure 11b, page 16).

striate: bearing **striae**.

submuriform: pertaining to **spores** in which both lengthwise/longitudinal and crosswise/transverse **septa** are present, though the former are sparse or poorly developed (see Figure 12k, page 17). See also **muriform**.

substrate (= substratum): as used here, a general term for the surfaces colonized by lichens, whether wood, bark, soil, rock, or other.

substratum: see **substrate**.

terminal: borne at the tip.

thalline: bearing a **thallus**. See **lichenized**.

thalline margin: see **excipulum**.

thalloconidia (sing.: -ium): minute asexual **spores** (**conidia**) borne directly on the **cortex** of some lichens. In *Umbilicaria*, thalloconidia confer a black, sooty texture to the lower surface and **rhizines** of some species.

thallus (pl: -i): the vegetative body of a lichen in which both a fungal partner (**mycobiont**) and an algal and/or cyanobacterial partner (**photobiont**) are present (see Figures 4 and 5, page 11). The mycobiont and photobiont are said to be **lichenized** or **thalline** in those portions of a lichen in which both partners are present, and **nonlichenized** or **nonthalline** in those portions in which only one partner is present.

thin-layer chromatography: a method for determining the presence of specified chemical substances. See page 21.

threadlike: see **filiform**.

tomentose: bearing a **tomentum**.

tomentum: in lichens, a minute, feltlike mat of fungal hyphae covering the upper and/or lower surface of some species (see Figure 10c, page 15).

turbinate: resembling a top: expanding upwards.

umbilicate: attached by an **umbilicus**.

umbilicus: in lichens, a thickened, centrally positioned point of attachment characteristic of some rock-dwelling **foliose** species (see Figure 7f, page 13).

uneven: see **anisotomic**.

UT: Utah.

uv: ultraviolet light; used in lichenology to detect certain lichen substances. See page 21.

WA: Washington State.

wNT: western Northwest Territories, east

to the MacKenzie River.

WY: Wyoming.

YU: Yukon.

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Accepted genus names are given in **bold** type; accepted species names appear in roman type; and synonyms in *italic* type. Page references for the primary genus and species accounts are in **bold** type. Genera and species appearing in the keys, but not treated in this manual, are indicated by an asterisk (*). Square brackets [...] denote

species either excluded from the British Columbia flora, or else expected to occur in British Columbia, but not yet reliably documented. Common names appear in roman type, and are given for genera only. Nonlichenized genera are indicated by a dagger (†).

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