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The Lichens of British Columbia

Illustrated Keys

Part 1 — Foliose and Squamulose Species

Ministry of Forests
Research Program
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Part 1 — Foliose and Squamulose Species

by

Trevor Goward, Bruce McCune, and Del Meidinger

(Illustrations by Trevor Goward)

Ministry of Forests
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Finally, this manual is fondly dedicated to Wilfred Schofield, of the University of British Columbia, whose continued support and friendship have directly and indirectly made it possible. Thanks Wilf!

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INTRODUCTION

Approximately 1100 species of lichens have been reported to occur in British Columbia (B.C.). Although this figure may appear impressive, lichens are among the most poorly documented elements of the province's macroscopic flora. Judging from the rate at which new species are being added to the lichen flora, it seems likely that hundreds of additional lichens await discovery in this province. Moreover, our understanding of the frequency status of the vast majority of species remains dolefully incomplete.

To date, comprehensive lichen studies have been conducted in only two regions of the province: the Queen Charlotte Islands and southeast Vancouver Island. The macrolichen flora of Wells Gray Park is also reasonably well documented. Most of the remainder of the province has received scant attention. Important collections have been made in the regions indicated in Figure 1, but most of these studies are unpublished and the specimens are now scattered in various herbaria.

A major impediment to the study of lichens in British Columbia is the lack of comprehensive keys to the species. This manual helps to correct this situation by providing illustrated keys to all "leaf" and "scale" (foliose and squamulose) lichens known to occur in the province. In total, 327 species are included, while 19 taxa are excluded from earlier accounts of the flora. Future volumes in this series will provide keys to the fruticose and crustose species.

This manual has two primary objectives. The first is to stimulate lichenological research by making the province's lichens accessible to as broad an audience as possible. To this end, the keys are tailored primarily to the needs and resources of ecologists, biologists, naturalists, teachers and other non-lichenologists wishing to identify lichens. These users can be assumed: (1) to lack access to thin-layer chromatography (TLC) facilities, as well as to various chemical reagents, ultraviolet lamps, light microscopes and/or other apparatus of detailed lichen identification; (2) to be reluctant

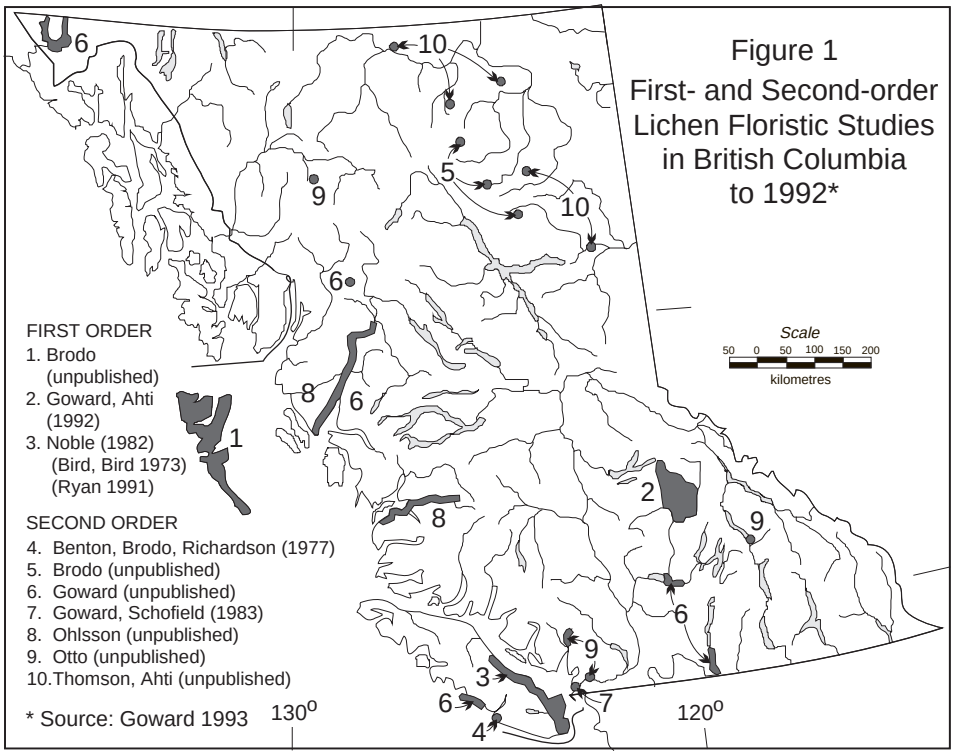

FIGURE 1. First- and second-order lichen floristic studies in British Columbia to 1992.

to handle unnecessary technical jargon; and (3) to be unfamiliar with basic lichen taxonomy. Based on these assumptions, the keys in this manual:

- emphasize morphological characters over chemical and spore characters;
- incorporate technical terms only where necessary[1]; and
- give more or less equal weight to phylogenetic relatedness and morphological similarity.

Accompanying the keys are approximately 350 line drawings. These are intended to convey species concepts based on typical material. In most cases, they illustrate only those portions of a thallus that bear the characters expressed in the adjacent key. Illustrations of whole lichens may be found in Hale (1979), MacKinnon et al. (1992), Pojar and MacKinnon (1994), Thomson (1984) and Vitt et al. (1988).

The manual's second objective is to briefly summarize the ecology, distribution and frequency status of the province's foliose and squamulose lichens. Until the status and ecological requirements of lichens are understood, resource managers will have little hope of intelligently managing for lichen diversity. For this reason, distribution maps are provided for species considered vulnerable to logging, grazing, urban development and other forms of human activity. These maps are based primarily on specimens housed at the University of British Columbia, in Vancouver, and the National Museum of Natural Sciences, in Ottawa, though reliable literature reports are also incorporated in some cases.

It is beyond the scope of this manual to provide a comprehensive summary of the biology of lichens (see instead: Hale 1983; Hawksworth and Hill 1984; Lawrey 1984). Effective identification does, however, require a basic understanding of lichen morphology and chemistry. The reader is therefore urged to consult the remainder of the Introduction before attempting to use the keys.

This manual represents a first attempt to provide comprehensive keys to the province's foliose and squamulose lichens. The keys have been tested by friends, colleagues and students, but numerous errors and oversights doubtless remain. The user is invited to bring these to the authors' attention for the benefit of future users.[2]

Interpreting the Species Accounts

Lichens may be arranged into as many as seven different lichen growth forms (see "Identifying Lichens," page 10). Because these are units of convenience rather than biological units, it is not surprising that some lichen genera embrace more than one growth form. The following accounts incorporate all genera known to occur in British Columbia in which a majority of the species can be described as foliose or squamulose. In a few instances, foliose and squamulose species from other essentially crustose or fruticose genera are also included in the keys. These appear in parentheses (...) and are not discussed in the species accounts. Species appearing in square brackets [...] have not been reliably recorded in the province, but are expected to occur here. These may or may not be discussed in the text.

The body of the manual consists of genus and species accounts. These accounts are arranged alphabetically first by genus and then by species within each genus. Each genus account provides:

- a common name;
- a short description of the genus, with diagnostic characters placed in ***bold italic*** type;
- pertinent references;
- notes on the derivation of the common name; and
- notes on global status and distribution, taxonomy, chemistry and/or similar genera.

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1 Technical terms are discussed in "Identifying Lichens" (page 10) and appear in **boldface** at first mention. Additional terms are defined in the keys, as well as in the Glossary (page 165).

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

The species accounts are organized in the following manner:

Species and Author Citation (Synonym):
Except in cases of recent taxonomic or nomenclatural revision, species names and author citations follow Egan (1987, 1989, 1990, 1991). Only synonyms in recent and/or widespread use are given.

Distribution Maps:
Distribution maps are provided (in Appendix 1) for species judged to be of rare or localized occurrence in the province. Map numbers appear to the right of the species names.

Common Names:
Common names are adopted, adapted or introduced for all lichen species included in this manual. Names given in parentheses (...) have been used by previous authors, but are not accepted here. See also "A Note on Common Names," page 14.

Habitat:
Habitat descriptions provide information about lichen frequency, common substrates, site characteristics and provincial ranges (see "Lichen Distribution in British Columbia," below). The following terms and schema are adopted: (Rare, infrequent, frequent, or common) *over* (acid, base-rich, mossy, or seasonally inundated) rock, (coniferous or deciduous) trees, (decaying) wood, moss, duff, or soil *in* (exposed, open, sheltered, or shady) (provincial range) (old growth) forests, steppe, depressions, or outcrops, at lower or higher elevations (throughout).

Lichen Distribution in British Columbia:
Lichen distribution is expressed according to the terms listed in the first two columns of Table 1 and in part mapped in Figure 2. Distribution is occasionally expressed in biogeoclimatic units, and these are listed in the third column of Table 1 and mapped in Figure 3. For further notes on the Biogeoclimatic System, see "Understanding Biogeoclimatic Zonation," page 5. Species of widespread occurrence in the province are described as occurring "throughout." The corresponding units of continentality in the fourth column are based on Conrad's Index of Continentality (Conrad 1946). These are included to enable ecoclimatic comparisons with other portions of the world (for further details, see Goward and Ahti 1992).

TABLE 1. Distributional units and their definition

General range	Life zone	Biogeoclimatic equivalent[a]	Conrad's Index of Continentality
Coast	Hypermaritime	CWH wh and vh	< 8
	Maritime		9–29
	– dry	CDF	
	– wet	CWH (not wh and vh)	
	– subalpine	MH	
Inland	Intermontane		29–39
	– semi-arid	BG, PP	
	– dry	IDF	
	– moist	SBS, SBPS, MS	
	– wet	ICH	
	– subalpine	ESSF	
	Boreal	BBWS, 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.

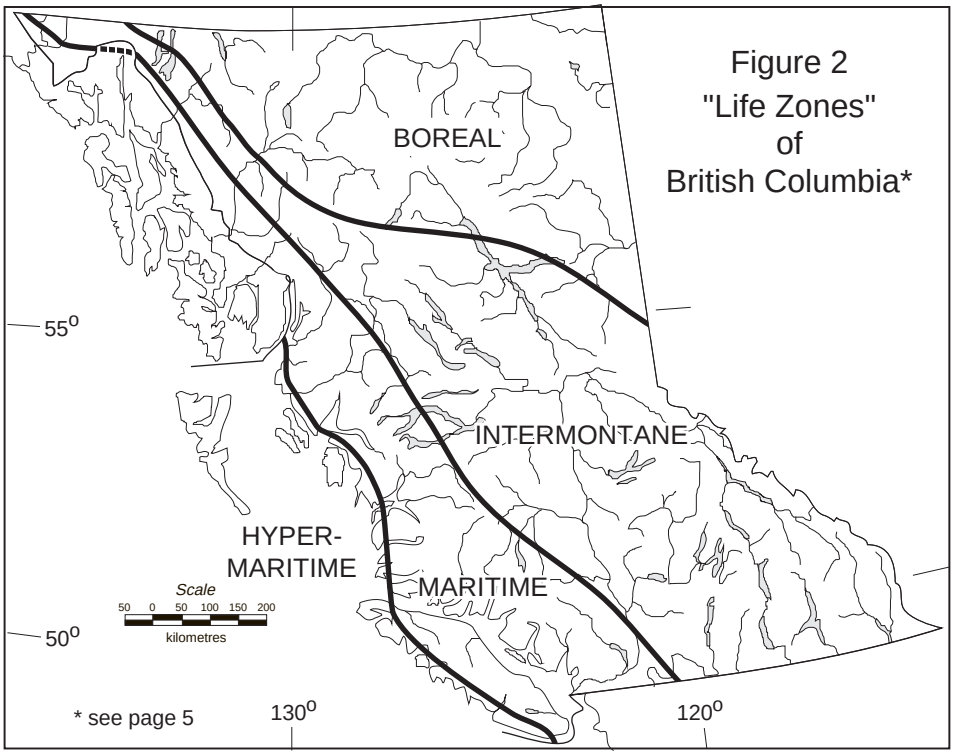


FIGURE 2. “Life zones” of British Columbia.

Total Range in the Northern Hemisphere:
Total range in the northern hemisphere is expressed relative to western North America in the following distributional units:

- 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

North–south ranges in western North America are summarized for each species using the following geographic units: N to AK (Alaska) or YU (Yukon); 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). Species considered to have the northern or southern limits of their range within the province are denoted as N to BC and S to BC, respectively.

Reactions:
Only positive spot test reactions to commonly used chemical reagents are given. For further details see “Making Use of Lichen Chemistry,” page 13.

Contents:
Here a listing of dominant lichen substances is presented in alphabetical order. Substances given in parentheses (...) do not occur in all specimens.

Notes:
This section is reserved for details pertinent to the determination or treatment of the species — taxonomic and nomenclatural problems, notes on similar species, chemistry, and keys to varieties and subspecies.

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)

				Selected climatic characteristics[a]				
Zone	**Code**	**Zonal vegetation**	**Zonal soils**	**Monthly temp. range**	**°days > 5°C**	**°days <0°C**	**May–Sept. ppt (mm)**	**Oct.–April ppt (mm)**
Alpine Tundra	AT	*Cassiope* spp., *Phyllodoce* spp., *Luetkea pectinata, Loiseleuria procumbens, Dryas* spp., *Salix* spp., *Silene acaulis*, *Poa* spp., *Festuca* spp., *Carex* spp., *Cetraria* spp., *Stereocaulon* spp., *Polytrichum piliferum*	Regosols, Humic Regosols, Brunisols, Humo-Ferric Podzols	-11.1–9.5	427	1763	287	469
Boreal White and Black Spruce	BWBS	White spruce, lodgepole pine, black spruce, *Rosa acicularis, Viburnum edule, Mertensia paniculata, Pyrola asarifolia, Cornus canadensis, Vaccinium vitis-idaea, Ptilium crista-castrensis, Pleurozium schreberi*	Gray Luvisols, Dystric and Eutric Brunisols	-24.5–16.6	709–1268	1692–2742	145–305	182–198
Bunchgrass	BG	*Agropyron spicatum, Artemisia tridentata, Artemisia frigida, Poa sandbergii, Koeleria macrantha, Festuca scabrella, Festuca idahoensis, Chrysothamnus nauseous*	Brown and Dark Brown Chernozems	-10.8–22.4	1771–2516	230–878	98–175	108–208

TABLE 2. (Continued)

Zone	Code	Zonal vegetation	Zonal soils	Selected climatic characteristics				
				Monthly temp. range	°days > 5°C	°days <0°C	May–Sept. ppt (mm)	Oct.–April ppt (mm)
Coastal Douglas-fir	CDF	Douglas-fir, grand fir, bigleaf maple, western flowering dogwood, *Holodiscus discolor, Gaultheria shallon, Mahonia nervosa, Rosa gymnocarpa, Symphoricarpos albus, Trientalis latifolia, Rubus ursinus, Pteridium aquilinum, Kindbergia oregana, Rhytidiadelphus triquetrus*	Dystric Brunisols	1.8–18.0	1794–2121	9–43	107–238	540–1107
Coastal Western Hemlock	CWH	Western hemlock, amabilis fir, Sitka spruce, yellow-cedar, *Vaccinium alaskaense, Vaccinium parvifolium, Menziesia ferruginea, Gaultheria shallon, Polystichum munitum, Pteridium aquilinum, Blechnum spicant, Clintonia uniflora, Rhytidiadelphus loreus, Hylocomium splendens*	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, *Rhododendron albiflorum, Menziesia ferruginea, Vaccinium (membranaceum, ovalifolium, scoparium), Rubus pedatus, Gymnocarpium dryopteris, Tiarella unifoliata, Valeriana sitchensis, Orthilia secunda, Streptopus roseus, Veratrum viride, Barbilophozia lycopodioides, Pleurozium schreberi, Rhytidiopsis robusta*	Humo-Ferric Podzols	-10.9–13.3	629–801	879–1189	205–425	271–1597
Interior Cedar–Hemlock	ICH	Western hemlock, western redcedar, hybrid white spruce, Douglas-fir, subalpine fir, *Vaccinium ovalifolium, Oplopanax horridus, Vaccinium membranaceum, Rubus parviflorous, Paxistima myrsinites, Smilacina racemosa, Streptopus (amplexifolius, roseus), Chimaphila umbellata, Goodyera oblongifolia, Gymnocarpium dryopteris, Ptilium crista-castrensis, Pleurozium schreberi, Hylocomium splendens, Rhytidiadelphus triquetrus*	Humo-Ferric Podzols Gray Luvisols, and Dystric Brunisols	-10.7–20.8	1267–2140	238–820	200–439	294–1098

TABLE 2. (Continued)

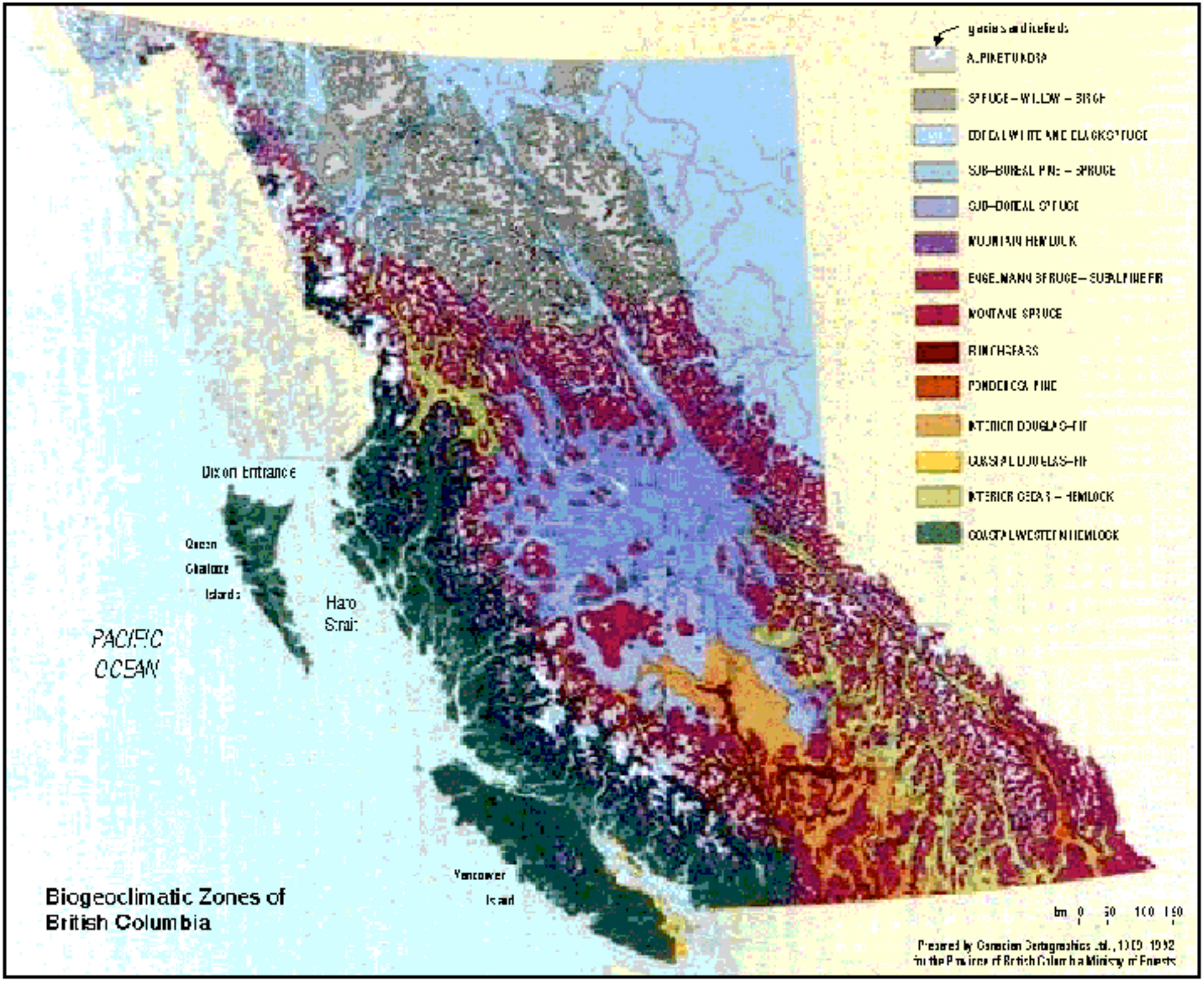
Zone	Code	Zonal vegetation	Zonal soils	Selected climatic characteristics				
				Monthly temp. range	°days > 5°C	°days <0°C	May–Sept. ppt (mm)	Oct.–April ppt (mm)
Interior Douglas-fir	IDF	Douglas-fir, lodgepole pine, ponderosa pine, *Spiraea betulifolia, Amelanchier alnifolia, Juniperus communis, Symphoricarpos albus, Mahonia aquifolium, Paxistima myrsinites, Calamagrostis rubescens, Arctostaphylos uva-ursi, Agropyron spicatum, Pleurozium schreberi*	Gray Luvisols, Eutric and Dystric Brunisols	-13.1–21.3	903–2366	235–1260	107–291	149 –1022
Montane Spruce	MS	Hybrid white spruce, subalpine fir, lodgepole pine, Douglas-fir, *Vaccinium scoparium, Lonicera utahensis, Shepherdia canadensis, Paxistima myrsinites, Vaccinium membranaceum, Alnus viridis, Linnaea borealis, Empetrum nigrum, Calamagrostis rubescens, Pleurozium schreberi*	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, *Vaccinium (ovalifolium, membranaceum, alaskaense), Menziesia ferruginea, Rhododendron albiflorum, Rubus pedatus, Phyllodoce empetriformis, Rhytidiopsis robusta, Rhytidiadelphus loreus, Hylocomium splendens*	Ferro-Humic Podzols and Folisols	-2.3–13.2	919–933	307–352	694–707	1857–2260
Ponderosa Pine	PP	Ponderosa pine, *Agropyron spicatum, Balsamorhiza sagittata, Festuca (saximontana, idahoensis), Koeleria macrantha, Lithosperum ruderale, Achillea millefolium*	Eutric and Dystric Brunisols	-8.6–21.6	1505–2442	258–861	86–270	170–334
Spruce – Willow – Birch	SWB	White spruce, subalpine fir, *Salix glauca, Betula glandulosa, Potentilla fruticosa, Shepherdia canadensis, Festuca altaica, Lupinus arcticus, Pedicularis labradorica, Epilobium angustifolium, Empetrum nigrum, Vaccinium (vitis-idaea, caespitosum), Hylocomium splendens, Cladina* spp., *Nephroma arcticum*	Eutric or Dystric Brunisols, Humo-Ferric Podzols	-19.2–14.0	534–933	2036–2298	275–280	179–424

TABLE 2. (Concluded)

Zone	Code	Zonal vegetation	Zonal soils	Selected climatic characteristics				
				Monthly temp. range	°days > 5°C	°days <0°C	May–Sept. ppt (mm)	Oct.–April ppt (mm)
Sub-Boreal Pine – Spruce	SBPS	Lodgepole pine, white spruce, *Shepherdia canadensis, Spiraea betulifolia, Rosa acicularis, Calamagrostis rubescens, Arctostaphylos uva-ursi, Vaccinium caespitosum, Linnaea borealis, Pleurozium schreberi, Peltigera* spp., *Cladina* spp.	Gray Luvisols and Dystric Brunisols	-13.8–14.3	697–1044	1140–1405	243–300	218–222
Sub-Boreal Spruce	SBS	Hybrid white spruce, subalpine fir, lodgepole pine, *Vaccinium membranaceum, Rubus parviflorus, Viburnum edule, Lonicera involucrata, Spiraea betulifolia, Rosa acicularis, Aralia nudicaulis, Cornus canadensis, Linnaea borealis, Arnica cordifolia, Clintonia uniflora, Aster conspicuus, Osmorhiza chilensis, Oryzopsis asperifolia, Smilacina racemosa, Gymnocarpium dryopteris, Pleurozium schreberi, Ptilium crista-castrensis, Hylocomium splendens, Dicranum polysetum, Rhytidiadelphus triquetrus, Peltigera* spp.	Gray Luvisols and Dystric Brunisols Humo-Ferric Podzols	-14.6–16.9	884–1510	792–1369	189–353	250–1383

[a] Selected climatic characteristics summarized from AES Long-term stations. Prepared by D. Meidinger.

FIGURE 3. Biogeoclimatic zones of British Columbia.



Identifying Lichens

The vast majority of lichens are classified as cup fungi (**Ascomycetes**) — the same group to which morels and elf saddles belong**.** However, while most cup fungi derive their nourishment from sources external to themselves (e.g., decaying leaves or logs), lichen cup fungi "cultivate" their foodstuff among the fungal threads of which they themselves are composed. This foodstuff consists of tiny, photosynthesizing algal and/or cyanobacterial cells. Lichens can therefore be viewed as living greenhouses supported by carbohydrates derived from the photosynthetic "crops" growing within them. This accounts for the unusually exposed life style adopted by most lichens: whereas a majority of other fungi (except when fruiting) live within the things they feed on, lichens colonize the surfaces of rocks, trees, duff and soil.

The body of a lichen is called a **thallus** (Figures 4–5). A lichen thallus can be thought of as a kind of biological sandwich in which the fungal partner (**mycobiont**) and the "algal" partner (**photobiont**) are usually **stratified** in distinct layers (Figure 4). In many conspicuous lichen species four layers are present: a protective rind or **upper cortex** (Figure 4a); an "algal" or **photobiont layer** (Figure 4b); a pale, usually whitish region of loose 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 are comprised of green algae or **cyanobacteria**, or occasionally both. When exposed by a razor blade and viewed under a hand lens, algae are usually easily recognized by their bright grassy green colour. Cyanobacteria are more variable in colour and range from holly-green to bluish green or a dark steel-blue. In some species dominated by a green algal photobiont, scattered colonies of cyanobacteria may also be present. Such colonies are called **cephalodia** (Figure 4e) and may occur internally or over the upper or lower surface (Figure 8e).

In some lichens in which the photobiont is a cyanobacterium, the photobiont cells are intermingled throughout with fungal threads, and the thallus appears dark from top to bottom. These lichens, which are said to be **nonstratified** (Figure 5), tend to be brownish, blackish or bluish grey. They often assume a gelatinous consistency when wet, and are also popularly called "gel lichens." Most nonstratified lichens lack a cortex (Figure 5a), though a primitive cellular cortex is present in the genus *Leptogium* (Figure 5b).

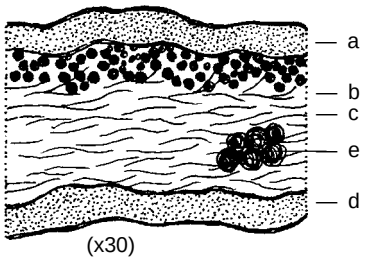


FIGURE 4. Thallus stratified/heteromerous (cross-section): a) upper cortex, b) algal or cyanobacterial layer/ photobiont layer, c) medulla, d) lower cortex, and e) cephalodia.

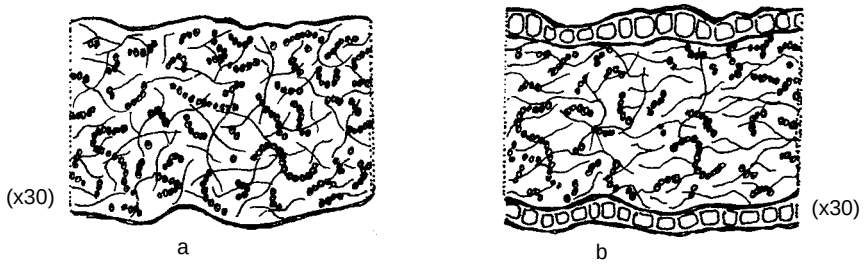
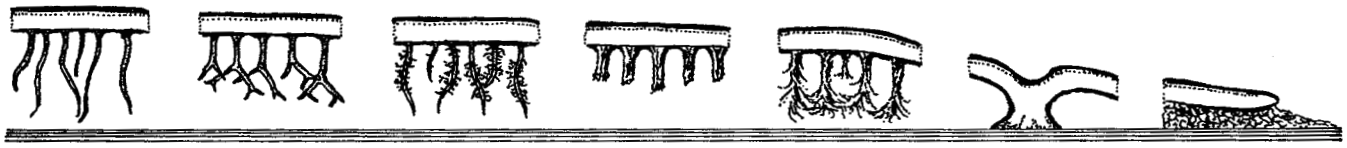


FIGURE 5. Thallus nonstratified/homoiomerous (cross-section): a) noncorticate, and b) corticate.

Distinct hairlike holdfasts or **rhizines** (Figure 6a–e) may occur in many species having a lower cortex. Rhizines anchor the lichen to the colonized surface or **substrate**, and may be **simple** (Figure 6a), **forking** (Figure 6b), **laterally branching** (Figure 6c), **tufted** (Figure 6d) or **flocculent** (Figure 6e). In a few groups of lichens, rhizines are replaced by a single thickened point of attachment, the **umbilicus** (Figure 6f). In others, the rhizines are replaced by a dark, woolly **hypothallus** (Figure 6g) that may sometimes extend beyond the margins of the lichen. Rhizine-like structures that occur along the lobe margins are called **cilia** (See Figure 8g).



a b c d e f g

FIGURE 6. Organs of attachment (cross-section): a) simple rhizines, b) forking/dichotomous rhizines, c) laterally branching/squarrose rhizines, d) tufted rhizines, e) flocculent, confluent rhizines, f) umbilicus, and g) hypothallus.

Traditionally, lichens have been divided into three growth forms (crustose, foliose, and fruticose), though other classification systems are possible. The one adopted here recognizes seven growth forms.

1. **Dust lichens/leprose lichens** (Figure 7a) lack both an upper and lower cortex, the medulla being attached directly to the substrate so that the lichen cannot be separated from it intact. The medulla's upper surface disintegrates into a continuous covering of fine powder.
2. **Crust lichens/crustose lichens** (Figure 7b) resemble dust lichens, but have a hard, protective upper cortex, often giving a stain-like appearance. Some crust lichens intergrade with scale and leaf lichens, below.
3. **Scale lichens/squamulose lichens** (Figure 7c) 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 **scales** or **squamules**, the lower surface of which is often white and cottony. Some scale lichens give rise to a fruiting structure called a **podetium** (Figure 7e): an erect, hollow stalk, resembling a golf tee, a toothpick or, less often, a branching shrub (see Club and Shrub Lichens).
4. **Leaf lichens/foliose lichens** (Figure 7d) more or less resemble leaves — their thalli are flattened and typically possess both an upper and lower cortex. The lobes can be narrow or broad, elongate or short. This is the only growth form in which rhizines occur. The degree of attachment varies from closely appressed through loosely attached to semi-erect or even unattached.
5. **Club lichens/fruticose lichens** (Figure 7e), being radially symmetrical, have no lower surface and therefore no lower cortex and rhizines. In most instances, club lichens have thickened, upright, unbranched, or sometimes sparsely branched stems. When hollow, the stems are called podetia and are then usually associated with basal scales.
6. **Shrub lichens/fruticose lichens** (Figure 7f) resemble club lichens in having somewhat thickened stems, and in being more or less radially symmetrical. In these species, however, the stems are also strongly branched. Occasionally the stems may be hollow, in which case they are again called podetia; usually, however, they are solid. Shrub lichens are typically upright and tufted.
7. **Hair lichens/fruticose lichens** (Figure 7g) differ from shrub lichens in having much finer, and proportionately much longer, branches. Hair lichens are frequently pendent.

In most lichens, the upper cortex is smooth and naked, though in some species it may be minutely roughened (i.e., **scabrid**) or else covered in a fine whitish frosting called **pruina**. In others, the cortex may bear a fine nap of tiny, erect or appressed glasslike hairs, which are collectively termed **tomentum** (Figure 8a). These may also be present over the lower surface.

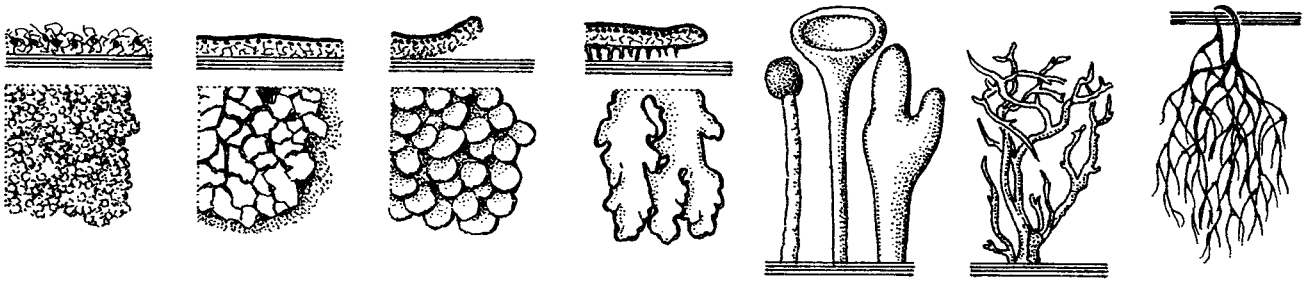


FIGURE 7. Lichen growth forms: a) dust/leprose (cross-section and surface view), b) crust/crustose (cross-section and surface view), c) scale/squamulose (cross-section and surface view), d) leaf/foliose (cross-section and surface view), e) club/fruticose, f) shrub/fruticose, and g) hair/fruticose.

The lower surface of some leaf lichens can also be sparsely speckled with minute pits through which the medulla is exposed. When rimmed and crater-like, these are termed **cyphellae** (Figure 8c); otherwise they are called **pseudocyphellae** (Figure 8d). Pseudocyphellae occur in some lichens over the upper cortex as well, and then must be carefully distinguished from **maculae** (Figure 8b): pale areas of the upper surface in which the cortex is unbroken.

Wart-like outgrowths called **cephalodia** (Figure 8e) are also present in the upper surface of some species. Cephalodia are localized colonies of cyanobacteria that occur (also internally or over the lower surface) in many lichens in which the primary photobiont is a green alga.

The lower surface of most lichens is smooth, though a **veined** (Figure 8f) surface is present in many species of *Peltigera* and, to a lesser extent, *Solorina*.

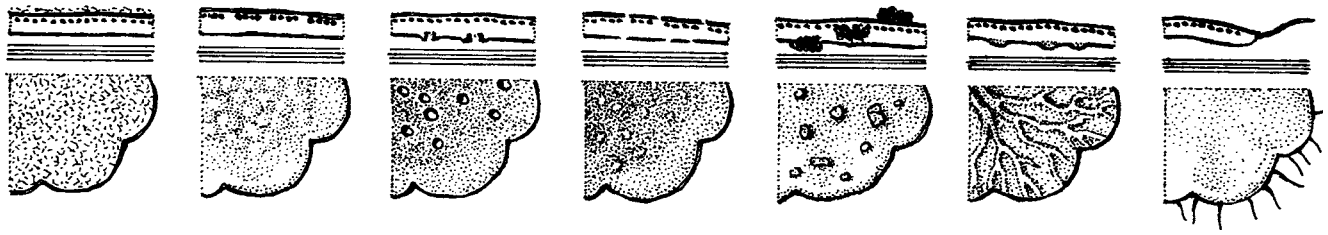


FIGURE 8. Surface details (cross-section and surface view): a) tomentum, b) maculae, c) cyphellae, d) pseudocyphellae, e) cephalodia, f) veins, and g) cilia.

Lichen fungi reproduce both sexually and asexually. For most species covered in this manual, sexual fruiting bodies take the form of tiny button-like, saucer-like or hemispherical structures called **apothecia** (Figure 9a). Fruiting bodies in other groups, however, can take the form of **perithecia** (Figure 9b) (i.e., sunken, flask-shaped structures that are visible from above as blackish dots). The primary function of both types of fruiting bodies is to produce sexual **spores** (Figure 9d–e).

Within apothecia and perithecia, spores are borne in microscopic, club-shaped sacs called **asci**. A majority of fungal spores are simple, **two-celled** or **multi-celled** (Figure 9d), though in some lichens the spores can be **submuriform** or **muriform** (Figure 9e). The spores can be examined only with a light microscope.

Perithecia must be carefully distinguished from **pycnidia** (Figure 9c) which, though also dot-like, bear asexual reproductive cells called **pycnoconidia**. Pycnoconidia tend to be very small, usually only 4–5µ long. By contrast, sexual spores are usually much longer and are produced in asci. In *Umbilicaria*, conidia may be produced (in well-demarcated, black, sooty patches) directly over the lower cortex and are then known as **thalloconidia**.

Asexual (vegetative) reproduction is also achieved by mechanical fragmentation (wear and tear) or by specialized outgrowths called soredia and isidia. **Soredia** (Figure 9f) arise in the medulla, erupting through the thallus surface as a soft, often granular powder. This powder may be diffuse or confined to delimited “wounds” called **soralia** (Figure 9f).

Isidia (Figure 9g), by contrast, are tiny fingerlike or coral-like outgrowths of the upper cortex. Their hardened outer surface is usually readily distinguished from the powdery appearance of soredia. Both propagules contain photobiont cells *and* fungal threads.

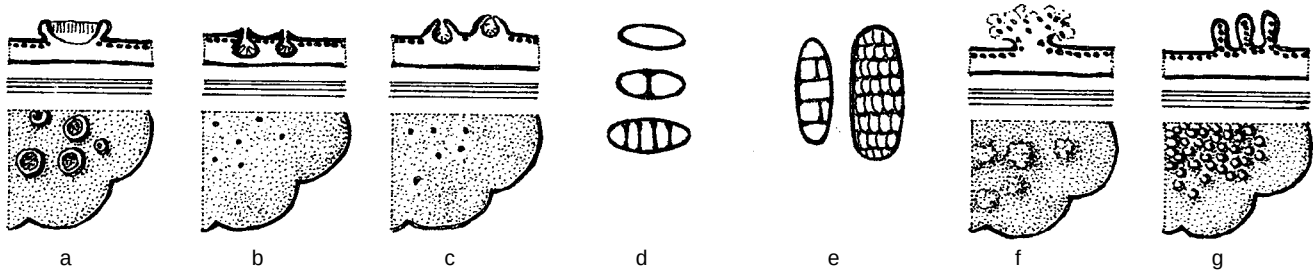


FIGURE 9. Reproductive structures (cross-section and surface view): a) apothecia, b) perithecia, c) pycnidia (protruberant), d) spores (simple, two-celled, multi-celled), e) spores (submuriform, muriform), f) soredia in soralium, and g) isidia.

Making Use of Lichen Chemistry

Lichens produce a diverse array of chemicals and for this reason lichen chemistry provides a useful tool in the identification of many species. Chemical substances are commonly identified by use of: (1) spot tests; (2) ultraviolet lamps; and (3) thin-layer chromatography.

1. Spot Tests

Spot tests are performed using small quantities of various liquid reagents applied with a capillary pipette that has been drawn to a point over a flame. Five reagents are mentioned in the identification keys: calcium hypochlorite (C),[3] nitric acid (HNO_3), potassuim iodide (I), potassium hydroxide (K), and paraphenylenediamine (PD). Of these, only C, K and PD are used routinely. All of these substances are toxic and should be stored carefully in small, tightly sealed glass bottles. Spot tests can be performed using a hand lens (10x or stronger), though a dissecting microscope is preferable. When examining the specimen, it is helpful to work the material using a stiff, single-edged razor blade and a pair of fine forceps or tweezers. Never apply a reagent to the specimen itself; instead, apply it to a tiny fragment from which the cortex has been partly scraped away to reveal the medulla. Having tested both the medulla and the cortex, record the colour reactions (e.g., "Cortex K+ yellow"; "Medulla PD+ yellow becoming orange") for future reference. It is helpful to record both positive *and* negative reactions.

Calcium hypochlorite (C): This reagent, commercial chlorine bleach (e.g., Javex), can be purchased from most grocery stores. Because the reaction (a reddish or pinkish coloration) is usually fleeting, the lichen must be closely observed when it is wetted. In cases where the reaction is unconvincing, a more vivid reaction can usually be obtained by using K followed by C. Calcium hypochlorite is unstable and should be tested periodically (e.g., once per month, using a species known to give a C+ reaction) to ensure that it is still active.

Nitric acid (HNO_3): This reagent is rarely used but is helpful in distinguishing the genus *Neofuscelia* from *Melanelia*. The expected reaction (in *Neofuscelia*) is a rapid darkening of the upper cortex, with a blue-green tinge.

Potassium iodide (I): Iodine solutions react with a variety of starches. When applied to the **hymenium** in, for example, *Pannaria*, the colour change is to blue, violet or even blueish black. 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.

Potassium hydroxide/calcium hypochlorite (KC): In this test, the K is applied first and then the C. The reactions yield vivid pinks or reds, and, though instantaneous, these colours often fade quickly.

---

[3] The abbreviations of calcium hypochlorite (C), potassium iodide (I), and potassium hydroxide (K) are commonly used by lichenologists and should not be confused with the standard symbols for the chemical elements carbon, iodine, and potassium.

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 can also be prepared by dissolving a few crystals of PD in two or three drops of 70% ethyl alcohol. This solution is highly unstable, however, 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 after it has turned a dark pink. This reagent must be handled carefully, as it is absorbed through the skin, is suspected of being a carcinogen, and stains cloth, books, and specimens. Reactions may require a minute or more to develop properly and result in yellow, orange, or red coloration. The reagent is often available from scientific supply outlets.

2. Ultraviolet Lamps

Ultraviolet (UV) fluorescence is an effective means of detecting many lichen substances. 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 is unmistakable, yielding a vivid bluish or whitish colour. Because UV light is damaging to the eye, protective goggles should always 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

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

A Note on Common Names

In this manual, common names are proposed for all foliose and squamulose lichens known to occur in British Columbia. Although many lichenologists (including the second author) resist the coining of common names, others (including the first author) feel common names are prerequisite to the popularization of lichenology. To some extent the names adopted here are based on the latest recommendations of the Lichen Names Working Committee, though most are original with this publication. Names in parentheses have been used by earlier authors — for example, Ainsworth (1971), Alvin (1977), Benton and Underhill (1977), Bland (1971), Bolton (1960), Brodo (1988), McGrath (1977), MacKinnon et al. (1992), Nearing (1947), Perez-Llano (1944), Richardson (1975), Smith (1921) and Vitt et al. (1988) — but for various reasons are not accepted here.

Most of the common names are based on readily observable attributes of the species and genera, though some are also intentionally fanciful. Members of a given genus usually bear the same common "family" name, but that name may also apply to similar genera. Likewise, the same names are often applied to similar species within a genus on the assumption that students prepared to distinguish beyond this level of detail already favour the use of Latin binomials over that of common names.

Common names can be 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 of the species.

KEYS TO GENERA OF FOLIOSE AND SQUAMULOSE LICHENS

Making Use of the Keys

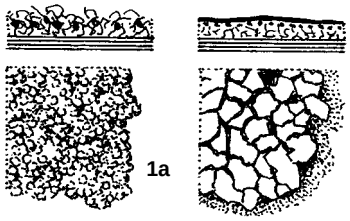
The keys in this manual consist of sequential pairs of parallel, but opposing, statements that can be compared against any foliose or squamulose species known to occur in British Columbia. To identify a lichen, begin with the first statement or "lead" in Key A and select the statement (i.e., 1a or 1b) that most accurately describes the specimen in hand. Proceed next to the lead indicated at the end of the more appropriate statement and repeat this process. The user will eventually be directed to one of the genus keys (i.e., Keys B, C or D), and then, following the same process, to one of the species keys (i.e., the keys appearing within the genus accounts). 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 where a wrong turn was taken. It may prove helpful to jot down the identification sequence so as to retrace it more quickly.

Many species are keyed out at more than one location: where a specimen seems well described by both leads of a pair, it can usually be looked for under both leads.

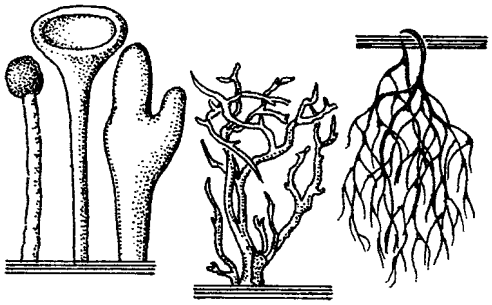
Unless otherwise indicated, the colour values given in the keys are based on dry material; moist specimens may be considerably darker. Measurements are also based on dry material. Spores, however, can only be accurately measured when mounted in water (or other liquid) on a glass slide and covered with a cover slip. Spores are measured in microns (μ) and should be examined under a light microscope, usually at between 100x and 400x. Measurements represent the average of the *larger* spores — an observation that also applies to lobes, isidia, pseudocyphellae, and other structures.

The line drawings accompanying the keys are tied to the keys by lead number (e.g., 23a) and, in many cases, by pointer arrows (←). The arrows 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 a lichen shown at twice life size). The drawings illustrate the upper surface of the species, unless otherwise noted.

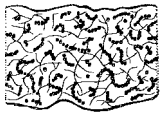
KEY A: LICHEN GROWTH FORMS



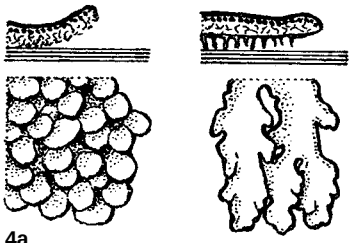
1a



2a



3a
(x.5)



4a 4b

1a Thallus crustose: entirely crust-like, paint-like, granular or powdery, attached to the substrate throughout and inseparable from it .... ***Leprose and Crustose Lichens*** **(i.e., *Dust and Crust Lichens*)** (not treated)

1b Thallus otherwise: either flattened and with a distinct upper and lower surface or else club-like, shrub-like or hairlike 2

2a Thallus fruticose: consisting of cylindrical branches that are club-like, shrub-like or hairlike; or, if thallus somewhat flattened, then coloured alike on all sides .... ***Fruticose Lichens*** **(i.e., *Club, Shrub and Hair Lichens*)** R(not treated)

2b Thallus foliose or squamulose: consisting of more or less flattened, dorsiventral lobes that are usually coloured differently above and below (Note: all orange-coloured lichens key here) 3

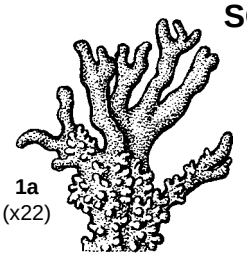
3a Thallus nonstratified, internal portions of thallus darkened throughout; upper surface dark (blackish, dark brownish, or bluish grey); thallus often swollen and/or semi-translucent when wet .... Key B: ***Nonstratified Foliose and Squamulose Lichens*** **(i.e., *Gel Lichens*)** (page **17**)

3b Thallus stratified, internal portions of thallus white or pale; upper surface pale or dark; thallus pliant when wet, but never distinctly swollen or semi-translucent 4

4a Thallus squamulose: consisting of numerous short, rounded/isodiametric scalelike lobes/squamules, these averaging to at most 8 mm wide, often overlapping .... Key C: ***Stratified Squamulose Lichens*** **(i.e., *Scale Lichens*)** (page **18**)

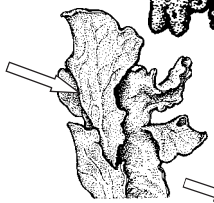
4b Thallus foliose: consisting of more or less elongate lobes, or if lobes short/isodiametric, then individual lobes averaging to more than 8 mm wide ..... Key D: ***Stratified Foliose Lichens*** **(i.e., *Leaf Lichens*)** (page **22**)

KEY B: NONSTRATIFIED (OR APPARENTLY NONSTRATIFIED) FOLIOSE AND SQUAMULOSE LICHEN GENERA OF BRITISH COLUMBIA

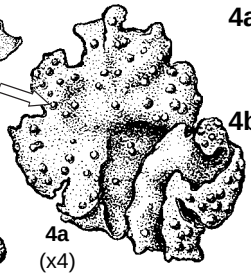


1a (x22)

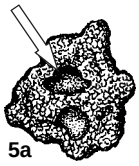
2a (x8)



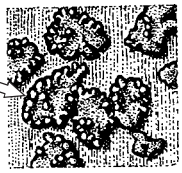
3a (x2.5) lower



4a (x4)

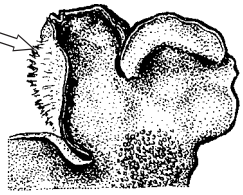


5a (x9)

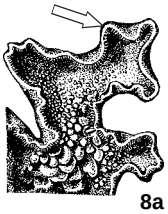


6a (x15)

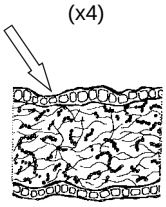
6b (x10)



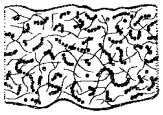
7a, 8b (x4)



8a (x5)



9a (x15) (cross-section)



9b (x15) (cross-section)

"GEL LICHENS"

1a Lobes minute, usually elongate, averaging to less than 0.5 mm wide; upper surface medium olive-brown; over rock ..... ***Koerberia***, ***Placynthium***, ***Vestergrenopsis*** (see key to ***Placynthium***)

1b Differing in one or more respects from the above: larger, or coloured differently, or over other substrates 2

2a Thallus distinctly umbilicate: attached by a thickened central holdfast; upper surface blackish; over rock; coastal ..... ***Phylliscum demangeonii***

2b Thallus not at all umbilicate; colour, habitat and distribution various 3

3a Thallus permanently submerged in mountain streams; lower surface veined(←) ..... ***Hydrothyria venosa***

3b Thallus not permanently submerged; lower surface not at all veined 4

4a Thallus a "seaweed," occurring over rock below high tide (intertidal zone); numerous dot-like perithecia present(←); apothecia absent ..... (***Kohlmeyera complicatula, Turgidosculum ulvae***)

4b Habit and habitat various, but never occurring below high tide; perithecia absent; apothecia present or absent 5

5a Over soil in arid inland localities; apothecia present(←), sunken below average level of thallus, disc reddish ..... ***Heppia lutosa***

5b Habitat and distribution various; apothecia absent or if present, then not sunken, the disc usually brownish (rarely reddish) 6

6a Thallus squamulose: consisting of numerous short, rounded/isodiametric, scalelike lobes(←), these averaging to at most 0.3 mm wide, often overlapping; upper surface never black ..... ***Pannaria, Parmeliella*** (see key to ***Pannaria***)

6b Thallus foliose: consisting of more or less elongate lobes, or if lobes short or rounded/isodiametric, then individual lobes averaging to more than 0.4 mm wide (Note: species having a distinctly black upper surface should key here) 7

7a Lower surface more or less evenly covered in dense, white woolly hairs/tomentum(←) 8

8a Upper surface naked; lobe margins and/or isidia bearing minute, erect white hairs(←) ..... ***Leptochidium albociliatum***

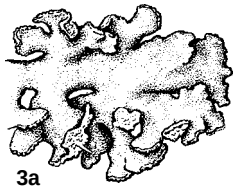
8b Upper surface naked or sparsely covered in white hairs (i.e., hairs, if present, not confined to lobe margins and/or isidia) ..... ***Leptogium***

7b Lower surface naked or, if in part hairy, then hairs distributed in localized tufts 9

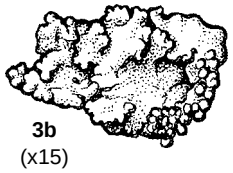
9a Cellular cortex present(←); upper surface often finely wrinkled, usually partly bluish or slate grey, and often somewhat shiny near lobe tips; thallus thin or at least not distinctly thick and swollen ..... ***Leptogium***

9b Cellular cortex absent: upper surface smooth to pustulate (rarely finely wrinkled), olive-green to blackish and with dull lobe tips; thallus thin or distinctly swollen, especially at the lobe tips ..... ***Collema***, ***Gonohymenia***, (***Leciophysma***), (***Lempholemma***) (see key to ***Collema***)

KEY C: STRATIFIED SQUAMULOSE LICHEN GENERA OF BRITISH COLUMBIA



3a (x15)



3b (x15)

"SCALE LICHENS"

1a Upper surface bright orange, bright yellow or bright greenish yellow 2

2a Soredia and/or isidia present (check lobe tips); over bark, wood or rock; widespread 3

3a Upper surface bright orange, K+ purple ..... ***Xanthoria fallax***

3b Upper surface bright yellowish, never distinctly orange, K- ..... ***Candelaria concolor***

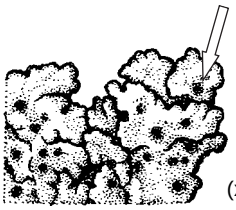
2b Soredia and isidia absent; over soil usually in semi-arid climates 4

4a Thallus K+ purple, resting on a white hypothallus (readily seen by carefully scraping away the lobes); apothecia uncommon, disc orangish or reddish .... (***Fulgensia bracteata***)

4b Thallus K-; hypothallus absent; apothecia usually abundant, the disc medium brown to dark brownish ..... (***Acarospora schleicheri***)

1b Upper surface not coloured as above 5

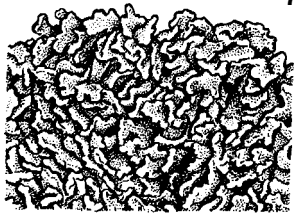
5a Photobiont a grass-green alga; upper surface pale or dark 6



6a (x10)

6a Upper surface bearing scattered immersed perithecia and/or pycnidia(←), these appearing as tiny brownish or blackish dots or slightly raised "nipples"; apothecia absent; over soil or rock 7

7a Over soil (including thin soil over rock) or over moss 8

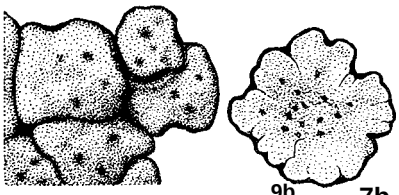


8a (x3)

8a Lobes raised, attached to substrate at one edge; lower surface pale, often rather exposed, readily seen from above ..... (***Cladonia***)

8b Lobes appressed, broadly attached to substrate by wefts of threadlike rhizoids that cover much of the lower surface; lower surface pale or dark, exposed only along margins, if at all 9

9a Lobes strong reddish brown (or pale greyish to brownish grey in some alpine species); spores simple, colourless, never intermixed with algal cells .... ***Catapyrenium***

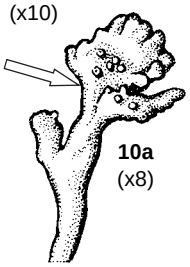


9a (x10)

9b (x8)

9b Lobes pale or occasionally dark, but never strong reddish brown; lowland intermontane; spores multi-celled/muriform, brownish, intermixed with algal cells ..... ***Endocarpon pusillum***

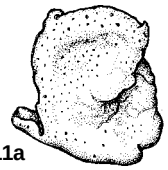
7b Growing directly attached to rock 10



10a (x8)

10a Lobes upright(←), dark brownish; pruina absent; spores muriform ....***Endocarpon pulvinatum***

10b Lobes appressed, pale brownish to pale greyish; pruina present or absent; spores simple or few-celled 11

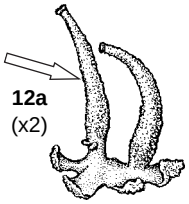


11a (x1)

11a Upper surface distinctly pruinose or, if otherwise, then lower surface dark ..... ***Dermatocarpon***

11b Upper surface not at all pruinose; lower surface pale brownish .... (***Acarospora***)

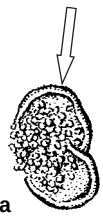
6b Upper surface usually lacking black dots (i.e., perithecia absent); apothecia present or absent; habitat various (Note: all lichens occurring over bark, wood or moss key here) 12



12a (x2)

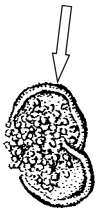
12a Lobes associated with hollow, upright podetia(←)..... (***Baeomyces***, ***Cladonia***)

12b Lobes not associated with podetia 13



13a, 14a (x9)

13a Lobe margins minutely and strongly inrolled, forming a thin, white peripheral rim(←) especially at lobe tips; upper surface greenish or pale greyish; apothecia absent; over moss, lichens or bark in humid climates 14



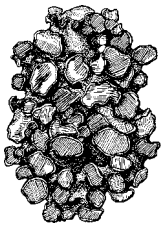
13a, 14a
(x9)

14a Upper surface sorediate in patches, often bearing faint concentric "growth rings"; infrequent ..... ***Normandina pulchella***

14b Soredia absent; upper surface not at all concentrically zoned; rare .... (***Omphalina***)

13b Lobe margins not minutely and strongly inrolled; upper surface variously coloured; apothecia present or absent; habitat and distribution various (Note: all lichens having soredia over the lower surface key here) 15

15a Growing directly over bark or wood 16



16a
(x2.5)

16a Upper and lower surface coloured alike, dark brown; apothecia present, abundant ..... ***Cetraria sepincola***

17a
(x8)

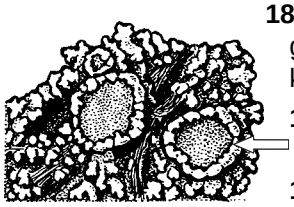
16b Upper and lower surface coloured differently, lower surface pale; apothecia present or absent 17

17a Lobes mostly less than 1 mm long, often wider than long(←); apothecia present or absent; upper surface C+ red or C- .... ***Hypocenomyce***, ***Waynea*** (see key to ***Hypocenomyce***)

17b Lobes mostly to more than 1.5 mm long, generally longer than wide; apothecia absent; upper surface C- ..... (***Cladonia***)

15b Growing over soil, moss, or rock, never directly over bark or wood 18

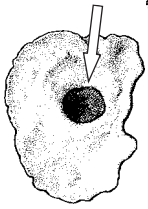
18a Upper surface with a distinctly greenish (or pale bluish green) cast; never growing directly over rock (Note: all species having strongly ascending lobes key here) 19



19a
(x6)

19a Apothecia present, apothecial rim distinctly "warty"(←); over moss or plant debris ..... ***Psoroma hypnorum***

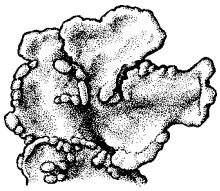
19b Apothecia present or absent, apothecial rim not at all warty; habitat various 20



20a
(x2.5)

20a Apothecia present(←), sunken below average surface of thallus .... ***Solorina***

20b Apothecia absent or, if present, then not at all sunken 21



22a
(x5)

21a Thallus more or less crustose, attached to substrate almost throughout, only the margins elevated and lobe-like 22

22a Apothecia absent; upper surface often exfoliating in spots; humid localities ..... (***Baeomyces placophyllus***)

22b Apothecia usually present; upper surface never exfoliating; dry, exposed localities ..... (***Squamarina cartilaginea***)

23a
(x2)

21b Thallus not at all crustose; lobes elevated above substrate almost throughout 23

23a Lower surface distinctly veined(←) ..... ***Peltigera venosa***

23b Lower surface not at all veined 24

24b, 25a
(x8)

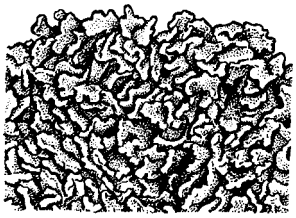
24a Lobes averaging to less than 0.4 mm wide; apothecia absent or, if present, erect and strawberry-shaped/ampulliform .... ***Agonimia tristicula***

24a
(x18)

24b Lobes averaging to at least 0.8 mm wide (often much wider); apothecia absent or if present, hemispherical(←) 25

25a Apothecia present: hemispherical at maturity ..... ***Psora***

25b Apothecia absent ..... (***Cladonia***)



25b
(x3)

18b Upper surface blackish, whitish, brownish, greyish or pinkish; occasionally growing directly over rock 26

28a
(x4)

26a Lobes strongly convex, largely hemispherical; spores colourless .... (***Toninia***)

26b Lobes concave or partly convex, but never largely hemispherical; spores colourless or dark 27

27a Lobes whitish, greyish or blackish 28

28a Lobes blackish; alpine ..... ***Umbilicaria lambii***

28b Lobes whitish or greyish; restricted to lowland sites 29

29a Lobes averaging to less than 1.5 mm wide, tending to overlap; medulla C+ red; coastal ..... (***Trapeliopsis wallrothii***)

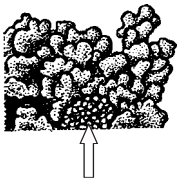
29b Lobes averaging to more than 1.5 mm wide, not overlapping; medulla C-; inland ..... (***Squamarina cartilaginea***)

30a
(x6)

27b Lobes brownish or pinkish 30

30a Apothecia present, apothecial rim distinctly "warty"(←); lobes strongly appressed throughout, over moss ..... ***Psoroma hypnorum***

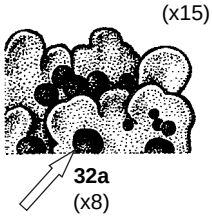
30b Apothecia present or absent; apothecial rim smooth, not at all warty; lobes usually somewhat elevated toward tips; habitat various 31



31a
(x15)

31a Lobes intermixed with (sparse) external brownish or blackish cephalodia(←), these distinctly convoluted above and measuring to 1 mm across; over acid outcrops in northern alpine localities .... ***Psoroma*** sp. 1

31b Cephalodia absent; habitat and distribution various 32



32a
(x8)

32a Apothecial disc strongly convex, often hemispherical at maturity(←); spores 1-celled; inland ..... ***Psora***

32b Apothecial disc plane(←) or weakly convex; spores 2-celled at maturity; distribution various 33

32b, 33a
(x11)

33a Apothecial disc black(←); spores brown; inland .... (***Buellia badia***)

33b Apothecial disc brownish; spores colourless; over seaside rocks ..... (***Lecania dudleyi***)

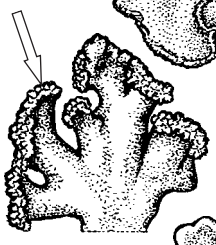
34a
(x2.5)

5b Photobiont a dark holly-green to greyish blue cyanobacterium; upper surface generally greyish, bluish, brownish or blackish 34

34a Lobes attached by thickened central holdfast/umbilicus; growing directly over vertical rock in arid climates ..... ***Peltula euploca***

34b Lobes variously attached, but umbilicus absent; habitat various 35

35a True soredia present, originating on undersides of lobes(←) 36



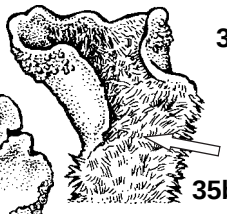
35a, 36a
(x9)

36a Upper surface lacking hairs (Note: a few cobwebby hairs may be present at the lobe tips in ***Pannaria ahlneri***) ..... ***Pannaria***

36b Upper surface partly bearing hairs, these stiffly erect or appressed-woolly/tomentose 37

37a Hairs stiffly erect(←) ..... ***Erioderma sorediatum***

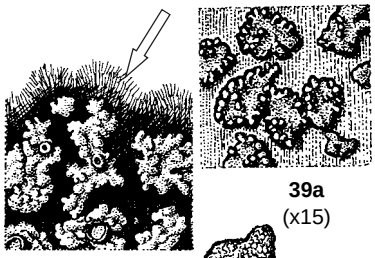
37b Hairs appressed and woolly/tomentose ..... ***Leioderma sorediatum***



37a
(x9)

37b
(x6)

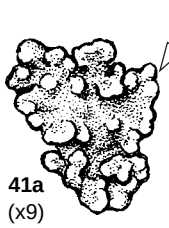
35b True soredia absent (Note: species having soredia-like isidia or lobules that do not originate on the undersides of the lobes should key here) 38



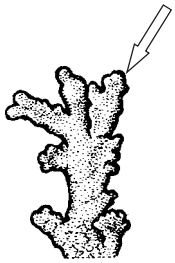
38a, 39b
(x11)

39a
(x15)

40a
(x9)



41a
(x9)



41b
(x8)

38a Thallus resting on conspicuous black hypothallus(←); lobes scalelike; over bark or rock in humid climates 39

39a Over bark or wood (also rarely among moss over rock) ..... ***Parmeliella triptophylla***

39b Growing directly over rock ..... ***Placynthium nigrum***

38b Hypothallus absent or inconspicuous; lobes scalelike or elongate; habitat and distribution various 40

40a Apothecia present(←), strong reddish, sunken below the average surface of the thallus; over soil in arid climates ..... ***Heppia lutosa***

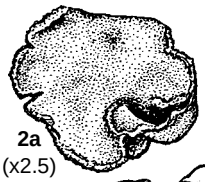
40b Apothecia present or absent, never strong reddish or sunken; habitat and distribution various 41

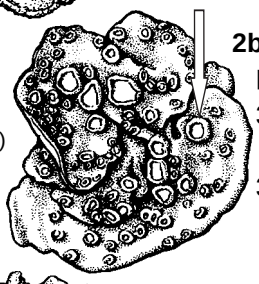
41a Exposed areas of upper surface grey, greyish brown or almost black; lobe tips and/or "isidia" often soft-corticate and pale-felted(←); over wood or bark or, if over moss, then thallus forming a dense mat that completely obscures the substrate; spores 1-celled (but often containing one or more oil bodies) ..... ***Pannaria***

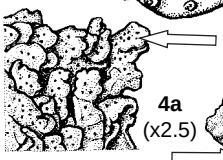
41b Exposed areas of upper surface more or less medium brown; lobe tips and "isidia" hard-corticate(←), never pale-felted; over soil, rock or, if over moss, then usually forming loose mats that do not usually completely obscure the substrate; spores 2–multi-celled ..... ***Massalongia***

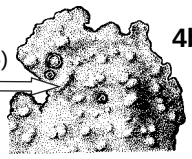
KEY D: STRATIFIED FOLIOSE LICHEN GENERA OF BRITISH COLUMBIA

"LEAF LICHENS"

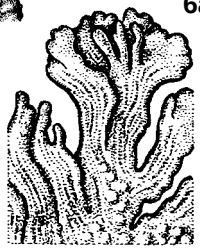

2a (x2.5)


3a (x2.5)

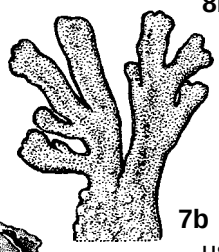

4a (x2.5)

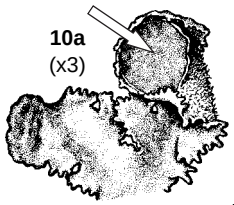

5a (x1.5)

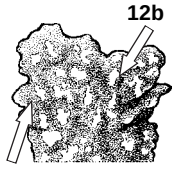

5b (x2.5)

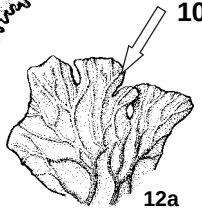

8a (x22)


9a (x8) *Massalongia*


9b (x22) *Placynthium*


10a (x3)


12b


12a (x2) lower

14a (x1) lower

1a Thallus umbilicate: attached to the substrate by a single, thickened, more or less central holdfast; over rock 2

2a Photobiont a dark greyish blue cyanobacterium; restricted to arid inland climates; rare ..... ***Peltula euploca***

2b Photobiont a grass-green alga; distribution various (Note: specimens in which the photobiont is difficult to assess with a hand lens should key here) 3

3a Upper surface distinctly pale greenish; apothecia also pale(←); restricted to arid or dry inland climates ..... ***Rhizoplaca***

3b Upper surface pale or dark, but never pale greenish; apothecia black or absent; distribution various 4

4a Upper surface bearing scattered immersed perithecia and pycnidia, these appearing from above as tiny brownish or blackish dots(←); apothecia and rhizines absent; medulla C- ..... ***Dermatocarpon***

4b Upper surface usually lacking black dots (i.e., perithecia absent); apothecia and rhizines present or absent; medulla C+ red or C- 5

5a Upper surface bearing scattered blisters/pustules(←), these never united and ridge-like; spores 1 or 2 per ascus ..... ***Lasallia pensylvanica***

5b Upper surface plane or variously wrinkled or ridged(←), but never bearing scattered pustules; spores 8 per ascus ..... ***Umbilicaria***

1b Thallus not umbilicate, central holdfast absent; ecology various 6

6a Primary photobiont a dark greenish blue to dark greyish blue cyanobacterium; upper surface generally dark greyish, bluish or brownish 7

7a Lobes narrow or if proportionately broad, then minute, averaging to less than 2 mm wide, often elongate; lower surface never bearing veins or pale spots 8

8a Lower surface and rhizines blue-green (Note: this character is best demonstrated under a light microscope, but can sometimes be checked by scraping away portions of thallus, and examining the [discoloured] substrate below) ..... ***Placynthium***

8b Lower surface pale, or at least never blue-green 9

9a Lobes averaging to more than 0.5 mm wide; thallus growing over moss, soil, bark or wood, almost never directly over rock ..... ***Massalongia***, ***Pannaria***, ***Parmeliella*** (see key to ***Pannaria***)

9b Lobes averaging to less than 0.2 (–0.3) mm wide; thallus growing directly over rock ..... ***Koerberia***, ***Placynthium***, ***Vestergrenopsis*** (see key to ***Placynthium***)

7b Lobes proportionately broad, often rather large, averaging to more than 3 mm wide, usually short and rounded; lower surface often veined or sparsely covered in pale spots 10

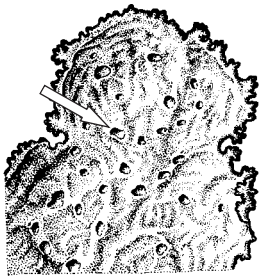
10a Apothecia located on lower surface(←) ..... ***Nephroma***

10b Apothecia located on upper surface, or apothecia absent 11

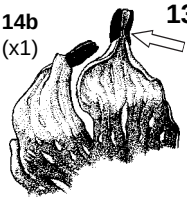
11a Lower surface veined or sparsely covered in pale spots 12

12a Lower surface at least in part distinctly veined(←), bearing copious rhizines; usually ground-dwelling ..... ***Peltigera***

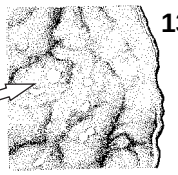
12b Lower surface more or less sparsely covered in pale spots(←), not veined; rhizines absent or sparse; habitat various 13



15a
(x4) lower

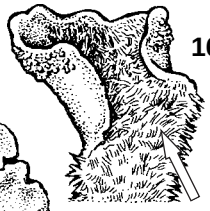


14b
(x1)

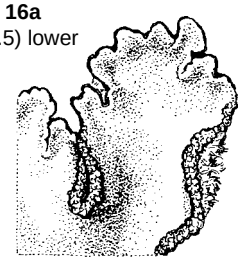


15b
(x5) lower

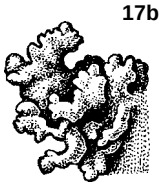
16a
(x1.5) lower



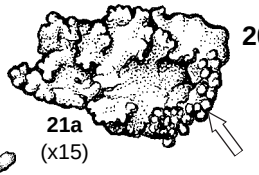
17a (x9)



17b (x6)



20a
(x20)



21a
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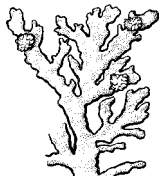
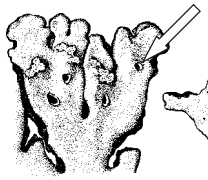


22a
(x5)

22b
(x5)



24a
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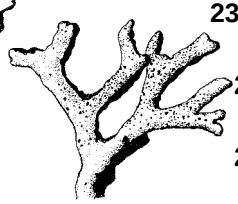


24b
(x2.5)

13a Spots averaging to more than 1.5 mm wide 14

14a Lower surface (except spots) densely covered in minute erect hairs(←); spots hard-corticate, often somewhat shiny; apothecia located primarily over central portions of upper surface ..... ***Lobaria***

14b Lower surface cottony, but not at all covered in minute erect hairs; spots also cottony, dull; apothecia located at thallus periphery(←) ..... ***Peltigera***

13b Spots minute, averaging to less than 1 mm wide 15

15a Lower surface cyphellate: spots distinctly sunken(←) and rimmed ..... ***Sticta***

15b Lower surface pseudocyphellate: spots plane or raised(←), not rimmed ..... ***Pseudocyphellaria***

11b Lower surface more or less uniform, not at all veined or pale-spotted 16

16a Lower surface either hard-corticate and naked, or densely covered in minute erect hairs; widespread ..... ***Nephroma***

16b Lower surface appressed-cottony, not hard-corticate or densely covered in minute erect hairs; hypermaritime 17

17a Upper surface bearing minute erect hairs(←), medulla PD+ orange ..... ***Erioderma sorediatum***

17b Upper surface hairless or bearing minute appressed hairs; medulla PD- ..... ***Leioderma sorediatum***

6b Primary photobiont a grass-green alga; upper surface pale or dark (Note: all brightly coloured species key here) 18

18a Upper surface orange or, if yellow-green or grey-green, then lobes tiny, less than 0.5 mm wide 19

19a Upper surface orange (sometimes yellowish green in shady sites), K+ purplish ..... ***Xanthoria***

19b Upper surface yellowish green or grey-green, K- 20

20a Thallus minute; lobes averaging to 0.1–0.3 mm wide; isidia and soredia absent; over moss ..... ***Agonimia tristicula***

20b Thallus minute or small; lobe sometimes averaging to more than 0.3 mm wide; isidia and/or soredia present; growing directly over bark or rock 21

21a Isidia and/or soredia present(←), located mostly along lobe margins and/or lobe tips; lobes averaging to less than 0.2 mm wide ..... ***Candelaria concolor***

21b Isidia absent; soredia present, located over upper surface (including upper surface of lobe tips); lobes averaging to more than 0.4 mm wide 22

22a Over rock; upper surface generally somewhat shiny throughout; coastal; medulla K+ yellow, PD+ orange ..... ***Xanthoparmelia mougeotii***

22b Over bark (very rare over rock); upper surface generally dull toward thallus centre; widespread; medulla K-, PD- ..... ***Parmeliopsis ambigua***

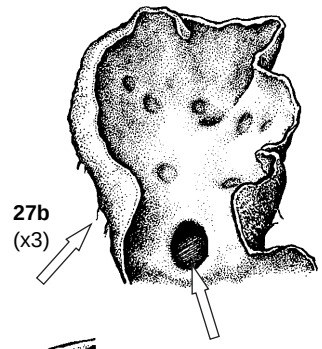
18b Upper surface variously coloured, but never orange; if yellow-green or grey-green, then lobes larger, averaging to more than 1 mm wide 23

23a Lobes distinctly hollow in cross-section (readily observed through hand lens) 24

24a Upper surface sparsely perforate(←), perforations to 2 mm across; soredia sometimes present around openings; coastal ..... ***Menegazzia***

24b Upper surface not perforate, but lobe tips occasionally perforate; soredia variously located or soredia absent; distribution various ..... ***Hypogymnia***

23b Lobes leaflike or partly cylindrical, but never hollow 25


27b
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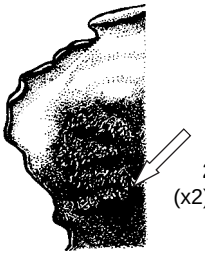
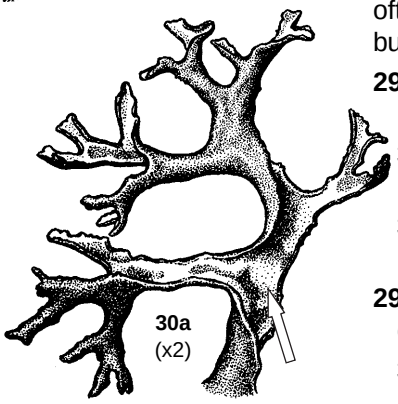

28a
(x2) lower


30a
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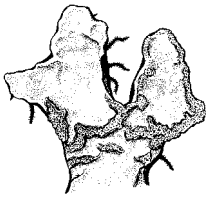
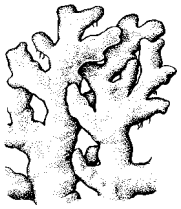
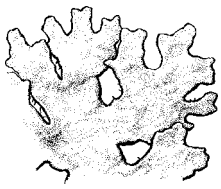

31a
(x4)


33a
(x5)


33b
(x2.5)

25a Lobes proportionately broad; lower surface with an appressed-cottony appearance (check near lobe tips), often bearing darkened veins; wart-like cephalodia sometimes scattered over upper surface (Note: species with distinctly sunken apothecia key here) 26

26a Lower surface more or less distinctly veined or pale-spotted; and/or upper surface bearing wart-like cephalodia; apothecia located near lobe margins 12

26b Lower surface uniform or weakly veined, not at all pale-spotted; cephalodia absent over upper surface; apothecia located over central portions of upper surface, more or less sunken (Note: species with an orange lower surface key here) 27

27a Lobes numerous and conspicuously overlapping; rhizines and apothecia absent ..... (***Cladonia***)

27b Lobes sparse to numerous, but never conspicuously overlapping; rhizines and apothecia usually present(←) ..... ***Solorina***

25b Lobes broad or narrow; lower surface hard-corticate to rarely appressed-cottony; veins absent; wart-like cephalodia also absent over upper surface 28

28a Apothecia (if present) located on lower surface; lobes averaging to more than 15 mm wide; lower surface strongly woolly-tomentose toward thallus centre(←); rhizines absent; usually ground-dwelling ..... ***Nephroma***

28b Apothecia (if present) located over upper surface or along lobe margins; lobes often averaging to less than 15 mm wide; lower surface bare or bearing rhizines, but never strongly woolly-tomentose; ecology various 29

29a Thallus unattached to substrate, *and* upper surface dark brown; exposed localities 30

30a Lower surface partly white-pruinose(←); northern B.C.; alpine ..... ***Masonhalea richardsonii***

30b Lower surface not white-pruinose; southern B.C.; restricted to arid inland sites at lower elevations ..... ***Dermatocarpon***

29b Thallus attached or if unattached (as very rarely), then upper surface not dark brown; distribution various 31

31a Thallus "parmelioid," (i.e., combining at least two of the following characters: upper and lower surfaces obviously unlike in colour; rhizines abundant over lower surface; lobes more or less closely appressed) (Note: all species having a white-pruinose upper surface key here) 32

32a Upper surface distinctly yellowish (including yellowish green), *and* thallus growing over rock or soil 33

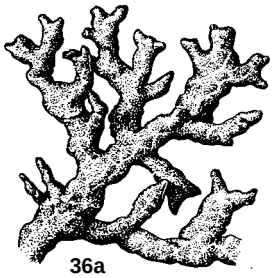
33a Upper surface dull throughout; lower surface also dull, usually weakly white-pruinose; boreal and alpine localities; medulla KC+ reddish, UV+ ..... ***Arctoparmelia***

33b Upper surface more or less distinctly shiny (check lobe tips); lower surface also shiny, never white-pruinose; widespread, but most common in southern regions of B.C. at lower elevations; medulla KC-, UV- ..... ***Xanthoparmelia***

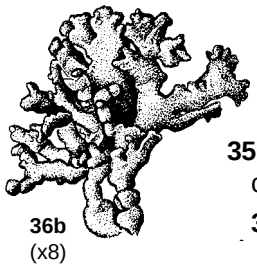
32b Upper surface coloured otherwise or, if yellowish, then growing over bark or wood 34

34a Upper surface essentially dark: brownish, olivaceous or blackish 35

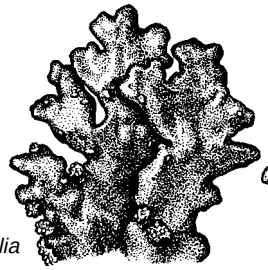
35a Rhizines absent over lower surface (sparse peg-like outgrowths may, however, be present); lobes strongly convex throughout; over acid rock in exposed alpine localities 36



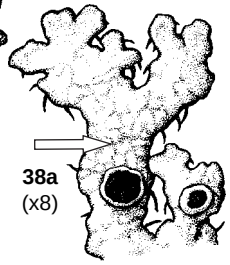
36a
(x4)



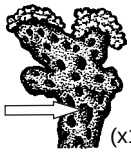
36b
(x8)



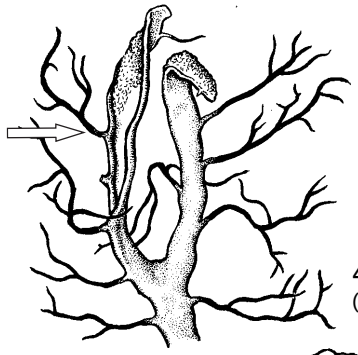
37a
(x8)
Melanelia



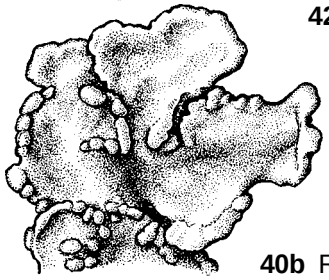
38a
(x8)



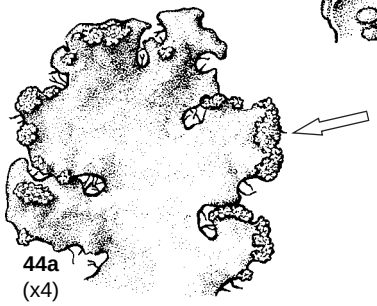
41a
(x15) lower



42a
(x8)



43b
(x8)



44a
(x4)

36a Lobes partly semi-erect, sparsely branched, seldom completely obscuring substrate; cortex K+ yellow (check lobe tips or other pale areas); medulla PD+ orangish or PD- ..... ***Brodoa oroarctica***

36b Lobes mostly appressed throughout, densely branched, generally completely obscuring substrate; cortex K- throughout; medulla PD+ strong yellow or PD- ..... ***Allantoparmelia***

35b Rhizines present below; lobes generally weakly convex (rarely strongly convex) throughout; ecology and distribution various 37

37a Upper surface medium brown, partly shiny (check lobe tips); apothecial discs distinctly brown; lobes generally averaging to more than 2 mm wide; spores 1-celled/simple, colourless .... ***Melanelia***, ***Neofuscelia*** (see key to ***Melanelia***)

37b Upper surface medium brown to nearly black, dull throughout; apothecial discs black or (when pruinose) pale greyish; lobes generally averaging to less than 2 mm wide; spores 2-celled, brown 38

38a Upper surface dark greyish (never distinctly brownish), pale-spotted/maculate(←), K+ yellow (check sheltered lobes); lower surface pale; rhizines unbranched ..... ***Physcia***

38b Upper surface brownish or blackish brown, not at all pale-spotted/maculate, K-; lower surface pale or more often dark; rhizines branched or unbranched 49

34b Upper surface occasionally brown where exposed, but otherwise pale: whitish, greyish, bluish, greenish or yellow (check sheltered lobes) 39

39a Lobes generally averaging to less than 4 mm wide; rhizines abundant or occasionally absent; lobe margins ciliate or not 40

40a Rhizines absent over lower surface (cilia, however, present along lobe margins in *Heterodermia*); lower cortex hard-corticate or not 41

41a Lower surface black, regularly pitted with minute black craters(←) (hand lens); essentially coastal ..... ***Cavernularia***

41b Lower surface pale and smooth or at most wrinkled, never pitted; distribution various 42

42a Over bark; lobe margins strongly ciliate (←) ..... ***Heterodermia***

42b Over rock or soil; lobe margins lacking cilia 43

43a Lobes distinctly elongate; upper surface strongly white-pruinose; restricted to exposed soil in semi-arid intermontane localities ..... (***Buellia elegans***)

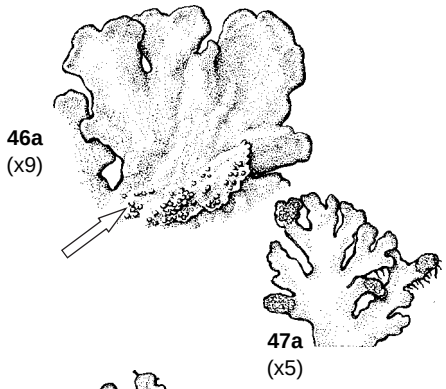
43b Lobes short, more or less squamulose; upper surface at most weakly white-pruinose; over rock or soil in cool, boreal localities ..... (***Baeomyces placophyllus***)

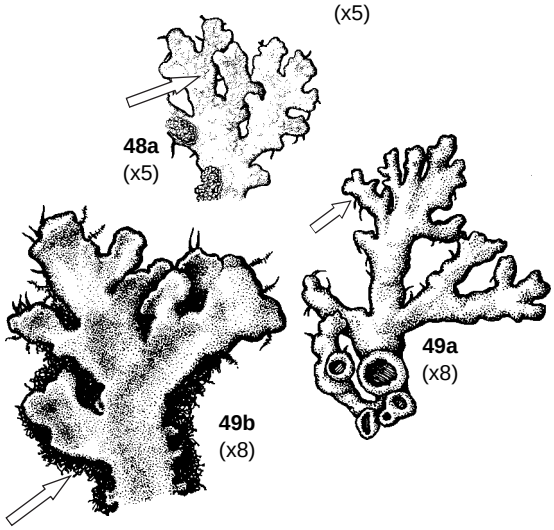
40b Rhizines present and usually conspicuous over lower surface; lower cortex hard-corticate 44

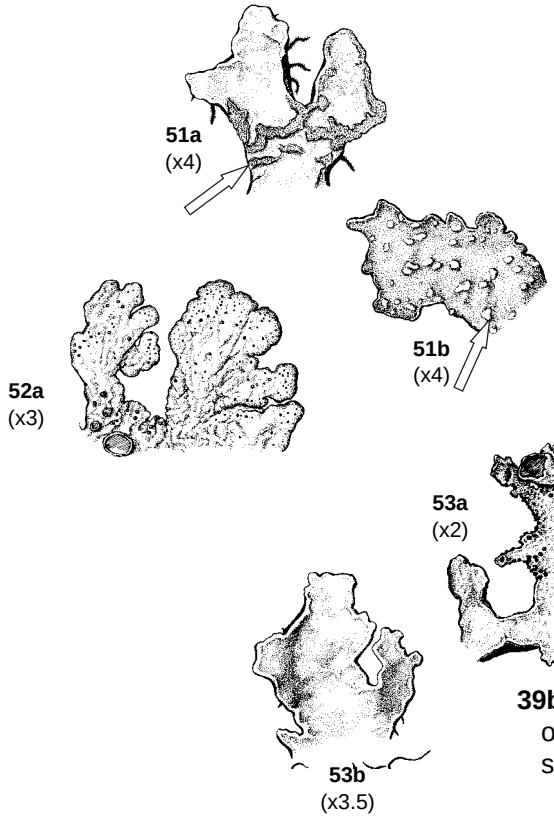
44a Lobes semi-erect at maturity, sorediate, soredia borne partly on downturned lobe tips(←); coastal ..... ***Hypotrachyna***

44b Lobes appressed or semi-erect at maturity; lobe tips never both sorediate and downturned; distribution various 45

45a Lobes averaging to less than 2.5 mm wide; pseudocyphellae absent 46







46a Upper surface isidiate(←), isidia pale; soredia absent; lower surface pale throughout; upper cortex K+ gold ..... ***Imshaugia aleurites***

46b Upper surface isidiate or not; isidia (if present) dark brown or black; soredia present or absent; upper cortex K- or K+ yellow 47

47a Upper surface shiny, especially near lobe tips; soredia present over upper surface; often over conifers; medulla KC+ rose (fading), UV+ ..... ***Parmeliopsis***

47b Upper surface dull near lobe tips; thallus sorediate or not; rarely over conifers (except in localities rich in calcium); medulla KC-, UV- 48

48a Upper surface pale greyish or rarely dark greyish (never distinctly brownish), often pale-spotted/maculate(←); rhizines unbranched; lower cortex pale; upper cortex K+ yellow ..... ***Physcia***

48b Upper surface partly distinctly brownish at maturity, lacking pale-spotting/maculae; rhizines unbranched or woolly-branched; lower cortex dark or occasionally pale; upper cortex K- 49

49a Rhizines unbranched(←) or only sparsely branched at maturity; upper surface generally lacking white pruina ..... ***Phaeophyscia***

49b Rhizines densely woolly-branched(←) at maturity; upper surface generally distinctly white-pruinose (check lobe tips) ..... ***Physconia***

45b Lobes averaging to more than 3 mm wide; pseudocyphellae sometimes present over upper surface 50

50a Soredia and/or isidia present, conspicuous 51

51a Upper surface isidiate or sorediate, soredia confined to somewhat elongate soralia(←); lower surface rhizinate almost to lobe tips; widespread ..... ***Parmelia***

51b Upper surface sorediate, soredia confined to somewhat circular soralia(←); isidia absent; lower surface rhizinate mostly toward the thallus centre; coastal ..... ***Punctelia***

50b Soredia and isidia absent 52

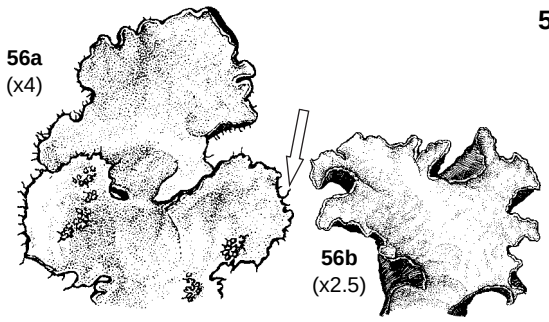
52a Upper surface strong yellow, thallus closely appressed throughout; mostly over whitebark pine ..... ***Ahtiana sphaerosporella***

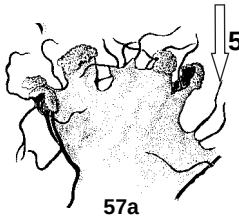
52b Upper surface greyish or only weakly yellowish; thallus loosely appressed to occasionally semi-erect; never over whitebark pine 53

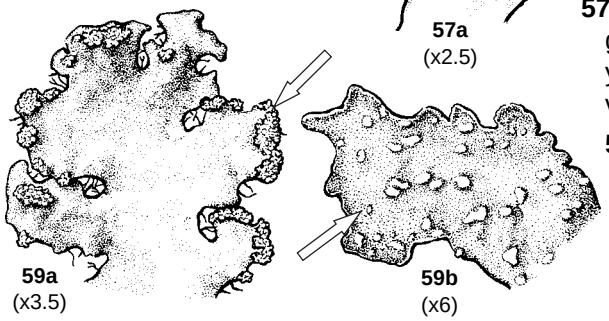
53a Over bark or wood; lower surface distinctly wrinkled; rhizines sparse ..... ***Esslingeriana idahoensis***

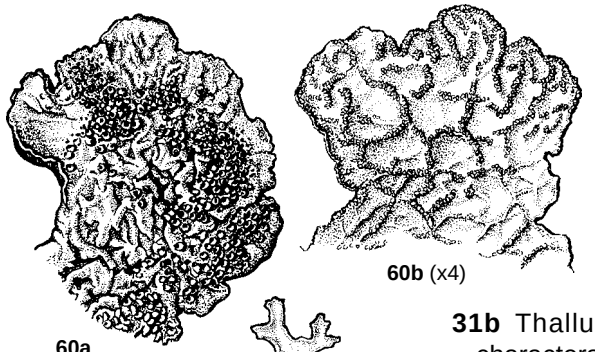
53b Over rock; lower surface more or less smooth; rhizines rather abundant ..... ***Parmelia omphalodes***

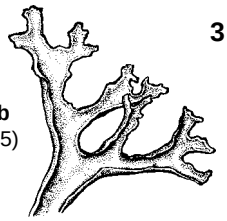
39b Lobes generally averaging to more than 5 mm wide; rhizines absent or sparse and restricted to thallus centre (lobe margins, however, occasionally ciliate) 54

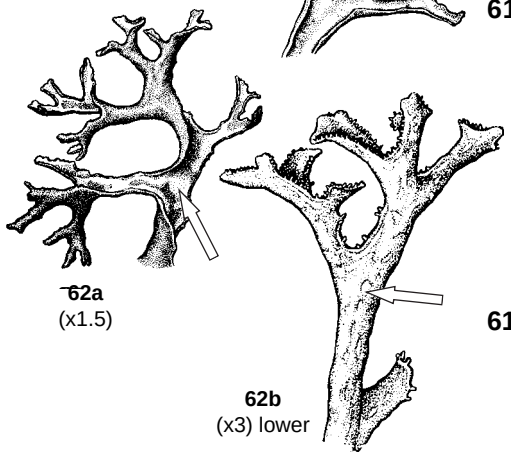












54a Soredia and isidia absent 55

55a Lobes mostly elongate, averaging to 1.5–4 (–6) mm wide; inland ..... ***Esslingeriana idahoensis*** (see lead **53a**)

55b Lobes mostly short, averaging to 5–20 mm wide; distribution various, but most common in humid localities 56

56a Lobe margins bearing flexuous black cilia(←); upper surface more or less smooth; coastal; medulla K- or K+ yellow ..... ***Parmotrema***

56b Lobe margins lacking cilia; upper surface smooth to strongly ridged; distribution various; medulla K- ..... ***Platismatia***

54b Soredia and/or isidia present 57

57a Lobe margins bearing long black cilia(←); lower surface lacking rhizines near lobe margins; upper surface whitish grey, lacking pseudocyphellae; coastal ..... ***Parmotrema***

57b Lobe margins naked; lower surface rhizinate almost to lobe margins or rhizines sparse or absent; upper surface whitish grey or yellowish green; pseudocyphellae present or absent; distribution various 58

58a Thallus sorediate 59

59a Upper surface lacking pseudocyphellae; soredia borne at least partly on distinctly downturned lobe tips(←) ..... ***Hypotrachyna***

59b Upper surface pseudocyphellate(←); soredia variously positioned but never associated with distinctly downturned lobe tips ..... ***Punctelia***

58b Thallus strictly isidiate or bearing both isidia and soredia 60

60a Upper surface often blackening when growing in exposed conditions; over rock; alpine; northern; medulla KC+ reddish, PD+ slowly strong yellow ..... ***Asahinea scholanderi***

60b Upper surface brownish when exposed, never blackening; over bark (rare over rock); temperate to boreal; medulla KC-, PD- ..... ***Platismatia***

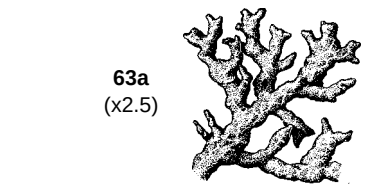
31b Thallus "cetrarioid," (i.e., combining at least two of the following characters: upper and lower surface coloured more or less alike; rhizines absent or very sparse [marginal cilia, however, may be present in some species]; lobes loosely attached or semi-erect) 61

61a Upper surface essentially dark throughout: olive-green, brown or blackish 62

62a Lower surface broadly white-pruinose(←); rhizines absent; thallus growing unattached to substrate, often ball-like in the dry condition; northern B.C.; alpine ..... ***Masonhalea richardsonii***

62b Lower surface occasionally bearing small, white, localized pseudocyphellae(←), but never broadly white-pruinose; rhizines present or absent; thallus attached to substrate; individual thalli never ball-like; distribution various ..... ***Cetraria***

61b Upper surface occasionally brownish or blackish where exposed, but otherwise mostly pale: yellowish, greyish, pale greenish or pale bluish (check sheltered lobes) 63


63a
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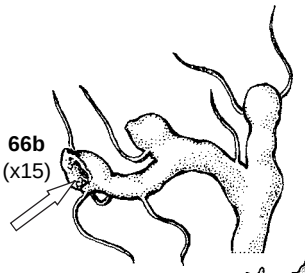
66b
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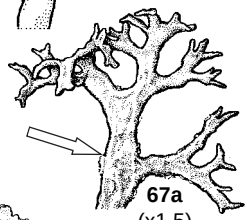
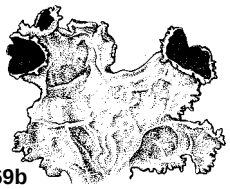
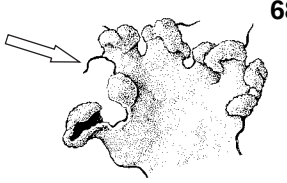
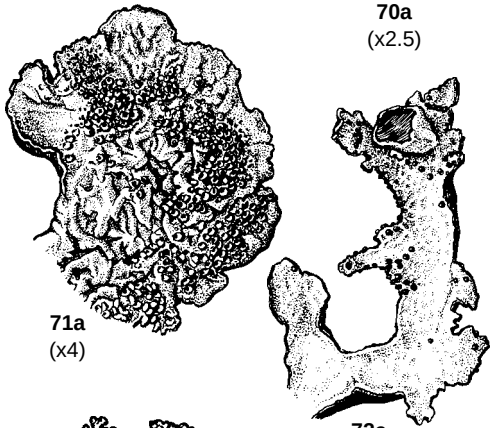
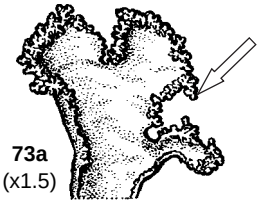

67a
(x1.5)


69a
(x2.5)


69b
(x2.5)


70a
(x2.5)


71a
(x4)
72a
(x4)


73a
(x1.5)

63a Lobes narrow, elongate *and* distinctly swollen (i.e., convex above and below); over rock in exposed alpine localities ..... ***Brodoa oroarctica***

63b Lobes various but never distinctly swollen; restricted primarily to lowland localities (Exception: *Asahinea scholanderi*) 64

64a Lower surface more or less white, hard-corticate or partly appressed-cottony (i.e., lower cortex lacking); lobes narrow, elongate 65

65a Lobe margins distinctly ciliate 66

66a Lower surface appressed-cottony (i.e., lower cortex absent); rhizines, if present, restricted to area of lobe margins; soredia present or absent ..... ***Heterodermia*** (see lead **42a**)

66b Lower surface distinctly hard-corticate (rarely in part appressed-cottony), bearing scattered rhizines throughout; soredia present(←) (check lobe tips) ..... ***Physcia***

65b Lobe margins lacking cilia 67

67a Soredia present(←); upper surface dull, pale yellowish green; widespread ..... (***Evernia prunastri***)

67b Soredia absent; upper surface generally shiny, pale bluish grey to greenish grey; coastal ..... ***Platismatia*** (see lead **31b**)

64b Lower surface dark or at least not white (Exception: some ***Platismatia*** species may occasionally have a white lower surface), never appressed-cottony; lobes various 68

68a Upper surface yellowish or yellowish green, never bearing pseudocyphellae; lower surface more or less coloured alike with upper surface; medulla white or pale yellow 69

69a Medulla white ..... ***Cetraria***

69b Medulla pale yellow ..... ***Vulpicida***

68b Upper surface coloured differently or, if yellowish, then lower surface partly distinctly blackish; upper surface pseudocyphellate or not; medulla white 70

70a Lobe margins ciliate(←); lower surface mostly black ..... ***Parmotrema***

70b Lobe margins lacking cilia; lower surface pale or blackening 71

71a Lobes short and broad, averaging to more than 12 mm wide; rhizines absent; over rock and soil; alpine; northern ..... ***Asahinea scholanderi***

71b Lobes of various proportions, but averaging to less than 10 mm wide; lower surface rhizinate or not; over bark (rare over rock); temperate and boreal 72

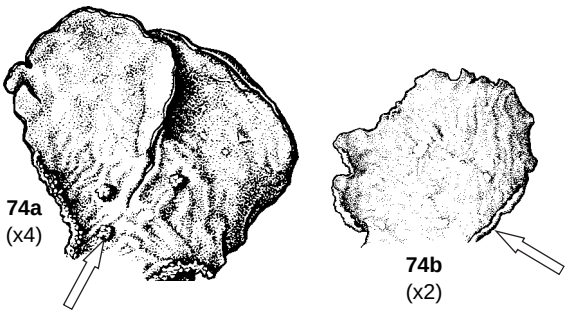
72a Soredia absent: thallus isidiate or not ..... ***Esslingeriana***, ***Platismatia*** (see key to ***Platismatia***)

72b Soredia present; thallus isidiate or not 73

73a Lobe margins lacerate(←); isidia often intermixed with soredia ..... ***Platismatia glauca***

73b Lobe margins even; isidia absent 74

74a Upper surface yellowish green; soralia located both over



74a
(x4)

74b
(x2)

upper surface(←) and along lobe margins; pseudocyphellae absent over lower surface; medulla C+ reddish; widespread ..... ***Flavopunctelia flaventior***

74b Upper surface pale bluish grey or greenish grey; soralia more or less strictly marginal(←); pseudocyphellae present over lower surface; medulla C-; essentially coastal .... ***Cetrelia cetrarioides***

KEYS TO SPECIES OF FOLIOSE AND SQUAMULOSE LICHENS, BY GENUS

AGONIMIA

***Agonimia* Zahlbr.** **The Trifle Lichens**

Minute stratified scale (or crust) lichens, corticate above, ecorticate below, neither sorediate nor isidiate, lobes closely to loosely appressed, ***mostly elongate***, averaging to 0.1–0.3 mm wide, delicate. Upper surface pale whitish or bluish, dull, strongly convex, ***cortical cells obviously papillate at 400 magnification***. Lower surface pale, lacking rhizines. Medulla white. Photobiont green.

Ascocarp a ***perithecium***, located over upper surface, ***protruberant***, ***strawberry-shaped/ampulliform***, black; spores muriform, ellipsoid, brown, 1 or 2 per ascus (ours).[4]

References: Coppins and James (1978); Coppins and Bennell (1979).

Common Name: Reflects the minute size of the species.

Notes: *Agonimia* is a widespread genus of north temperate latitudes. It contains two species worldwide, only one of which occurs in B.C. The papillate cortical cells provide a useful diagnostic character for this genus. Chemistry, however, is of no taxonomic value.

***Agonimia tristicula* (Nyl.) Zahlbr.** Map 2

(Syn. *Polyblastia tristicula* (Nyl.) Arnold)

(x20)

Moss trifle

Habitat/Range: Rare (overlooked?) over moss in sheltered base-rich intermontane outcrops at lower elevations; western N Am – western Eurasia, N to BC, S to CO.

Notes: Mature ascocarps have not yet been found in B.C. Material resembling *A. tristicula* has been detected over Garry oak on southeast Vancouver Island and can probably be referred to *Bacidia rubella* (Hoffm.) Massal.

AHTIANA

***Ahtiana* Goward** **The Candlewax Lichen**

A small to medium ***stratified foliose lichen***, corticate above and below, neither sorediate nor isidiate, lobes ***closely appressed***, ***short to subrotund***, averaging to 2–3 (–4) mm wide, thin. Upper surface ***pale yellowish green*** (except blackish in exposed sites), shiny. ***Lower surface whitish to pale tan***, bearing sparse to abundant short, simple rhizines. Medulla white. Photobiont green.

Apothecia located over upper surface, disc brown; spores simple, spherical, colourless, 8 per ascus.

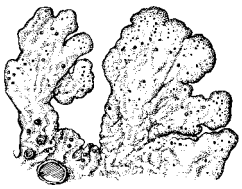
Reference: Goward (1985).

Common Name: Stresses the fluid, waxlike configuration of the lobes.

Notes: *Ahtiana* is a monotypic genus. It was formerly included within *Parmelia*, but is more closely related to *Cetraria* (in the broad sense).

***Ahtiana sphaerosporella* (Müll. Arg.) Goward**

(Syn. *Parmelia sphaerosporella* Müll. Arg.)



(x3)

Whitebark candlewax

Habitat/Range: Frequent over whitebark pine, rare over other conifers, in open intermontane subalpine forests; western N Am, N to BC (rarely to NWT), S to CA.

Reactions: Cortex KC+ yellow.

Contents: Caperatic and usnic acids.

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[4] "Ours" refers to British Columbia material, but does not necessarily apply to the genus as a whole.

ALLANTOPARMELIA

Allantoparmelia (**Vainio**) **Essl.** **The Rockgrub Lichens**

Small to occasionally medium ***stratified foliose lichens***, corticate above and below, neither sorediate nor isidiate, lobes closely appressed, elongate, ***thick***, averaging to ***0.15–1.5 mm*** wide. Upper surface olive-brown to more often blackening, dull. Lower surface pale tan to black, dull, ***lacking rhizines***, attached by thickened cortical outgrowths. Medulla white. Photobiont green.

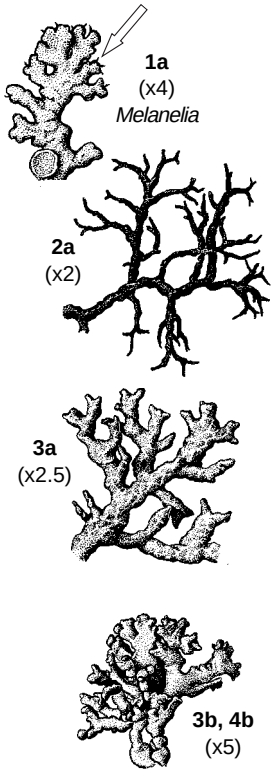
Apothecia located over upper surface, disc black; spores simple, ellipsoid, colourless, 8 per ascus.

Over acid rock in exposed ***alpine*** localities.

Common Name: Describes the habitat and the thick, annulate, grub-like lobes.

Reference: Esslinger (1977a).

Notes: *Allantoparmelia,* which was recently segregated from *Parmelia,* is an arctic-alpine genus consisting of three species worldwide. Two of these occur in B.C.



Key to *Allantoparmelia* and Similar Lichens

1a Rhizines present below(←); lobes usually (but not always) thin and leaflike; upper surface often convex or plane; over trees or rock; widespread ..... ***Melanelia/Neofuscelia***

1b Rhizines absent (sparse peg-like cortical outgrowths, however, sometimes present); lobes oval or circular in cross-section; upper surface distinctly convex; over rock; alpine 2

2a Thallus shrub-like/fruticose; lobes more or less circular/terete in cross-section; medulla KC- ..... ***Pseudephebe***

2b Thallus not shrub-like; lobes more flattened and with distinct upper and lower surface; medulla KC+ reddish 3

3a Lower surface apparently white-pruinose; at least some lobes in part semi-erect when mature, sparsely branched, seldom completely obscuring substrate; cortex K+ yellow (check lobe tips or other pale areas); medulla PD+ orangish or PD- .... ***Brodoa oroarctica***

3b Lower surface not at all white-pruinose; lobes mostly appressed throughout, densely branched, generally obscuring substrate; cortex K- throughout; medulla PD+ strong yellow or PD- 4

4a Lobes generally averaging to less than 0.5 mm wide; lower surface usually pale brownish throughout; medulla C+ orangish to reddish, PD-, K-; rare .... ***Allantoparmelia almquistii***

4b Lobes generally averaging to more than 0.5 mm wide; lower surface blackening; medulla C- or C+ reddish, PD+ yellow, K+ pale yellow; common .... ***Allantoparmelia alpicola***

Allantoparmelia almquistii (**Vainio**) **Essl.** Map 3

(Syn. *Parmelia almquistii* Vainio)

Rockgrub

Habitat/Range: Rare over acid rock in exposed maritime alpine and subalpine localities; western N Am – eastern N Am – eastern Eurasia, S to BC.

Reactions: Medulla C+ reddish to orangish, KC+ reddish.

Contents: Olivetoric acid.

Allantoparmelia alpicola (**Th. Fr.**) **Essl.**

(Syn. *Parmelia alpicola* Th. Fr.)

Rockgrub

Habitat/Range: Infrequent over acid rock in exposed inland alpine localities; possibly incompletely circumpolar, S to CO.

Reactions: Medulla K+ pale to dingy yellow, C- or C+ reddish, KC+ reddish, PD+ strong yellow.

Contents: Alectorialic acid, barbatolic acid, one unknown substance (and a fatty acid).

Notes: Spot tests are required to reliably distinguish *A. alpicola* from *A. almquistii.*

ANAPTYCHIA

***Anaptychia* Körber** **The Centipede Lichens**

Small to medium ***stratified foliose lichens***, corticate above, corticate or ***ecorticate below*** (ours), lacking soredia and isidia (ours), lobes ***loosely attached or semi-erect***, elongate-linear to ***elongate***, averaging to 0.2–0.5 mm wide (ours), thin. Upper surface ***pale whitish green to pale brownish grey, often weakly longitudinally striate (check also below), lobe margins ciliate or not.*** Medulla white. Photobiont green.

Apothecia located over upper surface, often near lobe tips, disc brown; spores 2-celled, ellipsoid, brown, 8 per ascus.

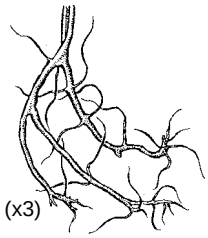
References: Kurokawa (1962, 1973); Morberg (1980).

Common Name: Descriptive of the often elongate lobes and leg-like cilia that line the lobe margins in most species.

Notes: *Anaptychia* is a primarily temperate genus of approximately 40 species worldwide. Four of these occur in North America and one in B.C. For points of distinction with similar species, see the key under *Heterodermia*.

***Anaptychia setifera* Räsänen** Map 4

(Syn. *Anaptychia kaspica* Gyelnik)


(x3)

Eyed centipede

Habitat/Range: Rare (but locally common: Goward et al. 1994a) over base-enriched conifers in intermontane forests at lower elevations; incompletely circumpolar, N to AK, S to BC.

Reactions: All spot tests negative.

Contents: No lichen substances reported.

Notes: The B.C. material is abundantly fertile.

ARCTOPARMELIA

***Arctoparmelia* Hale** **The Rockfrog Lichens**

Medium to large ***stratified foliose lichens***, corticate above and below, sorediate or not, lobes ***closely appressed***, elongate, averaging to 0.3–0.5 mm wide, thin. Upper surface ***pale yellowish green***, ***dull***. ***Lower surface*** pale to black, ***apparently white-pruinose***, bearing scattered, short, simple rhizines. Medulla white. Photobiont green.

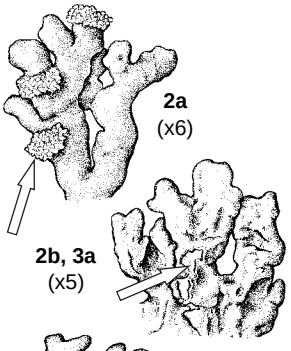
Apothecia located over upper surface, disc brown; spores simple, ellipsoid, colourless, 8 per ascus.

Over acid rock in arctic-alpine to boreal localities.

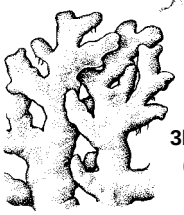
References: Thomson (1984); Hale (1986); Clayden (1992).

Common Name: Suggested by the greenish colour of the upper surface, as well as by the strict association with rock surfaces.

Notes: *Arctoparmelia* consists of four species worldwide, all of which occur in B.C. For points of distinction with similar species in other genera, see the key under *Xanthoparmelia*.


2a (x6)

2b, 3a (x5)


3b, 4b (x5)

1a Thallus sorediate or apparently sorediate 2

2a Upper cortex firm; soredia confined to large, discrete, orbicular soralia(←) ..... ***Arctoparmelia incurva***

2b Upper cortex soft and eroding(←); soredia more or less diffuse ..... ***Arctoparmelia subcentrifuga***

1b Thallus lacking soredia 3

3a Upper cortex soft and eroding(←); lobe tips generally downturned ..... ***Arctoparmelia subcentrifuga***

3b Upper cortex firm, never eroding; lobe tips only rarely downturned 4

4a Lower surface grey or black toward thallus centre; northern B.C. ..... ***Arctoparmelia separata***

4b Lower surface whitish or tan throughout; widespread ..... ***Arctoparmelia centrifuga***

***Arctoparmelia centrifuga* (L.) Hale**
(Syn. *Parmelia centrifuga* (L.) Ach.; *Xanthoparmelia centrifuga* (L.) Hale)
Rippled rockfrog (ring lichen, sunburst lichen)
Habitat/Range: Frequent over acid or somewhat base-rich rock in open inland sites, especially in boulderbeds; circumpolar, S to OR.
Reactions: Cortex K+ pale yellow, KC+ yellow; medulla C+ slowly yellow, KC+ reddish.
Contents: Alectoronic acid, atranorin and usnic acid.

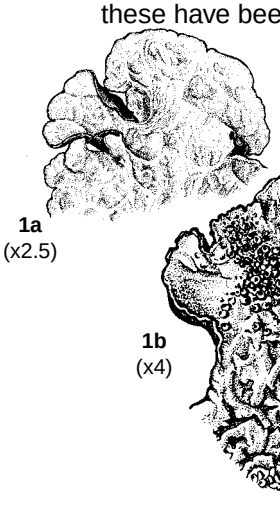
***Arctoparmelia incurva* (Pers.) Hale**
(Syn. *Parmelia incurva* (Pers.) Fr.; *Xanthoparmelia incurva* (Pers.) Hale)
Powdered rockfrog (fist lichen)
Habitat/Range: Infrequent over acid rock in open inland sites, reported only in ICH zone; circumpolar, S to BC.
Reactions: Cortex K+ pale yellow, KC+ yellow; medulla C+ slowly yellow, KC+ reddish.
Contents: Alectoronic acid, atranorin and usnic acid.

***Arctoparmelia separata* (Th. Fr.) Hale** Map 5
(Syn. *Parmelia separata* Th. Fr.; *Xanthoparmelia separata* (Th. Fr.) Hale)
Rippled rockfrog
Habitat/Range: Infrequent over acid rock in open boreal localities; probably circumpolar, S to northern BC.
Reactions: Cortex K+ yellow; medulla KC+ reddish, I+ blue.
Contents: Alectoronic acid, atranorin and usnic acid.

***Arctoparmelia subcentrifuga* (Oxner) Hale** Map 6
(Syn. *Parmelia subcentrifuga* Oxner; *Xanthoparmelia subcentrifuga* (Oxner) Hale)
Dissolving rockfrog
Habitat/Range: Rare over acid and somewhat base-rich rock in rather sheltered intermontane sites; apparently western N Am – eastern N Am – eastern Eurasia, N to AK, S to southern BC.
Reactions: Cortex K+ pale yellow, KC+ yellow; medulla C+ slowly yellow, KC+ reddish.
Contents: Alectoronic acid, atranorin and usnic acid.

ASAHINEA

***Asahinea* Culb. & C. Culb.** **The Rag Lichens**
Medium to ***large stratified foliose lichens***, corticate above and below, isidiate or not, lobes loosely attached, ***rotund***, ***1–3 mm wide***, thin. Upper surface whitish to yellowish, pseudocyphellate or not, shiny. ***Lower surface black***, shiny, ***lacking rhizines***. Medulla white. Photobiont green.
Apothecia unknown in B.C. material, located on lobe margins.
References: Culberson and Culberson (1965); Randlane and Saag (1989); Gao (1991).
Common Name: Describes the broad, pale, often wrinkled lobes of the species.
Notes: *Asahinea*, a recent arctic-alpine segregate of *Cetraria*, is comprised of three species worldwide. Two of these have been reported for B.C. (but see notes below).


1a (x2.5)

1b (x4)

1a Upper surface yellowish, lacking isidia .....
..... [***Asahinea chrysantha***] (see ***Asahinea scholanderi***)

1b Upper surface whitish (except blackening where exposed), isidiate .....
..... ***Asahinea scholanderi***

Asahinea scholanderi (**Llano**) **Culb. & C. Culb.** Map 7

(Syn. *Cetraria scholanderi* Llano)

Arctic rag

Habitat/Range: Rare over acid rock and humus in open alpine localities in northern regions; western N Am – eastern Eurasia, S to BC.

Reactions: Medulla KC+ pinkish.

Contents: Alectoronic acid, alpha-collatolic acid, atranorin, (and unidentified purple pigment).

Notes: *Asahinea chrysantha* (Tuck.) Culb. & C. Culb. has also been reported for B.C., but the record is doubtful. See comments under "Excluded Species."

BRODOA

Brodoa **Goward** **The Rockgrub Lichens**

Small to occasionally medium ***stratified foliose lichens***, corticate above and below, lacking soredia and isidia, lobes closely appressed to in part ***semi-erect***, elongate-linear to elongate, averaging to 0.5–1.5 mm wide, ***thick***. Upper surface ***pale grey to nearly black, bearing white angular markings/maculae***. Lower surface tan or black, dull, apparently white-pruinose, ***lacking rhizines***. Medulla white. Photobiont green.

Apothecia located over upper surface; spores simple, ellipsoid, colourless, 8 per ascus.

References: Krog (1974); Goward (1986).

Common Name: Descriptive of the habitat and the cylindrical lobes of the species.

Notes: *Brodoa* is an arctic-alpine genus containing three species worldwide, though only one of these occurs in B.C. *Brodoa* was formerly treated within *Hypogymnia*. For points of distinction with similar species in other genera, see the keys under *Allantoparmelia* and *Melanelia*.

Brodoa oroarctica (**Krog**) **Goward**

(Syn. *Hypogymnia oroarctica* Krog)

(x2.5)

Rockgrub

Habitat/Range: Frequent over acid rock in exposed inland alpine sites; circumpolar, N to AK, S to NM.

Reactions: Cortex K+ yellow; medulla KC+ reddish, PD- or PD+ orange in upper portions.

Contents: Atranorin, physodic acid (and protocetraric acid).

CANDELARIA

Candelaria **Massal.** **The Candleflame Lichens**

Minute stratified foliose or fruticose lichens, corticate above and below, sorediate or not, lobes loosely appressed to semi-erect, elongate, finely divided, averaging to ***0.2 mm wide.*** Upper surface ***greenish yellow, K-***. Lower surface pale, bearing scattered, short, simple rhizines. Medulla white. Photobiont green.

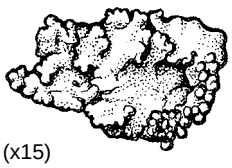
Apothecia unknown in B.C. material.

Reference: Poelt (1974).

Common Name: Reflects the yellowish orange colour and typically narrow, erect lobes.

Notes: *Candelaria* is a cosmopolitan genus consisting of seven species worldwide. Of these, two species occur in North America and only one in B.C. For points of distinction with similar species, see the key under *Xanthoria*.

Candelaria concolor (**Dickson**) **B. Stein**



(x15)

Candleflame

Habitat/Range: Infrequent over base-rich bark, rare over rock, in open to sheltered sites at lower elevations throughout, except probably absent from boreal regions; circumpolar, N to BC, S to NM.

Reactions: All spot tests negative.

Contents: Calycin and pulvinic dilactone.