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Processing Lichens

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Summary

This document describes the procedures, training, and resource materials used to process and identify lichens for the ABMI. A two step process has been implemented to identify lichens. First, from each microhabitat sampled, ABMI field technicians identify specimens of the most common and/or easily identifiable species and classify the remaining specimens into taxonomic groups. To maintain accuracy, field technicians go through rigorous training and their sorting results are checked regularly by a qualified lab supervisor. Second, after the initial sorting by field technicians, the specimens are sent to experts and identified to genus/species. A random sample of the specimens identified by experts is subsequently re-identified by a second expert to assess accuracy

Data Management

Transferring Data from the Sample Tracking Log to the Sorting Database

All lichen samples received by the Sample Processing Center (RAM) are tracked using the Sample Tracking Log (Appendix 1). At the conclusion of the field season, sample information that was recorded in the Sample Tracking Log is transferred to the Lichen Sorting Database (Appendix 2). The ABMI lab coordinator checks to ensure that lichen information for all ABMI sites is present.

Data Entry During Sorting

Technicians are responsible for entering information into the data sheets (Appendix 3) while sorting specimens. Upon completing the sorting of a site the sorter checks the data sheet against the specimen envelopes to ensure all specimens are accounted for and then enters the information on the data sheets into the Lichen Sorting Database. If more than one species has been identified in an individual sample, the lab technician inserts a new row below the original row in the database, and fills in the required information for each species present. Indicate if the specimen is a voucher, residual or to be sent for advanced ID by placing an "X" in the appropriate column.

Checking and Storing Data Sheets During Sorting

Data sheets are transferred to the lab supervisor at the completion of data entry. The lab supervisor checks data sheets to ensure that all data fields are filled in and legible. Data sheets that are not legible will be re-written, and both copies kept on file. Data sheets are stored in a secure location in the sorting lab. Data sheets are transferred to the lab coordinator at the completion of lichen sorting. Original copies of the data sheets are stored in a secure location and do not subsequently leave that location. If data entry occurs away from the secure location, then the data sheets are photocopied and data entry occurs from the photocopies.

The lab supervisor also checks the database to ensure that all information is recorded accurately and that all data fields are filled in. Data entry is verified by comparing the electronic information to information on the original data sheets. In addition, electronic verification routines are performed on the database to ensure that data are consistent with allowable codes. A copy of the Lichen Sorting Database is transferred to the ABMI lab coordinator at the end of each day. All copies of the database are stored on a secure computer with a back-up stored in a different building.

Data Entry During Advanced Identification

The ABMI lab coordinator sends an electronic copy of the Lichen Sorting Database to the taxonomic expert. The taxonomic expert fills in the required information (gray columns) as specimens are identified. If more than one species is identified from an individual sample, the expert inserts a new row below the original row and fills in the required information for each species present. The ABMI lab coordinator records the data transfer in the Sample Tracking Log.

Transferring Data from the Taxonomic Expert to the ABMI Information Center

Once the advanced ID has been completed, the expert returns the completed electronic copy of the Lichen Sorting Database to the lab coordinator. A hard copy is also printed and sent to the lab coordinator along with the identified samples. The lab coordinator checks the database for omissions or errors, stores it on a secure computer with a back-up stored in a different location, sends a copy of the database to the ABMI Information Center, and records the data transfer in the Sample Tracking Log.

Specimen Management

Lichen samples pass through a variety of facilities during processing. To ensure that samples are not lost, all specimens received by the Sample Processing Center (RAM) are tracked using the Sample Tracking Log (Appendix 1). All subsequent transfers of specimens, samples and data are recorded into the log.

Specimen Management in the Field

- At the end of each field shift, package all the small paper bags containing lichens from each micro-habitat at an ABMI site into one larger paper bag, and on the outside of the large bag record the ABMI site number and number of micro-habitat bags that are present. Cross reference with the field data sheets to ensure that all samples are included for each site.

Specimen Transfer from the Field to the Sample Processing Center

- At the end of each field shift, the paper bags for the sites are packaged into cardboard boxes, and the boxes shipped via courier to the Sample Processing Center (see Terrestrial Protocols for Lichens). The number of cardboard boxes in the shipment, and the identity of sites within each box, is recorded onto the Sample Shipping Checklist (Appendix 4).
- Samples are logged-in when they arrive at the Sample Processing Center. Each shipment is assigned a “lot number”, and the contents of each lot tracked by that number.
- The Sample Tracking Log includes information about the date the lot arrived, the location where the samples are stored, the ABMI sites where the samples were collected, the number of samples of each type in the lot, and a detailed listing of the information about each sample (Appendix 1).
- The ABMI lab coordinator ensures that all specimens listed on the Sample Shipping Checklist are present, organized, and recorded in the sample tracking log.
- After being logged in, samples are frozen (-20°C for 24 hrs) and then allowed to dry at room temperature prior to being sorted.

Specimen Transfer from the Sample Processing Center to the Taxonomic Expert

- Boxes containing lichen samples are shipped via courier to the taxonomic expert for advanced identification to the lowest taxonomic level possible.
- The ABMI lab coordinator records the new location and the date of transfer in the sample tracking log.

Specimen Transfer from the Taxonomic Expert to the Sample Processing Center

- All specimens and materials received from the Sample Processing Center are returned after species have been identified.
- Samples are packed and shipped in the same manner as listed above.
- The ABMI lab coordinator checks to ensure that all samples have been returned and are properly labelled. Samples are organized and boxed for storage at the Sample Processing Center.
- The ABMI lab coordinator records the new location and the date of transfer in the sample tracking log.

Long-term Specimen Curation at the RAM

- All specimens collected by the ABMI are gifted to, and where appropriate curated by, RAM.
- RAM retains all ABMI materials for 2 years.
- After 2 years, voucher specimens from each genus/species (or taxonomic group if the specimens were not identified to genus/species) and training specimens are retained by the RAM for use by the ABMI. All other ABMI specimens can be loaned, traded, distributed, or disposed of at the discretion of the RAM project manager.
- A policy describing the procedure RAM will use to loan and gift ABMI specimens is under development.

Preliminary Specimen Sorting and Identification by Field Technicians

Field data collection is finished by the end of July, with the result that field crews have August to sort specimens. Technicians receive training so they can effectively separate lichen specimens from debris in the sample bags, and sort the specimens into species/groups. Training and quality control are conducted by a qualified lab supervisor

Laboratory Equipment

ABMI Lab Protocols & data sheets

Reference books

Lichen reference collections

Dissecting microscope with incident and transmitted light

#5 Forceps, razor blades, probe, scalpel, water bottle, high-edged sorting trays

Ultra-violet light and protective eye wear (e.g., sunglasses)

Sorting envelopes

Sorting trays and Petri dishes

Supervision of Lichen Sorting

- A qualified lab supervisor oversees all stages of training and sorting by field staff.
- To be classified as a qualified lab supervisor, the person must have:
 1. More than 1 year's experience identifying lichens found in Alberta.
 2. Worked with the RAM-appointed lichen expert for at least two days to ensure that lichen sorting will be effective for the expert.
 3. Successfully completed an exam by identifying representative specimens from the lichens that are sorted for the ABMI (Appendix 6). The exam consists of at least 100 specimens (with at least one specimen from each of the species/groups that are sorted by technicians). More than 95% of the specimens on the test must be identified correctly

Sorting Specimens into Common Species and Taxonomic Groups

The goal is to identify/isolate as many lichen species as possible from each microhabitat at each ABMI site. Some lichen species are relatively easy to identify; these are identified to species by the field technicians (see Appendix 7). Other lichen species are not easily identified by field technicians; these are isolated and sent to experts for identification.

General Procedure

- Select an ABMI site to process (only work on one site at a time).
- For the selected site, open the large paper bag and ensure that all samples for each microhabitat are present (note that a photocopy of the Sample Shipping Checklist is required to determine the number and type of microhabitat bags that should be present).
- Sort through each microhabitat, and within each microhabitat sort the samples in order listed on the Sample Shipping Checklist (i.e. NE, NW, SE, SW)
- Empty the contents of a single microhabitat sample into the sorting tray.
- Sort the lichens into basic growth forms (see Appendix 5).
- Use Appendices 6 and 7, and the lichen reference collection to sort lichens into genera and morphological groups and identify the common lichen species.

Lichens that can be Identified to Species

- Specimens that are to be identified to species (listed in Appendix 5) typically account for 50-60% of lichens specimens collected at an ABMI site. These pre-determined specimens are distinctive and possess characteristics that make them easily identifiable by technicians with the appropriate training.
- In each microhabitat bag, identify the pre-determined lichen species

- Species names are recorded onto laboratory data sheets (Appendix 3) using 7-letter species codes.
- The first time a species is encountered at an ABMI site; it is collected as a voucher specimen. Record a unique specimen number for the voucher on the data sheet. (Note that a voucher is created for each new species at each site.)
- Place the voucher specimen in an envelope and label the envelope with the unique specimen number, specimen type, ABMI site number, date collected, collector, microhabitat, plot, and species (Appendix 9).
- After a voucher specimen has been collected at an ABMI site, subsequent specimens of the same species are not made into reference specimens; instead, they are recorded on the data sheet and returned to the original collection bag. The original collection bags are placed in cardboard boxes labelled with the year, sample type and “Residual”.
- However, if the first reference specimen for a species at an ABMI site is of low quality (i.e., lacking key features), and a better quality specimen is subsequently encountered from the same ABMI site, make an additional reference specimen.
- All voucher specimens are stored in cardboard boxes labelled with the year, sample type and “Vouchers”.

All Other Lichens

- Place all remaining specimens that cannot be identified into separate envelopes (see Appendix 9 for labelling examples) for further processing and/or for expert identification.
- Specimen envelopes for further processing are labelled using a pre-made stamp with a unique specimen number, the collector’s name(s), ABMI site number, date collected, collector, microhabitat, plot number, and tentative family/genus for the specimen inside.
- Envelopes containing unknowns are recorded onto the laboratory data sheet using their tentative name and specimen number.
- If unknown specimens cannot be separated from known specimens, then the unknown specimen (*e.g. Peltigera* spp.) as well as all other lichens identified are listed on the envelope (see Appendix 9).
- All specimens for advanced ID are placed in cardboard boxes labelled with the year, sample type and “Advanced ID”.

Training - Week 1

- New field technicians must undergo the training and have their identification accuracy assessed by the lab supervisor before they start to sort lichens from ABMI sites. Training requires approximately one week.
- Technicians that return from previous years usually require less training. If after reviewing the reference material, returning technicians are confident in lichen identification, and they pass an assessment by the lab supervisor, they start to sort lichens during the first week.

Day 1: Goals and Expectations

- ABMI technicians understand the ecology and basic forms of lichens.
- Technicians know the parts (characteristics) and terminology of lichens that will help them identify species.
- Technicians know how to separate, sort, and identify select species lichens
- Technicians understand how to identify the 3 hair-like lichens selected for identification and be able to differentiate and sort the remaining fruticose lichens into genera.
- Technicians know how to differentiate hair-like lichens and fruticose lichens from crustose lichens.
- By the end of day 1, technicians have begun sorting lichens from tree microhabitats.

Training:

Lab Safety

1. Review lab safety protocols

Introduction to Lichens

1. Read “Chapter 1” of Lichens of North America (*Brodo et al. 2001*) – Pages 3-8.

2. Read “Identifying Lichens” in Lichens of British Columbia – Part I, Foliose and Squamulose species (Goward *et al.* 1994) – Pages 10-13.
3. Read “Identifying Lichens” in Lichens of British Columbia – Part II, Foliose and Fruiticose species (Goward 1999) – Pages 10-19.

Lichen Growth Forms

1. Read “Chapter 2” of Lichens of North America (Brodo *et al.* 2001) – Pages 9-22.
2. See Appendix 5: ABMI simplified flow chart
3. Look at reference collection.

Terminology

1. Read Appendix 6: Illustrated lichen glossary

Hair-like and Crustose Lichens

1. Read Appendix 7: Initial lichen species and genera for identification (7a and b)
2. Look at reference collection

Hands On Experience

1. Sort through a prepared sample of “unknown” hair-like specimen collections (in pairs); check results with supervisor.

Quality Control:

- The lab supervisor verifies all identifications of the test specimens to ensure the technicians achieve an accuracy of $\geq 95\%$.
- Technicians having trouble achieving $\geq 95\%$ accuracy are given an opportunity to review the training material and then retest.

Days 2-3: Goals and Expectations

- Field technicians understand how to differentiate club and shrub-like lichens and sort them into genera and morphological groups.
- Technicians able to identify 2 club and shrub-like species selected for identification, as well as the 3 genera and 10 *Cladonia* groups.
- Technicians able to identify the 5 predetermined lichen species (3 hair-like and 2 club and shrub-like) with $\geq 95\%$ accuracy.
- Technicians start to learn the leaf-like lichen genera.
- Technicians have finished sorting lichens from one tree microhabitat, and begun sorting lichens from a log microhabitat.

Training:

Club and Shrub-like Lichens

1. Read Appendix 6: Initial lichen species and genera for identification (7c)
2. Look at reference collection

Leaf-like Lichens

1. Read Appendix 6: Initial lichen species and genera for identification (7d)
2. Look at reference collection

Hands On Experience

1. Sort through a prepared sample of “unknown” club and shrub-like specimen collections (in pairs); check results with supervisor.
2. Sort through a prepared sample of “unknown” leaf-like specimen collections (in pairs); check results with supervisor.

Quality Control:

- The lab supervisor verifies all identifications of hair-like, crustose, and club/shrub-like test specimens to ensure the technicians achieve an accuracy of $\geq 95\%$.

- The lab supervisor verifies all identifications of genus and morphological groupings of test specimens to ensure the technicians achieve an accuracy of $\geq 80\%$.
- Technicians having trouble achieving $\geq 95\%$ accuracy are given an opportunity to review the training material and then retest.

Days 4-5: Goals and Expectations

- Technicians are able to differentiate and sort lichens by growth form, capable of identifying 15 predetermined lichen species with $\geq 95\%$ accuracy and are able to sort the remaining lichens into genus groups with $\geq 80\%$ accuracy.
- Technicians are able to create a reference specimen for all positively identified species from each ABMI site.
- Technicians are able to sort through actual ABMI collection bags, record identified species onto datasheets, and sort remaining unknown specimens into envelopes.
- Technicians are able to sort through ABMI collection bags, record identified species onto datasheets, and sort unknown specimens into envelopes.
- Technicians are able to label envelopes correctly.
- Each technician has sorted at least one ABMI site completely.

Training:

Leaf-like Lichens

1. Look at reference collection

Labelling Envelopes for Further Processing

1. Read Appendix 3: Labelling of Envelopes for Unknown and Voucher Specimens

Hands On Experience

1. Sort one ABMI site in pairs
2. Start sorting ABMI sites individually

Quality Control:

- The lab supervisor verifies sorting and all identifications from the first 2 ABMI sites.
 - The technician must have detected $\geq 80\%$ of the lichen species from each site, and identified $\geq 95\%$ of the target species correctly.
 - If accuracy is lower than required, the technician undergoes additional training and re-sorts the ABMI sites, until the competency is reached.
- For each technician, the lab supervisor verifies the first 10 identifications of each species/taxonomic group.
 - Depending on results from the verifications, the lab supervisor continues verifying identifications until 5 consecutive identifications are correct for each species/taxonomic group.

Sorting & Identification - Weeks 2 & 3

- Most technicians will have completed training and passed the tests from the lab supervisor by the end of week 1. Technicians sort the specimens from ABMI sites into genera and morphological groups and identify the common lichens species during weeks 2 and 3.

Goals and Expectations:

- Based on the training and instructional guidelines learned from week 1, technicians should be sorting ABMI sites at an average rate of one site every 1-2 days during week 2.
- On average technicians are expected to have completed sorting/identification of at least 4 ABMI sites by the end of the second week in the laboratory.
- By week 3, technicians will have become efficient at sorting lichens and are should have increased their sorting rate to an average of one ABMI site per day.

- On average technicians are expected to have completed sorting/identification of 9 ABMI sites by the end of week 3.
- At least some of the technicians will need to continue sorting ABMI sites during week 4. These technicians are expected to have completed sorting/identification of at least 14 ABMI sites by the end of week 4.

Quality Control:

- If a technician has not achieved the minimum sorting or identification competency during week 1, then training and assessment are continued during week 2.
- If competency has been achieved, the technician sorts lichens from ABMI sites during weeks 2 and 3.
- The lab supervisor verifies sorting and all identifications from the first 2 ABMI sites.
 - The technician must have detected $\geq 80\%$ of the lichen species from each site, and identified $\geq 95\%$ of the target species correctly.
 - If accuracy is lower than required, the technician undergoes additional training and re-sorts the ABMI sites, until the accuracy is reached.
- For each technician, the lab supervisor verifies the first 10 identifications of each species/taxonomic group.
 - Depending on results from the verifications, the lab supervisor continues verifying identifications until 5 consecutive identifications are correct for each species/taxonomic group.
- If the required accuracy of specimen sorting cannot be achieved by a technician by the end of the second week, he/she is re-assigned to other tasks.
- After a technician has achieved the required competency for specimen sorting and identification, the lab supervisor performs quality control by verifying results at random ABMI sites.
 - The lab supervisor randomly chooses one out of every five ABMI sites sorted by each technician.
 - Five microhabitat bags are randomly chosen from the chosen sites and these are checked to ensure that $\geq 80\%$ of species in the bags were detected by the technician.
 - In addition, all reference specimens, for the target species, from the chosen bags are verified to ensure accuracy to $\geq 95\%$.
 - If accuracy is lower than required during any verification, the technician undergoes additional training and re-sorts all sites since the previous acceptable evaluation.

Advanced Identification of select species - Week 4

- Some technicians need to continue sorting ABMI sites during week 4 to complete the first round of sorting. Methods for weeks 2 & 3 are continued for these technicians.
- If possible, a few technicians will be assigned to advanced identification, and the following methods apply.
- During advanced identification, technicians work through the envelopes containing unknowns and identify 2-4 of the more difficult species from a particular genus.
- Envelopes are sorted into similar groups and ordered by ABMI site number.
- Each technician works with a particular genus and identifies a few additional species.

Goals and Expectations:

- Working with a specific genus from the sorted specimens, technicians are able to identify a few more species.
- Identification of species from the genus continues until the end of August.
- Specimen envelopes are prepared to be sent to an expert for further species identification.

Training:

1. Technicians are assigned a genus to work with.
2. Read Appendix 7: Selected Species for Advanced Identification.
3. Review the reference collection of the selected species.

Quality Control:

- Specimens must be identified with $>95\%$ accuracy.
- The lab supervisor verifies the first 5 identifications of each advanced species for each technician.
- If any of the first 5 verifications for a species are incorrect, the supervisor continues verifying that species until 5 consecutive identifications are correct.

- After the technician has achieved 5 consecutive correct identifications, the lab supervisor continues to randomly check identifications.
 - Each day, the lab supervisor randomly chooses 10% of specimens identified by the technician and verifies these to ensure $\geq 95\%$ accuracy.

Taxonomic Nomenclature

Taxonomy for sorting by lab technicians (Appendix 7) follows Brodo *et. al.* 2001.

Advanced Identification of Specimens to Genus/Species

Selecting the Expert

- The ABMI will select experts who are known specialists in the field of lichen taxonomy. To ensure the highest of standards, and to maintain ABMI's level of credibility, the ABMI will only select experts who can meet at least one of the following criteria:
 1. Expert is endorsed by the Royal Alberta Museum, or an associated museum (e.g., Canadian Museum of Nature), as capable of identifying bryophytes with $\geq 95\%$ accuracy.
 2. Expert is endorsed by 2 members of the scientific community, recognized in the field of bryophyte taxonomy, as capable of identifying bryophytes with $\geq 95\%$ accuracy.

Identifying Lichen Specimens

- Lichen specimens are sent to experts to be identified to the lowest taxonomic level possible (usually species). Species names must be determined based on the Species References/Authorities listed below.
- RAM maintains the References/Authorities list, and if there is discrepancy between keys determines their order of precedence.
- Whenever possible, specimens are to be identified to species, with the following exceptions;
 - *Usnea* – If specimen is <1 cm in length or no chemical test can be performed, leave as *Usnea* spp.
 - *Bryoria* – If specimen is <1 cm in length or no chemical test can be performed, leave as *Bryoria* spp.
 - Specimens <1 cm in diameter that lack key identifying features (use discretion).
 - Damaged specimens or those too small for determinations – these are not identified by the ABMI.
- If during the process of identifying a species additional reference literature is needed, the expert will note this additional literature in the database. If the additional literature is unpublished, the expert will send a copy to the ABMI lab coordinator
- Specimens are examined, identified, and the species name(s) written directly on the envelope (or a separate stick-on label) along with the identification date and expert's initials.
- If more species are present than have been indicated on the envelope label (and in the database), insert a new row below the original row in the database, and fill in the required information for each species present.
- If it is necessary to isolate a specimen from the original envelope, label the new envelope with all of the information from the original envelope and amend the new specimen number(s) by adding sequential letters to the original number (e.g., samples isolated from envelope 136 become 136a, 136b etc.).
- Isolate a voucher specimen for every unique species/taxon identified, and label the new specimen as indicated above with the word "Voucher" on the label.

Verification Process

- Specimens that have been identified by experts will undergo a verification process by their peers to ensure accuracy.
- For each expert identifying ABMI lichens, 10% of the identified specimens (up to a maximum of 200) will be randomly selected for verification. Note that at least one randomly selected specimen from each species (or higher taxonomic group if the specimens are not identified to species) will be included.

- The ABMI lab coordinator will re-label each specimen with a reference number and send the specimens to a second expert that meets the above credibility criteria.
- The second expert will identify the specimens and record the species name beside the matching reference number on a provided data sheet.
- The second expert will ship the specimens back to the ABMI, and email the data sheet to the ABMI lab coordinator.
- The ABMI lab coordinator will compare the data between the two experts.
- Discrepancies are reviewed by both experts (plus additional experts if necessary) to determine the identification based on the most recent literature. If a discrepancy cannot be resolved, the specimen in question will be recorded in the database at the lowest taxonomic level that is agreed upon by the experts.
- If, after all discrepancies have been resolved, there is $\geq 5\%$ error on the part of the initial taxonomic expert, then the genera/species with $\geq 5\%$ mis-identifications are highlighted. All individuals the initial expert identified from the highlighted species are re-identified to confirm their identity.

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Appendix 1: Sample Tracking Log

Note: This is a portion of the complete Sample Tracking Log that shows only the columns relevant to the receiving and processing of lichen samples.

RAM ACCESSION INFO						ABMI SAMPLE COLLECTION INFO					LICHENS	
Data Series Count	Project	Year	Group	RAM Lot #	Date Received	Sample Type	Site #	Sub-site	Collector	Date Collected	Lichen Specimen Number	Lichen Habitat / Stratum
1												
2												
3												
4												
5												
6												
7												
8												
9												

SAMPLE DISPOSITION									
Data Transferred to Database	Samples Sent for Sorting	Samples Returned from Sorting	Samples Sent for Advanced ID or Processing	Samples Returned from Advanced ID or Processing	Database Sent to Information Center	Current Sample Disposition	Current Residual Disposition	Samples Transferred to RAM's TMS	Comments

Appendix 2: Lichen Sorting Database

LICHEN SORTING														
RAM Lot No.	ABMI Site Number	Sub-site / Plot	Habitat / Stratum	Collected By	Field Collection Date	Specimen Number	Date Sorted	Sorted By	Voucher Location	Residual Box #	Advanced ID Box #	Sample Disposition	Field Crew Comments	Lab Comments

ADVANCED IDENTIFICATION											
Identification Date	Identified By	Family	Genus	Species	Species Author	ABMI Species Code	Reference Used	Advanced ID Comments	Verified By	Verification Date	

Appendix 4: Sample Shipping Checklist

Sample Shipping Checklist Terrestrial Protocol – Summer

Crew ID: _____ Site Block #: _____ Sites Completed in Block: ____ of ____
 Shipping Date: _____ Shipping Method: _____ Waybill #: _____
 Type and Total # of Containers: _____

Complete one sheet for each site block in the shipment. Complete one section for each site completed in the block.

You must fill in all fields in each completed section - Record "VNA" for any fields that do not apply.

If shipping by Bus or Courier, save a copy of your waybill for future reference. If dropping off at RAM – enter the date samples are dropped off as the shipping date, enter "Delivered" as the shipping method, and enter the initials of the person dropping it off as the waybill #.

Site # _____ Field Collection Date _____ Prairie Protocol¹ (circle) Y N Field Crew Initials _____
 Total Plant Specimens Collected² _____ Plant Press ID³ _____ Collected by: _____
 Moss⁴: Collected by: _____ Lichen⁴: Collected by: _____ Tree Cores⁵: Collected by: _____

	NE	NW	SE	SW		NE	NW	SE	SW		NE	NW	SE	SW
Log/stump					Log/stump					1°				
Tree/other					Tree/other					2°				
Wetland					Wetland									
Upland					Upland					1 ha				

Comments: _____

Site # _____ Field Collection Date _____ Prairie Protocol¹ (circle) Y N Field Crew Initials _____
 Total Plant Specimens Collected² _____ Plant Press ID³ _____ Collected by: _____
 Moss⁴: Collected by: _____ Lichen⁴: Collected by: _____ Tree Cores⁵: Collected by: _____

	NE	NW	SE	SW		NE	NW	SE	SW		NE	NW	SE	SW
Log/stump					Log/stump					1°				
Tree/other					Tree/other					2°				
Wetland					Wetland									
Upland					Upland					1 ha				

Comments: _____

Site # _____ Field Collection Date _____ Prairie Protocol¹ (circle) Y N Field Crew Initials _____
 Total Plant Specimens Collected² _____ Plant Press ID³ _____ Collected by: _____
 Moss⁴: Collected by: _____ Lichen⁴: Collected by: _____ Tree Cores⁵: Collected by: _____

	NE	NW	SE	SW		NE	NW	SE	SW		NE	NW	SE	SW
Log/stump					Log/stump					1°				
Tree/other					Tree/other					2°				
Wetland					Wetland									
Upland					Upland					1 ha				

Comments: _____

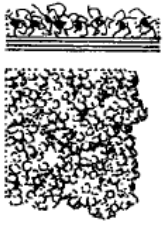
Site # _____ Field Collection Date _____ Prairie Protocol¹ (circle) Y N Field Crew Initials _____
 Total Plant Specimens Collected² _____ Plant Press ID³ _____ Collected by: _____
 Moss⁴: Collected by: _____ Lichen⁴: Collected by: _____ Tree Cores⁵: Collected by: _____

	NE	NW	SE	SW		NE	NW	SE	SW		NE	NW	SE	SW
Log/stump					Log/stump					1°				
Tree/other					Tree/other					2°				
Wetland					Wetland									
Upland					Upland					1 ha				

Comments: _____

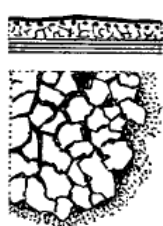
1 – Circle "No" if the site was not sampled using prairie protocols – if yes, circle "Yes" and enter "VNA for Moss and Lichen."
 2 – Record the total number of unknown vascular plant specimens collected from this site. If no unknown plant specimens were collected, indicate "None". List unique specimen ID numbers for all unknown plants collected on the appropriate Plant Press Log.
 3 – Record the Plant Press ID number where the specimens are located.
 4 – For each quadrant, record "C" if a sample was collected, "None" if no specimens were found, or "VNA" if the stratum was not present.
 5 – Indicate species for tree cores or cookies that were collected. Indicate "None" if not collected (include comments indicating why the sample was not collected).

Appendix 5: Lichen Growth Forms - ABMI Simplified Flow Chart to Sorting and Species Identification

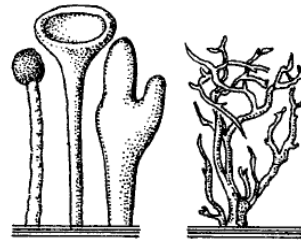


Dust or crust-like: no lower cortex, closely attached to substrate (paint-like, grainy, or powdery), upper surface hard

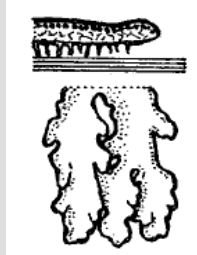
DO NOT ID



Hair-like: mainly round, flexible, pendant branches. If flattened, both sides alike. Arboreal.



Club or shrub-like: mainly round, erect, upright-growing lichens. Commonly found on the ground, base of trees, and downed wood.



Leaf-like: flattened, prostrate. Thallus typically divided into branches or lobes. Very diverse in habitat and appearance. **WARNING:** some may appear crustose.



ID to Species

1. *Evernia mesomorpha* P. 26
2. *Letharia vulpina* P. 28
3. *Ramalina dilacerata* P. 30

Not any of the above?

ID to Genus P. 32

- *Alectoria*
- *Bryoria*
- *Ramalina*
- *Usnea*



ID to Species

1. *Cladina stellaris* P. 34
2. *Cladonia botrytes* P. 36

Not any of the above?

ID to Genus & Group

- *Cladina* P. 38
- *Cladonia* A to J
- Go to Key P. 39
- *Stereocaulon* P. 38



ID to Species

1. *Hypogymnia physodes* P. 42
2. *Imshaugia aleurites* P. 44
3. *Parmelia sulcata* P. 46
4. *Parmeliopsis ambigua* P. 48
5. *Parmeliopsis hyperotera* P. 50
6. *Peltigera neckeri* P. 52
7. *Physcia adscendens* P. 54
8. *Platismatia glauca* P. 56
9. *Tuckermannopsis americana* P. 58
10. *Vulpicida pinastri* P. 60

Not any of the above?

ID to Genus, beginning with the colour groupings

- *Lobaria* P. 66
- *Melanelia*
- *Nephroma*
- *Tuckermannopsis*

- *Hypogymnia* P. 62
- *Phaeophyscia*
- *Physconia*
- *Physcia*
- *Xanthoparmelia*

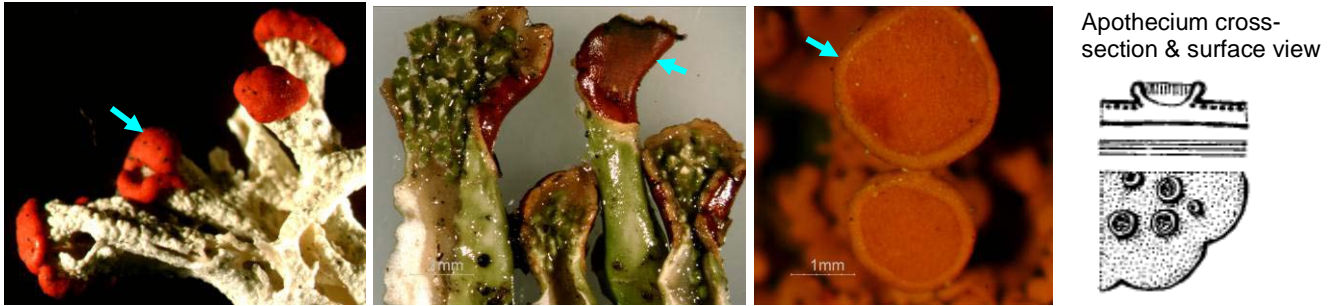
- *Collema* P. 64
- *Leptogium*
- *Umbilicaria*

- *Flavocetraria* P. 64
- *Xanthoria*

- *Flavopunctilia* P. 68
- *Peltigera*
 - Freckled Green
 - Blue-green
- *Solorina*

Line drawings reproduced courtesy of BC Ministry of Forests and T. Goward, from Goward *et al.* 1994, fig. 1 and 2

Appendix 6: Illustrated Lichen Glossary



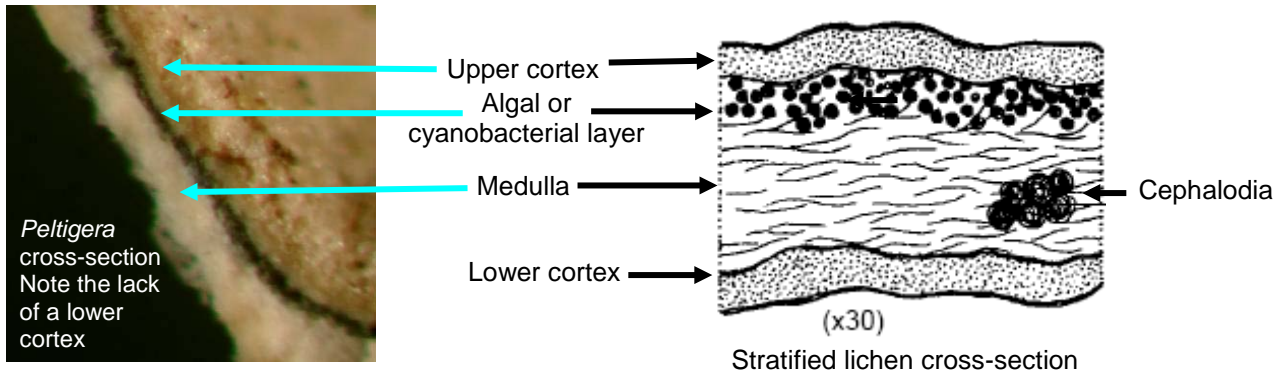
Apothecium cross-section & surface view

Apothecium (plural: apothecia): disc or cup-shaped structures formed by the fungal symbiont, where sexual spores are created. The spore-containing surface is usually a different colour than the thallus of the lichen. Line drawing reproduced courtesy of BC Ministry of Forests and T. Goward, from Goward *et al.* 1994, fig. 9a.

Cephalodium (plural: cephalodia): colony of cyanobacteria on a lichen with a primarily-green algal photobiont. When occurring on the surface, appear as small, brain-shaped, wart-like structures. Vary in shape and degree of attachment. Line drawing reproduced courtesy of BC Ministry of Forests and T. Goward, from Goward *et al.* 1994, Key to *Peltigera* and Similar Lichens, p. 97.

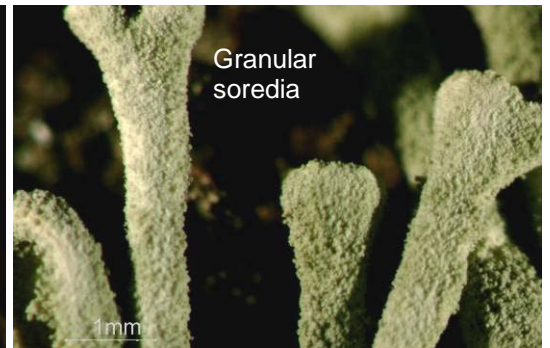


Cilia: hair-like structures, arising from *lobe margins and tips*, sometimes from apothecia margins



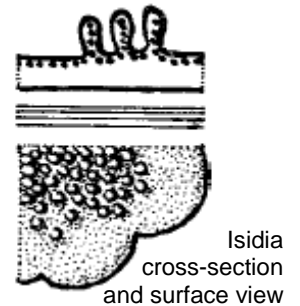
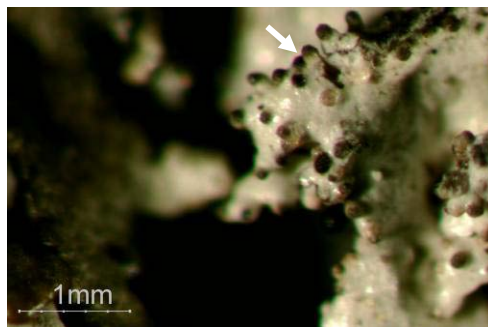
Cortex: outer protective layer of a stratified lichen thallus, composed entirely of fungal cells. Many of the lichens we identify are stratified, *i.e.*, they have defined layers, as above. Some lichens, such as *Peltigera* species, lack one or more of the strata, while other lichens, such as *Collema* species, have their photobiont mixed evenly with the fungal partner. Line drawing reproduced courtesy of BC Ministry of Forests and T. Goward, from Goward *et al.* 1994, fig. 4.

Farinose: fine and powdery or chalky, as compared to coarse, granular. Describes soredia.



Hyphae: fungal filaments, composing most of the lichen. Refer to the entry for *cortex*.

Isidia: asexual reproductive or carbon storage outgrowths from the upper surface of a lichen, composed of both fungal threads and photobiont cells. Line drawing reproduced courtesy of BC Ministry of Forests and T. Goward, from Goward *et al.* 1994, fig. 9g.

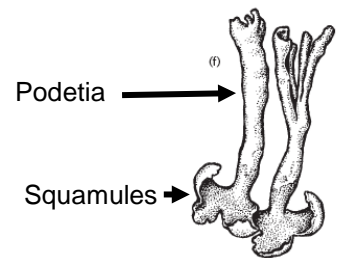


Maculae (adjective: maculate): white spots (like a sponge-painted wall) as seen in *Physcia* species, caused by discontinuities in the algal layer of the lichen, through which you can see the medulla.

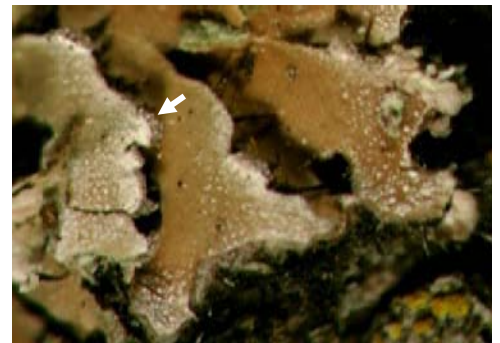


Medulla: the area of loosely packed fungal hyphae within a thallus. Refer to the entry for *cortex*.

Podetia: erect, stalk-like structures, often bearing cups and/or apothecia, as seen in the genus *Cladonia*. Typically, podetia arise secondarily from a primary thallus such as squamules. Squamules may persist or disappear after podetia form. Line drawing reproduced courtesy of BC Ministry of Forests and T. Goward, from Goward 1999, fig. 8f.



Pruina (adjective: pruinose): powdery or scaly spots on the upper thallus surface, typically made of deposits of dead cells and calcium oxide. Compare with the entry for *maculae*.



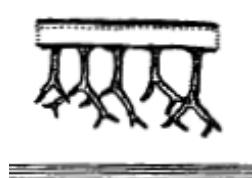
Pseudocyphellae: small irregular pits in the cortex through which the medulla shows



Reticulate: raised network on surface as seen in *Parmelia sulcata*.



Simple



Forked/Dichotomous



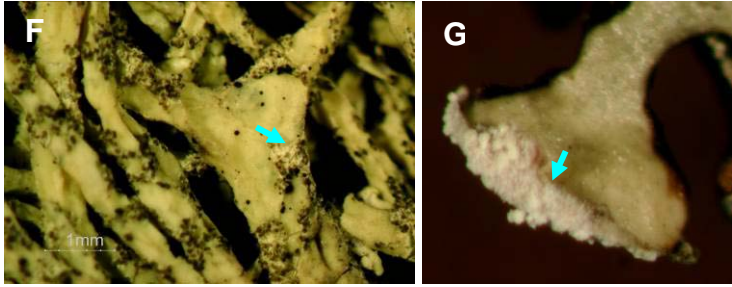
Squarrose



Tufted

Rhizines: anchoring hyphae or groups of hyphae, arising from the lower surface. Line drawings of attachment cross-sections reproduced courtesy of BC Ministry of Forests and T. Goward, from Goward *et al.* 1994, fig. 6a,b,c and e.



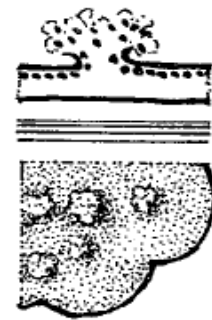


Forms of soralia:

- a) laminal
- b-c) marginal
- d) terminal
- e-f) fissural
- g) labriform

Soralium (plural: soredia): patch of soredia. Where soralia occur on each species is a key identifying feature.

Soredia: small, rounded, asexual reproductive structures made of hyphae and a few photobiont cells. Soredia originate from the algal layer and become exposed through a crack or hole in the cortex. Refer to entry for *farinose* and *soralia*. Line drawing reproduced courtesy of BC Ministry of Forests and T. Goward, from Goward *et al.* 1994, fig. 9f.



Cross-section and surface view of soredia in a soralium

Squamules: small, flat, leaf-like lobes. In general, squamules are attached at one edge and have a white lower surface, without any attachment structures. Refer to entry for *podetia*.

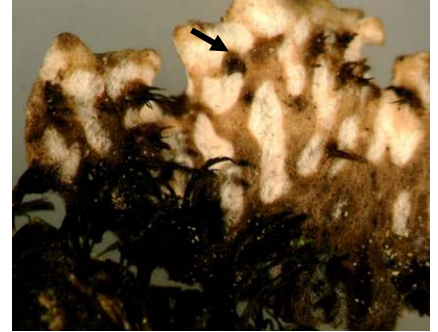
Squarose: like a bottle-brush. Refer to entry for *rhizines*.

Thallus: the body of a lichen.

Tomentum (adjective: tomentose): cottony fuzz, varying in thickness. Caused by the outgrowth of surface cells into simple to branched hyphae. Commonly seen on the surface of some *Peltigera* and *Nephroma* (seen here) species.



Veins: lines of darkened thickened areas, with intervening areas being lighter in colour as seen on the lower surface of species of *Peltigera*. Not vascular tissue.



Appendix 7: Initial Lichen Species and Genera for Identification in the Laboratory

- There are four sections to this appendix, corresponding to the growth forms in Appendix 5.
- Technicians determine the growth form of a specimen, and then go to the corresponding section to further identify the specimen.
- In the beginning of each section, the lichens technicians are expected to identify to species are described in alphabetic order.
- Following the species descriptions, the most frequently encountered genera within the growth form are described.
- As their ID skills develop, technicians are expected to decrease their reliance on the appendices.
- If the specimen does not seem to fit within the described genera, technicians describe the specimen's growth form as a minimum level of identification, and if possible, add the genus it appears closest to. For example:

LICHEN SPECIMEN 2007	Specimen #
ABMI Site: _	
Date: _____	
Crew Member: _____	
Microhabitat: _____	
Plot: _____	
Leaf-like (Melanelia like?)	

Appendix 7a: Dust & crust-like species

- No lower cortex
- Closely attached to substrate (paint-like, grainy, or powdery)
- Upper surface hard

DO NOT IDENTIFY



*Appendix 7b: Hair-like species****Evernia mesomorpha* - EVERMES**

Boreal Oakmoss Lichen

Field Characteristics

- Thallus forming pendent or shrubby tufts, 4-8 cm long
- Irregular but abundantly divided
- **Branches flabby and angular, not flattened**
- Plants greyish-green to yellowish, depending on exposure
- **Medulla cottony and solid**
- **Coarse soredia developing on ridges**
- Fungus galls often present

Habitat

- Grows on branches and trunks of trees across Alberta
- May be found in leaf litter on fallen twigs

For more information

- Brodo *et al.* 2001, pg 312

Similar species*Evernia prunastri*

- Branches are flattened

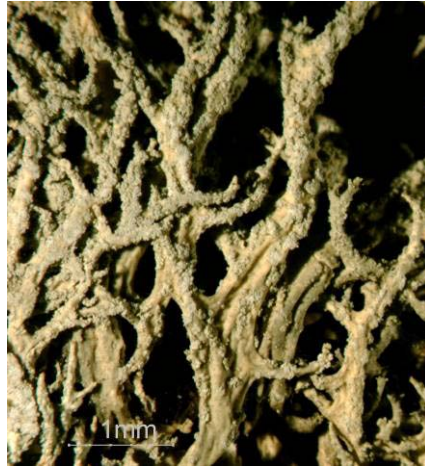
Usnea spp.

- Branches round in cross-section
- Branches have a central cord

Young Ramalina spp.

- Branches flattened
- Branches webby inside, not cottony

EVERMES



Cottony medulla



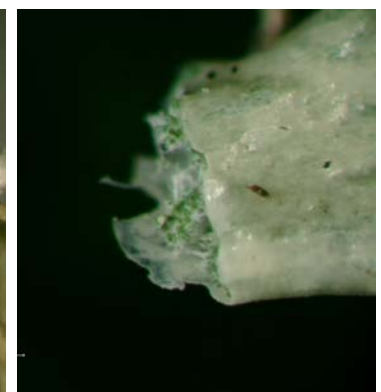
Angular branches with coarse soredia



Evernia prunastri



Usnea sp. showing central cord



Ramalina dilacerata showing loose, webby interior

Letharia vulpina - LETHVUL

Wolf Lichen

Field Characteristics

- Thallus **bright yellow**, forming pendent or shrubby tufts
- Irregular but abundantly divided
- **Branches angular, not flattened**
- **Coarse granular soredia**
- Cylindrical isidia on ridges
- **Apothecia rare**

Habitat

- Grows on branches and trunks of trees
- Found in Alberta's foothills and mountains

For more information

- Brodo *et al.* 2001, pg 412

Similar species

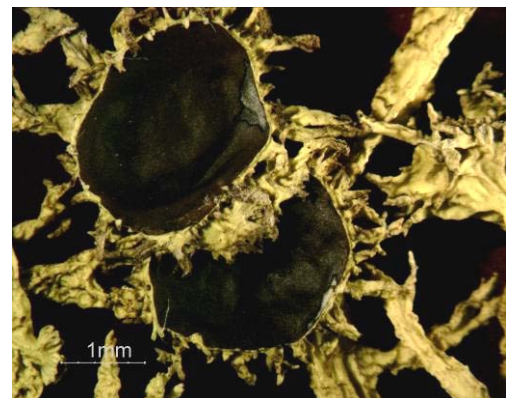
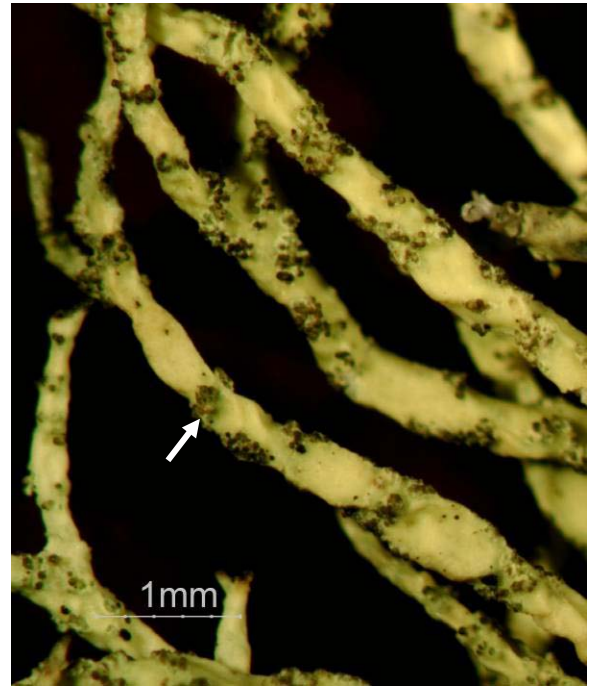
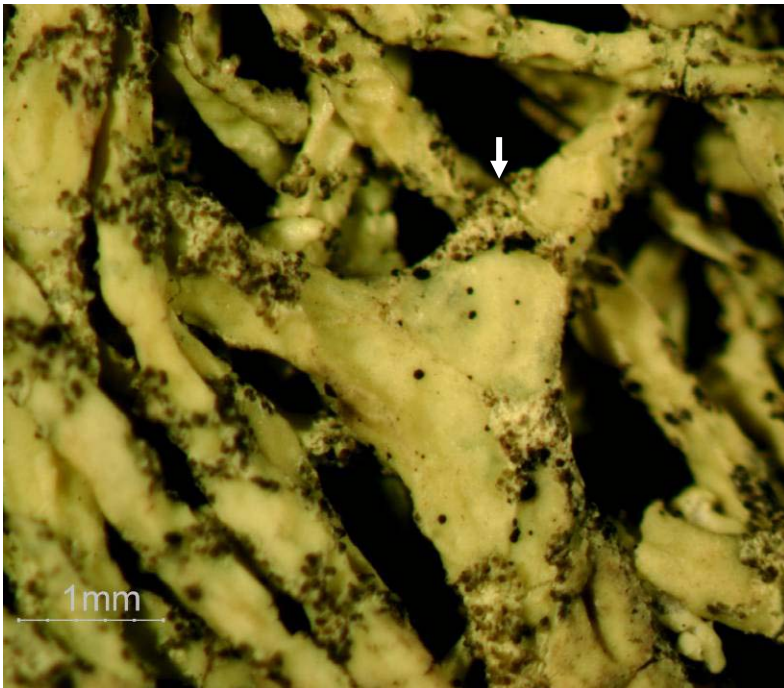
Letharia columbiana

- Apothecia common – large, brown
- Pycnidia often abundant

LETHVUL



Patches of soredia and isidia



Letharia columbiana

***Ramalina dilacerata* - RAMADIL**

Punctured Ramalina

Field Characteristics

- Thallus pale, short, densely shrubby
- Cortex thin and **smooth with many perforations**
***Perforations are often on the underside – check both sides of the thallus, or try using transmitted light**
- No pseudocyphellae or soredia
- **Medulla loose & webby**, not solid or not cottony
- **Apothecia abundant and usually at or close to branch tips**

Habitat

- Grows on twigs and branches
- Common in the boreal

For more information

- Brodo *et al.* 2001, pg 623

Similar species

Ramalina spp.

- Branches flattened
- Often sorediate, not punctured

Evernia spp.

- Branches flattened or angular, flabby
- Branches have cottony medulla

Usnea spp.

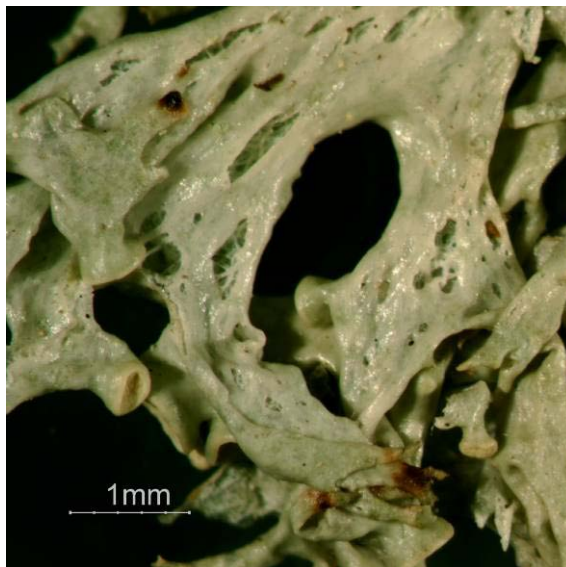
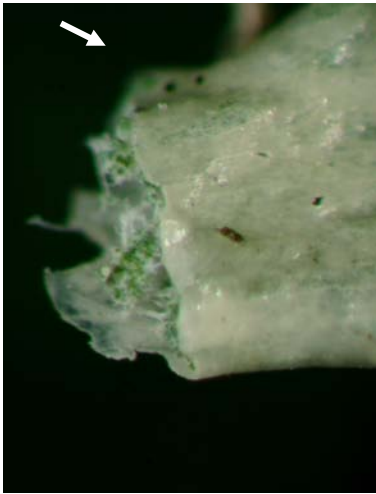
- Branches round in cross-section
- Branches have a central cord

RAMADIL

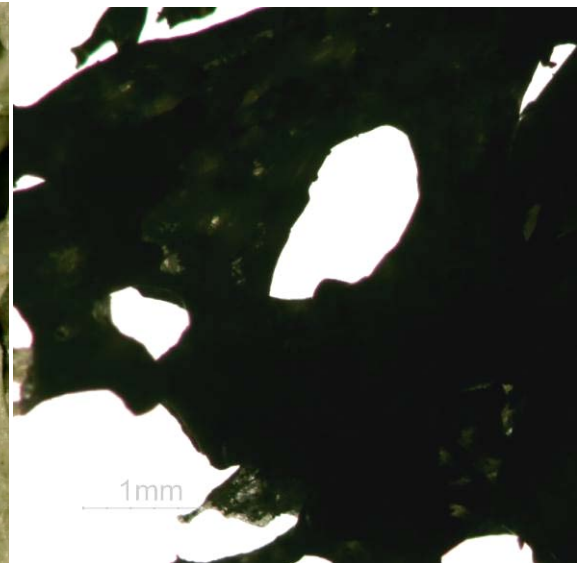
Apothecia



Webby interior



Perforated cortex under incident light



....and transmitted light

Other Commonly Encountered Hair-like Genera

Usnea

- Thallus yellowish-green
- Branches round or angular in cross-section
- **Central cartilaginous cord** (gently stretch large cord to separate cortex and see elastic cord inside)
- Found on trees and shrubs
- Brodo *et al.* 2001, pg 709-726, 16 species in Alberta

Bryoria

- **Thallus brownish-black**
- Branches round in cross-section
- Found on trees, almost exclusively conifers
- Brodo *et al.* 2001, pg 179-186, 18 species in Alberta

Alectoria

- Thallus yellowish-green
- Pseudocyphellae present along branches
- **Similar to Usnea, but lacks central cord**
- Found on bark and wood in well-lit areas
- Brodo *et al.* 2001, pg 150-154, 5 species in Alberta

Ramalina

- Thallus pale grey-green or yellow-green
- Branches flattened
- Medulla varies from solid to loose and webby to hollow at base
- Found on trees
- Brodo *et al.* 2001, pg , 10 species in Alberta

***Usnea* spp.**



Usnea lapponica



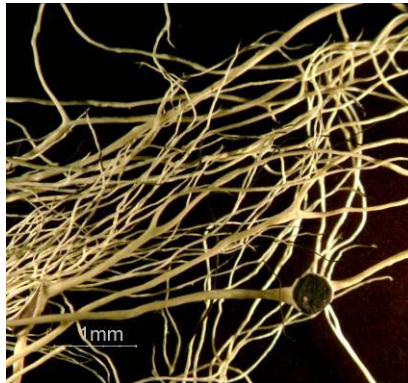
Usnea scabrata

***Bryoria* spp.**



Bryoria fuscescens

***Alectoria* spp.**



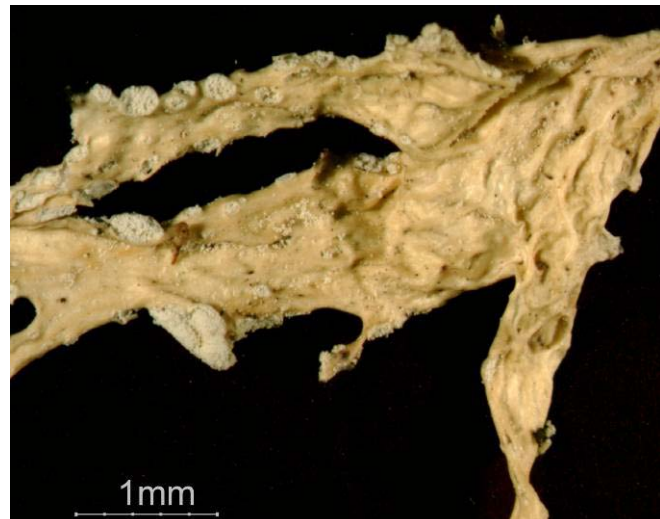
Alectoria sarmentosa



***Ramalina* spp.**



Ramalina sinensis



Ramalina pollinaria

Appendix 7c: Club and Shrub-like species

***Cladina stellaris* - CLADSTE**

Star-tipped Reindeer Lichen

Field Characteristics

- Thallus pale yellowish-green
- **Rounded “golf-ball” heads**
- Podetia branch extensively, typically lacking a central podetial “stem”
- **UV positive bluish-white** (may need to scrape or crumble a bit to expose fresh material)

Habitat

- On the ground, sometimes forming extensive mats
- Found across most of Alberta

For more information

- Brodo *et al.* 2001, pg 228

Similar species

None

CLADSTE



Cladina arbuscula – note the central tree-like 'stem', with branching towards the tips

***Cladonia botrytes* - CLADBOT**

Wooden Soldiers

Field Characteristics

- Podetia yellowish, smooth to bumpy, **without squamules or soredia**
- No cups
- Mostly 5-10 mm high
- **Topped with large, pale beige apothecia**

Habitat

- Grows on wood, especially stumps and logs
- Common across most of Alberta

For more information

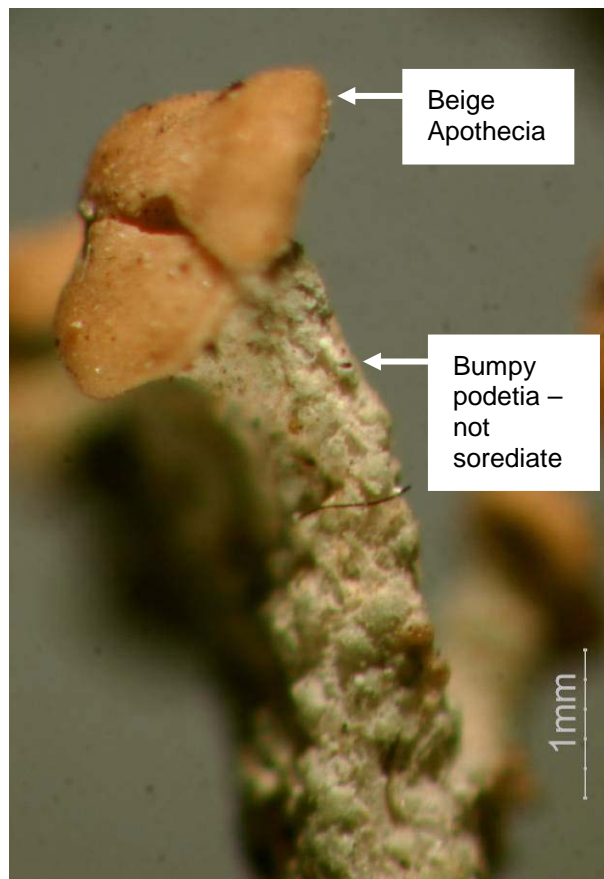
- Brodo *et al.* 2001, pg 242

Similar species

Cladonia cristatella & *Cladonia bellidiflora*

- Crimson red apothecia

CLADBOT



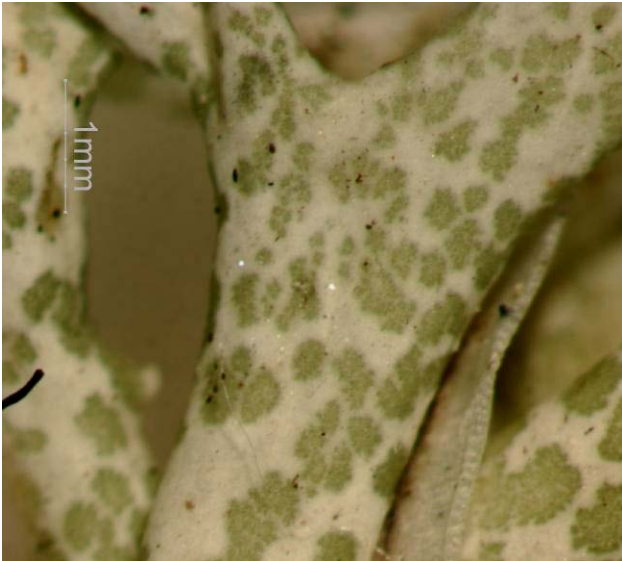
More on the Club and Shrub-like Genera

Cladina

- Thallus pale yellowish-green to grey-green
- Abundantly branched with hollow podetia
- Arises from a granular cortex – no squamules
- **No outer cortex** (can see hyphae)
- Usually grow on acidic ground, from dry to boggy
- Brodo *et al.* 2001, pg 223-230, 6 species in Alberta



Cladina arbuscula



Cladonia uncialis – note presence of cortex



Cladina arbuscula – note lack of cortex, visibility of hyphae

Cladonia

- Begin as squamules (primary thallus), which usually develop erect podetia
- Branches always hollow, but variable in branching and colour
- **Outer cortex usually present**
- Found on soil, peat, bark, tree bases, often mixed with moss
- Apothecia and soredia may be present
- Brodo *et al.* 2001, pg 231-278, 62 species in Alberta

Stereocaulon

- Pale grey to white erect, branched stalks
- **Branches bumpy, granular, coral-like, bearing cephalodia**
- Found on soil and rock
- Most species found in southwestern Alberta, some boreal species
- Apothecia and soredia may be present
- Brodo *et al.* 2001, pg 663-670, 11 species in Alberta



Stereocaulon paschale, reproduced courtesy of BC Ministry of Forests and T. Goward, from Goward 1999, Key to *Stereocaulon* and Similar Lichens, p.230.

Key to the Genus *Cladonia*

Key reproduced courtesy of BC Ministry of Forests and T. Goward, from Goward 1999, Key to *Cladonia* and Similar Lichens, p.115.

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

Synopsis

1a x12

1b Podetia present; basal squamules present or absent 2

2a Podetia much branched to richly branched . . . **GROUP B**

2b Podetia unbranched to once or twice branched 3

3a At least some podetia tips opening by a gaping hole(←) **GROUP C**

3b Podetia tips not at all opening by a gaping hole (Note: all specimens key here in which openings are restricted to other portions of the podetia, and the upper portion of the podetia is dull-tomentose) 4

4a Podetia distinctly longitudinally ribbed or fibrous(←) **GROUP D**

4b Podetia not distinctly longitudinally ribbed or fibrous (Note: specimens bearing soredia or forming distinct cups, or both, key here) 5

5a At least some podetia terminating in distinct cups(←) 6

6a Cortex with a distinct yellowish cast (usnic acid present) (Note: specimens bearing red apothecia key here, regardless of podetia colour) **GROUP E**

6b Cortex not distinctly yellowish (usnic acid absent or in low concentration) 7

7a Podetia bearing at least some soredia(←) (check upper portions) 8

8a Cups broad(←), the largest ones to more than 2.5 times wider than the width of the supporting stalk **GROUP F**

8b Cups narrow(←), the largest ones to less than 2.5 times wider than the width of the supporting stalk. . . . **GROUP G**

7b Podetia lacking soredia **GROUP H**

5b Podetia not at all cupped(←) 9

9a Podetia bearing soredia or corticate granules(←), or both (check upper portions). . . . **GROUP I**

9b Podetia lacking soredia and corticate granules (Note: dorsiventral squamules(←) and/or microsquamules may, however, be present). **GROUP J**

2a x5

3a x3

4a x2

5a x2

7a x3

8a x2

8b x2

9a

9b x4

Examples of *Cladonia* species in each group

- some species fit in more than one group

A - no podetia, squamules only

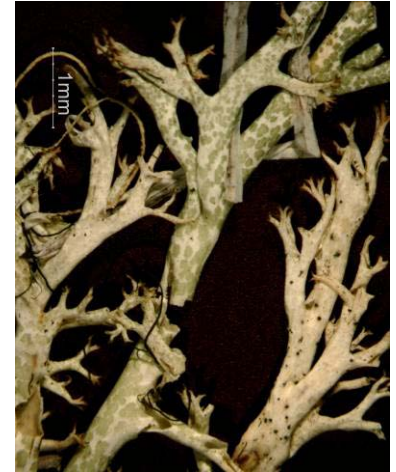


Cladonia pyxidata

B – branched podetia



Cladonia crispata



Cladonia uncialis

C – podetia opening by gaping hole



Cladonia cenotea

D – podetia longitudinally ribbed/fibrous



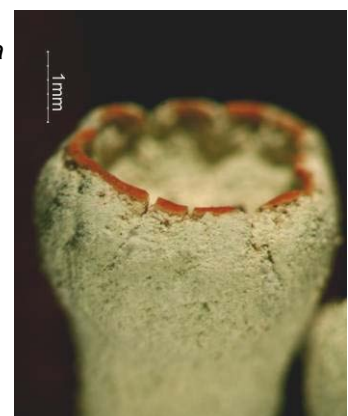
Cladonia cariosa

E – podetia ending in cups, cortex with a yellowish caste; all spp. with red apothecia grouped here

Cladonia cristatella



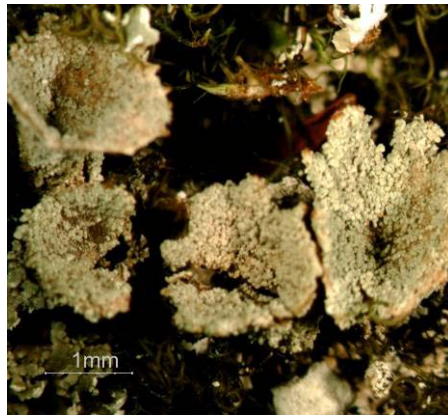
Cladonia sulphurina



F – sorediate podetia ending in broad cups



Cladonia fimbriata



Cladonia chlorophaea

G – sorediate podetia ending in narrow cups

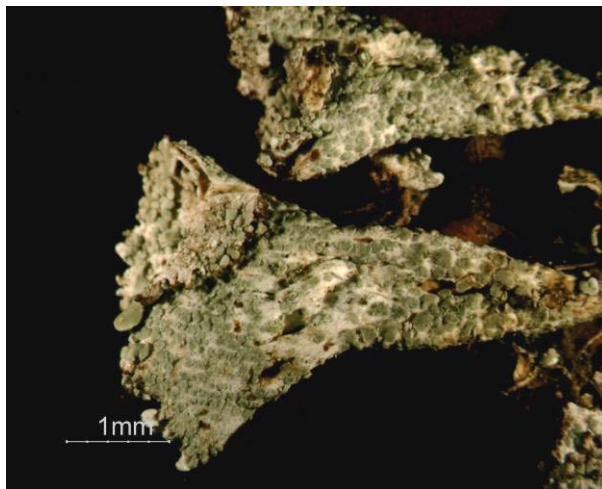


Cladonia coniocraea

H – non-sorediate podetia ending in cups



Cladonia cervicornis



Cladonia pyxidata



Cladonia gracilis

I – non-cupped sorediate podetia

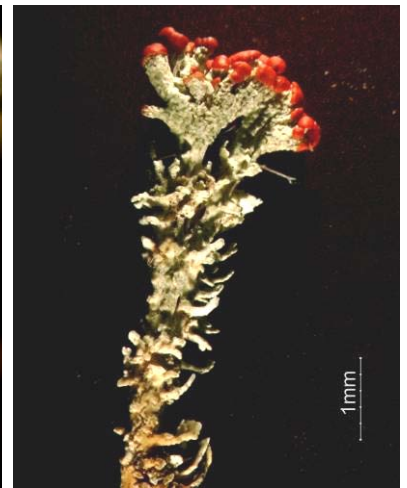


Cladonia cornuta

J – non-cupped, non-sorediate podetia



Cladonia botrytes



Cladonia bellidiflora

*Appendix 7d: Leaf-like species****Hypogymnia physodes* - HYPOPHY**

Monk's-hood Lichen, Hooded Tube Lichen, Puffed Lichen

Field Characteristics

- Thallus variable, **usually pale greenish-grey and smooth**
- **Underside of lobe tips bursting open with granular soredia**
- Lower cortex smooth, black, and burnt-looking
- Thallus hollow - inflates when water added
- **No rhizines**
- Apothecia rare

Habitat

- Grows mostly on bark and wood, rarely moss & soil, across Alberta
- Often grows intertwined with PARMASUL
***Watch for both spp**

For more information

- Brodo *et al.* 2001, pg 354

Similar species*Hypogymnia vittata*

- More slender and irregularly branched
- More coarsely sorediate

Hypogymnia tubulosa

- Smaller, tips intact
- Soralia laminal on lobes

Hypogymnia austerodes

- Appressed rosette
- Soredia laminal, in centre of rosette
- Thallus looks burnt

HYPOPHY

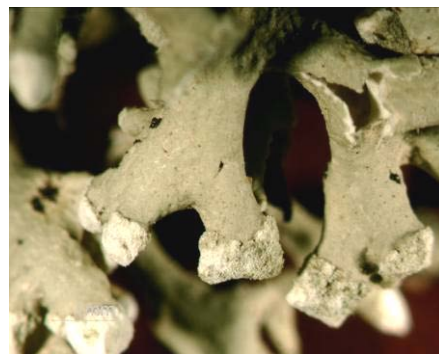


Wet HYPOPHY with
PARMSUL

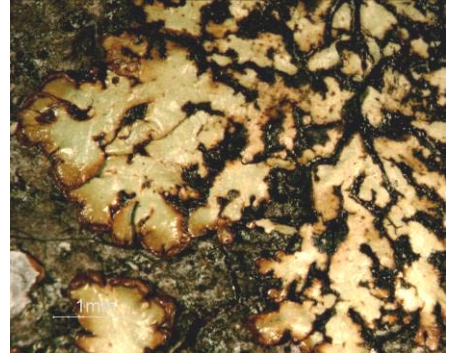
Lower cortex with
burst lobe tips



Hypogymnia vittata



Hypogymnia tubulosa



Hypogymnia austerodes

Imshaugia aleurites - IMSHALE

Salted Star-burst Lichen

Field Characteristics

- **Upper thallus white to pale grey, shiny;** lobe edges can be browned
- **Covered with cylindrical isidia,** except on extreme lobe tips
- Lower cortex tan to almost white, shiny
- Many short brown rhizines
- Apothecia brown, uncommon

Habitat

- Grows on conifer bark or wood across Alberta
- In well-lit conifer forests

For more information

- Brodo *et al.* 2001, pg 361

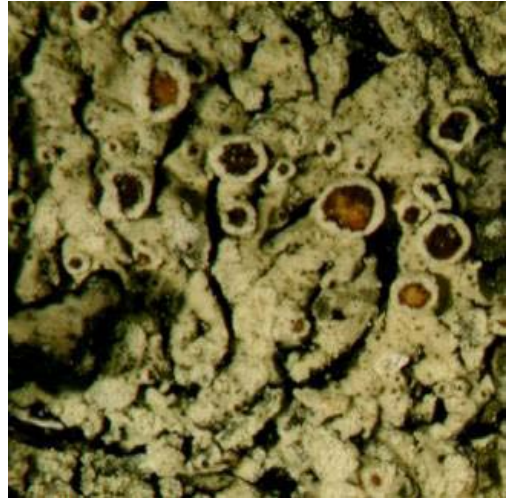
Similar species

Physcia spp.

- Lack cylindrical isidia

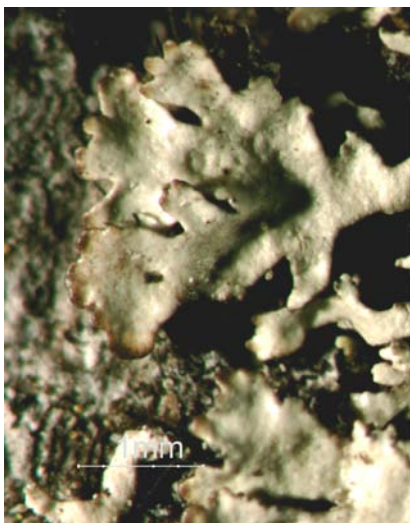
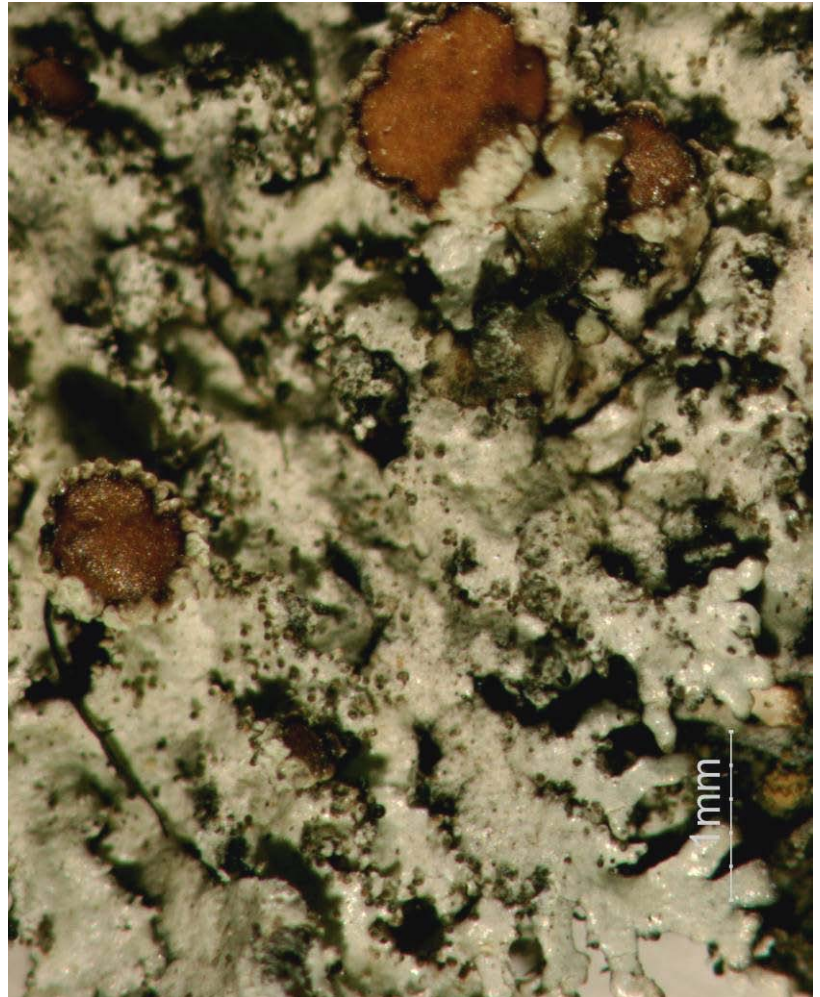
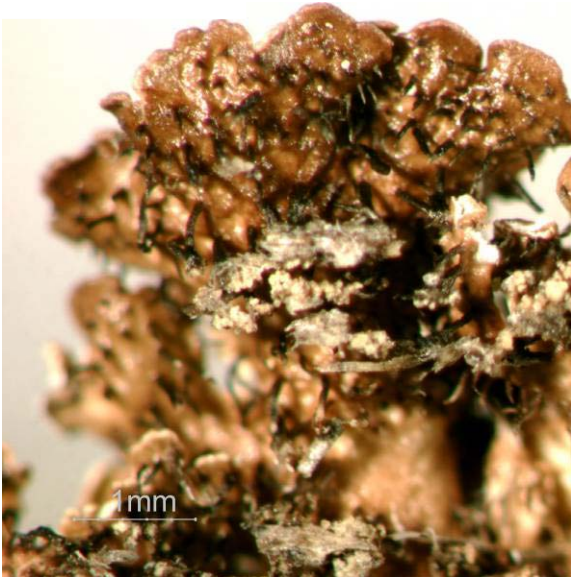
Parmeliopsis hyperopta

- Has soredia, not isidia
- Lower surface dark brown

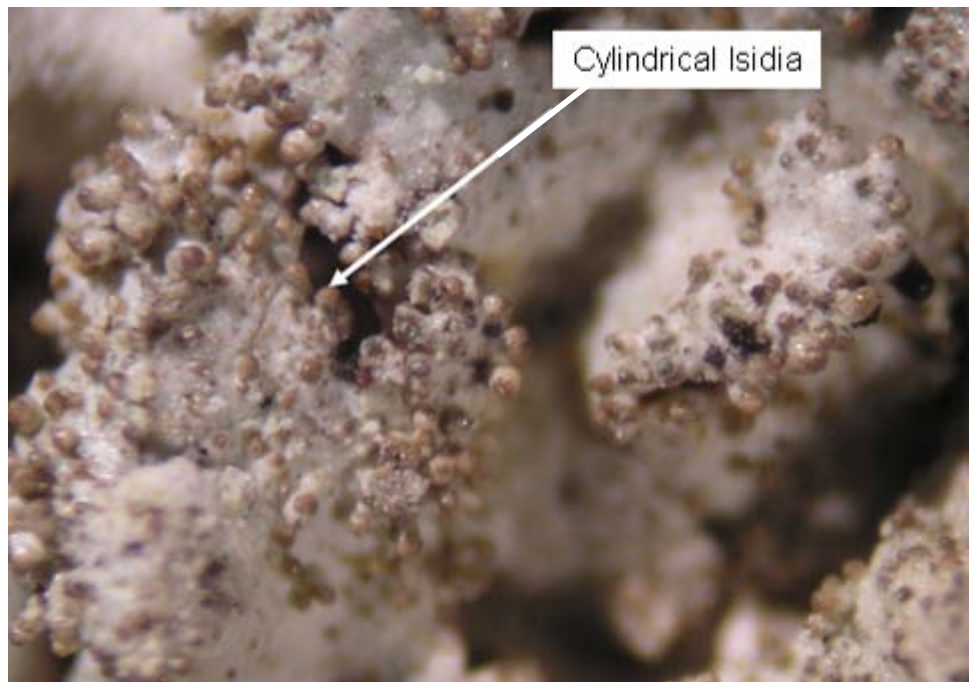


IMSHALE

Lower rhizines



Non-istiate lobe tips



Parmelia sulcata - PARMSUL

Hammered shield lichen

Field Characteristics

- **Upper surface blue-grey**
- **Powdery soredia along ridges and lobe margins** where cortex develops cracks
- Lobes often browned at edges
- Lower surface black
- Many black rhizines; rhizines unbranched on young lobes, **squarrose** on mature lobes
- Apothecia rare
- Widespread and variable

Habitat

- Grows mostly on bark, but also rock, wood, and soil, common across Alberta (can be weedy)
- Often grows intertwined with HYPOPHY
***Watch for both species**

For more information

- Brodo *et al.* 2001, pg 484

Similar species

Parmelia hygrophilia

- Has coarse, dull isidia, not soredia
- Likely found only close to border with BC

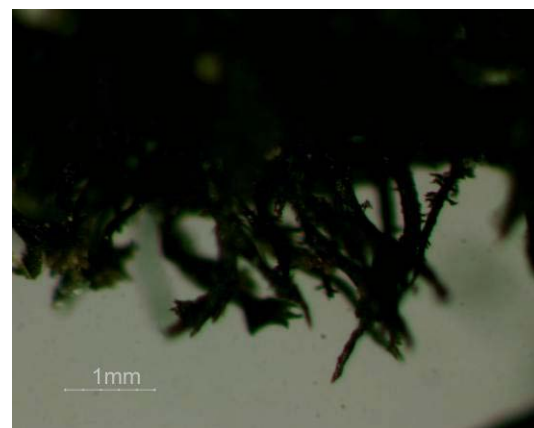
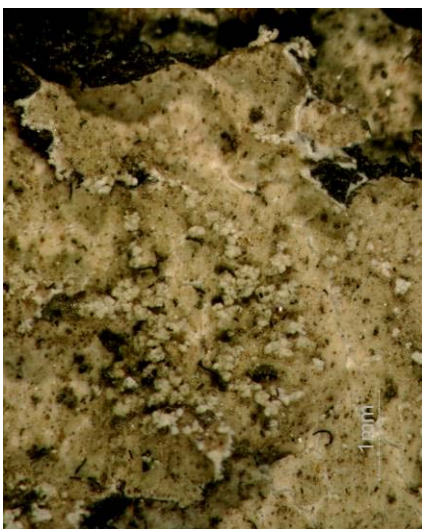
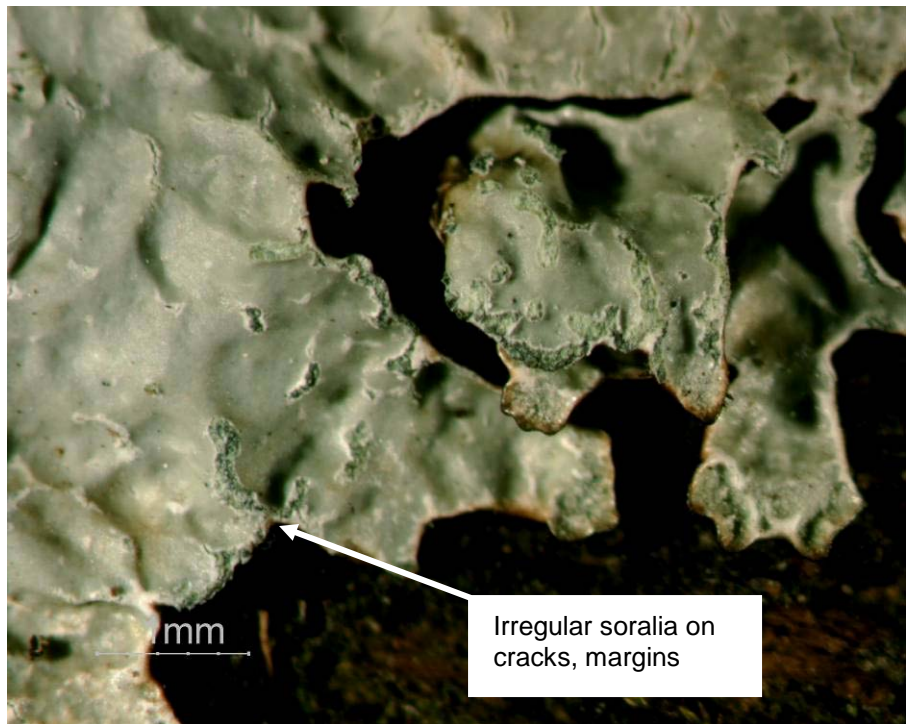
Parmelia fraudans

- Grows on rock in boreal
- Has unbranched to forked rhizines
- Soredia are yellowish, not white

PARMSUL



Mix of wet PARMSUL & HYPOPHY



Rhizines

Parmelia hygrophilia

***Parmeliopsis ambigua* - PARMAMB**

Green Starburst Lichen

Field Characteristics

- **Upper surface yellowish-green**
- **Powdery to granular yellowish soredia in irregular patches on lobe surface (laminal);**
lobe tips often not sorediate
- Lower cortex dark brown to almost black
- Sparse brown rhizines
- Apothecia brown, uncommon

Habitat

- Grows on conifer bark, stumps, & logs with *Parmeliopsis hyperopta*
- Common across most of Alberta

For more information

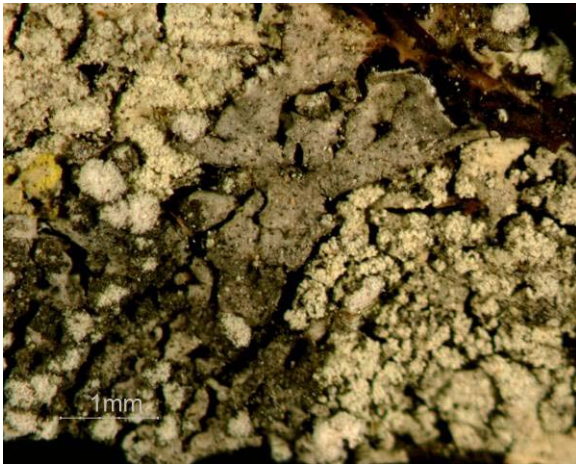
- Brodo *et al.* 2001, pg 489

Similar species

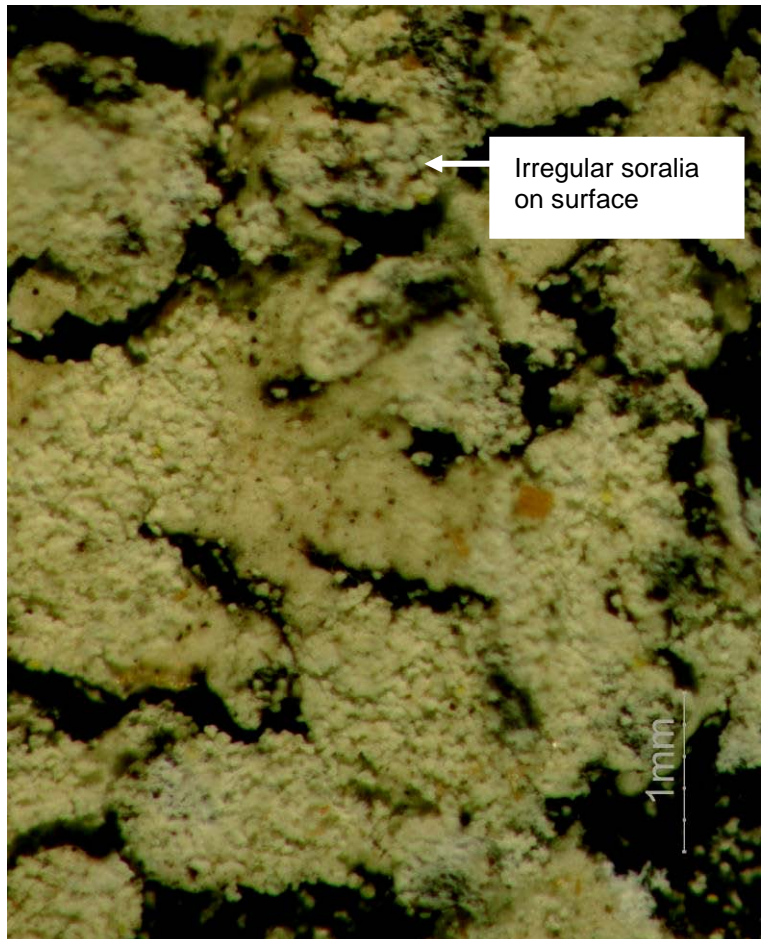
Parmeliopsis hyperopta

- Virtually identical, except it's pale-grey
- Can grow side-by-side with PARMAMB

PARMAMB



Mix of PARMAMB and PARMHYP



Irregular soralia on surface

Parmeliopsis hyperopta - PARMHYP

Grey Starburst Lichen

Field Characteristics

- **Upper surface pale grey**
- **Powdery to granular grey-green soredia in irregular patches on lobe surface (laminal);**
lobe tips often not sorediate
- Lower cortex dark brown to almost black
- Sparse brown rhizines
- Apothecia brown, uncommon

Habitat

- Grows on conifer bark, stumps, & logs , often with *Parmeliopsis ambigua*
- Not as common as PARMAMB

For more information

- Brodo *et al.* 2001, pg 489

Similar species

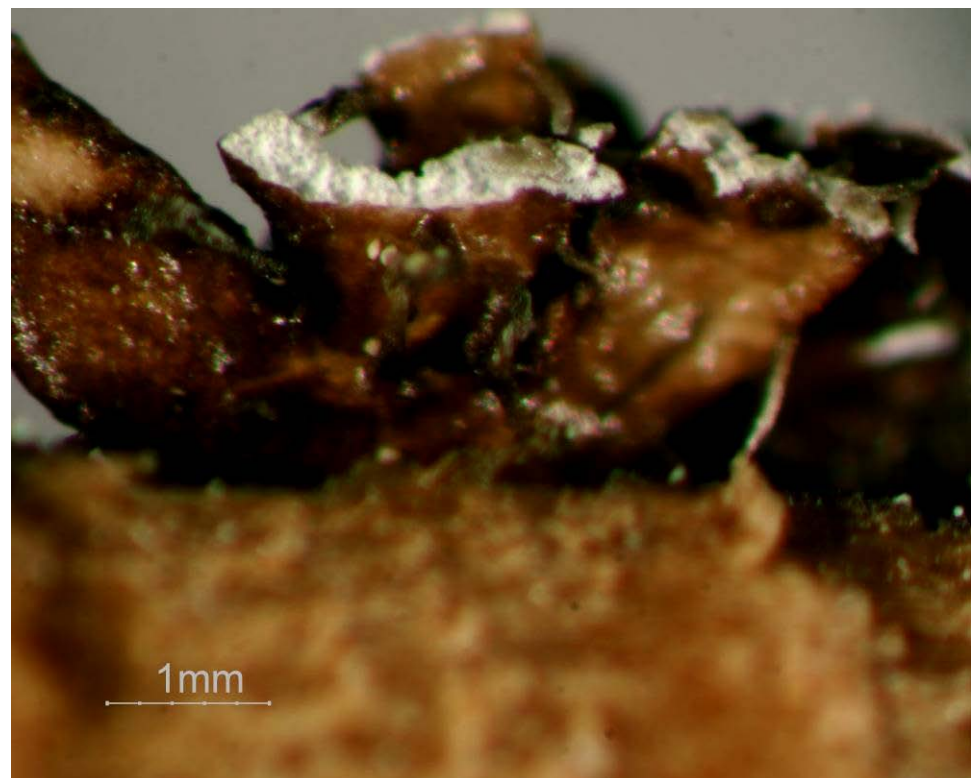
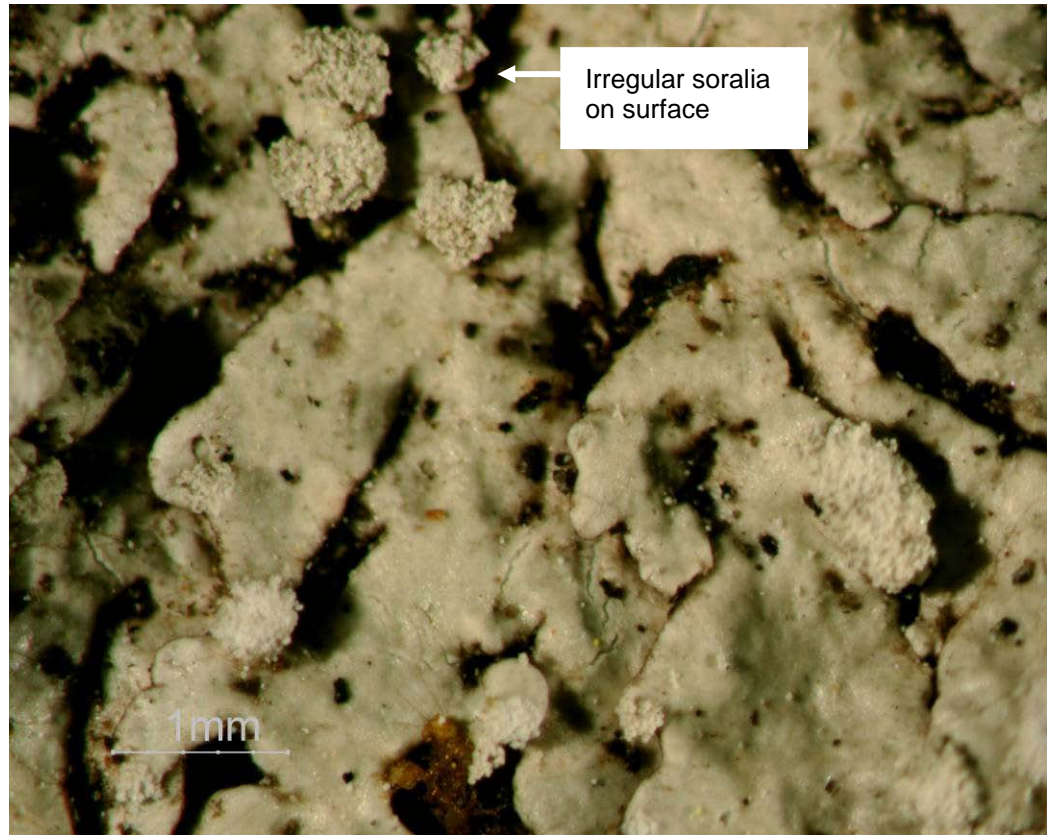
Physcia spp

- Similar upper cortex, but any species that may be confused with PARMHYP have a white lower cortex

Parmeliopsis ambigua

- Virtually identical, except it's yellow-green
- Can grow side-by-side with PARMHYP

PARMHYP



Sparse rhizines

***Peltigera neckeri* - PELTNEC**

Black Saddle Lichen

Field Characteristics

- **Upper thallus shiny, dark brownish grey to bluish grey, smooth (no tomentum)**
- **Can be lightly pruinose at lobe tips**
- Apothecia black, saddle shaped, erect
- Underside with pale to dark brown veins
- Rhizines sparse, tufted

Habitat

- Mossy logs and soil, particularly in wet habitats
- Tree bases, commonly aspen and poplar
- Common across Alberta

For more information

- Brodo *et al.* 2001, pg 514

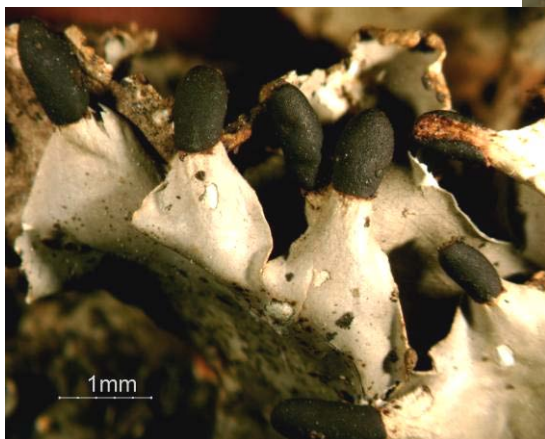
Similar species

None – this is the only species with black apothecia and a shiny upper surface with pruinose lobe tips

PELTNEC



Upper surface of lobes with pruina



Underside showing apothecia (left) and `veins`



Physcia adscendens - PHYSADS

Hooded Rosette Lichen

Field Characteristics

- **Very small – lobes less than 1 mm wide**
- **Long pale to brown cilia on lobe margins and tips**
- Upper surface pale grey to greenish grey, spotted with white maculae
- Ascending lobes, often with **helmet-shaped granular soralia (up to 2 mm wide)**
- Lower cortex is white
- Apothecia rare
- Common across Alberta

Habitat

- Bark, twigs, and wood of various trees

For more information

- Brodo *et al.* 2001, pg 549-550

Similar species

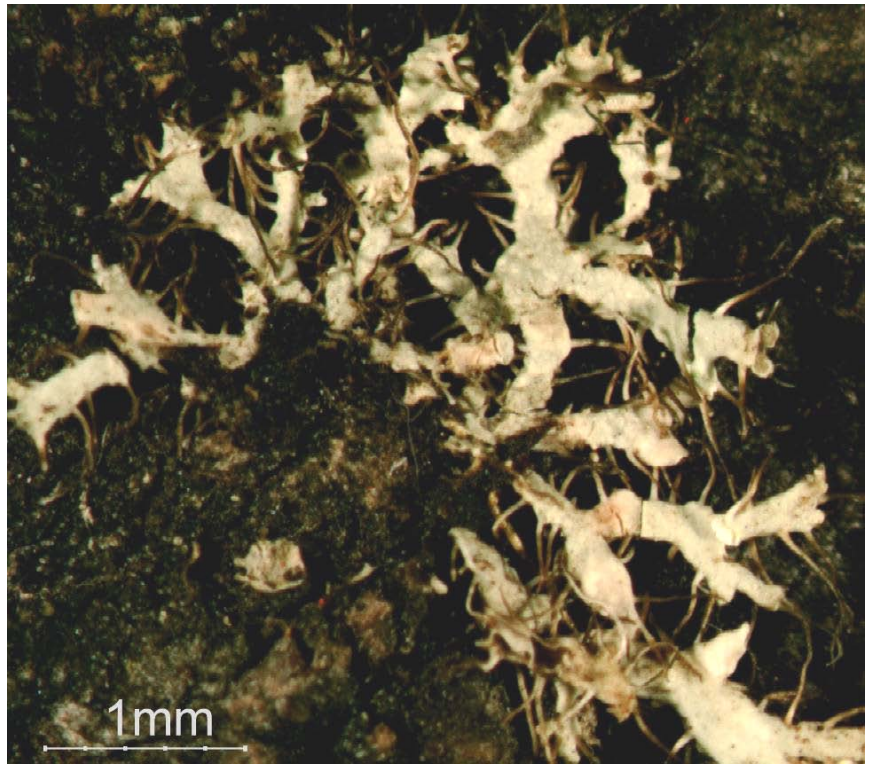
Physcia spp.

- Only *Physcia* with helmet-shaped soralia – most similar species is *P. tenella*

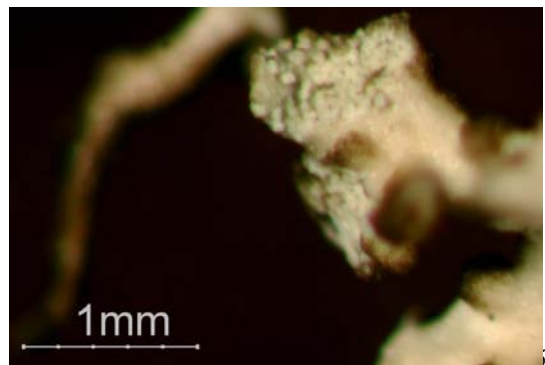
Physcia tenella

- Lip-shaped soralia on lobe tips, not in ‘hoods’
- Rare

PHYSADS



Physcia tenella (left, below)



***Platismatia glauca* - PLATGLA**

Varied Rag Lichen, Ragbag

Field Characteristics

- Upper surface yellow-green to green-grey
- **Irregular/ruffled, divided ascending lobes**
- **Lobe margins with abundant granular soredia &/or isidia**
- Laminal isidia common
- Lower cortex brown and shiny, with patches of white at edges, and black towards centre
- Rhizines sparse
- Apothecia rare

Habitat

- Common in southwestern Alberta (not boreal)
- Branches of spruce and fir trees

For more information

- Brodo *et al.* 2001, pg 574-575

Similar species

Only species of *Platismatia* in Alberta

PLATGLA



Laminal and marginal isidia



Tuckermannopsis americana - TUCKAME

Fringed Wrinkle-lichen

Field Characteristics

- Lobes ascending, upper surface dark to olive brown
- **Marginal cilia common**
- **Medulla glows blue-white under UV light**
***must do test for ID** (peel off part of cortex to see medulla under light)
- Margins appear crisped
- Thallus wrinkly
- Lower cortex pale to dark brown
- Rhizines sparse
- Apothecia common
- Black pycnidia abundant, barrel-shaped, usually marginal

Habitat

- Twigs and branches, mostly conifer and birch

For more information

- Brodo *et al.* 2001, pg 692

Similar species

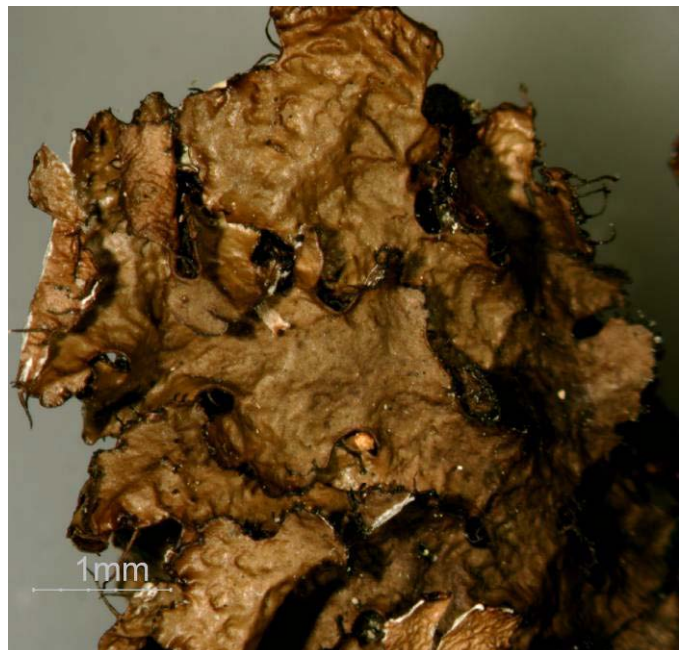
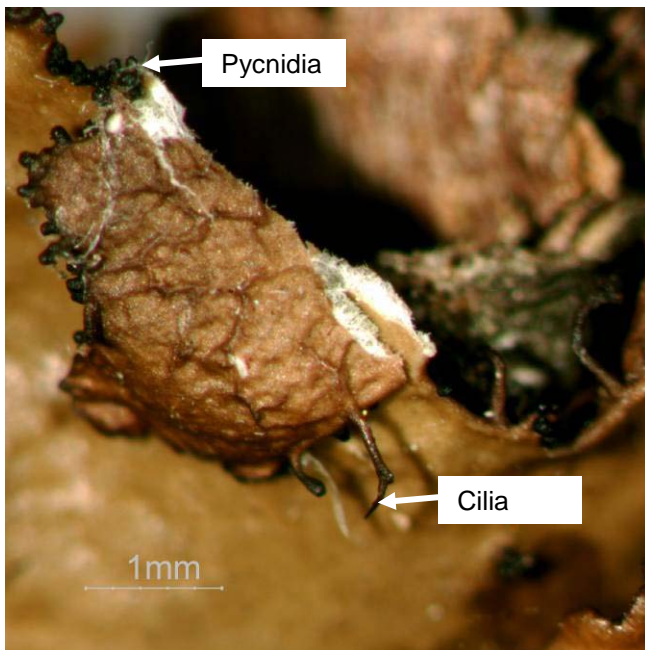
Tuckermannopsis orbata

- Lacks cilia
- Tends to be more finely divided or lobulate
- Medulla UV negative

Tuckermannopsis platyphylla

- Lacks cilia
- Lobes broad with wart-like tubercles and lobules
- Medulla UV negative

TUCKAME



Vulpicida pinnastre - VULPPIN

Powdered Sunshine

Field Characteristics

- **Greenish-yellow to bright yellow rosettes**
- **Margins with farinose soredia**
- Lower surface pale yellow to almost white
- Apothecia uncommon

Habitat

- Common in the boreal
- Bark, wood, and rocks

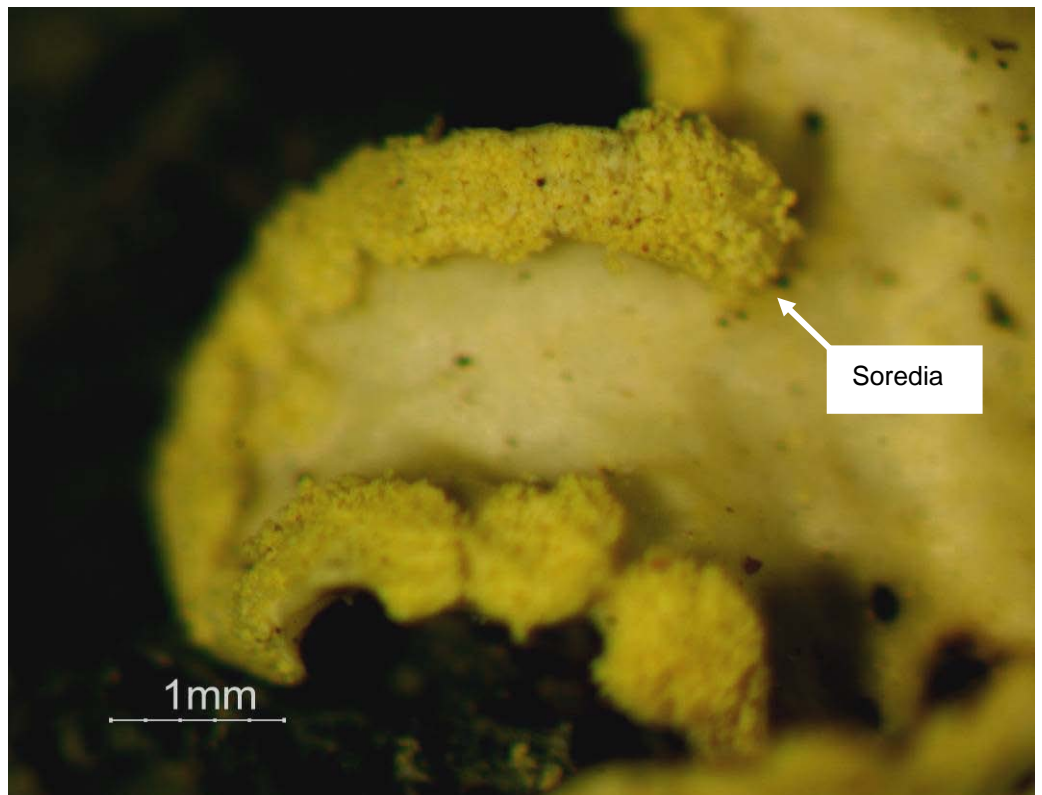
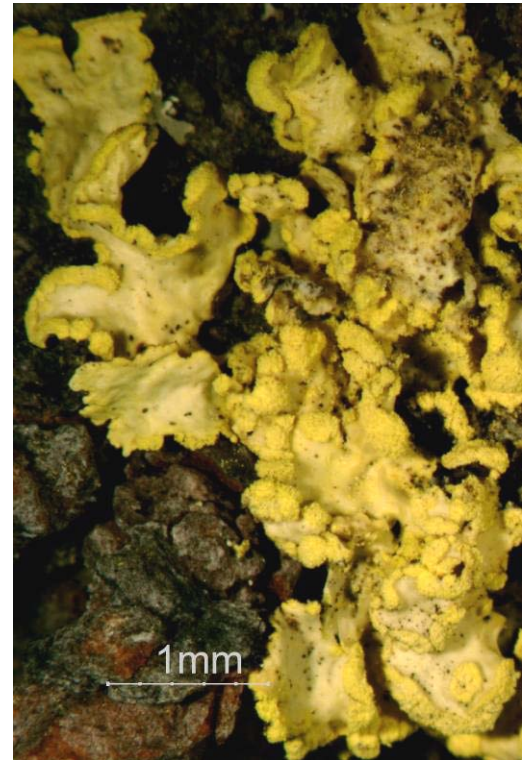
For more information

- Brodo *et al.* 2001, pg 731

Similar species

None

VULPPIN



Other Commonly Encountered Leaf-like Genera

Hypogymnia

- Upper surface green-grey to brown-grey
- **Inflated, hollow lobes**
- **Lower surface black, no rhizines**; smooth or wrinkled
- Found on twigs and bark, especially of conifer
- Brodo *et al.* 2001, pg 345-356, 13 species in Alberta

Xanthoparmelia

- Thallus green-grey to yellowish-green
- Varies from closely- to loosely attached, or tumbleweed-like
- Isidia or apothecia common
- **Grows on rocks and mineral soil, usually in dry, open sites**
- Brodo *et al.* 2001, pg 733-742, 7 species in Alberta

Physcia

- Thallus green-grey to almost white
- Small to mid-sized
- **Lower surface usually white to pale brown**
- **Frequently maculate**
- Brodo *et al.* 2001, pg 546-559, 12 species in Alberta

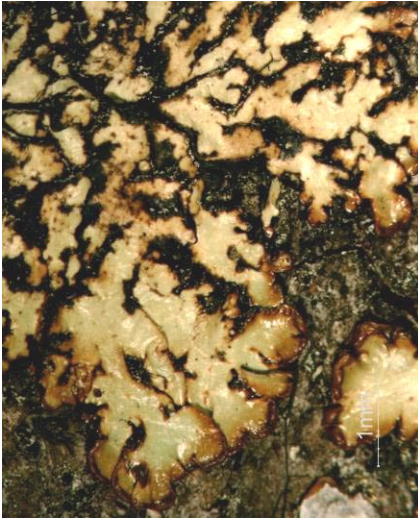
Phaeophyscia

- Thallus olive-brown to grey
- Lobes radiate out
- **Lower surface black**
- **Apothecia often with fringe of marginal cilia**
- Brodo *et al.* 2001, pg 538-544, 12 species in Alberta

Physconia

- Thallus grey-green to brown
- Appears paler because lobe tips usually **pruinose**
- Lower surface usually black with **dense, branched or squarrose rhizines that appear like a fringe around the lobes**
- Brodo *et al.* 2001, pg 560-565, 6 species in Alberta

***Hypogymnia* spp.**



Hypogymnia austerodes



Hypogymnia enteromorpha

***Xanthoparmelia* spp.**

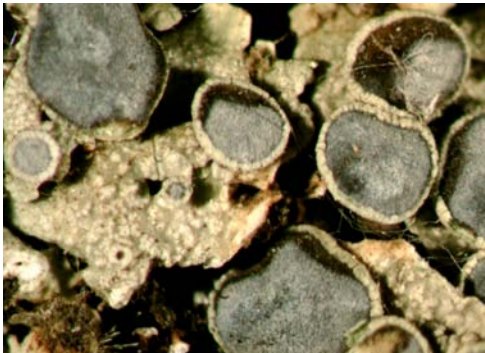


Xanthoparmelia sp

***Physcia* spp.**



Physcia tenella

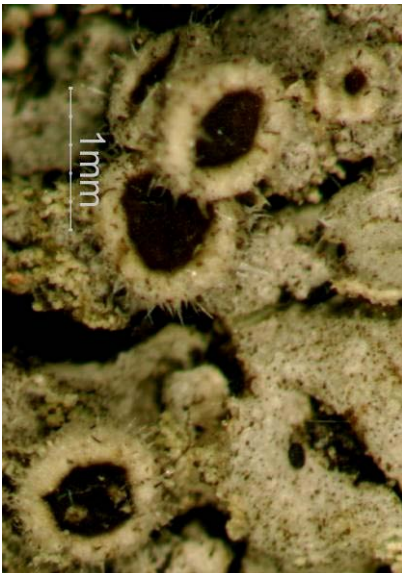


Physcia aipolia

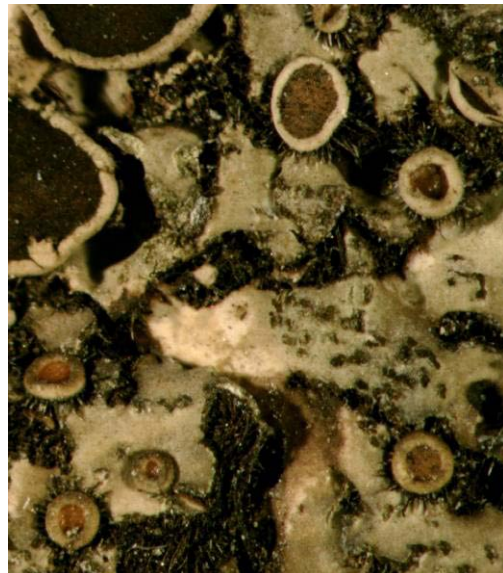


Physcia caesia

***Phaeophyscia* spp.**



Phaeophyscia hirsuta



Phaeophyscia orbicularis

***Physconia* spp.**



Physconia detersa

Other Commonly Encountered Leaf-like Genera cont'd

Collema

- **Jelly lichen** (photobiont unstratified), no upper or lower cortex
- Dry thallus black to dark olive-green
- Wet thallus gelatinous, black to blue-green
- Brodo *et al.* 2001, pg 282-288, 17 species in Alberta

Leptogium

- **Jelly lichen** (photobiont unstratified), but usually has cortices
- Dry thallus bluish-grey to olive-brown, often shiny
- Smoother, more skin-like texture as compared to *Collema*
- Wet thallus gelatinous
- Brodo *et al.* 2001, pg 400-411, 9 species in Alberta

Umbilicaria (no picture)

- **Thallus dark to grey**, shiny to dull
- Thallus rounded, **attached by central holdfast**
- Wet thallus not gelatinous
- May be confused with dried fungi or crustose species
- Brodo *et al.* 2001, pg 696-709, 21 species in Alberta



Cross-section of umbilicus, reproduced courtesy of BC Ministry of Forests and T. Goward, from Goward *et al.* 1994, fig. 6f.

Xanthoria

- **Upper surface orange**, lower surface white
- Usually appressed to substrate (may appear crustose)
- Brodo *et al.* 2001, pg 742-748, 8 species in Alberta

Flavocetraria

- Thallus pale yellow
- Lower and upper cortex similar
- Lobes flat and erect
- Grows on soil, rock, or on ground with moss
- Brodo *et al.* 2001, pg 314-315, 2 species in Alberta

***Collema* spp.**



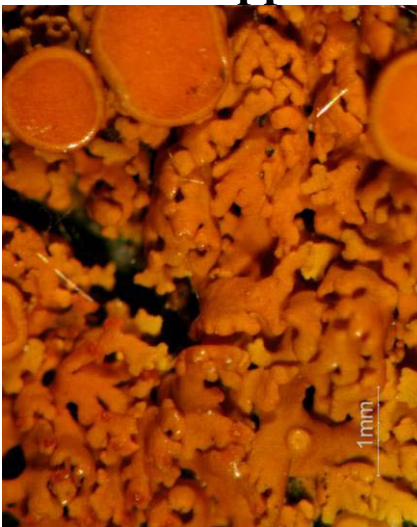
Collema furfuraceum, dry...and wet

***Leptogium* spp.**



Leptogium saturninum, dry...and wet

***Xanthoria* spp.**



Xanthoria polycarpa



Xanthoria elegans

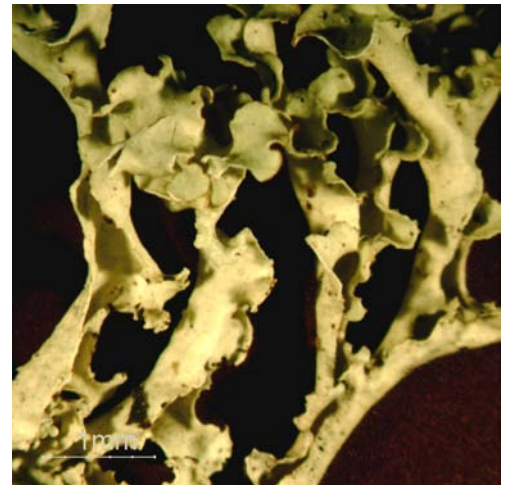
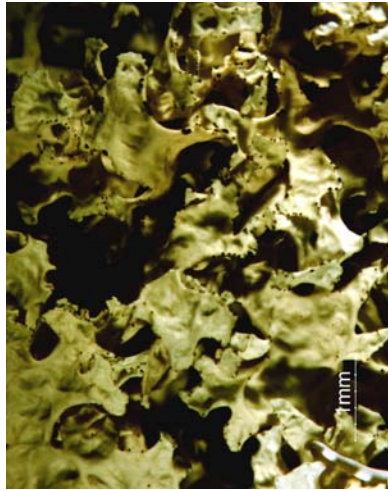


Xanthoria hasseana

***Flavocetraria* spp.**



Flavocetraria nivalis



Flavocetraria cuculatta

Other Commonly Encountered Leaf-like Genera cont'd

Melanelia

- Thallus dark-brown to olive-green
- Small to medium sized
- **Usually closely attached to substrate with many rhizines**
- Thinner and more appressed than *Tuckermannopsis*
- Found on twigs, bark, and rock
- Brodo *et al.* 2001, pg 430-441
- 22 species in Alberta

Tuckermannopsis

- Thallus brown to olive in colour
- Medium sized
- **Often ascending and lobes ruffled**
- Rhizines sparse, marginal cilia may be present
- Found on bark and branches, usually conifer and birch
- Brodo *et al.* 2001, pg 691-696
- 9 species in Alberta

Nephroma

- Thallus dark-brown or green to yellow-green
- Medium to large in size
- **Red, kidney-shaped apothecia on lower surface of lobe tips**
- Lower surface smooth and shiny, no rhizines
- Found on branches and twigs of trees and mossy rocks in humid forests
- Brodo *et al.* 2001, pg 451-457
- 7 species in Alberta
- NOTE: Can be confused with *Peltigera* – be sure to look at underside of lobe tips for apothecia

Lobaria

- Thallus pale-brown to olive-brown when dry, bright green when wet
- Large, broad, typically **squarish wrinkled lobes**
- Found on deciduous trees, soil, and mossy vegetation
- Brodo *et al.* 2001, pg 415-421
- 4 species in Alberta

Melanelia spp.



Melanelia albertana



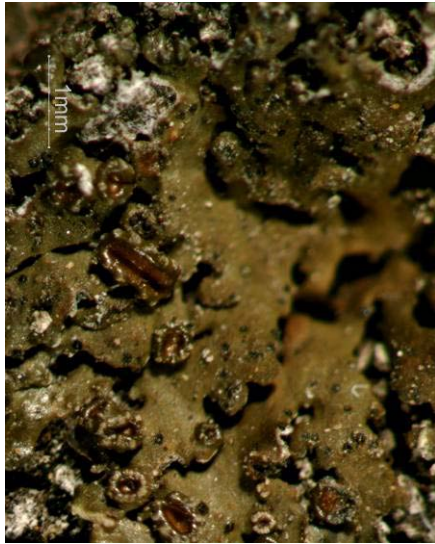
Melanelia exasperatula

Tuckermannopsis spp.



Tuckermannopsis orbata

Tuckermannopsis spp. cont'd



Tuckermannopsis fendleri



Tuckermannopsis americana



Tuckermannopsis chlorophylla

Nephroma spp.



Nephroma resupinatum
PROCESSING LICHENS VERSION 2009-05-27



Nephroma bellum

Lobaria spp.



Lobaria pulmonaria

Other Commonly Encountered Leaf-like Genera cont'd

Flavopunctilia

- Upper surface yellow-green with **pseudocyphellae**
- Lobes medium sized, fairly flat, wrinkled when older
- Lower surface black to brown
- Brodo *et al.* 2001, pg 317-319, 2 species in Alberta

Solorina

- Upper surface green, lower surface sometimes similar to *Peltigera*
- **Large, red-brown apothecia sunk in thallus**
- Grows on soil and rocks, mountainous regions
- Brodo *et al.* 2001, pg 654-656, 5 species in Alberta

Peltigera

- Broad-lobed
- Apothecia usually saddle-shaped
- Lower surface felty, no lower cortex, often with black 'veins'
- Grows in humid environments, usually soil and mossy rocks or tree bases
- Brodo *et al.* 2001, pg 503-522
- 2 morphological groups:

1. Freckled Green

- Upper thallus grey-brown when dry, **bright green when wet**
- **Warty-freckles (cephalodia) present**
- Rhizines usually sparse
- 3 species in Alberta

2. Blue-green

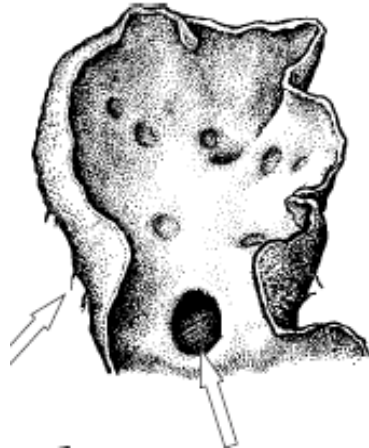
- Upper thallus dark grey to brown when dry, **darken when wet**
- **No 'freckles' (cephalodia)**
- Rhizines usually present
- 22 species in Alberta

Flavopunctilia spp.



Flavopunctilia flaventior

Solorina spp.



Solorina octospora

Solorina lobe, showing sunken apothecia

Reproduced courtesy of BC Ministry of Forests and T. Goward, from Goward *et al.* 1994, Key D: Stratified Foliose Lichen Genera of British Columbia, 27b.

Peltigera - Freckled Green spp.



Peltigera venosa



Peltigera aphthosa (damp)



Peltigera leucophlebia(damp)

Peltigera - Blue-green spp.



Peltigera neckerii



Peltigera malacea (damp and dry)

Appendix 8: Select Species for Advanced Identification

- After the initial sort is complete, and depending on the time remaining, field technicians will do a second round of identification.
- Each technician is assigned a species or pair of species to develop proficiency in identifying.
- The technician reviews the sorted unknown lichens, removing any specimens of the assigned species, and recording their identifications on an advanced ID laboratory data sheet. The newly identified species become vouchers.
- Only specimens the technician is $\geq 95\%$ confident in identifying are removed – anything with lower uncertainty remains in the unknowns to be sent to an expert lichenologist.

Species that are fairly common - 1st priority for advanced identification

- Species descriptions follow this page, in alphabetic order

Cladina rangiferina (technician must be able to differentiate usnic-acid yellow from grey)

Cladonia borealis

Cladonia cenotea

Cladonia cornuta

Flavocetraria cucullata & nivalis

Peltigera aphthosa & Peltigera leucophlebia

Peltigera malacea & Peltigera rufescens

Physcia aipolia (for 2nd year technicians)

Less common species – lower priority

- Species descriptions are not provided here: students should use the reference collection and the literature provided, under the guidance of the lab supervisor, to determine key characteristics.

Cladonia cervicornis

Cladonia uncialis

Hypogymnia tubulosa

Peltigera venosa

Cladina rangiferina - CLADRAN

Grey Reindeer Lichen

Field Characteristics

- Thallus **white to silver grey**
***Have a reference specimen of CLADRAN and a yellow-green *Cladina* such as *C. mitis* open during ID to ensure accurate colour determination**
- No outer cortex – surface dull, webby, & bumpy
- Thallus branching tree-like, with a central ‘stem’
- Often tips browned and appear brushed to one side

Habitat

- On the ground, in either wet or dry sites

For more information

- Brodo *et al.* 2001, pg 227-228

Similar species

Cladina stygia

- Similar colour but blackened at base (inside and out)

Other *Cladina* spp

- Thallus yellow-green

CLADRAN



Compare colour in *Cladina mitis* (left) and CLADRAN (right)

Cladonia borealis - CLADBOR

Boreal Pixie Cup (Group E)

Field Characteristics

- Primary squamules persistent, lobed
- Podetia **yellow-green** to grey-yellow
- **No soredia**
- Tips flare to form goblet-shaped cups
- **Cups may have small, round plates of thallus inside (areoles or squamules)**, which may also occur on outside of cup and on podetium
- Apothecia on cup margins common, **bright red**

Habitat

- Boreal forest, on soil, decaying conifer logs, or rocks, usually in the sun

For more information

- Brodo *et al.* 2001, pg 239-241

Similar species

Cladonia pleurota

- Has granular soredia inside and outside cups

CLADBOR



See Brodo *et al.* 2001 pg
241 for a better picture

Cladonia cenotea - CLADCEN

Powdered Funnel Lichen (Group C)

Field Characteristics

- Primary squamules small, often disappearing
- Podetia greenish-grey, **almost always browned at least on lower half**
- **Almost completely covered with farinose soredia**
- **Tips flare to form narrow cups open to hollow interior**
- **Cup margins curl inward and proliferate 1-3 times**
- Apothecia brown, uncommon

Habitat

- Boreal forest, on wood or soil, usually in the shade

For more information

- Brodo *et al.* 2001, pg 245

Similar species

Only cupped *Cladonia* with cup margins that curl inwards

CLADCEN



Cladonia cornuta - CLADCOR

Bighorn Cladonia (Group I)

Field Characteristics

- Primary squamules small, often disappearing
- Podetia shiny pale to olive-brown to greenish-grey (depending on sunlight)
- Podetia unbranched, tall (25-40mm)
- **Discrete patches of farinose soredia on upper half of podetia, smooth at base**
- **Tips vary from pointed to narrowly cupped**
- Apothecia brown, uncommon
- Common across Alberta

Habitat

- Grows on wood or soil in clumps, usually in the sun

For more information

- Brodo *et al.* 2001, pg 249

Similar species

Cladonia cornuta ssp. *groenlandica*

- Tips form narrow, slightly inflated cups

Cladonia ochrochlora

- Tips often form narrow, slightly inflated cups
- Podetia and soralia yellowish-green
- Soredia mealy, not powdery
- Primary squamules large, persistent, lobed

CLADCOR



***Flavocetraria cucullata* - FLAVCUC**

Curled snow lichen

Field Characteristics

- Thallus lobes pale yellow, erect
- Lobes ruffled at margins and **curled inwards, forming a sort of tube**
- Lobe margins smooth to toothed; may have black pycnidia at tips of teeth
- Base of thallus often **red-violet**

Habitat

- In tussocks on the ground, in open conifer woodlands and alpine sites

For more information

- Brodo *et al.* 2001, pg 314-315

Similar species

FLAVNIV

***Flavocetraria nivalis* - FLAVNIV**

Crinkled snow lichen

Field Characteristics

- Thallus lobes pale yellow, erect or prostrate
- Lobes dividing dichotomously, **flat, relatively thick, wrinkly**
- Lobes not curled inwards
- May have black pycnidia on/by margins
- Base of thallus often **yellow-orange**

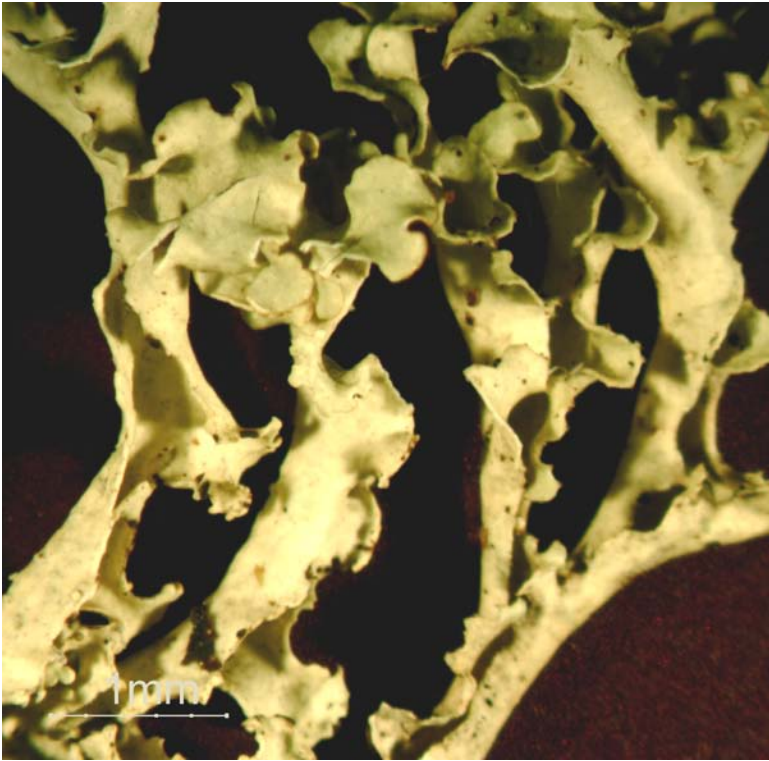
Habitat

- In tussocks on the ground, at mountainous sites

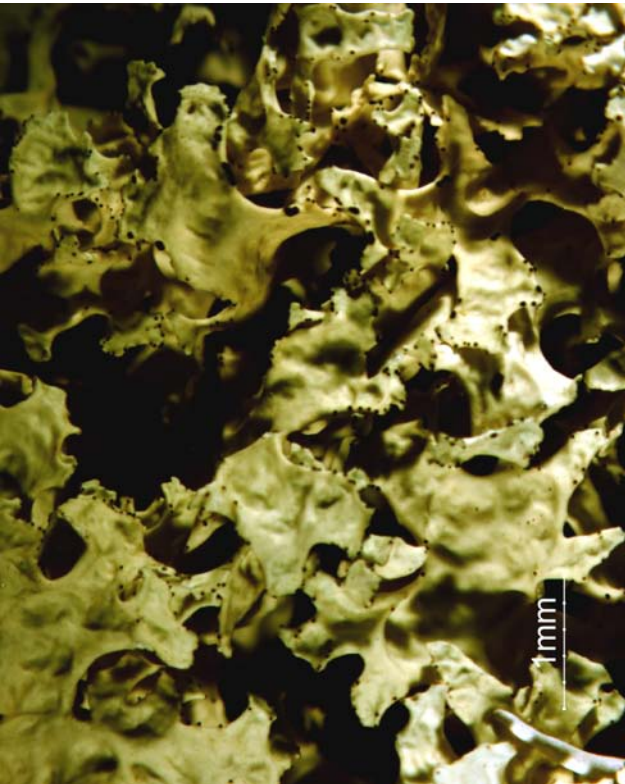
For more information

- Brodo *et al.* 2001, pg 314-315

FLAVCUC



FLAVNIV



Peltigera aphthosa - PELTAPH

Common Freckle Pelt

Field Characteristics

- **Upper surface bright green when wet**, grey-green to brown (depending on sunlight) when dry
- Photobiont green
- Lobes very broad (up to 4 cm)
- **Freckled with greyish-brown cephalodia (flat to convex)**, warty to scale-like in appearance
- **Lower surface uniformly black-brown, abruptly turning white at margins**
- Apothecia red-brown, back surface covered in a uniform to warty cortex

Habitat

- Mossy ground, rocks, logs, and tree bases

For more information

- Brodo *et al.* 2001, pg 502

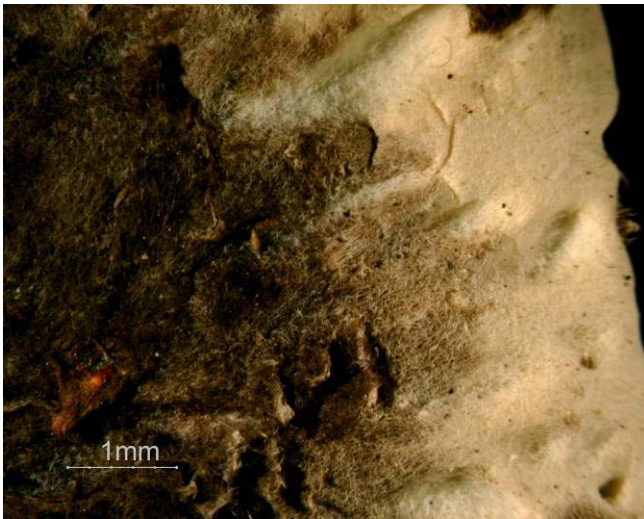
Similar species

Peltigera leucophlebia

- Lower surface veined
- Apothecia have patchy cortex on apothecia
- Lobe margins ruffled

PELTAPH

Damp (right), dry (below):
Note rounded lobes and
uniform cortex on back of
apothecia



Lower lobe surface: note lack of cortex or distinct
veins, dark hyphae, and white edge



Wet
apothecium:
note warty
cortex on back
(below)



***Peltigera leucophlebia* - PELTLEU**

Ruffled Freckle Pelt

Field Characteristics

- **Upper surface dark green when wet**, grey to brown (depending on sunlight) when dry
- Photobiont green
- Lobes broad (up to 3 cm)
- **Freckled with grey cephalodia convex,**
- **Lower surface with distinct dark veins**
- Rhizines present, varying from unbranched to tufted
- Apothecia red-brown, back surface with discontinuous patches of cortex

Habitat

- Mossy ground, rocks, logs, and tree bases

For more information

- Brodo *et al.* 2001, pg 513

Similar species

Peltigera aphthosa

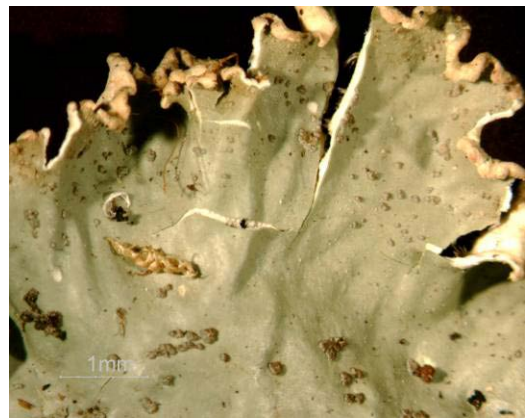
- Lower surface without veins
- Apothecia have uniform to warty cortex on back
- Lobe margins rounded

PELTLEU

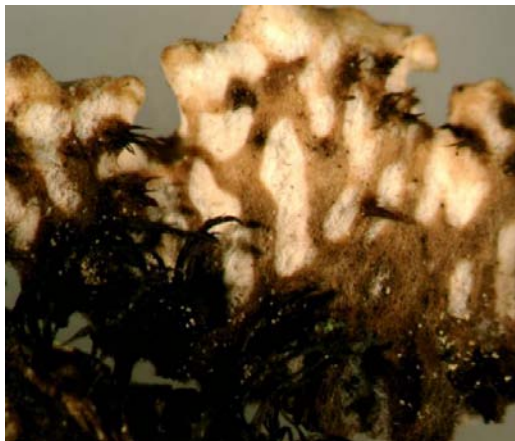
Lower lobe surface with distinct veins & tufted rhizines



Damp (left),
dry (below):
Note ruffled
lobes



Wet
apothecia
(below): note
patchy cortex
on back



***Peltigera rufescens* - PELTRUF** (See literature for pictures)

Field Dog-lichen

Field Characteristics

- Upper surface grey to brown (darkening when wet), **usually almost white with heavy tomentum**
- Photobiont cyanobacteria
- Lobe margins upturned, narrow (5-10 mm across)
- **Lower surface with distinct dark veins (pale at margin)**
- Rhizines present; short near margins, **forming a nearly continuous mat towards centre of thallus, especially along veins**
- Apothecia red-brown, saddle-shaped, common

Habitat

- Dry sandy soil in full sun

For more information

- Brodo *et al.* 2001, pg 520

Similar species*Peltigera canina*

- Wider lobes with thin tomentum
- Lobe margins curl downward
- Lower surface has white to tan veins and tufted or squarrose rhizines, not coalescing into a mat

Peltigera malacea - PELTMAL

Veinless Pelt, Apple Pelt, Boxboard Felt Lichen

Field Characteristics

- Upper surface greenish-brown (darkening when wet), **with tomentum towards lobe tips, otherwise smooth**
- **When dry, thallus feels thick, stiff and cardboard-like**
- Photobiont cyanobacteria
- Lobes broad (1-3 cm wide), ascending
- Lower surface pale at margins, grading to black towards centre
- **Lower surface with indistinct, broad veins, may not be distinguishable from surrounding hyphae**
- Rhizines sparse
- Apothecia red-brown rare

Habitat

- Dry sandy soil in full sun

For more information

- Brodo *et al.* 2001, pg 520

Similar species

No other *Peltigera* has the cardboard feel and this combination of characteristics



Physcia aipolia - PHYSAIP

Hoary Rosette Lichen

Field Characteristics

- Upper thallus pale to dark grey, **conspicuously spotted with abundant white maculae**
- Lower surface white/pale brown with many pale rhizines
- Lobes appressed, **flat to slightly concave or upturned at the tips**
- No soredia or isidia
- **Apothecia common, dark brown, typically heavily pruinose**
- Common across Alberta
- If a specimen's physical characteristics are intermediate between PHYSAIP and *P. stellaris*, send to expert for chemical tests.

Habitat

- Trunks and large branches of deciduous trees

For more information

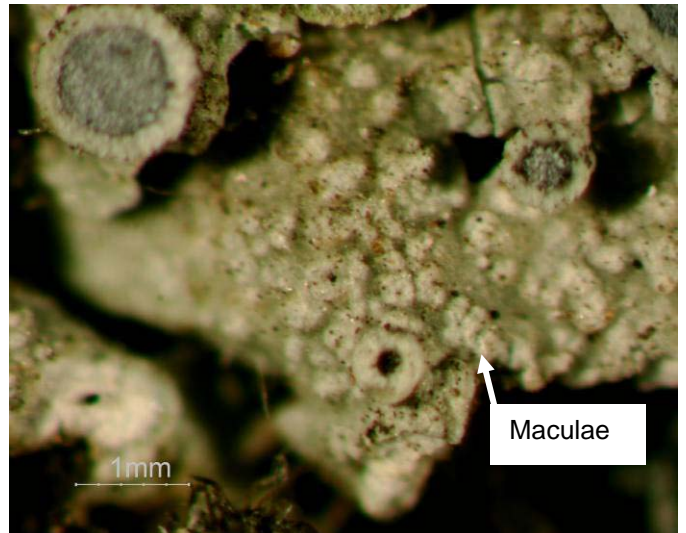
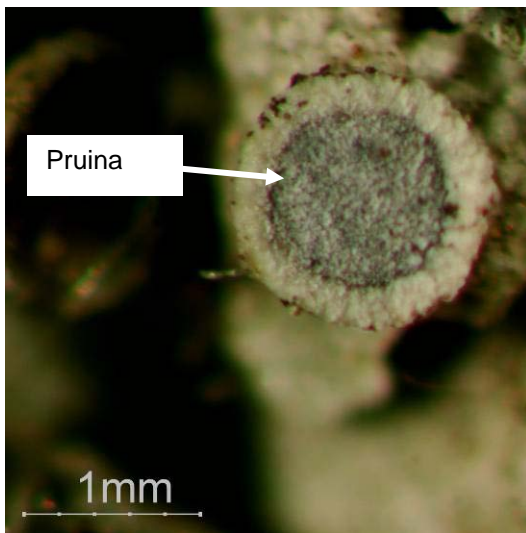
- Brodo *et al.* 2001, pg 549-550

Similar species

Physcia stellaris

- Lacks abundant maculae on surface
- Lobe tips are convex
- Tend to inhabit branches in canopy

PHYSAIP



Physcia stellaris (below, right)
Note: apothecia often pruinose, as
in PHYSAIP, despite lack of
pruinosity shown here



References

- Brodo, I. M., S. D. Sharnoff, and S. Sharnoff. 2001. *Lichens of North America*. Yale University Press. New Haven and London. 795 pp.
- Goward, T., B. McCune, and D. Meidinger. 1994. *The lichens of British Columbia, illustrated keys. Part I, Foliose and Squamulose species*. Ministry of Forests Research Program, Special Report ISSN 0843-6452, Victoria, British Columbia, Canada. 181 pp. Available at: <http://www.for.gov.bc.ca/hfd/pubs/Docs/Srs/Srs08.htm>
- Goward, T. 1999. *The lichens of British Columbia, illustrated keys. Part II, Fruticose species*. Ministry of Forests Research Branch, Special Report ISSN 0843-6452;9, Victoria, British Columbia, Canada. 319 pp. Available at: <http://www.for.gov.bc.ca/hfd/pubs/docs/Srs/Srs09.htm>
- Johnson, D., L. Kershaw, A. MacKinnon, J. Pojar, T. Goward, and D. Vitt. 1995. *Plants of the western boreal forest and aspen parkland*. Lone Pine Publishing, Edmonton, Alberta, Canada. 392 pp.
- Vitt, D. H., J. E. Marsh, and R. B. Bovey. 1988. *Mosses, lichens, and ferns of northwest North America*. Lone Pine Publishing, Edmonton, Alberta, Canada. 296 pp.

Appendix 9: Labelling of Envelopes for Unknown and Voucher Specimens

All specimens that cannot be identified in the laboratory must be isolated from the main collection bag and placed into individually labelled envelopes for further processing and/or expert identification. Labelling used for the envelopes must be standardized so ABMI technicians can easily review the envelopes and find certain specimens for advanced identification.

1) Single Unknown Species – Genus Known

LICHEN SPECIMEN 2007	Unique #
ABMI Site: __	
Date: _____	
Crew Member: _____	
Microhabitat: _____	
Plot: _____	
Peltigera (blue-green)	

2) Multiple Unknown Species – Genus Known

LICHEN SPECIMEN 2007	Unique #
ABMI Site: __	
Date: _____	
Crew Member: _____	
Microhabitat: _____	
Plot: _____	
Usnea Bryoria	

3) Group of Species – Species IDed and Unknown

LICHEN SPECIMEN 2007	Unique #
ABMI Site: __	
Date: _____	
Crew Member: _____	
Microhabitat: _____	
Plot: _____	
PARMSUL	Xanthoria
PHYSAIP	

4) Single Species - Unknown

LICHEN SPECIMEN 2007	Unique #
ABMI Site: __	
Date: _____	
Crew Member: _____	
Microhabitat: _____	
Plot: _____	
Leaf-like (Melanelia like?)	

ABMI collects one specimen (referred to as a voucher) of every species identified within a site. Technicians place these specimens into envelopes marked with a unique reference number, year, specimen type, and species. Datasheets contain a column for documenting reference numbers (from envelopes) for each specimen chosen as a voucher for that site.

5) Example of a Voucher Specimen Envelope

LICHEN SPECIMEN 2007	Unique #
ABMI Site: __	
Date: _____	
Crew Member: _____	
Microhabitat: _____	
Plot: _____	
VOUCHER	
VULPPIN	

6) Example of envelope (3) revised after paring down duplications within all sorted envelopes

LICHEN SPECIMEN 2007	Unique #
ABMP Site: __	
Date: _____	
Crew Member: _____	
Microhabitat: _____	
Plot: _____	
PARMSUL	Xanthoria
PHYSAIP	(same as # 154, 166, 388)