

# 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 Centre (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 Centre**

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 Centre, 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 Centre (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 Centre

- 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 Centre (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 Centre. 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 Centre 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 Centre

- All specimens and materials received from the Sample Processing Centre 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 Centre.
- 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).
- Specimens that the expert is unable to identify to species, due to the specimen being immature, damaged, too small, or lacking key features for proper identification, are recorded in the database at the lowest taxonomic level the expert is sure of
  - Specimens identified to Genus are entered into the Genus & Species column of the database as *Genus* sp.
  - Specimens identified to Family are entered into the Family column of the database and “UID” (unable to identify) entered into the Genus & Species column.
  - The reason the specimen was not identified to species is recorded in the “Expert Comments” column (e.g. sample not mature, missing key features etc.).
- Excluding the exceptions above, the expert will make every reasonable effort to identify all specimens to species.
  - The expert should be able to identify most specimens based on his/her existing knowledge and literature he/she has available.
  - If required, the specimen is identified based on a literature search for recent revisions, and comparison of the specimen to reference or herbarium specimens.
  - For specimens that cannot be identified by the expert, one other expert who is a specialist in that particular group, is contacted and the specimen identified based on this consultation. If specimens cannot be identified based on this consultation, no further action is taken.
  - Specimens that are not identified to species are recorded in the database at the lowest taxonomic level the experts are sure of, and the reason the specimen was not identified to species is recorded in the “Expert Comments” column (e.g. could not identify with assistance from specialist).
  - If during the process of identifying a specimen additional reference literature is needed, the expert will note this additional literature in the database by recording the literature in the “Reference Used” column.
  - If during the process of identifying a specimen another expert is consulted, the expert will note this in the database by recording the second expert's initials in the “Verified By” column.
- 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 from each site, and label the new specimen as indicated above with the word “Voucher” on the label. Organize all voucher specimens in separate boxes for return to the Sample Processing Centre.
- Enter all required information in the Lichen Sorting Database (Appendix 2).
- The expert will ship the specimens back to the Sample Processing Centre, via the method above, and e-mail a digital copy of the Lichen Sorting Database to the ABMI lab coordinator.
- The ABMI lab coordinator will add the 7-letter species codes to the electronic database.
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## 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.

## Species References/Authorities

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- 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>
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- Halonen, P., P. Clerc, T. Goward, I. M. Brodo and K. Wulff. 1998. Synopsis of the genus *Usnea* (lichenized Ascomycetes) in British Columbia, Canada. *The Bryologist* 101: 36-60.
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- McCune, B., and L. Geiser. 1997. Macrolichens of the Pacific Northwest. Oregon State University Press, Corvallis, Oregon, USA.
- Nash III, T. H., B. D. Ryan, P. Diederich, C. Gries, and F. Bungartz (eds.). 2004. Lichen Flora of the Greater Sonoran Desert Region, Vol. 2. Lichens Unlimited, Arizona State University, Tempe, Arizona. ( mainly for the genera *Peltigera*, *Phaeophyscia*, *Flavopunctelia*, *Lobaria*, *Physciella*, *Punctelia*, *Ramalina*, *Solorina*, *Tuckermanella*, *Tuckermannopsis*, *Xanthomendoza*, *Xanthoria*)
- Thomson, J. W. 1984. American Arctic Lichens 1. The Macrolichens. Columbia University Press, New York, New York, USA.

## 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	Habitat / Stratum	Collection Status
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 Centre	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 3: Data Sheet for Sorting/Identifying Lichens

**Site:**\_\_\_\_\_ **Page**\_\_\_\_\_ **of** \_\_\_\_\_

AD Spec Box #\_\_\_\_\_

**Date sampled:**\_\_\_\_\_ **Collector's Initials:**\_\_\_\_\_

**Voucher Box # \_\_\_\_\_**

**Date of ID:**\_\_\_\_\_ **Identifier's initials:**\_\_\_\_\_

Residuals Box #\_\_\_\_\_

[illegible]

## 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 Protocol<sup>1</sup> (circle) Y N Field Crew Initials \_\_\_\_\_

Total Plant Specimens Collected<sup>2</sup> \_\_\_\_\_ Plant Press ID<sup>3</sup> \_\_\_\_\_ Collected by: \_\_\_\_\_

Moss <sup>4</sup> : Collected by: _____	Lichen <sup>4</sup> : Collected by: _____	Tree Cores <sup>5</sup> : Collected by: _____
Log/stump	Log/stump	1°
Tree/other	Tree/other	2°
Wetland	Wetland	
Upland	Upland	1 ha

Comments: \_\_\_\_\_

Site # \_\_\_\_\_ Field Collection Date \_\_\_\_\_ Prairie Protocol<sup>1</sup> (circle) Y N Field Crew Initials \_\_\_\_\_

Total Plant Specimens Collected<sup>2</sup> \_\_\_\_\_ Plant Press ID<sup>3</sup> \_\_\_\_\_ Collected by: \_\_\_\_\_

Moss <sup>4</sup> : Collected by: _____	Lichen <sup>4</sup> : Collected by: _____	Tree Cores <sup>5</sup> : Collected by: _____
Log/stump	Log/stump	1°
Tree/other	Tree/other	2°
Wetland	Wetland	
Upland	Upland	1 ha

Comments: \_\_\_\_\_

Site # \_\_\_\_\_ Field Collection Date \_\_\_\_\_ Prairie Protocol<sup>1</sup> (circle) Y N Field Crew Initials \_\_\_\_\_

Total Plant Specimens Collected<sup>2</sup> \_\_\_\_\_ Plant Press ID<sup>3</sup> \_\_\_\_\_ Collected by: \_\_\_\_\_

Moss <sup>4</sup> : Collected by: _____	Lichen <sup>4</sup> : Collected by: _____	Tree Cores <sup>5</sup> : Collected by: _____
Log/stump	Log/stump	1°
Tree/other	Tree/other	2°
Wetland	Wetland	
Upland	Upland	1 ha

Comments: \_\_\_\_\_

Site # \_\_\_\_\_ Field Collection Date \_\_\_\_\_ Prairie Protocol<sup>1</sup> (circle) Y N Field Crew Initials \_\_\_\_\_

Total Plant Specimens Collected<sup>2</sup> \_\_\_\_\_ Plant Press ID<sup>3</sup> \_\_\_\_\_ Collected by: \_\_\_\_\_

Moss <sup>4</sup> : Collected by: _____	Lichen <sup>4</sup> : Collected by: _____	Tree Cores <sup>5</sup> : Collected by: _____
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.

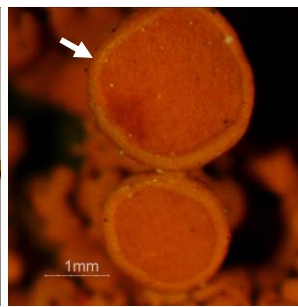
2 – Record the total number of unknown vascular plant specimens collected from this site. If no unknown plant specimens were collected, indicate "None". List unique specimen ID numbers for all unknown plants collected on the appropriate Plant Press Log.

3 – Record the Plant Press ID number where the specimens are located.

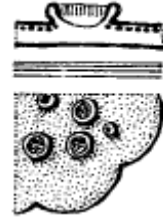
4 – For each quadrant, record "C" if a sample was collected, "None" if no specimens were found, or "VNA" if the stratum was not present.

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: Illustrated Lichen Glossary

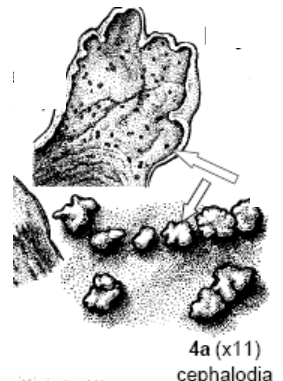
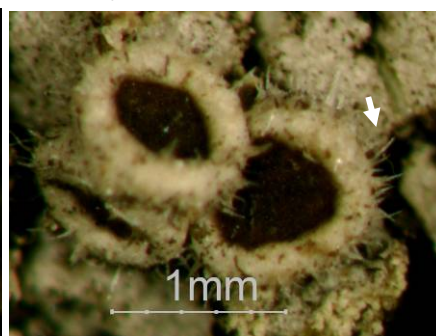
*Cladonia cristatella**Peltigera leucophlebia**Xanthoria polycarpa*

Apothecium cross-section & surface view



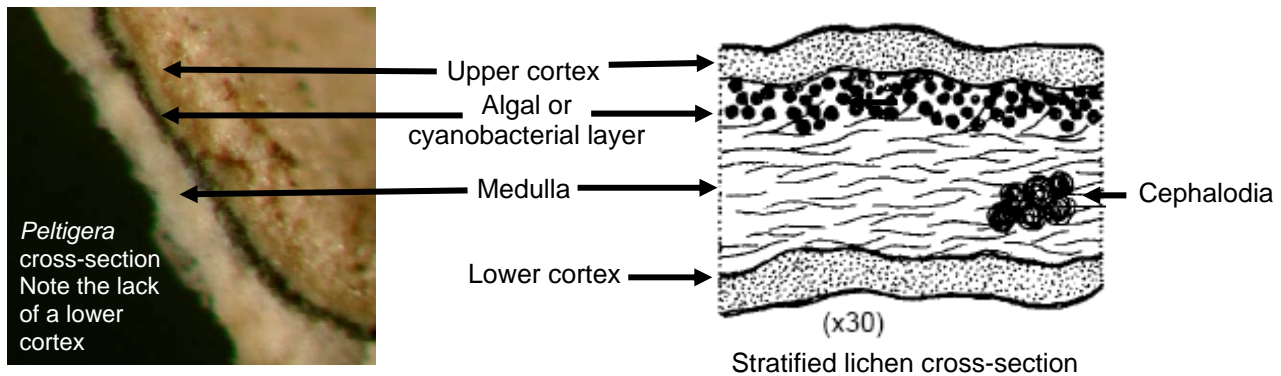
**Apothecium (plural: apothecia):** disc or cup-shaped structures formed by the fungal symbiont, where sexual spores are created. The spore-containing surface is usually a different colour than the thallus of the lichen. Line drawing reproduced courtesy of BC Ministry of Forests and T. Goward, from Goward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

*Peltigera leucophlebia**Tuckermannopsis americana**Physcia adscendens**Phaeophyscia hirsuta*

**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 identified 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 (flour-like), as compared to coarse, granular (salt-like). Describes soredia.



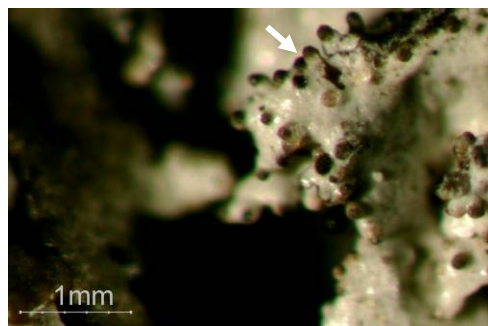
*Cladonia coniocraea*



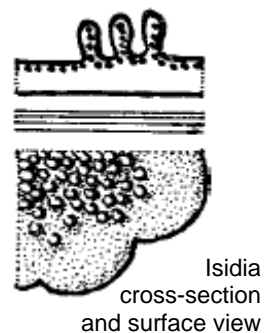
*Cladonia chlorophaea*

**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. Isidia typically are shiny and do not detach from the thallus when rubbed, while soredia detach and leave powdery residue on your finger. Line drawing reproduced courtesy of BC Ministry of Forests and T. Goward, from Goward *et al.* 1994, fig. 9g.



*Isidhaugia aleurites*



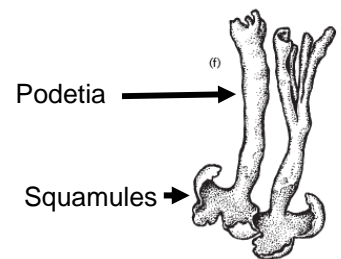


**Maculae (adjective: maculate):** white spots (like a sponge-painted wall) as seen in *Physcia* species, caused by discontinuities in the algal layer of the lichen, through which you can see the medulla.

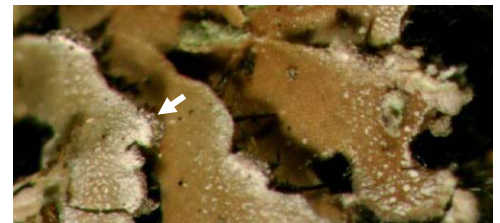
*Physcia aipolia*

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

**Podetium (plural: 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.

*Cladonia cariosa*

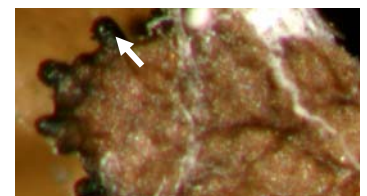
**Pruina (adjective: pruinose):** powdery or scaly spots on the upper thallus surface, typically made of deposits of dead cells and calcium oxide. Compare with the entry for *maculae*.

*Physconia detersa*

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

*Alectoria sarmentosa*

**Pycnidium (plural: pycnidia):** small barrel or flask-shaped growths that contain asexual spores. Can resemble isidia. May be on the surface or embedded in the thallus.

*Tuckermannopsis americana*

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

*Parmelia sulcata*



*Phaeophyscia hispidula*



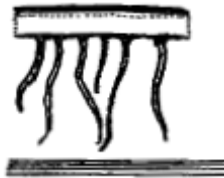
*Parmelia saxatilis*



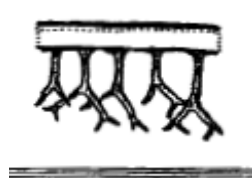
*Parmelia sulcata*



*Peltigera leucophlebia*



Simple



Forked/Dichotomous

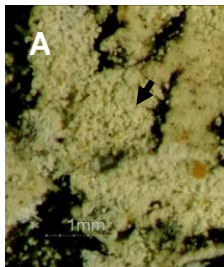


Squarrose

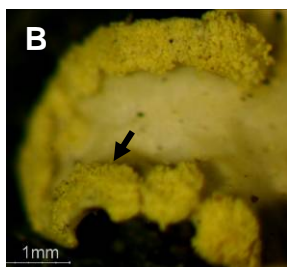


Tufted

**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.



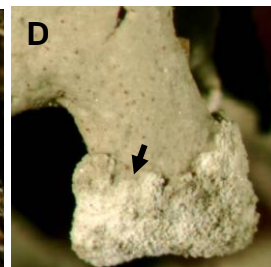
*Parmeliopsis ambigua*



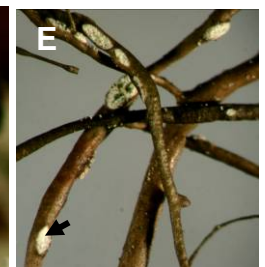
*Vulpicida pinastri*



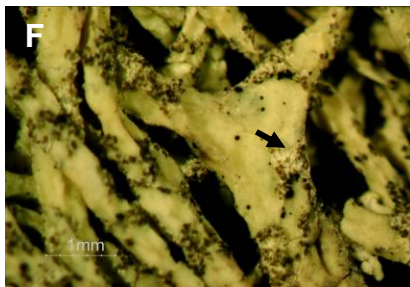
*Tuckermannopsis chlorophylla*



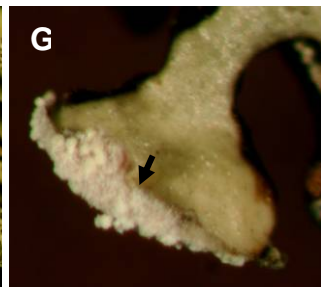
*Hypogymnia tubulosa*



*Bryoria fuscescens*



*Letharia vulpina*



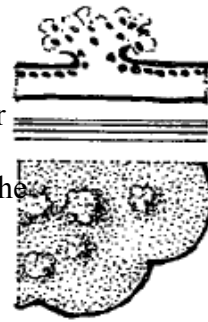
*Hypogymnia vittata*

Forms of soralia:

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

**Soralium (plural: soredia):** patche of soredia. Where soralia occur 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*. Soredia detach and leave powdery residue on your finger when rubbed, while isidia do not detach from the thallus. 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*.

**Squarrose:** 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. Can resemble fleece fabric!



*Nephroma resupinatum*

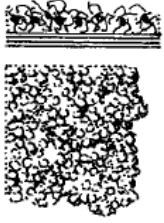
**Veins:** lines of darkened thickened areas, with intervening areas being lighter in colour as seen on the lower surface of species of *Peltigera*. Not vascular tissue.



*Peltigera leucophlebia*



## Appendix 6: Lichen Growth Forms - ABMI Simplified Flow Chart to Sorting and Species Identification

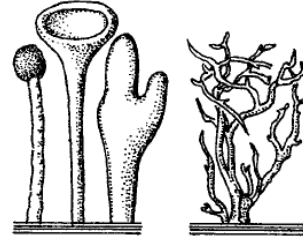


**Dust or crust-like:** no lower cortex, closely attached to substrate (paint-like, grainy, or powdery), Upper surface hard

**DO NOT ID**



**Hair-like:** mainly round, flexible, pendant branches. If flattened, both sides alike. Usually 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. 27**
2. *Letharia vulpina* **P. 29**
3. *Ramalina dilacerata* **P. 31**

Not any of the above?

**ID to Genus P. 33**

*Alectoria*      *Letharia*  
*Bryoria*        *Ramalina*  
*Ephebe et al.* *Usnea*  
*Evernia*



### ID to Species

1. *Cladina stellaris* **P. 35**
2. *Cladonia botrytes* **P. 37**

Not any of the above?

**ID to Genus/Group P. 45**

*Cladonia* **Key P. 48**  
*Cetraria* & *Bryocaulon*  
*Stereocaulon* & *Sphaerophorus*  
*Calicium* & *Chaenotheca*  
*Dactylina* & *Thamnia*  
*Squamulose* spp.



### ID to Species

1. *Hypogymnia physodes* **P. 51**
2. *Imshaugia aleurites* **P. 53**
3. *Parmelia sulcata* **P. 55**
4. *Parmeliopsis ambigua* **P. 57**
5. *Parmeliopsis hyperopta* **P. 59**
6. *Peltigera neckeri* **P. 61**
7. *Physcia adscendens* **P. 63**
8. *Tuckermannopsis americana* **P. 65**
9. *Vulpicida pinastri* **P. 67**

Not any of the above?  
**ID to Genus, beginning with the colour groupings**

*Lobaria* **P. 83**  
*Melanelia*  
*Nephroma*  
*Tuckermannopsis*

*Hypogymnia* **P. 79**  
*Phaeophyscia*  
*Physconia*  
*Physcia*  
*Xanthoparmelia* *Rhizoplaca*  
*Dermatocarpon* *Grey foliose*

*Collema* **P. 81**  
*Leptogium*  
*Umbilicaria*

*Flavocetraria* **P. 81**  
*Xanthoria*  
*Candelaria*

**Green foliose P. 85**  
*Peltigera*  
 • *Freckled Green*  
 • *Blue-green*  
*Solorina*

Line drawings reproduced courtesy of BC Ministry of Forests and T. Goward, from Goward *et al.* 1994, fig. 7a,b,d-g.

## Appendix 6: Initial Lichen Species and Genera for Identification in the Laboratory

- There are four sections to this appendix, corresponding to the growth forms in Appendix 3.
- 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	Unique #
ABMI Site: _____	
Date: _____	
Crew Member: _____	
Stratum: _____	
Quadrant: _____	
Leaf-like (Melanelia like?)	



*Appendix 6a: Dust & crust-like species*

- No lower cortex
- Closely attached to substrate (paint-like, grainy, or powdery) or growing into substrate – cannot be detached intact
- Upper surface hard

**DO NOT IDENTIFY**



*Appendix 6b: 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.

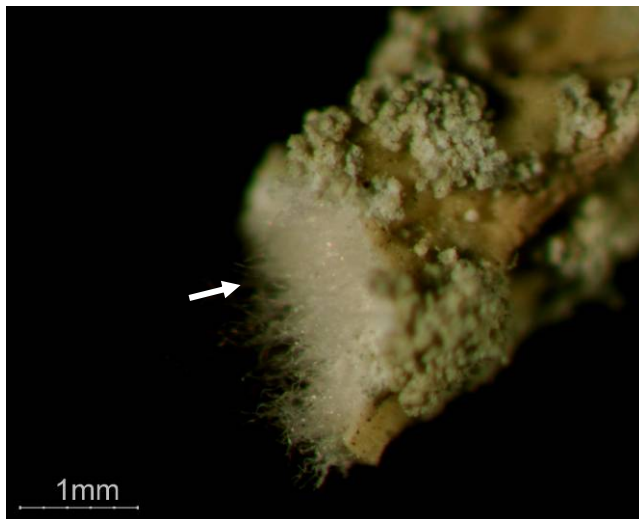
- Branches round in cross-section
- Branches have a central cord

*Young Ramalina* spp.

- Branches flattened
- Branches webby or solid inside, not cottony



# EVERMES



Cottony medulla



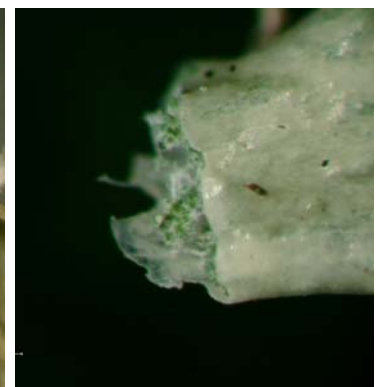
Angular branches with coarse soredia



*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

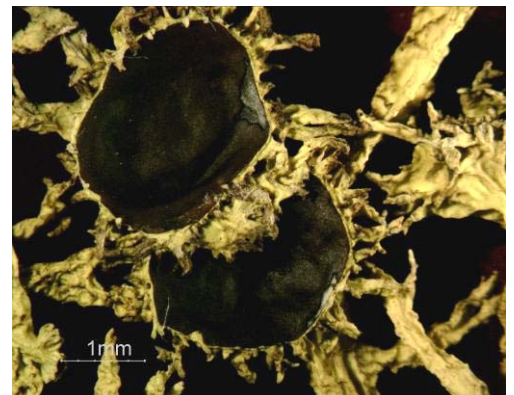
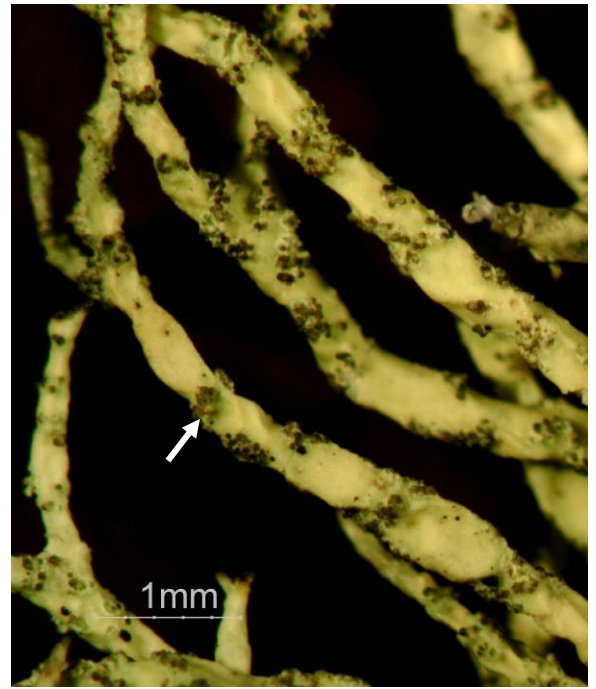
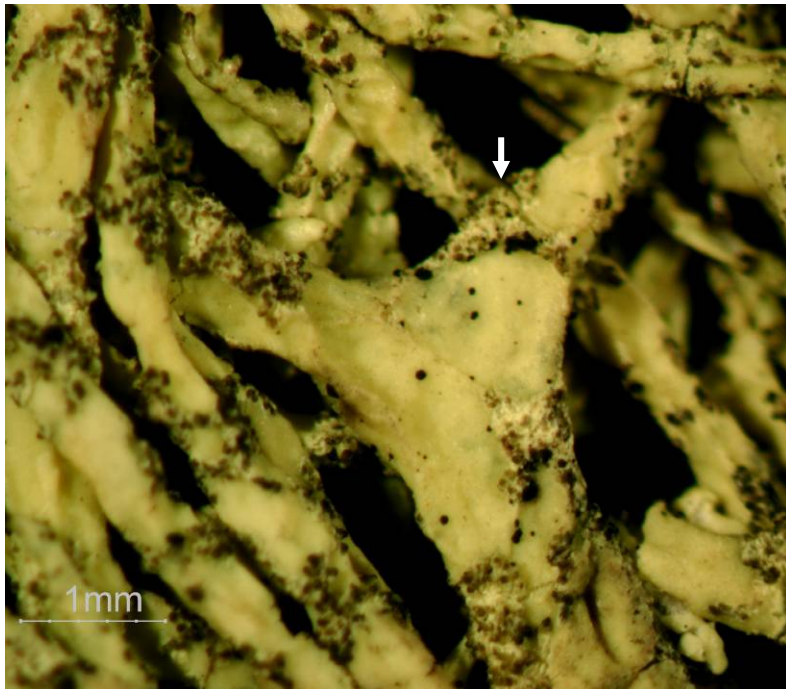
*Letharia columbiana*

- 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**

Other *Ramalina* spp.

- Often sorediate
- Branches often solid, rarely punctured
  - *R. roesleri* - has perforations on branches but also highly branched, with tips curled and ending in granular soredia; lacks apothecia
  - *R. sinensis* – thallus solid, lower surface has pseudocyphellae, branches often fan-shaped and ridged

*Evernia* spp.

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

*Usnea* spp.

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

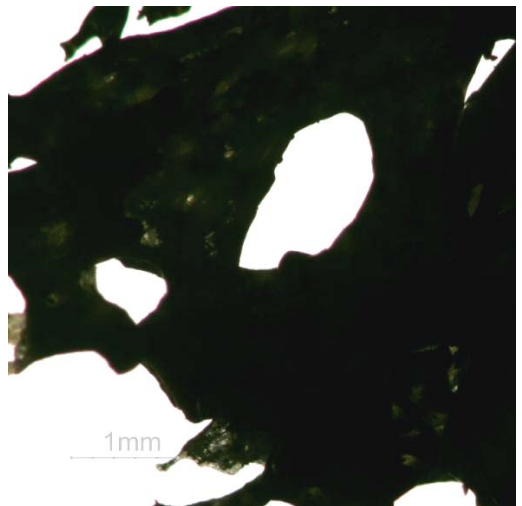


# RAMADIL

Webby interior



Perforated cortex under incident light



....and transmitted light



RAMADIL growing on a twig

## Summary of Hair-like Genera (ordered from common to rare)

### *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* (see also *Nodobryoria*)

- **Thallus brownish-black**, branches round in cross-section
- Found on trees, almost exclusively conifers
- Brodo *et al.* 2001, pg 179-186 & 460-461, 18 species in Alberta

### *Ramalina*

- Thallus pale grey-green or yellow-green, branches shape variable
- Medulla varies from solid to loose and webby to hollow at base
- Found on trees
- Brodo *et al.* 2001, pg 620-632, 10 species in Alberta

### *Evernia*

- Medulla cottony, cortex soft, highly branched, pale green to straw-coloured
- Grows on branches or on the ground
- Brodo *et al.* 2001, pg 311-313, 4 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

### *Letharia* (see page 29)

- Thallus yellow, highly branched, branches stiff and ridged
- Grows mainly on wood
- Brodo *et al.* 2001, pg 411-413, 2 species in Alberta

### *Black hair-like genera (no picture in manual)*

- E.g., *Ephebe*, *Kaernefeltia*, *Pseudoephebe*, and *Polychidium*
- Thallus black and tufted, resembling algae (occasionally shrub-like)
- Grows on rocks along water bodies, open/arctic areas or nestled in moss
- Brodo *et al.* 2001, pg 309, 365-366, 579-580, 587-588, 5 species in Alberta



***Usnea* spp.**



*Usnea lapponica*



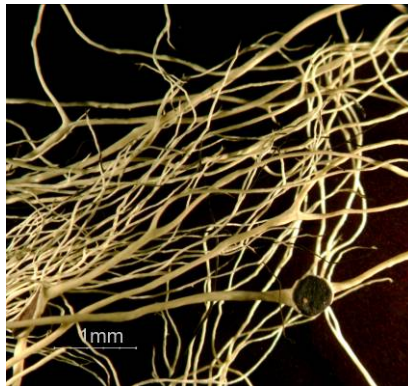
*Usnea scabrata*

***Bryoria* sp.**



*Bryoria fuscescens*

***Alectoria* sp.**



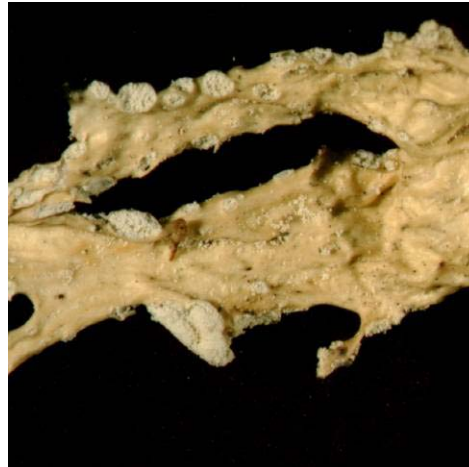
*Alectoria sarmentosa*



***Ramalina* spp.**



*Ramalina sinensis*



*Ramalina pollinaria*

***Evernia* sp.**



*Evernia prunastri*

*Appendix 6c: Club and Shrub-like species****Cladonia 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**

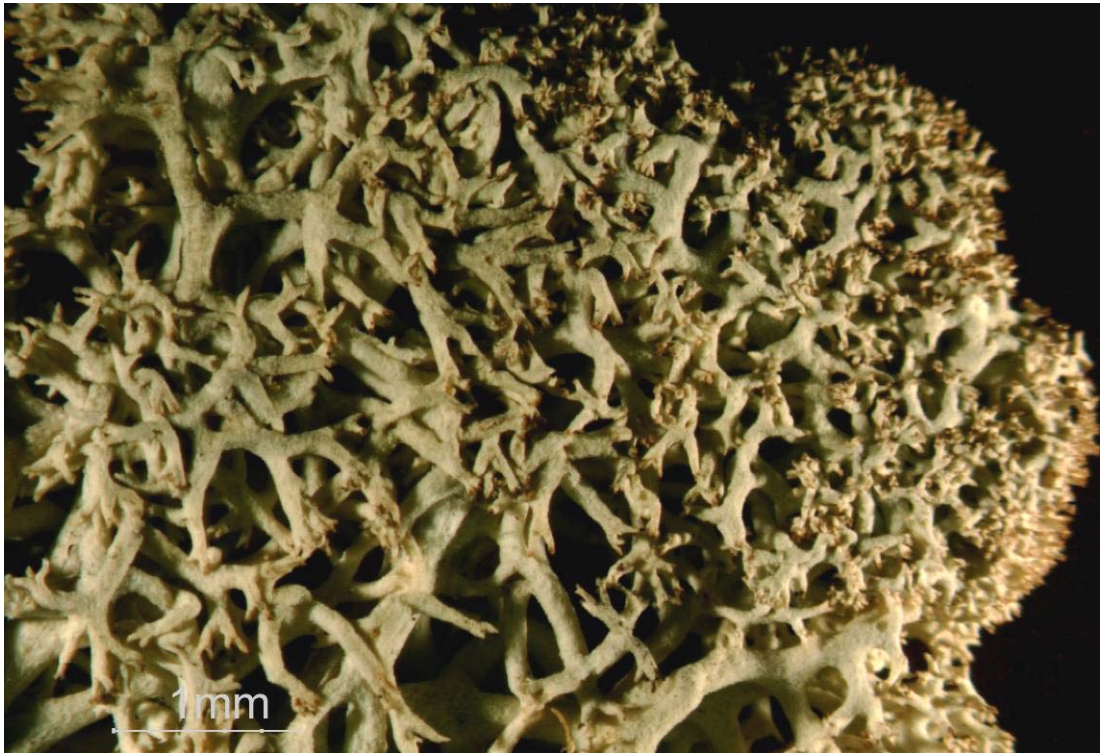
- Brodo *et al.* 2001, pg 228 (note change in genus; previously called *Cladina stellaris*)

**Similar species**

None



# CLADSTE



*Cladonia arbuscula* –  
(prev *Cladina*) 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



## ADVANCED

### *Cladonia rangiferina* - CLADRAN

Grey reindeer lichen

#### Field Characteristics

- Thallus **white to silver grey**  
**\*Have a reference specimen of CLADRAN and a yellow-green *Cladonia* 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 (note change in genus; previously called *Cladonia rangiferina*)

#### Similar species

##### *Cladonia stygia*

- Similar colour but blackened at base (inside and out)
- Previously called *Cladonia stygia*

#### Other branched *Cladonia* spp (previously called *Cladonia*)

- Thallus yellow-green

# CLADRAN



Compare colour in *C. mitis* (left) and CLADRAN (right)



## ADVANCED

### *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



## ADVANCED

### *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





## Summary of the Club and Shrub-like Genera (ordered from common to rare)

### *Cladonia*

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

### Branched *Cladonia* (previously called *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

### *Cetraria* & *Bryocaulon*

- Thallus yellow to reddish brown, often **shaped like a tumbleweed**
- Branches often **edged with cilia or spiny projections**
- Usually found on soil and amongst low-growing (e.g., alpine) shrubs
- Brodo *et al.* 2001, pg 178-179, 213-218, 10 species in Alberta

### *Stereocaulon* & *Sphaerophorus*

- Pale grey to white erect, branched stalks, **branches bumpy, granular, coral-like**
- Most species found in southwestern Alberta, some boreal species
- Found on soil and rock
- Brodo *et al.* 2001, pg 657-658, 663-670, 12 species in Alberta

### *Calicium* & *Chaenotheca*

- Thallus crustose, **apothecia on small stalks like pins**
- Usually grows on shaded wood and bark
- Brodo *et al.* 2001, pg 192-194, 220-222, 13 species in Alberta

### *Dactylina* & *Thamnolia* (no picture in manual)

- **Thallus worm or finger-like**, white to pale violet
- On exposed soil (gravelly to alpine sites)
- Brodo *et al.* 2001, pg 293-295, 677-678, 6 species in Alberta

### *Squamulose lichens* (no picture in manual)

- E.g., *Endocarpon*, *Phaeorrhiza*, *Placidium*, *Psora*, *Psoroma*, *Psorula*, *Squamarina*
- **No podetia, thallus entirely squamulose**
- Brodo *et al.* 2001, see examples on pg 293-295, 677-678, 22 species in Alberta

***Cladonia* spp. (see key on following page)**



*Cladonia*(prev.  
*Cladina*) *arbuscula*



*Cladonia uncialis* – note presence of cortex



*Cladonia* (prev. *Cladina*) *arbuscula*  
– note lack of cortex, visibility of hyphae

***Cetraria* spp.**



***Chaenotheca* sp.**



***Stereocaulon* sp.**

***Sphaerophorus* sp.**



*Sphaerophorus globosus*



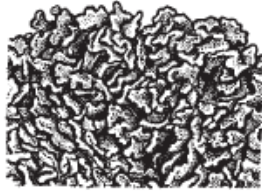
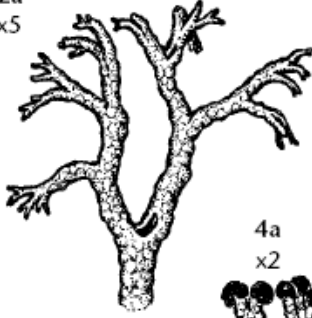



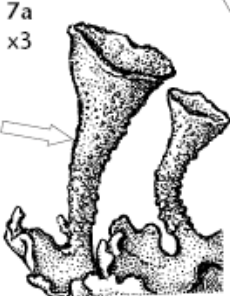

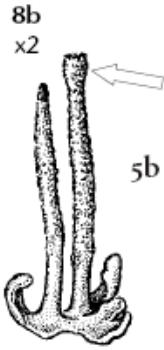
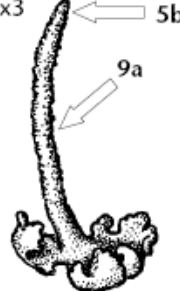



# Key to the Genus *Cladonia*

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 
- 1a** Podetia absent; thallus consisting entirely of basal squamules . . . **GROUP A**
- 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** x3 
- 9b** x4 

## Examples of *Cladonia* species in each group

- some species fit in more than one group

### A - no podetia, squamules only

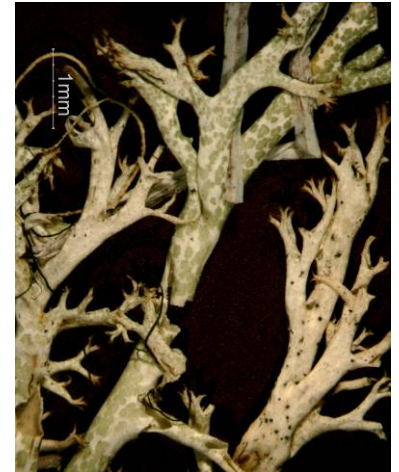


*Cladonia pyxidata*

### 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*



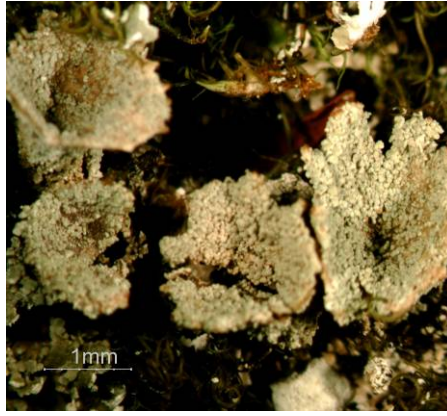
*Cladonia sulphurina*



**F – sorediate podetia ending in broad cups**



*Cladonia fimbriata*



*Cladonia chlorophaea*

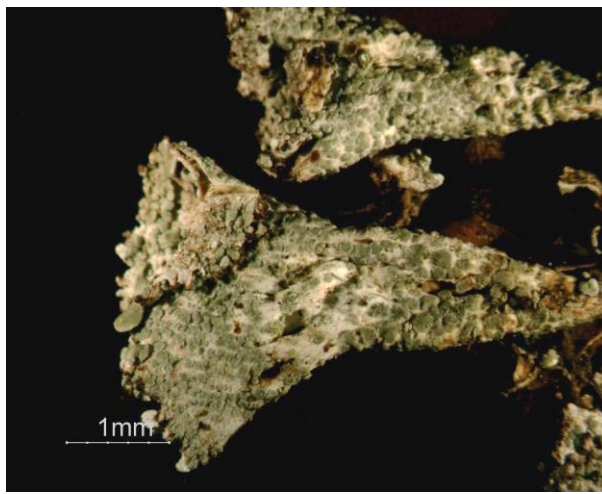


*Cladonia coniocraea*

**H – non-sorediate podetia ending in cups**



*Cladonia cervicornis*



*Cladonia pyxidata*



*Cladonia gracilis*

**I – non-cupped sorediate podetia**



*Cladonia cornuta*



*Cladonia botrytes*

**J – non-cupped, non-sorediate podetia**



*Cladonia bellidiflora*

*Appendix 6d: Leaf-like species****Hypogymnia physodes* - HYPOPHY**

Monk's-hood kichen, 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
- Medullary ceiling white
- 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 PARMSUL  
**\*Watch for mixed samples**

**For more information**

- Brodo *et al.* 2001, pg 354

**Similar species***Hypogymnia vittata*

- More slender and irregularly branched
- Medullary ceiling black
- More coarsely sorediate

*Hypogymnia tubulosa*

- Smaller, tips intact
- Soralia laminal on lobes

*Hypogymnia austerodes*

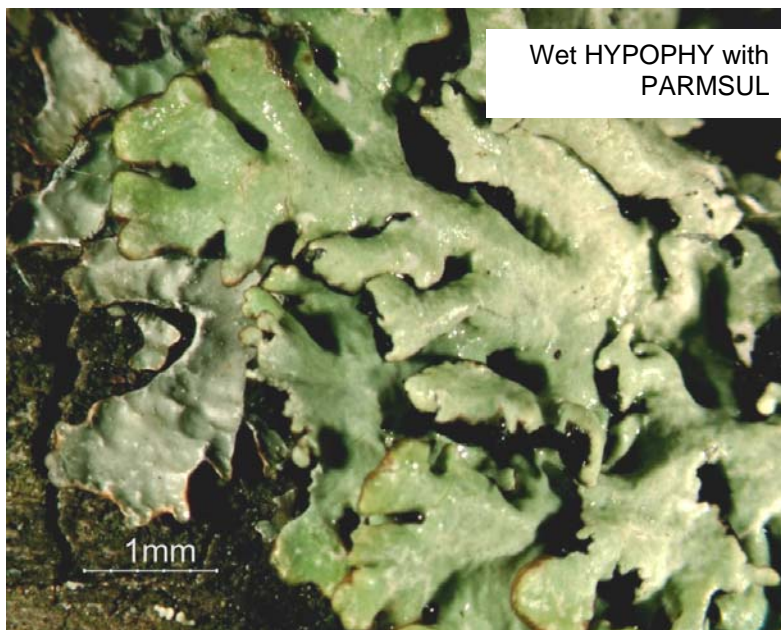
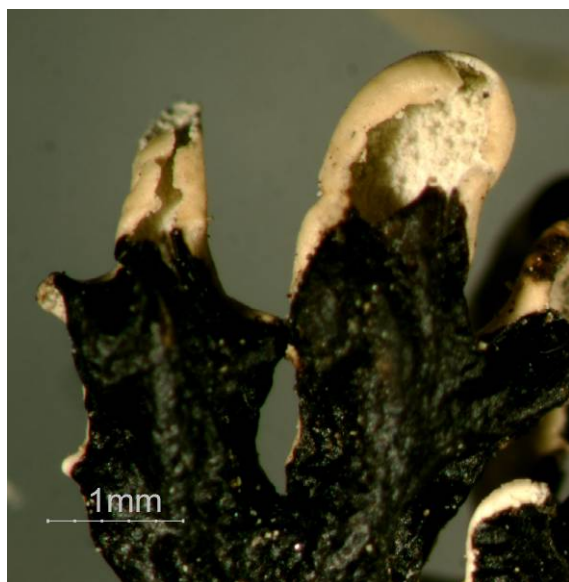
- Appressed rosette
- Soredia laminal, in centre of rosette
- Thallus looks burnt



# HYPOPHY



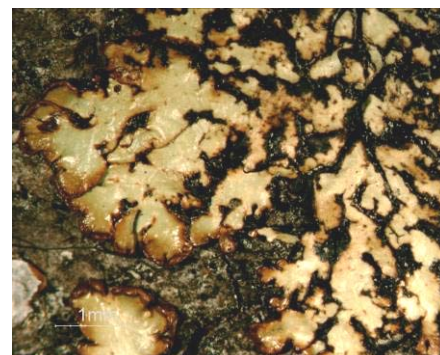
Lower cortex with  
burst lobe tips



*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 (tend to be firm, tan, shiny)** 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

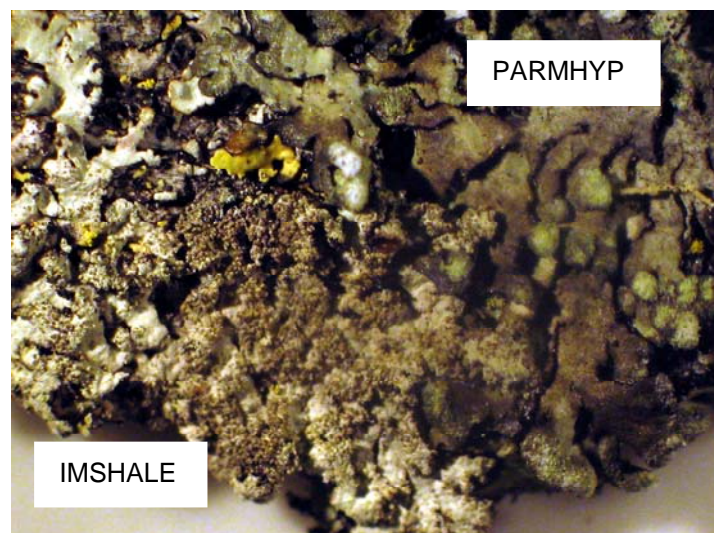
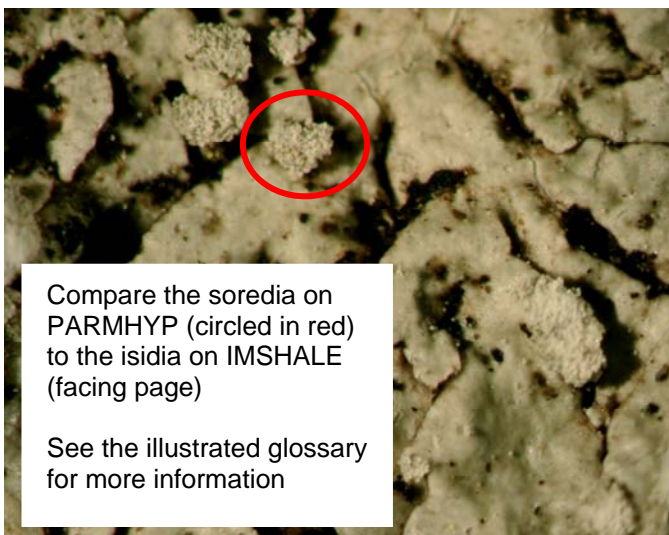
### Similar species

*Physcia* spp.

- Lack cylindrical isidia

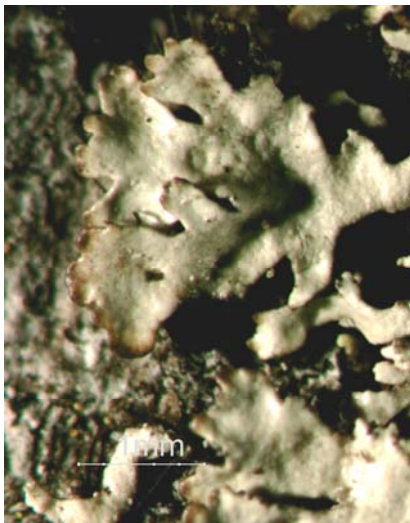
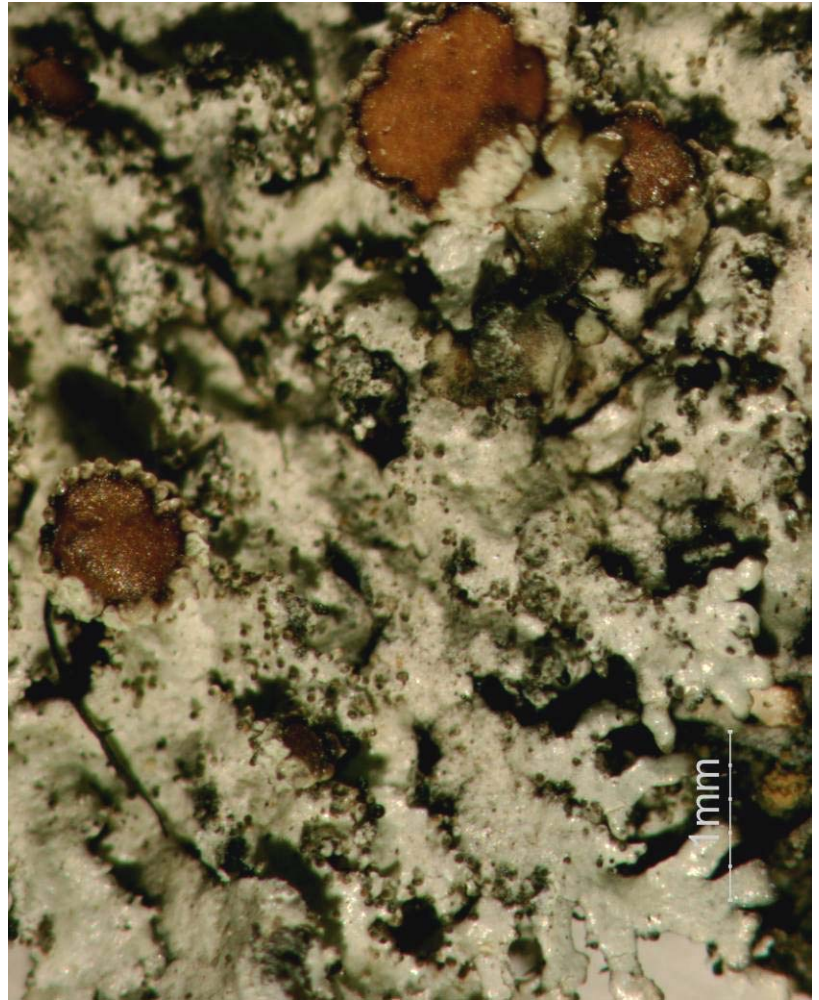
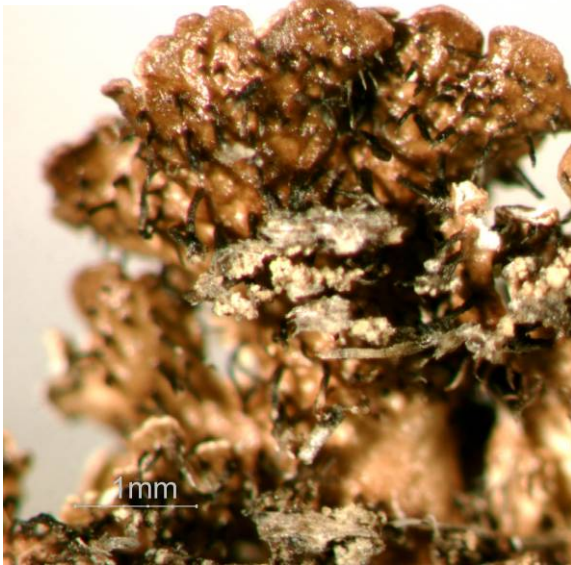
*Parmeliopsis hyperopta*

- Has soredia, not isidia
- Lower surface dark brown

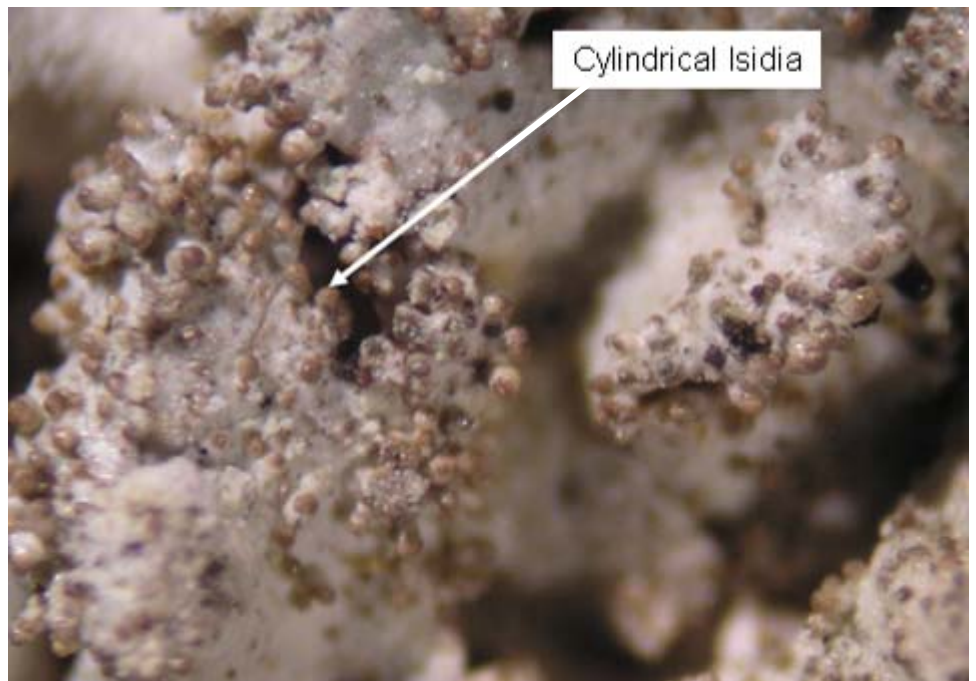


# IMSHALE

Lower rhizines



Non-isidiate 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 highly 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 mixed samples**

**For more information**

- Brodo *et al.* 2001, pg 484

**Similar species***Parmelia hygrophila*

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

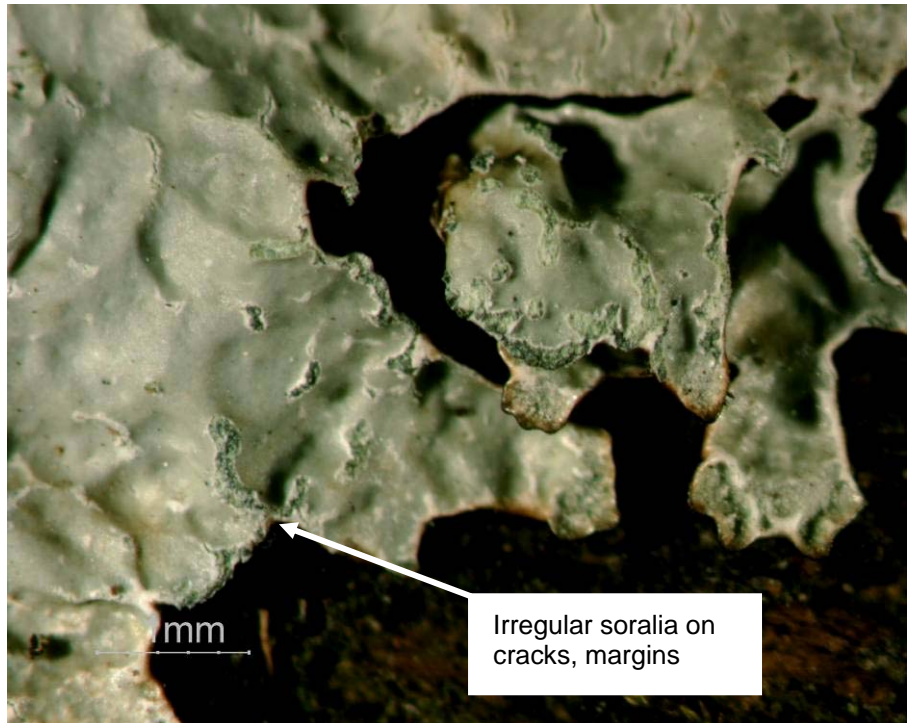
*Parmelia fraudans*

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

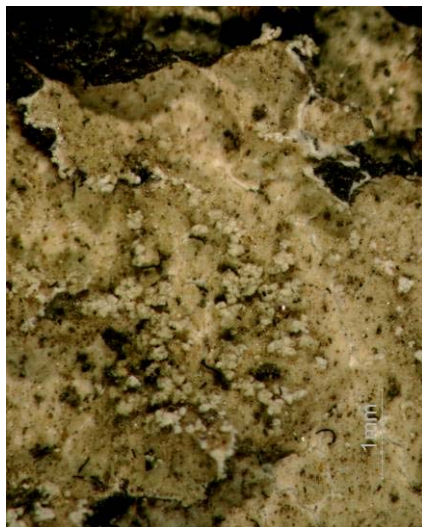
# PARMSUL



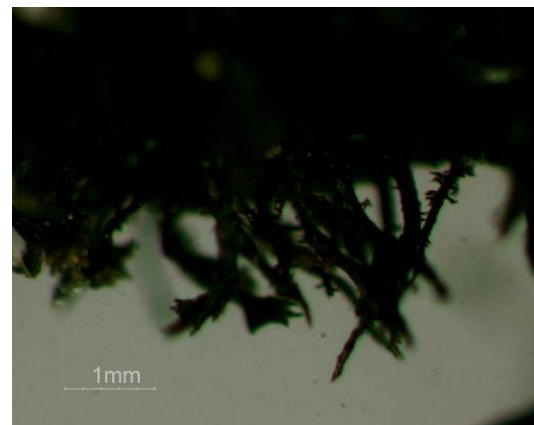
Mix of wet PARMsul & HYPOPHY



Irregular soralia on cracks, margins



*Parmelia hygrophila*



Rhizines

***Parmeliopsis ambigua* - PARMAMB**

Green starburst lichen

**Field Characteristics**

- **Upper surface yellowish-green**
- **Powdery to granular yellowish soledia in irregular patches on lobe surface (laminal);**  
lobe tips often not solediate
- 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*

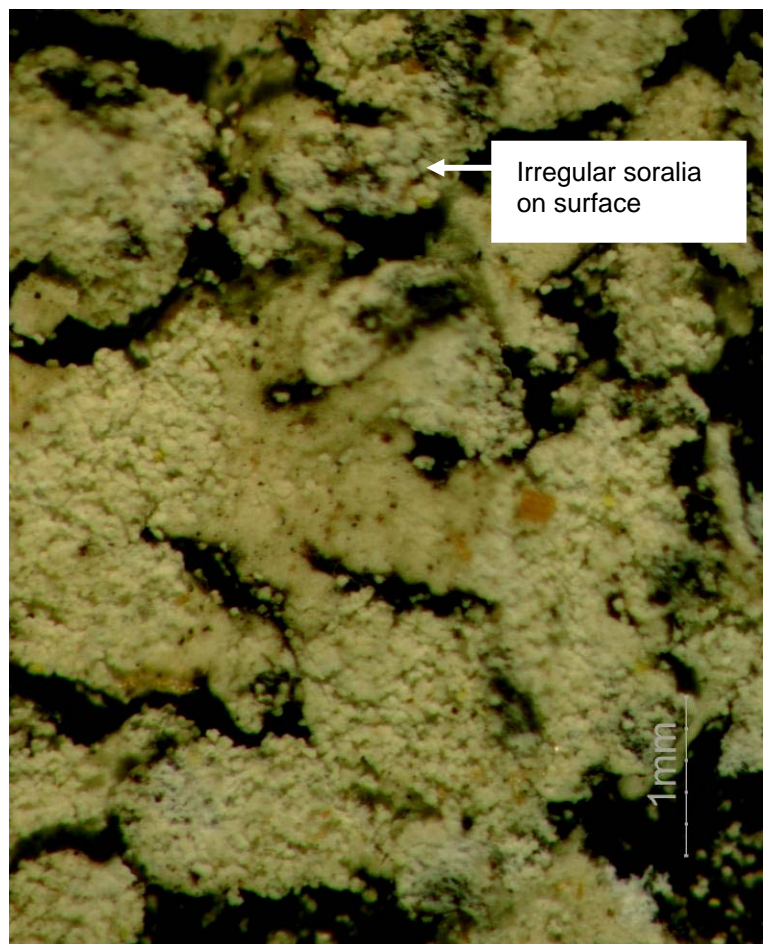
- Virtually identical, except it's pale-grey
- Can grow side-by-side with PARMAMB



## PARMAMB



Mix of PARMAMB and PARMHYP



## ***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**

*Phycia spp*

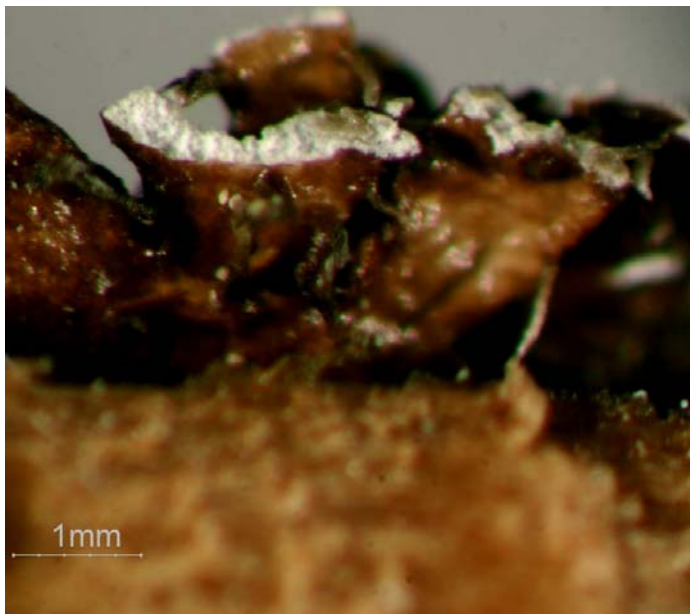
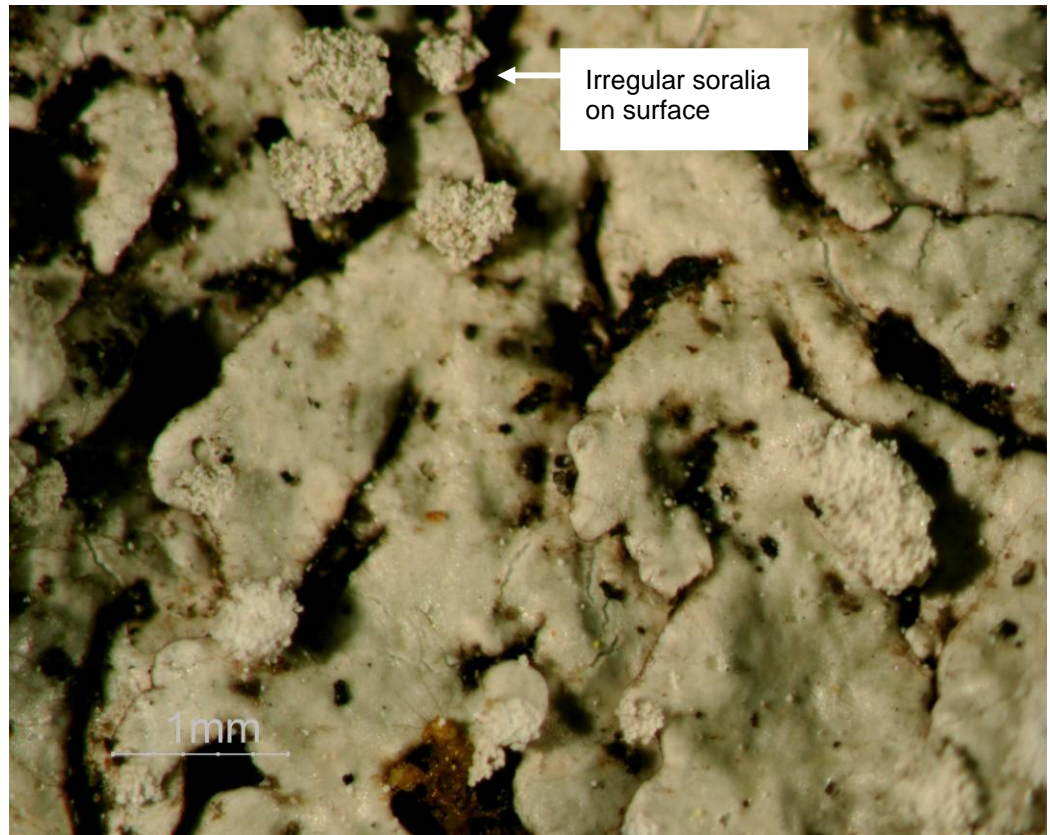
- Similar upper cortex, but any species that may be confused with PARMHYP have a white lower cortex

*Parmeliopsis ambigua*

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



# PARMHYP



Sparse rhizines



Growth form

## ***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**

This is the only species with black apothecia and a shiny upper surface with pruinose lobe tips – however, there are similar *Peltigera* with brown apothecia

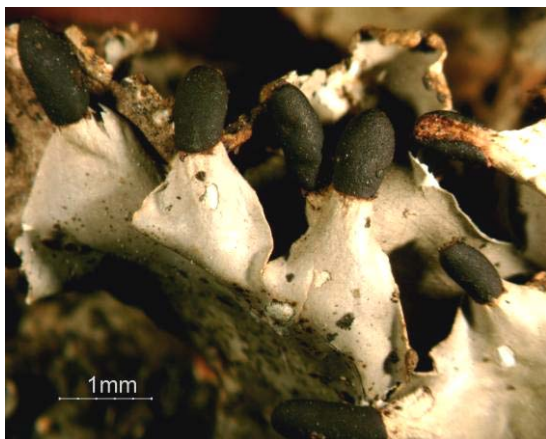
**\*Specimens lacking apothecia should be sent for advanced identification!**



# 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**

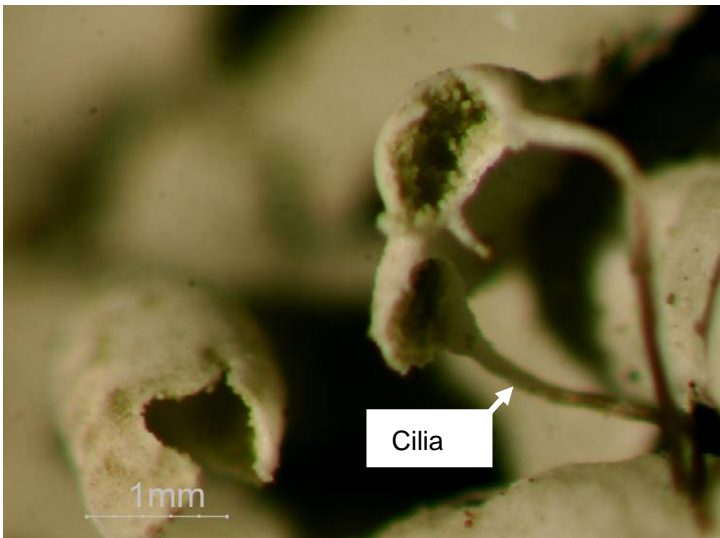
*Physcia* spp.

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

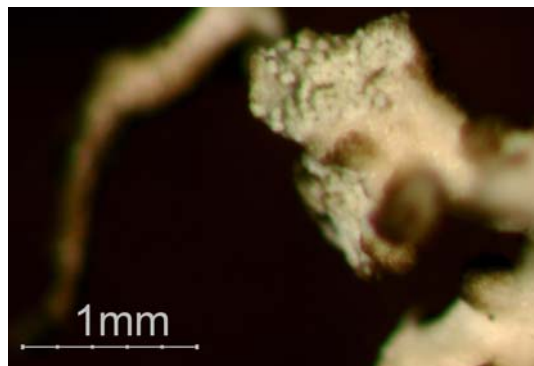
*Physcia tenella*

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

# PHYSADS



*Physcia tenella* (left, below)



***Tuckermannopsis americana* - TUCKAME**

Fringed wrinkle-lichen

**Field/Lab Characteristics**

- Lobes ascending, upper surface dark to olive brown
- **Marginal cilia common**
- **Medulla glows blue-white under UV light (only TUCK sp to fluoresce)**  
**\*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*

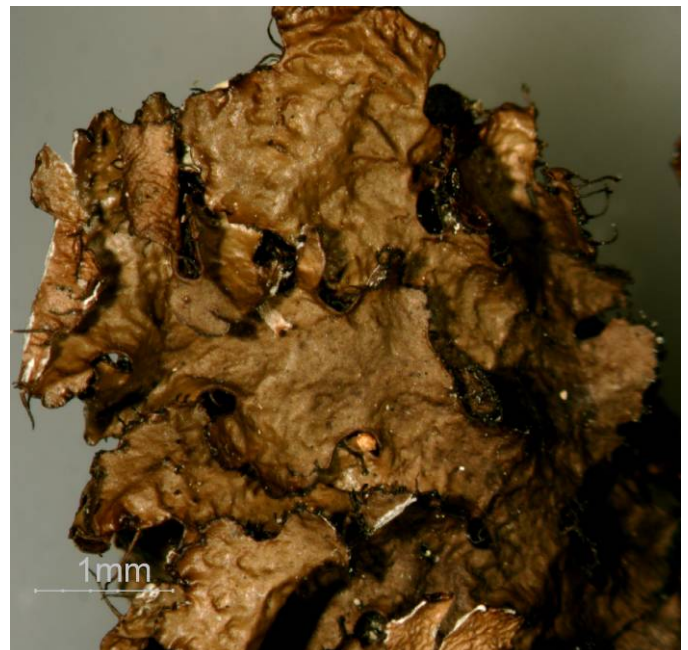
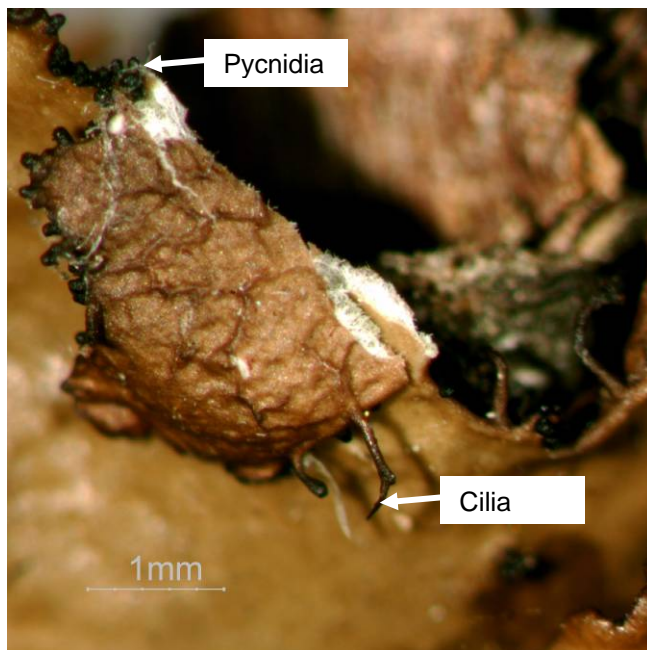
- Lacks cilia
- Lobes broad with wart-like tubercles and lobules
- Medulla UV negative

*Tuckermannopsis sepincola*

- More chocolate brown
- Narrower lobes with apothecia on upper lobe surface
- Medulla UV negative



# TUCKAME





***Vulpicida pinastri* - VULPPIN**

Powdered sunshine

**Field Characteristics**

- **Greenish-yellow to bright yellow rosettes**
- **Margins with farinose soredia**
- Lower surface pale yellow to almost white
- Apothecia uncommon
- Lobes ruffled, 1.5-5 mm wide

**Habitat**

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

**For more information**

- Brodo *et al.* 2001, pg 731

**Similar species***Vulpicida canadensis*

- Lacks soredia
- Large, red-brown apothecia common
- Common in montane habitats and dry pine forests

*Vulpicida tilesii*

- Lacks soredia, apothecia very rare
- Grows on soil in alpine environments

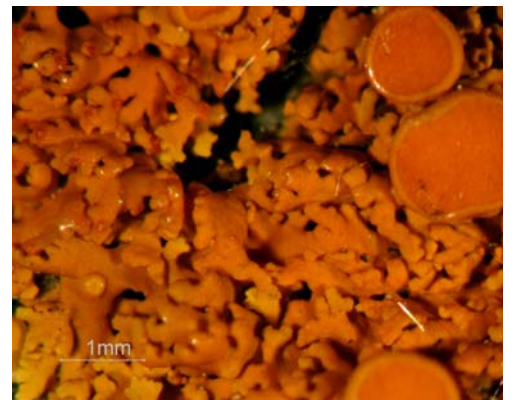
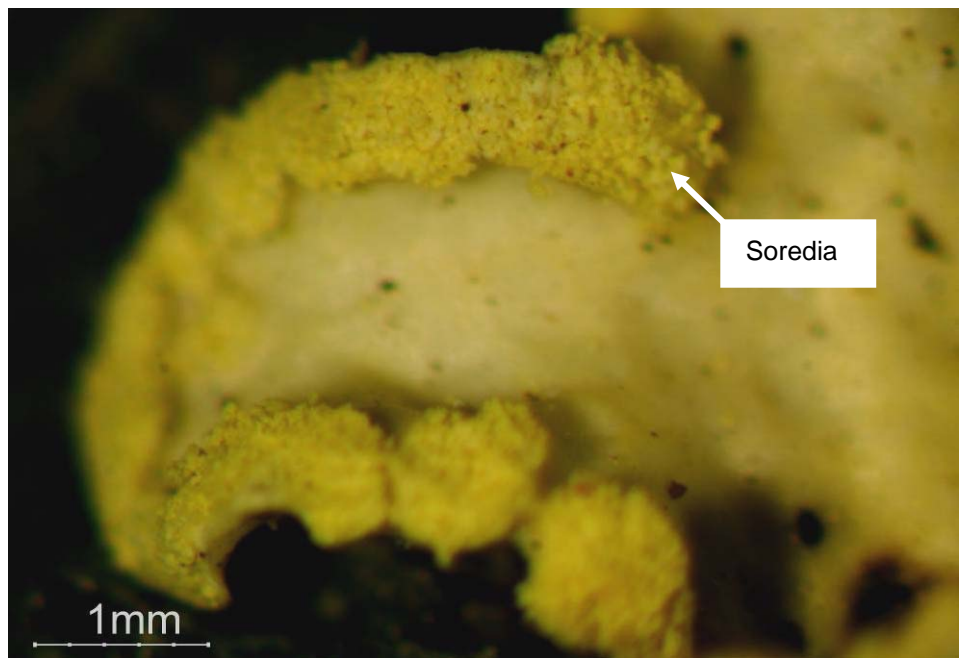
*Candelaria concolor* (Brodo *et al.* 2001, pg 205-207)

- Lobes 0.1-0.5 mm wide
- Lobes appressed

*Xanthoria* spp (Brodo *et al.* 2001, pg 742-748)

- More orange in colour
- Lobes smaller and typically more appressed

# VULPPIN



*Vulpicida canadensis*

*Candelaria concolor*

*Xanthoria polycarpa*

## ADVANCED

### *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

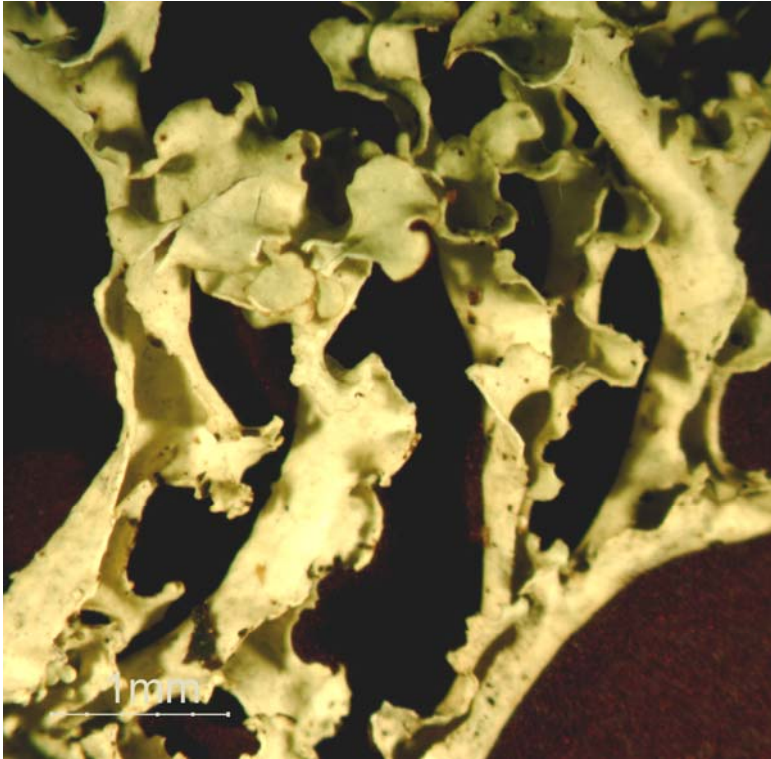
- In tussocks on the ground, at mountainous sites

#### For more information

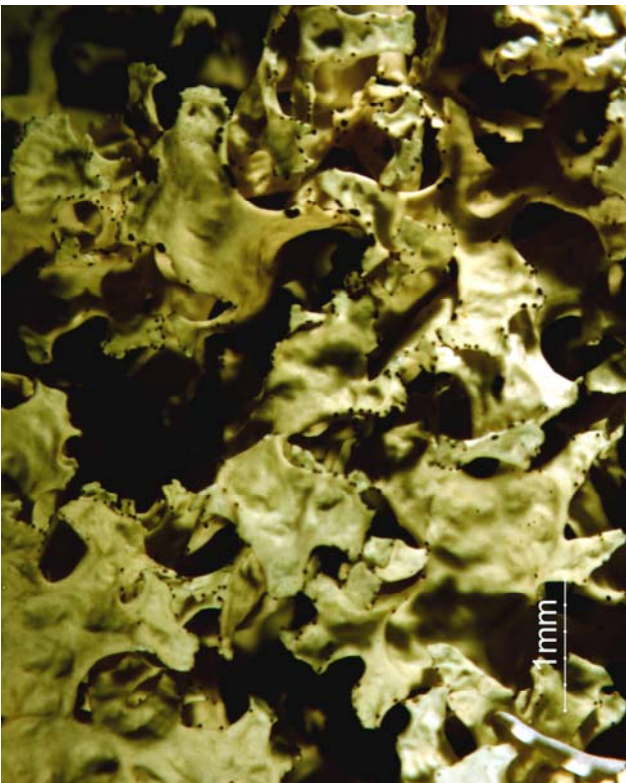
- Brodo *et al.* 2001, pg 314-315



## FLAVCUC



## FLAVNIV





## ADVANCED

### *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

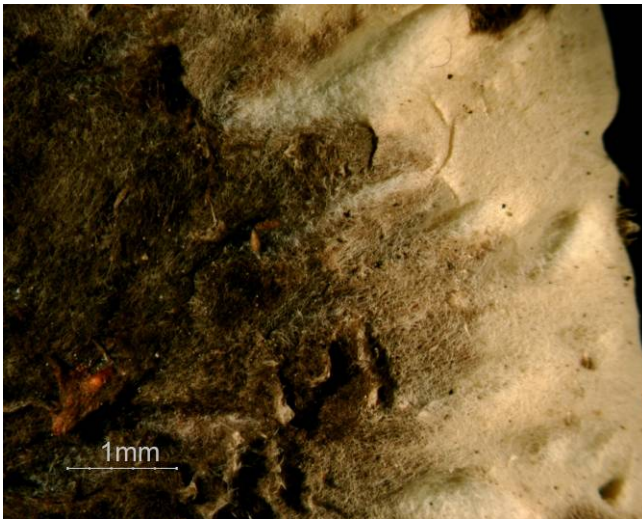
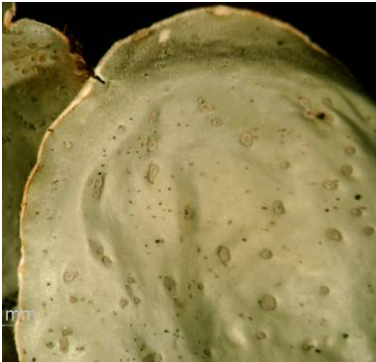
#### Similar species

*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)



## ADVANCED

### *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

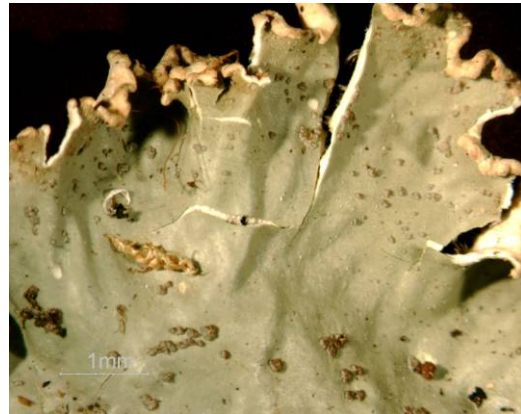


# PELTLEU

Lower lobe surface with distinct veins & tufted rhizines



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



Wet  
apothecia  
(below): note  
patchy cortex  
on back



## ADVANCED

### *Peltigera malacea* - PELTMAL

Veinless pelt, Apple pelt, Boxboard felt lichen

#### Field Characteristics

- Upper surface greenish-brown (darkening when wet), **with tomentum and sometimes pruina towards lobe tips, otherwise smooth**
- **When dry, thallus feels thick, stiff and cardboard-like**
- When wet, colour ranges from grey to dark forest green
- 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



# PELTMAL





## ADVANCED

### *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

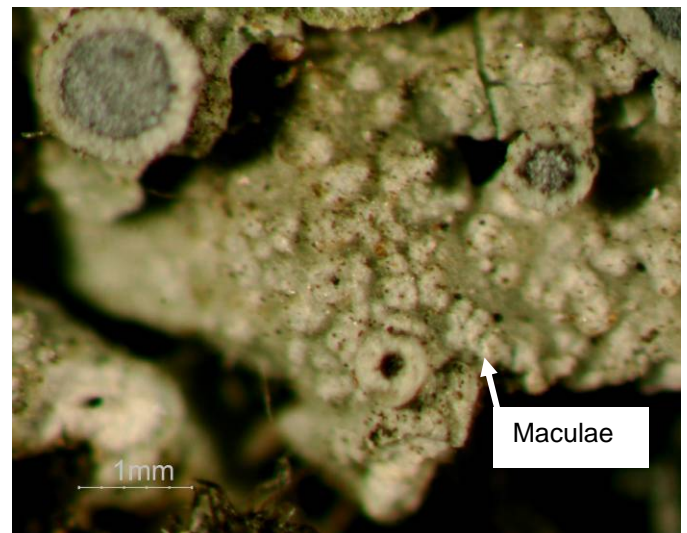
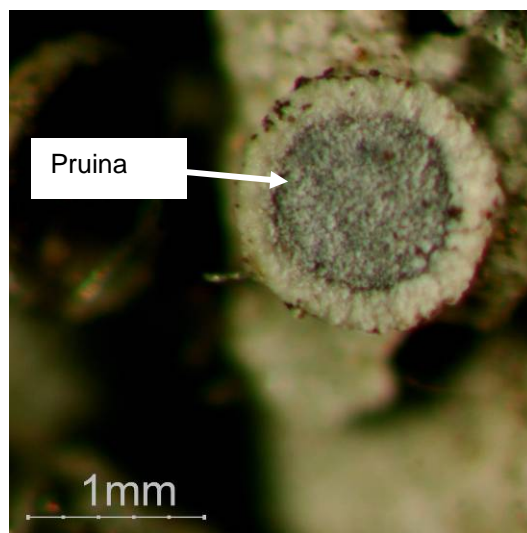
- Brodo *et al.* 2001, pg 549-550

#### 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



## Other Commonly Encountered Leaf-like Genera

### *Hypogymnia*

- Upper surface green-grey to brown-grey
- **Inflated, hollow lobes, lower surface black, no rhizines**
- Brodo *et al.* 2001, pg 345-356, 13 species in Alberta

### *Physcia*

- Thallus green-grey to almost white, small to mid-sized
- **Lower surface usually white to pale brown, often 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 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

### *Xanthoparmelia*

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

### *Dermatocarpon (no picture in manual)*

- grey umbilicate lichen, thallus leathery & thick
- Brodo *et al.* 2001, pg 297-299, 7 species in Alberta

### *Rhizoplaca*

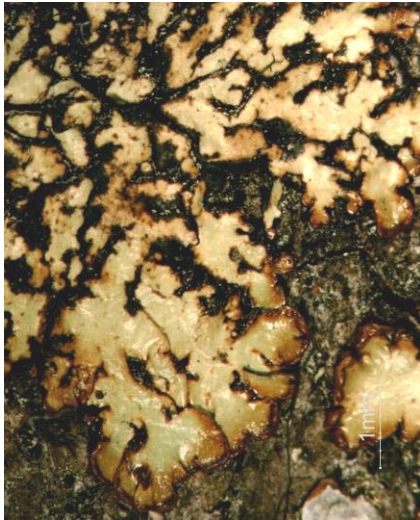
- Yellowish-green to grey umbilicate lichen, **thallus lumpy**
- Apothecia large, orange-pink to dark green
- Brodo *et al.* 2001, pg 638-641, 4 species in Alberta

### *Other grey foliose genera*

- Includes *Imshaugia* (2 spp.) *Parmelia* (3 spp.) & *Punctelia subrudecta*
- Brodo *et al.* 2001, pg 360-362, 479-484, 605-610



***Hypogymnia* spp.**



*Hypogymnia austerodes*



*Hypogymnia enteromorpha*

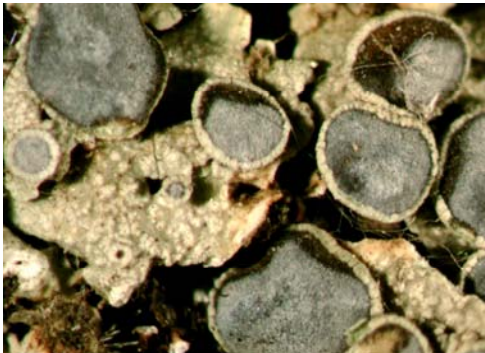


*Xanthoparmelia* sp.

***Physcia* spp.**



*Physcia tenella*



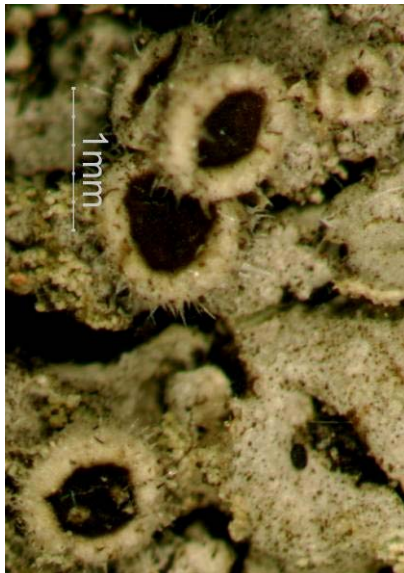
*Physcia aipolia*

***Rhizoplaca* sp.**

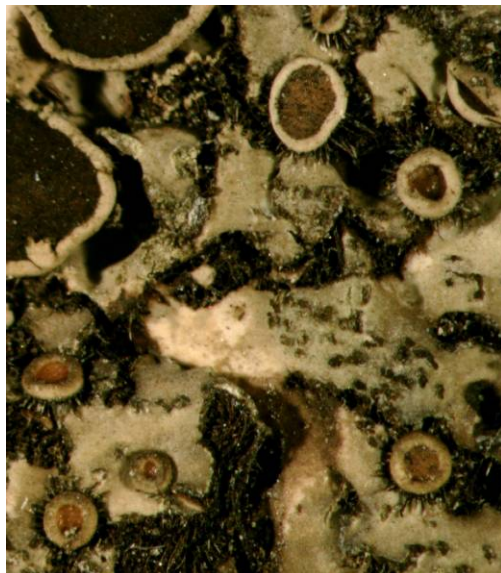


*Rhizoplaca* sp.

***Phaeophyscia* spp.**



*Phaeophyscia hirsuta*



*Phaeophyscia orbicularis*

***Physconia* sp.**



*Physconia detera*

## 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, never shiny
- 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*

- **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
- See also *Candelaria concolor*, Brodo *et al.* 2001, pg 205-207

### *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



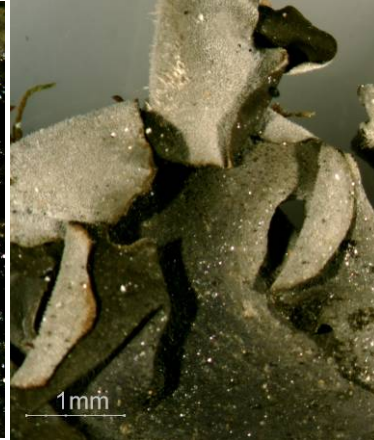
***Collema* sp.**



*Collema furfuraceum*, dry...and wet



***Leptogium* sp.**



*Leptogium saturninum*, dry...and wet

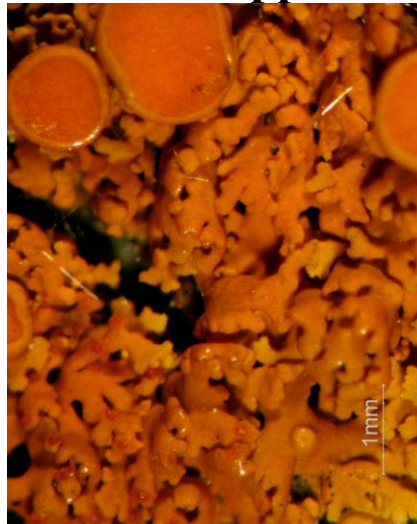


***Umbilicaria* sp.**



*Umbilicaria polyphylla*

***Xanthoria* spp.**



*Xanthoria polycarpa*

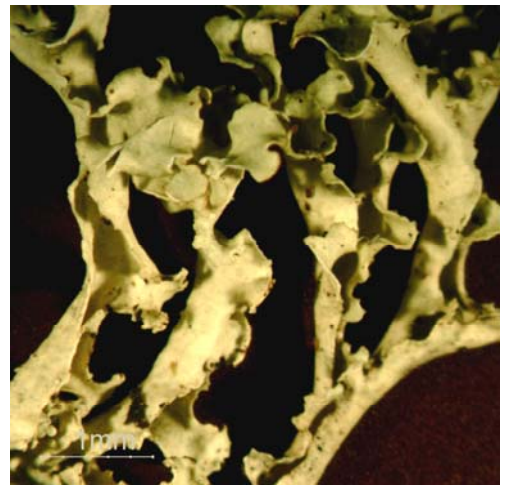
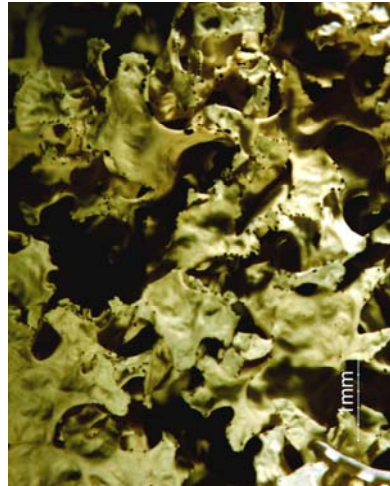


*Xanthoria elegans*

***Flavocetraria* spp.**



*Flavocetraria nivalis*



*Flavocetraria cuculatta*



## Other Commonly Encountered Leaf-like Genera cont'd

### *Melanelia-like (includes Melanohalea & Melanelixia)*

- 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-like spp.***



*Melanelia albertana*



*Melanelia exasperatula*



*Tuckermannopsis orbata*

***Tuckermannopsis spp. cont'd***



*Tuckermannopsis fendleri*



*Tuckermannopsis americana*



*Tuckermannopsis chlorophylla*

***Nephroma spp.***



*Nephroma resupinatum*



*Nephroma bellum*

***Lobaria sp.***



*Lobaria pulmonaria*



## Other Commonly Encountered Leaf-like Genera cont'd

### *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. Green

- Upper thallus grey-brown when dry, **bright green when wet**
- **Warty-freckles (cephalodia) usually 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

### *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

### *Other green foliose genera*

- Includes green-grey *Platismatia* and green-yellow *Arctoparmelia*, *Allocetraria*, *Flavoparmelia* & *Flavopunctelia*
- Lobes medium to large sized, either flat or appressed,
- Often wrinkled when older
- Often have pseudocyphellae and/or isidia or soredia
- Brodo *et al.* 2001, pg 156-158, 162, 316-319, 574-578, 8 species in Alberta



***Platismatia glauca***



***Flavopunctelia* sp.**



*Flavopunctelia flaventior*

***Solorina* sp.**



*Solorina cf spongiosa*

***Peltigera* - Green spp.**



*Peltigera venosa*



*Peltigera aphthosa* (damp)



*Peltigera leucophlebia*(damp)

***Peltigera* - Blue-green spp.**



*Peltigera neckerii*



*Peltigera malacea*



*Peltigera* sp.

## Appendix 7: Select Species for Advanced Identification

- As field technicians gain experience (particularly returning technicians) and the laboratory supervisor allows, they may add additional species to their identification repertoire.
- Alternately, if time allows after the primary sorting of all material, 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 - 1<sup>st</sup> priority for advanced identification

- Species descriptions are provided in Appendix 6 following the descriptions of the initial species technicians are to identify

*Cladonia rangiferina* (previously called *Cladina*; technician must be able to differentiate usnic-acid yellow from grey)

*Cladonia cenotea*

*Cladonia cornuta*

*Flavocetraria cucullata* & *Flavocetraria nivalis*

*Peltigera aphthosa* & *Peltigera leucophlebia*

*Peltigera malacea*

*Physcia aipolia* (for 2<sup>nd</sup> year technicians)

### Less common & more difficult 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*

*Lobaria pulmonaria*

*Peltigera venosa*

*Usnea herta*

*Usnea lapponica*

## Appendix 8: Microhabitat Descriptions

<b>Stratum #1: Logs and Stumps (samples in 1 bag)</b>
<b>LS:</b> Soft stumps & logs (decay classes 3-5) - sample roots and all sides
<b>LH:</b> Hard stumps & logs (decay classes 1-2) - sample roots and all sides
<b>Stratum #2: Trees and Other Vertical Structures (samples in 1 bag)</b>
<b>TD:</b> Deciduous Trees - all sides of the roots, bases, trunks, and branches of both live and dead deciduous trees
<b>TC:</b> Coniferous Trees - all sides of the roots, bases, trunks, and branches of both live and dead coniferous trees
<b>TS:</b> Shrubs - all sides of the roots, bases, stems, and branches of live & dead shrubs
<b>HB:</b> Human Structures - vertical and horizontal parts of the structures (survey from the ground)
<b>Stratum #3: Wetlands and Peatlands (samples in 1 bag)</b>
<b>WMF:</b> Wetlands, marshes, & fens - within the wetland survey both under and away from trees
<b>WSB:</b> Shores/banks of wetlands, ponds, lakes, & streams - survey on organic or mineral soil adjacent the water's edge
<b>WDS:</b> Moist depressions/seasonal wetlands dry at time of survey - sample sides and bottom in the area influenced by water
<b>WPW:</b> Peatlands with or without standing water - survey both standing water and vegetation hummocks
<b>Stratum #4: Rocks and Cliffs (samples in 1 bag)</b>
<b>BC:</b> Boulders (>50 cm diam.) - survey all surfaces (top, sides, and base) from the soil upwards
<b>RR:</b> Rocks (<50 cm diam.) - survey all surfaces (top, sides, and base) from the soil upwards
<b>CL:</b> Cliffs (steep high rock face) - survey all of the faces, ledges, and crevices that can be accessed safely
<b>Stratum #5: Upland Soils (samples in 1 bag)</b>
<b>UC:</b> Humus soils under trees/shrubs (shaded by canopy) - survey as large a variety as possible
<b>UO:</b> Humus soils without trees/shrubs (open to sunlight) - survey as large a variety as possible
<b>DC:</b> Agriculturally cultivated soils
<b>DM:</b> Mineral soil in upland areas from any causes

## 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: _____	
Stratum: _____	
Quadrant: _____	
Peltigera (blue-green)	

### 2) Multiple Unknown Species – Genus Known

LICHEN SPECIMEN 2007	Unique #
ABMI Site: _____	
Date: _____	
Crew Member: _____	
Stratum: _____	
Quadrant: _____	
Usnea Bryoria	

### 3) Group of Species – Species IDed and Unknown

LICHEN SPECIMEN 2007	Unique #
ABMI Site: _____	
Date: _____	
Crew Member: _____	
Stratum: _____	
Quadrant: _____	
PARMSUL                  Xanthoria	
PHYSAIP	

### 4) Single Species - Unknown

LICHEN SPECIMEN 2007	Unique #
ABMI Site: _____	
Date: _____	
Crew Member: _____	
Stratum: _____	
Quadrant: _____	
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: _____	VOUCHER
Date: _____	
Crew Member: _____	
Stratum: _____	
Quadrant: _____	
VULPPIN	

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

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