

Laboratory Protocols for Processing Bryophytes



Version 2.0

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Acknowledgements

Jennifer Doubt and Rene Belland reviewed the literature to suggested protocols for sampling bryophytes which were subsequently refined based on field testing. The present document was developed by Curtis Stambaugh with the training material compiled by Karen Brown and Brian Carabine with technical assistance from Jennifer Doubt. Jim Schieck provided input on earlier drafts of the present document.

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Disclaimer

The views, statements, and conclusions expressed in this report are those of the authors and should not be construed as conclusions or opinions of the ABMP. Development of the ABMP has continued since this report was produced. Thus, the report may not accurately reflect current ideas.

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Introduction

During the month of August, after the field data collection is complete, ABMP field staff sort the bryophyte (moss and liverwort) specimens that were collected from the field. Field staff are trained to identify some of the most common and/or easily identifiable species. By sorting the specimens into groups and identifying common species, less work is required by experts. Some of the groups sorted by field staff will only be taken to *Genus*, while most groups will be identified to species by experts. Due to the ABMP's high standards, and the need for maintaining a high level of credibility in the information gathered, experts in the field of bryology will perform the majority of the species-level taxonomic determinations.

This document outlines the training, procedures, and resource materials needed to accomplish bryophyte identification for the ABMP.

Sample Processing

This protocol is designed for field staff to identify the most common bryophytes that were collected in the field, and to sort the remaining "difficult" specimens into *Genera* or "meaningful groups" for expert identification.

Laboratory Equipment

ABMP Laboratory Protocols

Reference collections

Dissecting microscope

Compound microscope

Forceps

Sorting envelopes

Sorting to Genera/Groups and Species Identification

- Ensure that samples from all microhabitats at each ABMP site are present.
- Working on one site at a time, place the contents of a single microhabitat collection onto the workspace.
- Sort the bryophytes into basic groups or growth forms.
- Use the Laboratory Protocol Training Sections (see below) and moss/liverwort reference collection to sort all bryophytes into *Genera* and morphological groups and to identify the priority 17 moss/liverwort species.
- All species that can be identified are recorded onto laboratory data sheets using 7-letter species codes. Species names must be determined based on the Species References/Authorities listed below.
- A voucher specimen of each identified species, from each ABMP site, is placed in an envelope and given a unique identifying number.
- Basic sorting and identification of pre-determined species, will account for 50-60% of bryophyte specimens collected in the field.
- Place an example of all remaining specimens that cannot be identified into separate envelopes for further processing and/or for expert identification.
- Specimen envelopes are labeled using a pre-made stamp with the collector's name(s), ABMP site, microhabitat, plot number, and a unique number for the specimen inside.
- If unknown specimens cannot be separated from known specimens, then list the unknown specimen first (i.e., *Dicranum sp.*) followed by all other bryophytes identified on the envelope.
- Once one microhabitat has been completed, open and process the next microhabitat from that ABMP site.
- Once all specimens at a site have been identified/sorted and placed in envelopes, sort all envelopes into similar groups (eg., *Dicranum sp.*, Unknown liverwort, etc.) and by ABMP site.
- By the final week of August, each field staff should have sorted through their required 15 ABMP sites (see timeline below). At this time each staff is given an additional 2-4 "advanced" species of a particular *genera* to learn and to identify from the already sorted envelopes.

- All species determinations made by ABMP field staff (17 predetermined species, including advanced species) must be made with $\geq 95\%$ accuracy (see verification process below).
- After the advanced species identification is complete, there will still be some unknown specimens. If possible, field staff will isolate multiple specimens of the same unknown species' and only send away 1-2 representative samples for expert identification. Note: This is only done if staff are 100% certain that the unknown species are the same.
- If specimens can be refined/reduced so only 1-2 specimens are sent for expert identification of a particular unknown, ensure the unique number of the species being sent away indicates exactly which other unknown specimens are being represented (eg., 640_WPD_Sphagnum sp. – same as 1260_LS_Sphagnum sp.; 590_WPD_Sphagnum sp.).

Timeline for Laboratory Training, Sorting and Identification

Overview

The laboratory component to ABMP field work is designing for maximum efficiency based on each field crew having one month (August) to sort specimens. A great deal of focus is required by field staff for them to process and sort all the year's field collections within one month. If the following steps are followed however, all field staff should be able to attain the daily and weekly goals.

Week 1: Training

Day 1: Goals and Expectations

- ABMP staff will understand the ecology and forms of bryophytes.
- Staff will know the parts (characteristics) and terminology of bryophytes that will help them identify species.
- Staff will handle and know how to separate, sort, and identify select species of Pleurocarpus mosses and identify the difference between the 4 bryophyte growth forms.

Bryophyte Training and Sorting Specimens

Introduction to Bryophytes

1. Read Mosses, Lichens and Ferns of Northwest North America: Their Structure and Biology. *Vitt et.al. (1988)* – Pages 32-38.

Moss/Liverwort Growth Forms

1. Read Mosses, Lichens and Ferns of Northwest North America: Their Structure and Biology. *Vitt et. al. (1988)* – Pages 32-38.
2. Read Appendix 2: Morphology and Morphological Variation of the Mosses: Collected Diagrams. *Compiled by J. Doubt.*
3. See Appendix 1: Moss/Liverwort Growth Form Chart
4. Look at Reference collection.

Terminology

1. Read Appendix 3: Basic Bryophyte Terminology

Sorting ABMP Bryophyte Collections

1. Read Appendix 5: Selected Species for Identification (Section 1) – Pages 26-35 (This appendix is ordered by ease of identification and should be followed in the order it appears)
2. Sort through “unknown” Pleurocarpus specimens in collections (in pairs) using the reference collection and knowledgeable bryophyte staff as aids.

Quality Control

- If returning staff members (2nd or 3rd year technician) are confident in their species identification after reviewing the material, they can start to sort an ABMP site.
- New field staff must review the appropriate material and/or acquire assistance from knowledgeable field staff or the field coordinator before starting the sorting.
- Depending on how quickly staff learn the species, they may choose to not start sorting until day 2.

- A skilled bryologist (bryophyte expert, field coordinator, or returning technician with ≥ 2 year's experience) will verify all species identifications for the first 2 sites of every returning field staff to ensure specimens are accurately determined.

Days 2-3: Goals and Expectations

- Staff will understand how to identify 9 Pleurocarpus mosses and 5 Acrocarpus mosses selected for identification.
- Staff will learn the basic characteristics for identifying 6 different *Genera*.
- ABMP staff will understand how to sort mosses into known *Genus* groups and further into specific morphological categories. Remaining specimens that do not fit into known categories are sorted as 'unknown Pleurocarp' or 'unknown Acrocarp'.
- Staff will be able to identify between thaloid and foliose liverworts and identify 1 and 2 species of each, respectively.

Bryophyte Training and Sorting Specimens

Pleurocarpus Mosses

1. Review Appendix 5: Selected Species for Identification (Section 1) – Pages 26-25

Acrocarpus Mosses

1. Read Appendix 5: Selected Species for Identification (Section 2) – Pages 36-41
2. Sort through "unknown" Pleurocarpus and Acrocarpus specimen collections (in pairs) using the reference collection and knowledgeable bryophyte staff as aids.

Liverworts

1. Read Mosses, Lichens and Ferns of Northwest North America: Their Structure and Biology. *Vitt et. al. (1988)* – Pages 140-142
2. Read Appendix 5: Selected Species for Identification (Section 3) – Pages 42-44

Sorting Mosses by Genus

1. Read Appendix 5: Selected Species for Identification (Section 4) – Pages 45-49

Quality Control

- A skilled bryologist (bryophyte expert, field coordinator, or returning technician with ≥ 2 year's experience) will verify all pleurocarpus, acrocarpus, and liverwort species identifications during training to ensure accuracy to $\geq 95\%$. Returning staff who have started sorting ABMP sites will have all species identifications verified for the first 2 sites to ensure accuracy to $\geq 95\%$.
- A skilled bryologist will verify all *Genus* and morphological groupings during training to ensure consistency.
- Staff having trouble achieving the minimum standard will acquire assistance from a returning technician with ≥ 2 year's experience or the field coordinator before moving on to sorting ABMP sites.

Days 4-5: Goals and Expectations

- ABMP staff will be familiar with all bryophyte growth forms, capable of identifying 17 predetermined moss and liverwort species, and sorting the remaining mosses into *Genus* groups with $\geq 95\%$ accuracy.
- Staff will be able to sort through ABMP collection bags, record identified species onto datasheets, and sort remaining unknown specimens into envelopes.
- Staff will be able to consistently label envelopes for further processing
- Staff will retain a voucher specimen of all positively identified species for each ABMP site.
- Each staff member should have at least one ABMP site completely sorted.

Bryophyte Training and Sorting Specimens

Liverworts

1. Differentiate between Foliose and Thaloid Liverworts using Mosses, Lichens and Ferns of Northwest North America. *Vitt et. al. (1988)* and the reference collection.

Labelling Envelopes for Further Processing

1. Read Appendix 4: Labelling of Envelopes for Unknown and Reference Specimens – Page 25

Sorting ABMP Bryophyte Collections

1. Begin sorting ABMP site collections (in pairs)

Quality Control

- A skilled bryologist (bryophyte expert, field coordinator, or returning technician with ≥ 2 year's experience) will verify all species identifications during training and the first site sorted in pairs to ensure accuracy to $\geq 95\%$.
- A skilled bryologist will verify all *Genus* and morphological groupings to ensure consistency.
- Staff having trouble achieving the minimum standard will acquire assistance from a returning technician with ≥ 2 year's experience or the field coordinator before moving on to sorting ABMP sites individually.
- Returning technician with ≥ 2 year's experience or the field coordinator will verify all species determinations made by other staff for their first 2 ABMP sites to ensure accuracy to $\geq 95\%$.
- Returning technician with ≥ 2 year's experience (or the field coordinator) will verify each other's first 2 ABMP sites to ensure accuracy to $\geq 95\%$.

Week 2: Sorting and Basic Identification

Goals and Expectations

- Based on the training and instructional guidelines learned from week 1, ABMP field staff should begin sorting ABMP sites at an average rate of one site/day.
- Each staff member should have completed the sorting and identification of 5 (or more) ABMP sites between the 6th and 10th day in the laboratory.

Quality Control

- A skilled bryologist will verify 25% of the voucher specimens for 2 randomly selected ABMP sites sorted by each field staff to ensure accuracy to $\geq 95\%$.
- A skilled bryologist will verify 25% of *Genus* and morphological groupings for 2 randomly selected ABMP sites sorted by each field staff to ensure accuracy to $\geq 95\%$.

Week 3: Sorting and Basic Identification

Goals and Expectations

- ABMP field staff should be more efficient at sorting bryophytes and increase their average rate to 2 sites/day.
- Staff should have completed the sorting and identification of 15 or more ABMP sites between the 11th and 15th day in the laboratory.

Quality Control

- A skilled bryologist will verify 25% of voucher specimens for 2 randomly selected ABMP sites sorted by each field staff to ensure accuracy to $\geq 95\%$.

Week 4: Reduction of Sorted Specimens and Advanced Species Identification

Goals and Expectations

- Staff will examine all envelopes of the same *Genus* groups to reduce (where obvious) the number of similar/duplicate “unknown” species to be sent for expert identification.

- Staff will isolate potential specimen envelopes (i.e., particular *Genuses*) from the sorted envelopes for further identification.
- From the isolated envelopes, each staff member will be assigned a specific *Genus* to work with and attempt to ID a further 2-4 species from that *Genus*.
- Staff will continue advanced identification until the end of August.

Schedule

Day 1

1. Sort envelopes of all species into *Genus* or broader groups.
2. If possible, identify similar/duplicate species and isolate 1 or 2 specimens for expert identification. This process is only done if staff are positive specimens are the same, otherwise all specimens are sent to experts.
3. Re-label reference specimen envelopes to include identification of specimens not being sent for expert identification (continuity) – See Appendix 4

Day 2 – 5

1. Staff members choose a *Genus* to work with: *Dicranum* or *Polytrichum*
2. Read Appendix 5: Selected Species for Advanced Identification (Section 5) – Pages 50-60
3. Review reference collection of selected species
4. Examine and identify (when possible) specimens from the sorted envelopes containing species from your chosen *Genus* for advanced species identification.
5. Ensure all remaining specimen envelopes are prepared to be sent to an expert for further species identification.

Quality Control

- A skilled bryologist will verify all advanced species identifications for the first 25 specimens sorted by each field staff to ensure accuracy to $\geq 95\%$.
- On the 2nd last day, a skilled bryologist will verify 25 of the voucher specimens sorted by each field staff to ensure accuracy to $\geq 95\%$.

Expert Identification of Difficult Specimens

- Send all unknown specimen envelopes, via registered mail or courier service, to an expert in bryophyte taxonomy.
- Most specimens are to be identified to species. Species names must be determined based on the Species References/Authorities listed below.
- There are however, a few exceptions to species level identifications:
 - Brachythesium – to *Genus* only
 - Bryum – to *Genus* only
 - Damaged specimens or those too small for determinations should only be taken to *Genus* (use discretion).
- Specimens must be identified with $\geq 95\%$ accuracy.
- Experts ensure a voucher specimen is retained from species determinations. This may include isolating a particular species from a “clump” of species to obtain the voucher.
- Write the species name directly on the envelope, including a separate name for each unique specimen number.
- If additional reference literature was needed to determine the species name, note this additional literature on the label.
- Experts return the specimen envelopes to the ABMP field coordinator, via the same method, with the species determinations written directly on the envelope.
- Experts also email a digital copy of species determinations to the field coordinator, in a format suitable to the field coordinator.
- The field coordinator ensures the species’ 7-letter codes are added to the electronic data base.

Expert Credibility

- The ABMP will select experts who are experts for bryophytes found in Alberta. To ensure the highest of standards, and to maintain ABMP's level of credibility, the ABMP 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 (i.e., Canadian Museum of Nature, etc.), 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 bryology, and capable of identifying bryophytes with $\geq 95\%$ accuracy.
 3. Expert completes an ABMP certification exam consisting of 200 known bryophyte specimens from >50 species, and from at least 10 broadly separated areas throughout Alberta. The expert must identify the specimens with an accuracy of $\geq 95\%$ (i.e., maximum 10 wrong) to pass the exam.

Verification Process

- Specimens that have been identified by experts will undergo a verification process by their peers to ensure accuracy.
- For each expert identifying ABMP bryophytes, 10% of the identified specimens (up to a maximum of 300) will be randomly selected for verification.
- The ABMP field coordinator re-labels each specimen with a reference number and sends the specimens to a second expert that meets the above credibility criteria.
- The second expert identifies the specimens and records the species name beside the matching reference number on the data sheet.
- The second expert then ships the specimens back to the ABMP, and emails the data sheet to the ABMP field coordinator.
- The ABMP field coordinator compares 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 can not 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 many miss identifications are highlighted. All individuals the initial expert identified from the highlighted species are re-identified to confirm their identity.

Specimen Storage

- Species that are identified are stored in the envelopes for 2 years by the ABMP.
- After 2 years, all envelopes with specimens, and all residual specimens in the microhabitat bags, are given to the Royal Alberta Museum.
- The ABMP, however, will retain enough reference specimens of each species plus additional specimens for training purposes.

Species References/Authorities

- Yet to be decided

Literature Cited

Illustrations and Text:

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Flowers, S. 1973. Mosses: Utah and the west. Brigham Young University Press. Provo, Utah, USA. 567 pp.

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Photos referred to in the text:

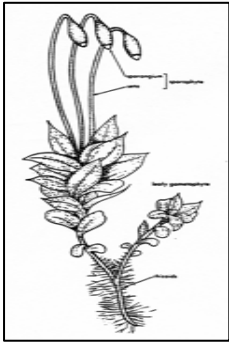
Johnson, D., L. Kershaw, A. MacKinnon, and J. Pojar. 1995. Plants of the western boreal forest and aspen parkland. Lone Pine Publishing, Edmonton, Alberta, Canada. 392 pp.

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.

* Permission to use the illustrations from Ireland (1982) was granted November 02, 2006 by Marcia Rak, Canada Science and Technology Museum Corporation.

Appendix 1: ABMP Simplified Flow Chart to Sorting and Species Identification

1) Acrocarpus



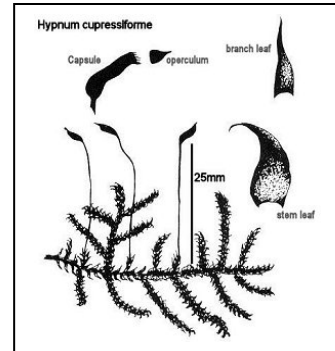
Sort by *Genus* Group:

- *Pohlia* spp.
- *Ceratodon* spp.
- *Dicranum* spp.
- *Mniaceae* spp.
- *Orthotrichum* spp.
- *Plagiomnium* spp.
- *Polytrichum* spp.
- *Sphagnum* spp.

Species to be ID'ed:

1. *Aulacomnium palustre*
2. *Ceratodon purpureus*
3. *Dicranum polysetum**
4. *Dicranum undulatum**
5. *Dicranum flagellare**
6. *Dicranum fragilifolium**
7. *Pohlia nutans*
8. *Polytrichum juniperinum**
9. *Polytrichum commune**
10. *Polytrichum strictum**
11. *Polytrichum piliferum**
12. *Orthotrichum obtusifolium*
13. *Tetraphis pellucida*

2) Pleurocarpus



Sort by *Genus* Group:

- *Brachythecium* spp.
- *Bryum* spp.
- *Pleurozium* spp.
- *Hylocomium* spp.
- *Ptilium* spp.
- *Sanionia* spp.

Species to be ID'ed:

1. *Pleurozium schreberi*
2. *Hylocomium splendens*
3. *Ptilium crista-castrensis*
4. *Sanionia uncinata*
5. *Pylaisiella polyantha*
6. *Tomenthypnum nitens*
7. *Platygyrium repens*
8. *Climacium dendroides*
9. *Eurhynchium pulchellum*

3) Foliose "bearing leaves" (Liverworts)



Sorted by *Genus* Group:

- Most of these are sent in
- *Ptilidium* spp.
- *Liverwort* spp. (general)

Species to be ID'ed:

1. *Ptilidium pulcherrimum*
2. *Ptilidium ciliare*

4) Thalloid 'plants strap like & w/o leaves' (Liverworts)



Sorted by *Genus* Group:

- Most of these are sent in

Species to be ID'ed:

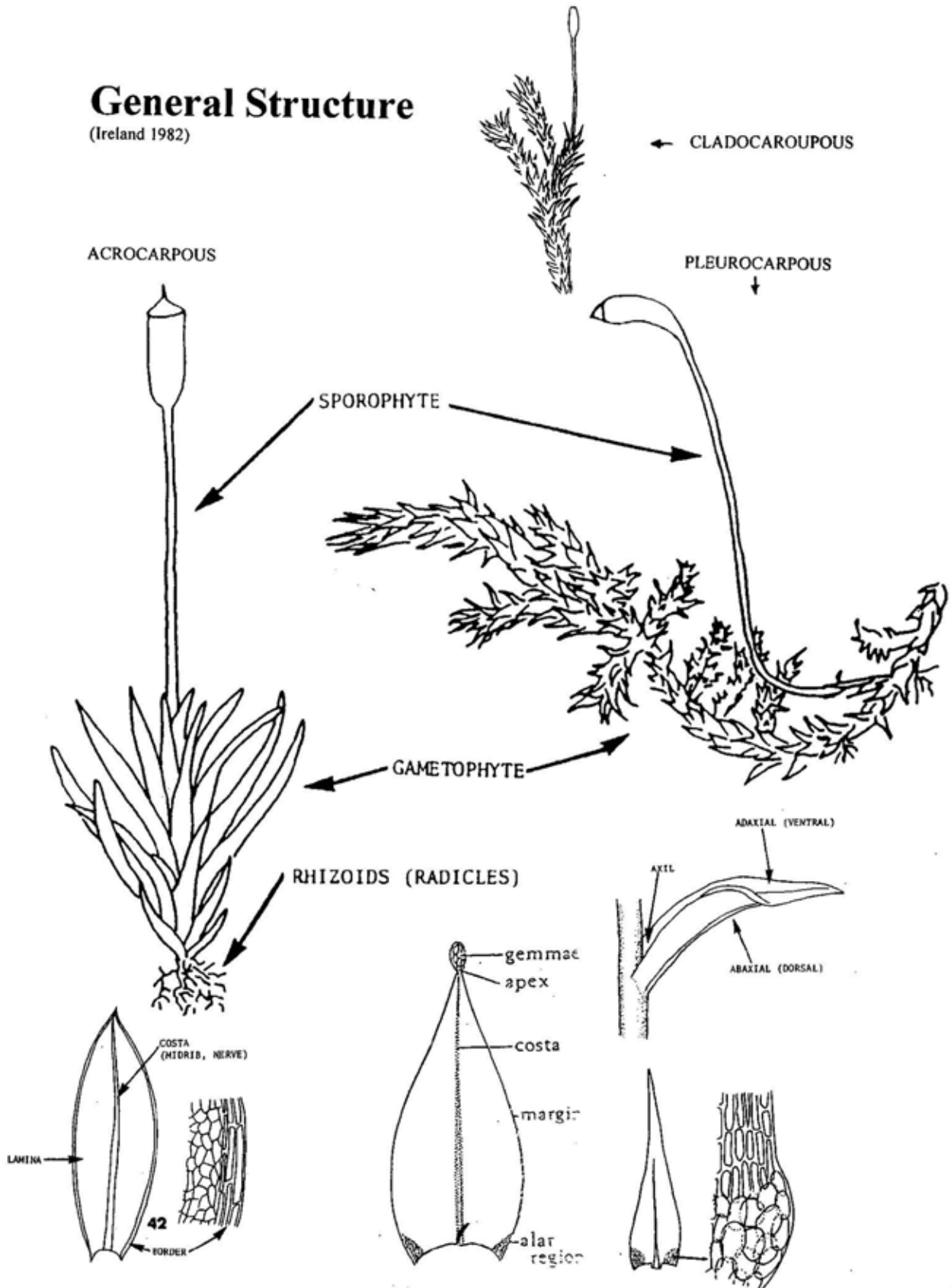
1. *Marchantia polymorpha*

Note: * denotes species for advanced ID only, do not attempt otherwise

Appendix 2: Morphology of Moss

General Structure

(Ireland 1982)



Leaf arrangement and stance; Branching

Ireland (1982)

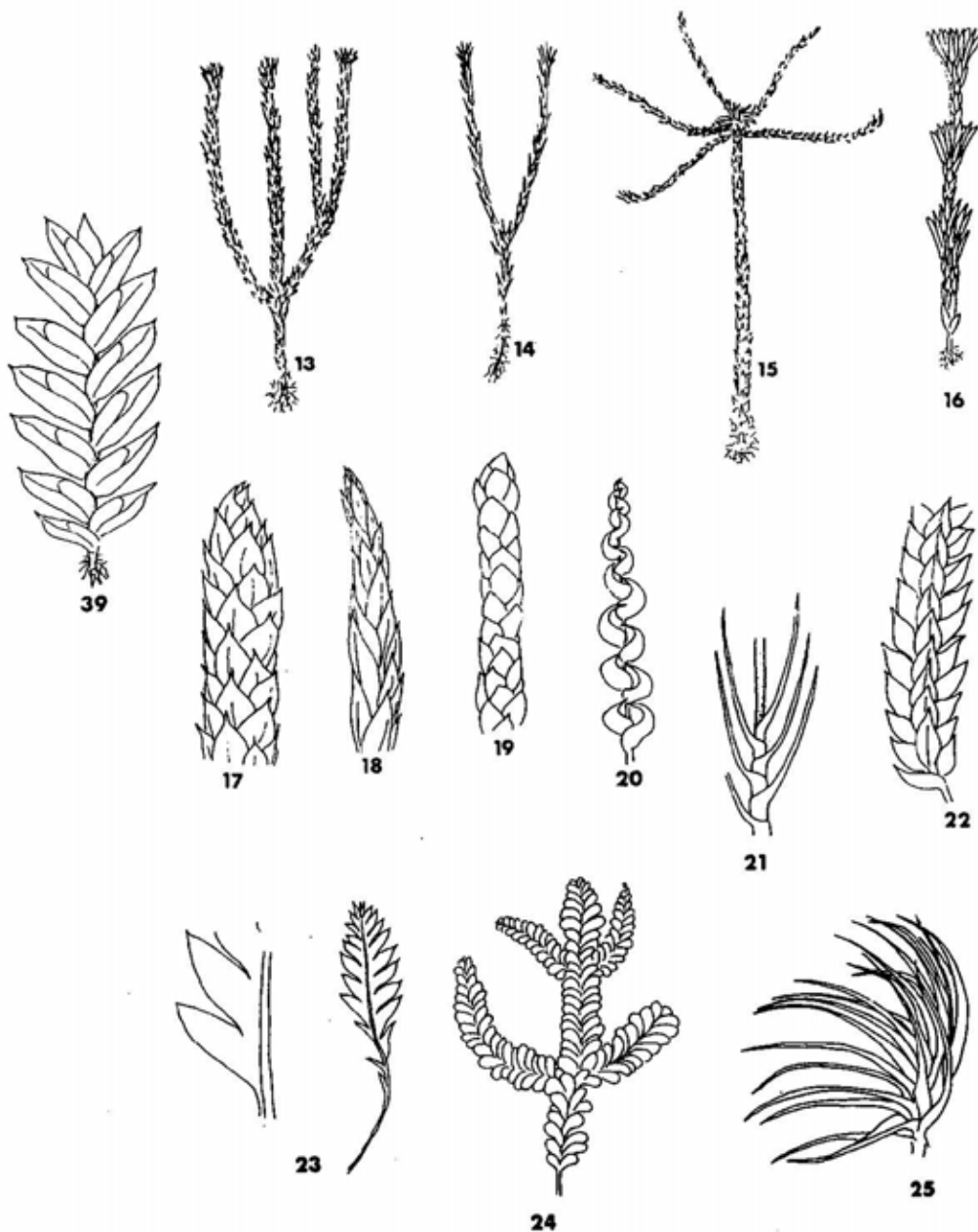


Plate 400. 13. Fastigate. 14. Dichotomous. 15. Whorled. 16. Annotinous. 17. Imbricate. 18. Appressed. 19. Julaceous, terete. 20. Catenulate. 21. Amplexicaul. 22. Trifarious. 23. Confluent, frondiform. 24. Complanate. 25. Falcate-secund 39. Distichous.

Leaf forms

(Ireland 1982)

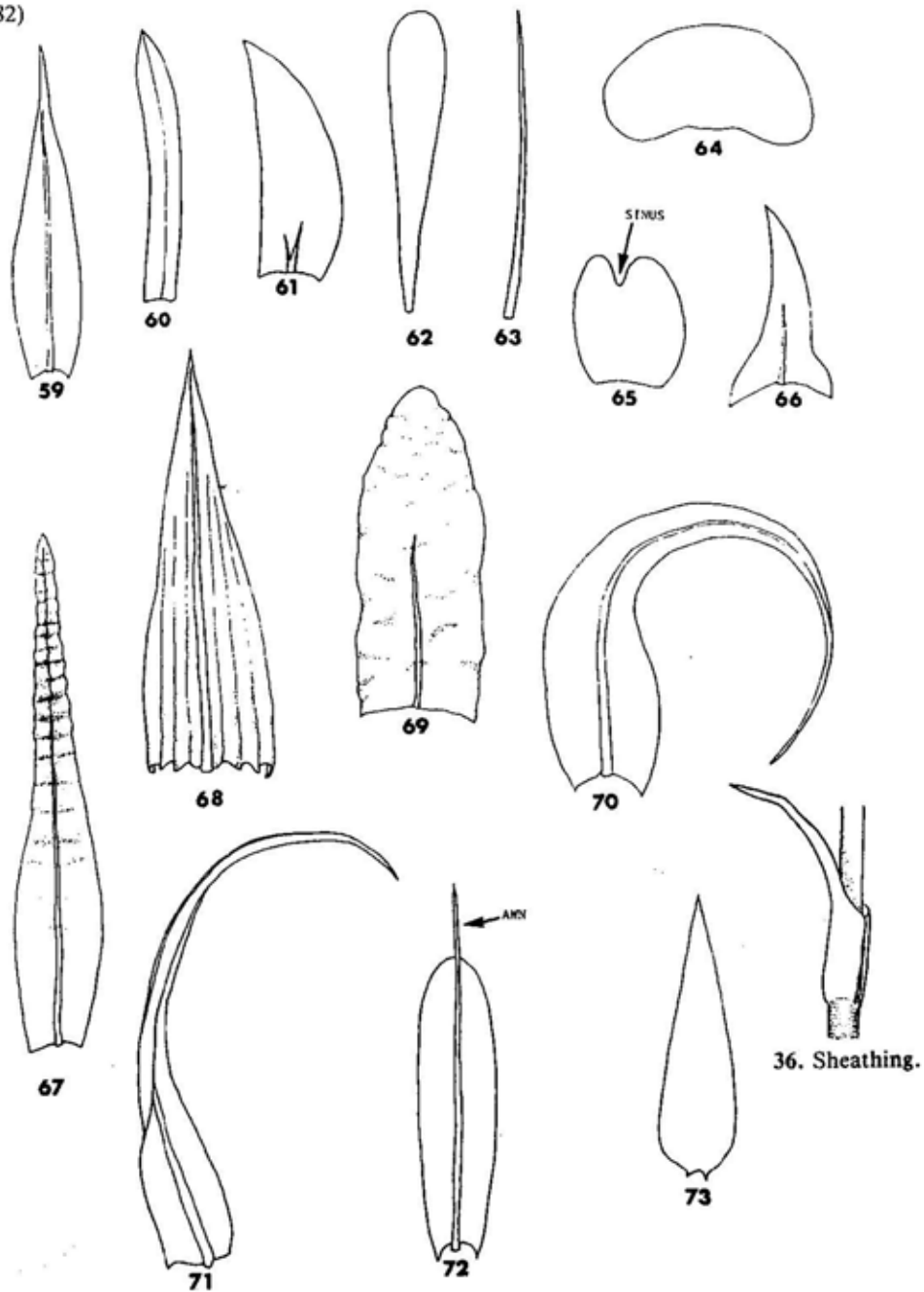


Plate 404. 59. Lanceolate. 60. Ensiform. 61. Cultriform, scalpelliform. 62. Clavate. 63. Acicular. 64. Reniform. 65. Bilobed. 66. Hastate. 67. Undulate. 68. Plicate. 69. Rugose. 70. Circinate, gyrate, uncinata. 71. Falcate. 72. Aristate, piliferous. 73. Ecostate, enervate.

Leaf forms

(Ireland 1982)

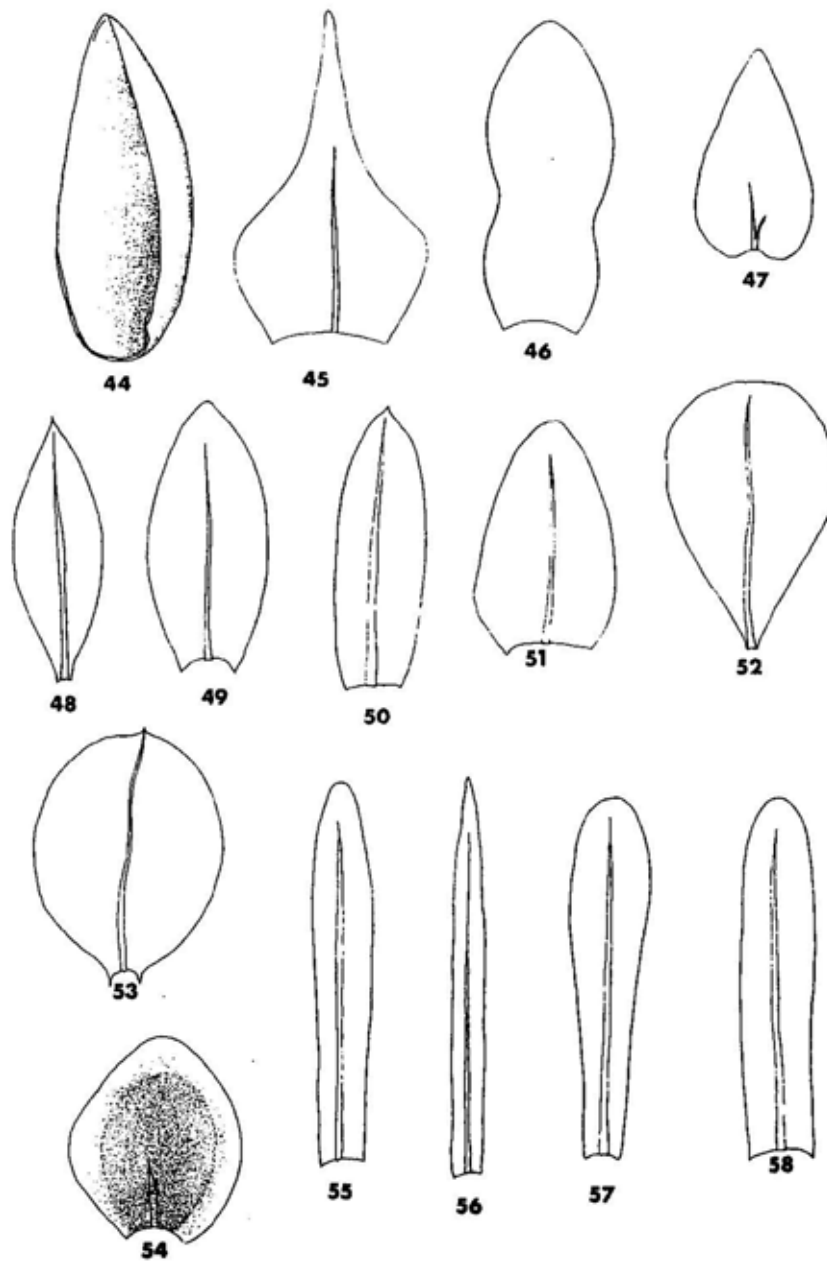
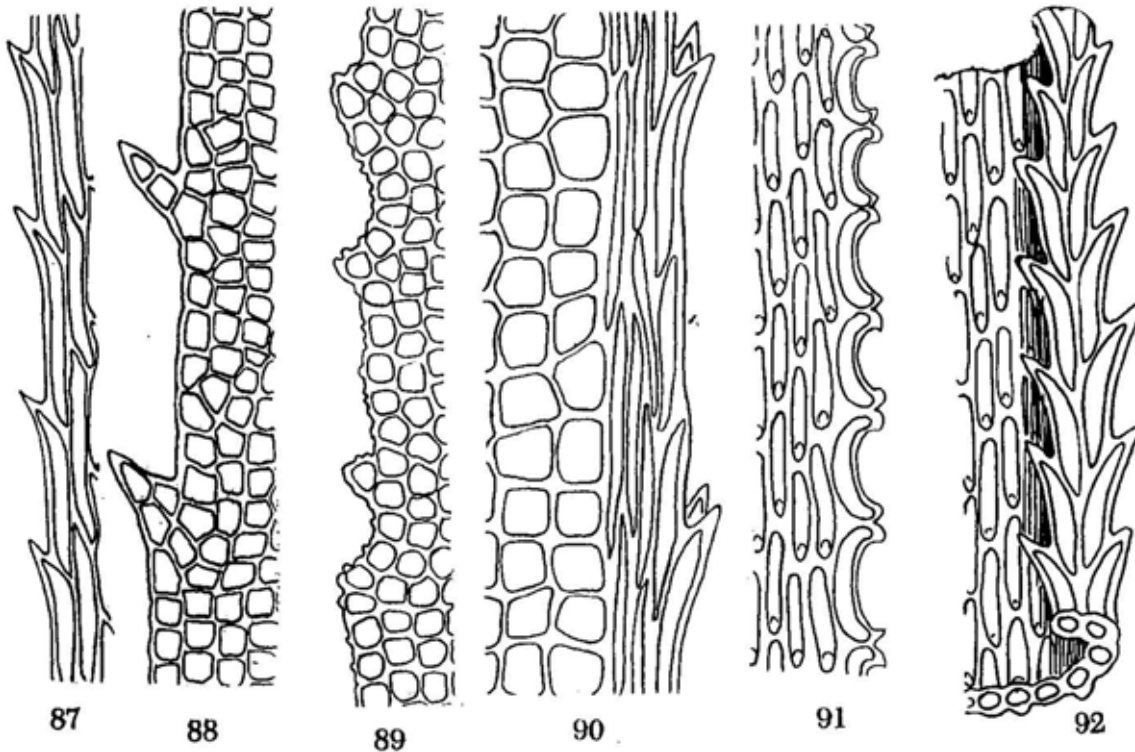


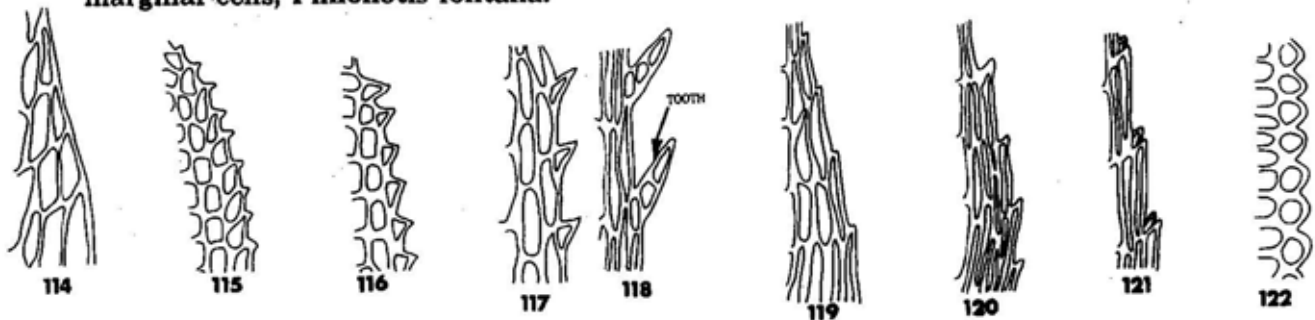
Plate 403. 44. Cymbiform, navicular. 45. Deltoid. 46. Panduriform. 47. Cordate. 48. Elliptic. 49. Oval. 50. Oblong. 51. Ovate. 52. Obovate. 53. Orbicular. 54. Cochleariform. 55. Ligulate. 56. Linear. 57. Spatulate. 58. Lingulate.

Leaf margins

(Flowers 1973, Ireland 1982)



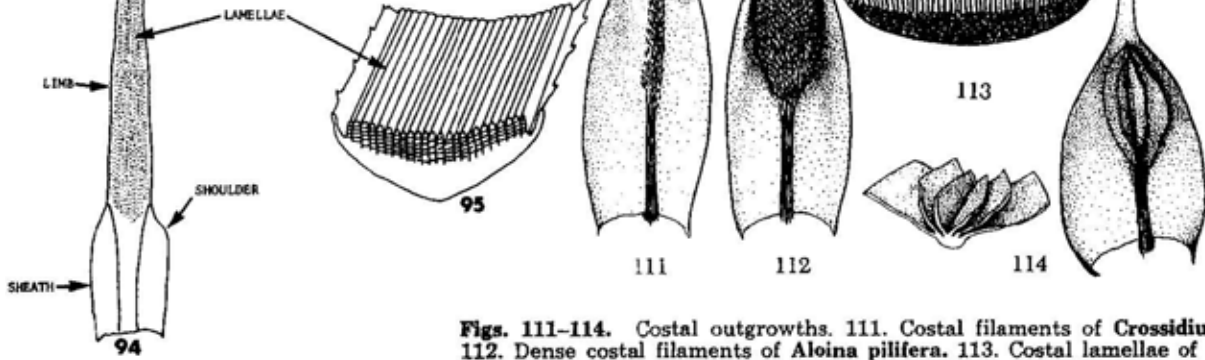
Figs. 87-92. Leaf margins, $\times 120$. 87. Serrate by the projection of the upper ends of the marginal cells, *Brachythecium lamprochryseum*. 88. Serrate, the teeth formed by 1-3 cells, *Timmia bavarica*. 89. Margin irregularly notched, *Trichostomum tenuirostre*. 90. Margins bordered with narrow cells and doubly serrate *Mnium marginatum*. 91. Margin doubly serrate, *Philonotis fontana*. 92. Margins doubly serrate by the projection of the upper ends of the marginal and sub-marginal cells, *Philonotis fontana*.



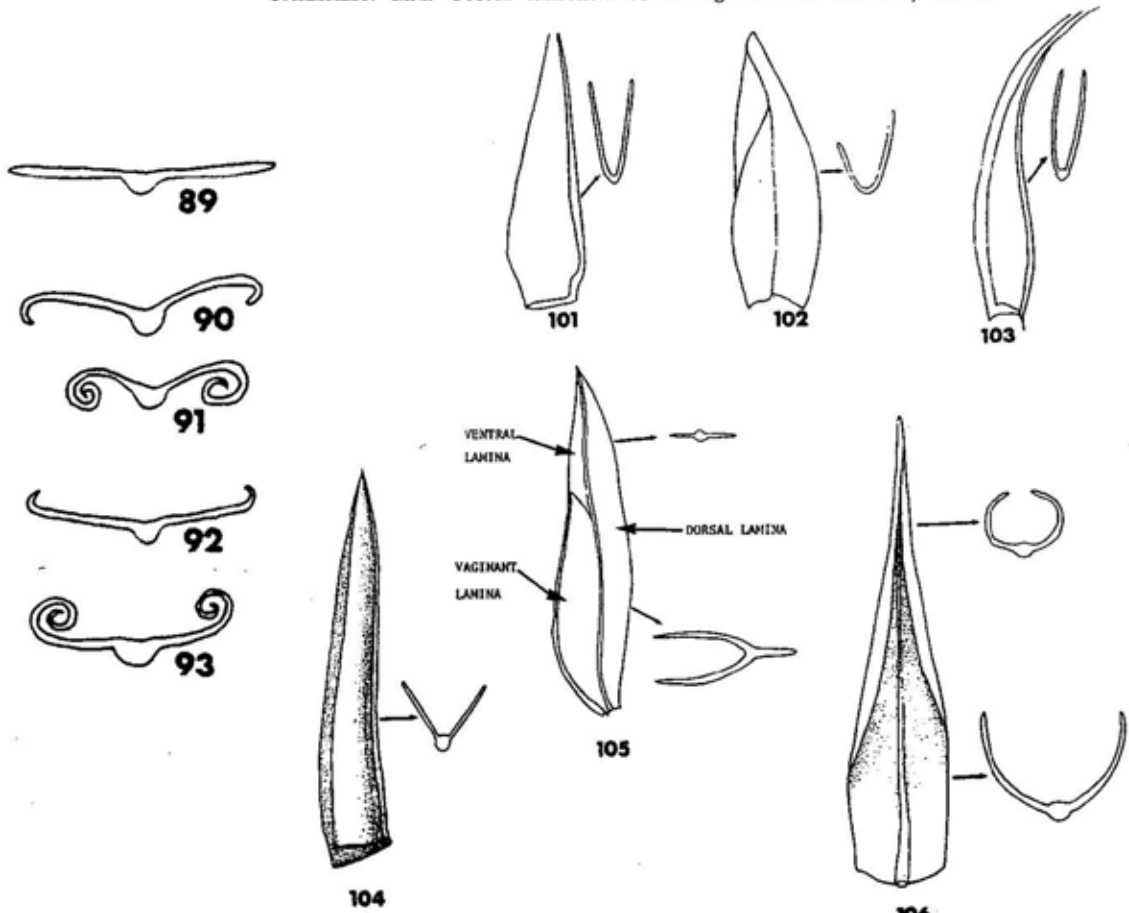
114-122. Leaf margins. 114. Entire, edentate. 115. Denticulate. 116. Dentate. 117. Spiculate. 118. Spinose, toothed. 119. Serrulate. 120. Serrate. 121. Doubly serrate. 122. Crenate.

Leaf cross-sections

(Flowers 1973, Ireland 1982)



Figs. 111-114. Costal outgrowths. 111. Costal filaments of *Crossidium aberrans*. 112. Dense costal filaments of *Aloina pilifera*. 113. Costal lamellae of *Polytrichum commune*. 114. Costal lamellae of *Pterigoneurum ovatum*, $\times 10$.



89-93. Cross-sections of leaves. 89. Plane. 90. Deflexed, recurved, reflexed. 91. Revolute. 92. Incurved, inflexed. 93. Involute. 94. Lamellae on *Polytrichum* leaf. 95. Section of lamellae on *Polytrichum* leaf. 101. Conduplicate. 102. Complicate. 103. Complicate-carinate. 104. Carinate, keeled. 105. Equitant. 106. Canaliculate, tubulose.

Capsule forms

(Ireland 1982)

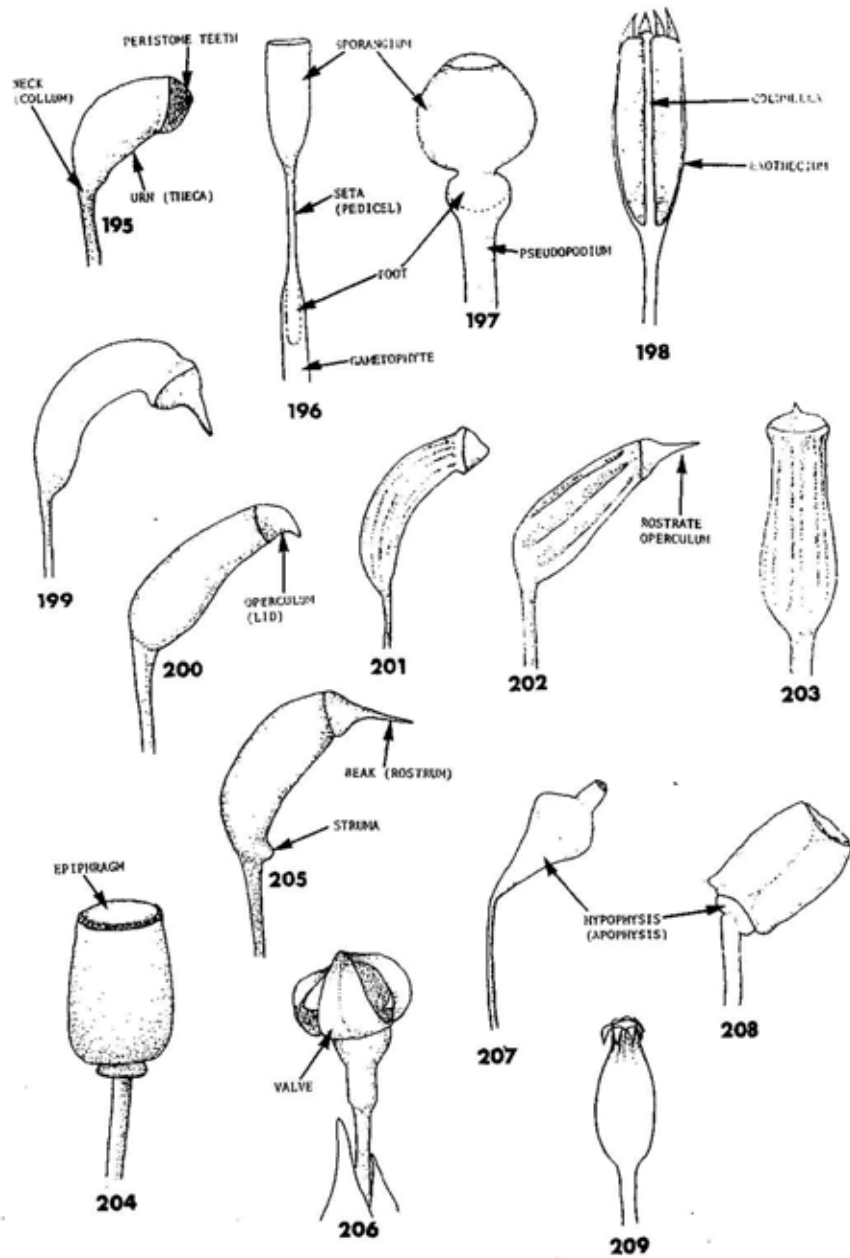


Plate 413. 195. Capsule. 196-197. Sporophyte. 198. Columella (seen in longitudinal section of capsule). 199-209. Capsules. 199. Arcuate. 200. Inclined. 201. Striate. 202. Sulcate. 203. Ribbed. 204. Epiphragm of Polytrichaceae capsule. 205. Strumose. 206. Valves of *Andreaea* capsule. 207. Hypophysis of *Splachnum* capsule. 208. Hypophysis of *Polytrichum* capsule. 209. Coarctate, constricted, strangulate.

Appendix 3: Basic Bryophyte Terminology

Acrocarpous.	Producing the sporophyte at the end of a stem or main branch, as opposed to <i>pleurocarpous</i> ; acrocarpous mosses generally grow erect in tufts (rather than mats) and are sparsely branched.
Acute.	Sharply pointed (less than 90°)
Alar cells.	Cells at the basal angles of a leaf, often differentiated in shape, size or color.
Androgynous.	Bearing male and female sex organs in the same inflorescence
Appressed.	Lying close together or closely applied to the stem.
Archegonium.	The female reproductive organ, a flask-shaped structure producing an egg.
Auricle:	A bulge or earlike lobe at the basal angles of the leaves.
Awn:	A bristle or hair point, usually formed by an excurrent costa.
Ceaspitose.	Tufted, growing in cushions or sods as opposed to mats.
Campanulate.	Bell-shaped, used in reference to broadly mitrate calyptrae.
Capillary.	Hairlike.
Capsule.	The spore case, often differentiated into an upper spore-bearing urn and a sterile basal neck.

Appendix 4: Labelling of Envelopes for Unknown and Reference 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. It is imperative that the labelling used for the envelopes be standardized so ABMP staff can easily review the envelopes and find certain specimens for advanced identification and potentially reducing duplicate “unknown” specimens.

1) Single Unknown Species – Genus Known

ABMP Site: _____ Date: _____ Crew Member: _____ Microhabitat: _____ Plot: _____ <p style="text-align: center;">Brachythecium sp.</p>

2) Multiple Unknown Species – Genus Known

ABMP Site: _____ Date: _____ Crew Member: _____ Microhabitat: _____ Plot: _____ <p style="text-align: center;">Brachythecium sp. Dicranum sp.</p>
--

3) Group of Species – Species IDed and Unknown

ABMP Site: _____ Date: _____ Crew Member: _____ Microhabitat: _____ Plot: _____ <p style="text-align: center;">POHLNUT DICRFRA Dicranum sp.</p>
--

4) Single Species - Unknown

ABMP Site: _____ Date: _____ Crew Member: _____ Microhabitat: _____ Plot: _____ <p style="text-align: center;">Unknown Sp. (Brachythecium like?)</p>

For continuity and credibility, the ABMP will collect one specimen of every species ID’ed within a site. Staff will place these specimens into “Pre-Stamped” envelopes containing a unique reference number. All datasheets contain a column for documenting reference numbers (from envelopes) for each specimen chosen as a reference for that site. Species names DO NOT need to be placed on the envelopes because they are already listed on the datasheets with the corresponding Ref. #.

5) Example of a Reference Specimen Envelope

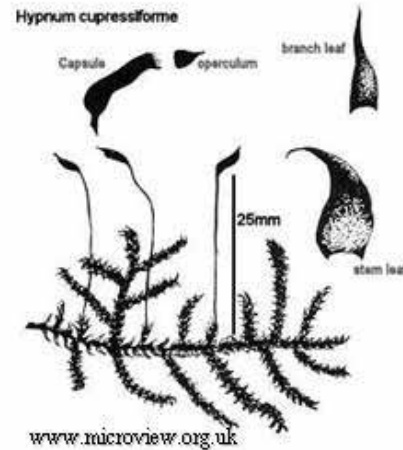
Moss Specimen: <u>2006</u>	Ref. # 138
----------------------------	------------

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

ABMP Site: _____ Date: _____ Crew Member: _____ Microhabitat: _____ Plot: _____ <p style="text-align: center;">POHLNUT DICRFRA Dicranum sp. – same as: 654-TCT-1, 789-TDB-2, 789-TDT-2</p>

Appendix 5: Selected Bryophyte Species for Identification in the Laboratory

Section 1: Pleurocarpus Mosses



Section 1: Pleurocarpus Mosses

- The sporophyte arises laterally (stems usually prostrate and much-branched)

Pleurozium schreberi PLEUSCH

Big red stem, Schreber's moss

Growth form: Pleurocarpous

Habitat: Humus, soil, and other substrates, in dry, open woods and also in bogs and wet coniferous forests

Field characters:

- **Stems and branches red**
- Leaves concave, smooth, and **shiny when dry**
- Branches 1-pinnate
- One of the most common mosses

Similar Species:

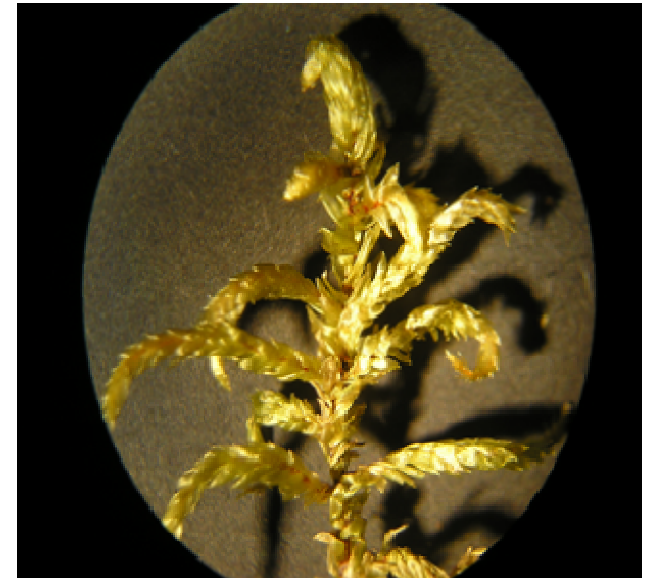
Hylocomium splendens (stair step) – is 2-3-pinnate

Climacium dendroides (tree moss) – has tree-like form

Rhytidiadelphus triquetrus (frightened cat tail moss) – has large, wide-spreading leaves

Vitt et. al.: 107

Notes:



Climacium dendroides

CLIMDEN

Tree moss, everlasting herb, common longevity moss, palm moss

Growth form: Pleurocarpous

Habitat: On soil or humus in moist, shady places in swamps, or depressions in forests, often along streams or at the edges of pools..

Field characters:

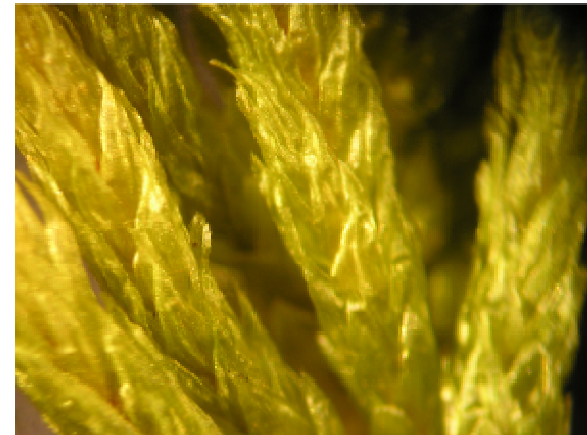
- Plants have a tree-like form, with branches crowded at the tops of the stems
- Leaves are concave and shiny when dry

Similar Species:

C. dendroides looks a lot like *Pleurozium schreberi* (big red stem), especially when it's dry, because of the red branches, but only *C. dendroides* has a tree-like form (vs. 1-pinnate in *P. schreberi*).

Vitt et. al: 113

Notes:



Hylocomium splendens HYLOSPL

Stair-step, mountain fern moss, glittering feathermoss

Growth form: Pleurocarpous

Habitat: Soil, humus, and old, mossy logs, in forests and wooded peatlands

Field characters:

- Branches 2-3 pinnate
- **Plants have 'stair-case' form, with horizontal fronds connected by upward-angling stems**
- Stems and branches red

Similar Species:

Rhytidiadelphus triquetrus (frightened cat tail moss) – has large, wide-spreading leaves

Pleurozium schreberi (big red stem) – is 1-pinnate

Climacium dendroides (tree moss) – has tree-like form

Other common 2-3-pinnate species:

Thuidium recognitum – usually has green stems, no 'stair steps'

Vitt et. al.: 107

Notes:



Ptilium crista-castrensis PTILCRI

Knight's plume, ostrich plume moss, comb moss

Growth form: Pleurocarpous

Habitat: On humus and old, moss-covered logs in rather dry to swampy often coniferous or mixedwood forests

Field characters:

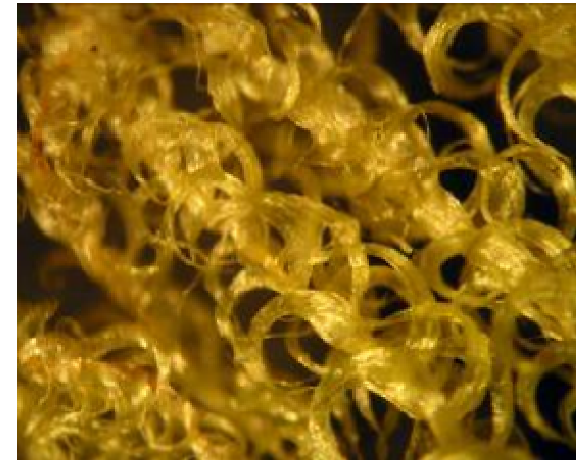
- Leaves hooked and longitudinally creased
- Branches strictly 1-pinnate
- Plants light green-yellow

Similar Species:

- *Sanionia uncinata* which also has hooked, longitudinally folded leaves, but which is much less regularly pinnate.

Vitt et.al: 106

Notes:



Tomenthypnum nitens

TOMENIT

Shining feather moss, golden moss

Growth form: Pleurocarpous

Habitat: Calciphile of muskeg, tundra, rich fens. Commonly found with *Campylium stellatum*, *Aulacomnium palustre*, and *Helodium blandowii*.

Field characters:

- Leaves golden in colour
- Leaves straight, narrowly pointed, erect or erect-spreading, and creased longitudinally
- **Stems 'felted' on under surface with thick brown tomentum**

Similar Species:

Aulacomnium palustre (Ribbed bog moss) also has brown tomentum and inhabits similar types of sites. However, *A. palustre* is acrocarpous and has shorter, blunter leaves that are dull waxy-yellow as opposed to than the shiny golden appearance of *Tomenthypnum nitens*.

Vitt et.al: 97

Notes:



Platygyrium repens

PLATREP

Common flat-brocade moss, copper lustrous moss

Growth form: Pleurocarpous

Habitat: Logs, stumps, and tree bases and trunks, in dry to moist forests

Field characters:

- **Branch tips often ascend from substrate and bear tiny 'pom-pom' clumps of brood bodies**
- Plants have a shiny, 'greasy' look, especially when shaded
- Capsules erect and cylindric

Similar species:

- *Pylaisiella polyantha* is more common (in boreal Alberta) and also occurs at tree bases and woody debris, has erect capsules, and upward-curling branch tips but lacks clusters of brood bodies at the branch tips (visible, with practice, using a hand lens).

Vitt et. al.: 105

Notes:



Eurhynchium pulchellum

EURHPUL

Elegant feather moss, common beautiful-beak moss, little rib moss

Growth form: Pleurocarpous

Habitat: Forest floors (usually deciduous or mixedwood) on rotten wood or humus and at the bases of trees.

Field characters:

- Leaves often standing out from stems and branches
- **Colony wide spreading – frizzy looking**
- Plants frilly and light green
- Leaves (especially stem leaves) quite triangular

Similar Species:

- Like *Brachythecium* spp. but generally smaller.

Vitt et.al.: 94

NOTES:



Sanionia uncinata SANIUNC

(formerly *Drepanocladus uncinatus*)

Sickle moss, hook moss, circle-leaf moss,

Growth form: Pleurocarpous

Habitat: On thin soil or humus, often over rock, decaying wood, and bark at the base of trees, under a range of moisture conditions, but most commonly in upland habitats

Field characters:

- **Leaves often hooked almost to the point of forming circles**
- Leaves longitudinally creased
- Plants usually light yellowish- to brownish-green
- Similar to *D. uduncus* and *P. crista-catrensis*
- Fairly common everywhere

Vitt et.al.: 90

Notes:



Pylaisiella polyantha

PYLAPOL

Aspen moss, stocking moss

Growth form: Pleurocarpous

Habitat: Bases and trunks of deciduous trees, especially aspens, or on recently fallen wood. Occasionally on coniferous trees or rocks.

Field characters:

- Capsules erect and cylindrical
- **Branch tips curve upward**
- Leaves shiny green when dry
- Colonies form 'stockings' on tree bases

Similar species:

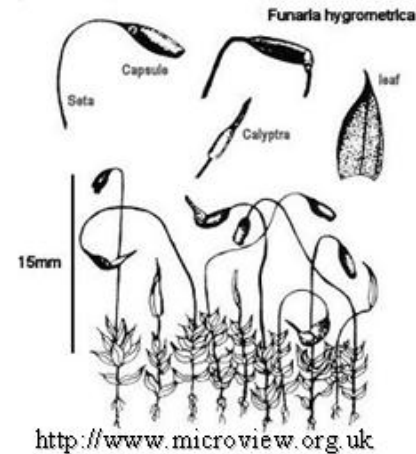
Platygyrium repens, though less common, often also occurs at tree bases, and has erect capsules, and has upward-curling branch tips. *P. repens*, however, has a more greasy, scraggly appearance and has clusters of brood bodies at the branch tips (visible with a hand lens).

Vitt et.al.: 105

Notes:



Section 2: Acrocarpous Mosses



Section 2: Acrocarpus Mosses

- Sporophyte (capsule and stalk) arising from plant apex (note stems usually erect and quite simple)

Orthotrichum obtusifolium ORTHOBT

Blunt-leaved bristle moss, Round-leaved erect rib moss, Obtuse-leaf wood-bark moss, Blunt hood moss

Growth form: Acrocarpous

Habitat: Found mainly on bark of **mature poplar trees**.

Field characters:

- Leaf apices blunt
- Leaf margins erect
- **Leaves expand when sprayed with water**
- Easy moss to identify

Similar species:

- *O. speciosum* which also grow on trees but which have **pointed** leaf apices and lack gemmae. (also easy to I.D. once you have a handle on the two, see reference specimens to compare).

Vitt et.al.: 65

Notes :



Aulacomnium palustre AULAPAL

Neon moss, ribbed bog moss, bog thread moss, marsh thread moss

Growth form: Acrocarpous

Habitat: Wet places - fens, marshes, meadows, wooded swamps, bogs, and brush thickets around ponds or along streams

Field characters:

- Leaves yellowish or yellow-green, 'waxy' when wet
- **Stems 'felted' with thick brown tomentum (fuzz)**
- Plants sometimes bear clusters of brood bodies on green stalks where sporophytes would normally be
- **Strong costa (midvein)**

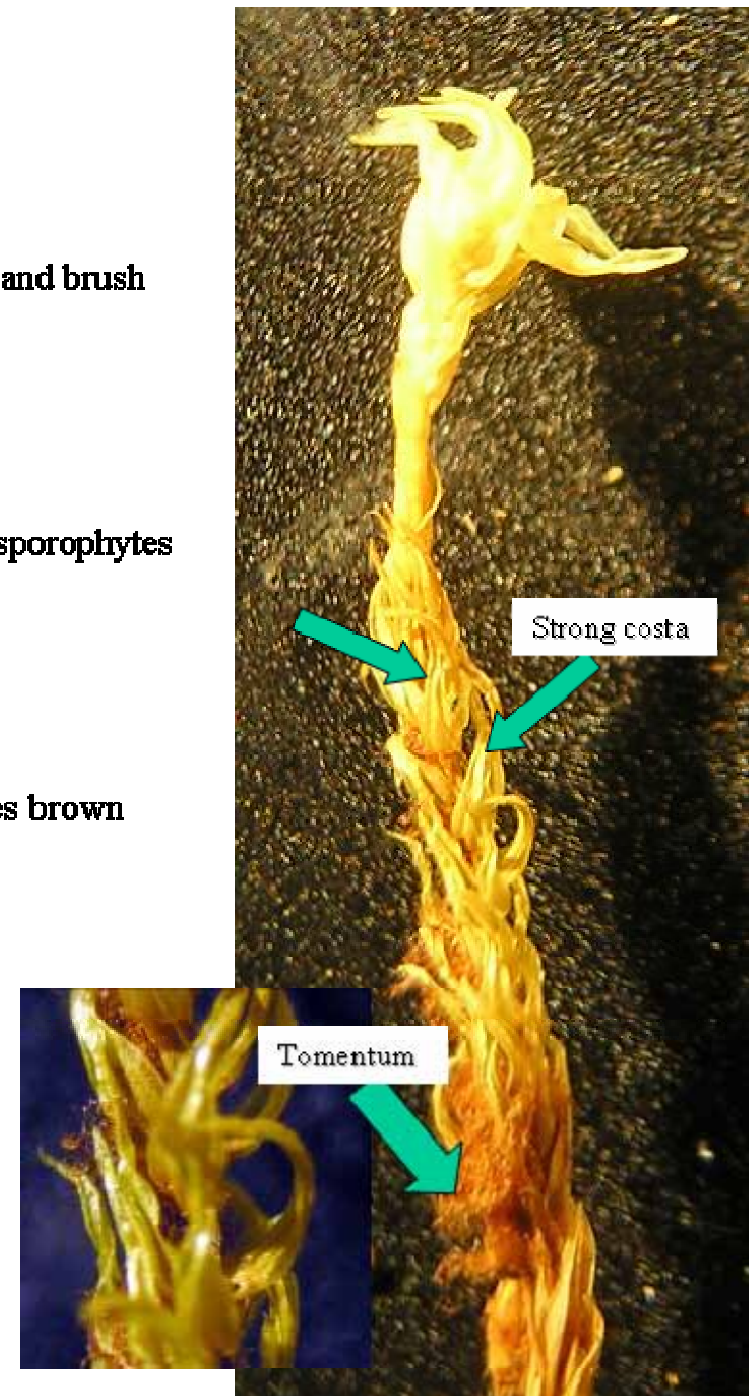
Similar Species:

This species is quite distinctive, and not much can be confused with it.

Tomenthypnum nitens (golden moss) also occurs in wetlands and features brown tomentum but the overall form and leaves of plants are very different.

Vitt et.al.: 78

Notes:



Ceratodon purpureus CERTPUR

Ceratodon, purple horn-tooth, burn moss, purple fork moss, red roof moss

Growth form: Acrocarpous

Habitat: Common in montane and boreal forests on disturbed soils, in open areas it prefers sandy soils.

Field characters:

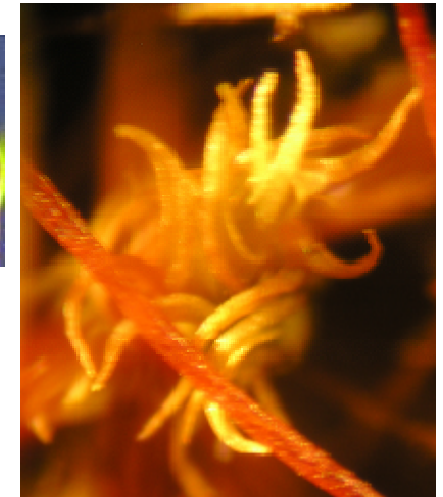
- Capsules and setae dark wine-red
- Capsules curved, 8 ribbed, horizontal, ridged
- Leaves lanolate and margins recurved
- Plants small with leaves contorted when dry, reddish tinge

Similar Species:

- *Pohlia nutans*: whose leaves are not recurved and are toothed along the margin.

Vitt et. al.: 130

Notes:



Capsules are the easiest way to ID Ceratodon

Pohlia nutans

POHLNUT

Copper wire moss, nodding pohlia, sponge gourd moss

Growth form: Acrocarpous

Habitat: Everywhere - on rotten logs, tops of rotten stumps and old *Sphagnum* hummocks, also on soil or humus at the base of trees or on banks and in the crevices of cliffs. Sometimes found on charred wood. In dense forests and open places.

Field characters:

- Setae shiny, copper-coloured
- Red stem
- Capsule nodding
- **NO revolute leaf margins**
- **Serrulate margins**
- Costa ending below apex

Similar Species:

- *Ceratodon purpurescens*: recurved margins, not toothed at apex
- *Bryum* species (which also have nodding capsules and reddish stem). *Bryum*'s often has recurved leaf margins and a more pronounced, excurrent costa.

Vitt et.al.: 70

Notes:



Tetraphis pellucida

Pellucid four-tooth moss, pellucid tetraphis

TETRPEL

Growth form: Acrocarpous

Habitat: Acidophile, most commonly on shaded, old, soft, rotten stumps or logs.

Field characters:

- Leaves broad (in relation to their length)
- **Gemmae cups common at plant apices**
- **Capsules 4-toothed** (visible with hand lens)

Similar Species:

This species might remind one of a miniature *Mnium*-type species because of its broad leaves. It almost always has gemmae cups or sporophytes, both of which differentiate it from *Mnium* sp.

Vitt et.al.: 61

Notes:



Section 3: Liverworts

Thalloid



Conocephalum conicum
www.botany.ubc.ca/

Foliose



Riccia rubrata
www.science.siu.edu

Section 3: Liverworts

- Thalloid liverworts have a gametophyte consisting of a flattened, dorsi-ventral thallus
- Leafy (foliose) liverworts grow mostly horizontal and have three ranks of leaves, 2 lateral and 1 ventral.

Ptilidium pulcherrimum

(liverwort)

PTILPUL

Growth form: Foliose

Habitat: Common on living and dead wood.

Field characters:

- **plant tightly appressed to substrate**
- Leaves deeply divided, fringed with cilia
- dark olive green to reddish brown

Similar Species:

Similar to *P. ciliare*, however *P. ciliare* is not appressed to its substrate like *P. pulcherrimum*

Vitt et. al.: 145

Notes:



Leaves of *Ptilidium* species are deeply divided, so they look fringed (Illustration from Schuster 1966)

Marchantia polymorpha

(liverwort)

MARCPOL

Growth form: Thallose

Habitat: Swampy areas, often abundant after a fire

Field characters:

- One of the largest thalloid liverworts
- Pores are obvious on the thallus and gemmae cups are often present near edges
- Unisexual: Males have lobed discs produced on stalks, female have finger like lobes

Similar Species:

- *Preissa quadrata*, but looks thicker, is smaller and only female portions are on raised stalks w/o finger-like projections

Vitt et al: 154

Notes:

Marchantia polymorpha showing air pores & results of chambered thallus + gemmae cups



Air pores

Gemmae Cups

www.z.uma.edu/~pdravis/marchantiales.htm



Usually have blackened line

Male

Female



Section 4: I.D. Just to Genus

- Sphagnum spp.
- Mniaceae
 - Mnium spp.
 - Plagiomnium spp.
 - Rhizomnium spp.
- Brachythecium spp.
- Bryum spp.

Sphagnum spp.

Peat Moss

SPHA Sp.

Growth form: Sphagnum

Habitat: bogs and fens

Field characters:

- Branches clustered.
- **Branches are attached to stem in groups and are either pendant along the stem or spread outward.**
- Look like POM-POM's
- Varying in color, determination of species

Vitt et.al.: 53-55

Notes:



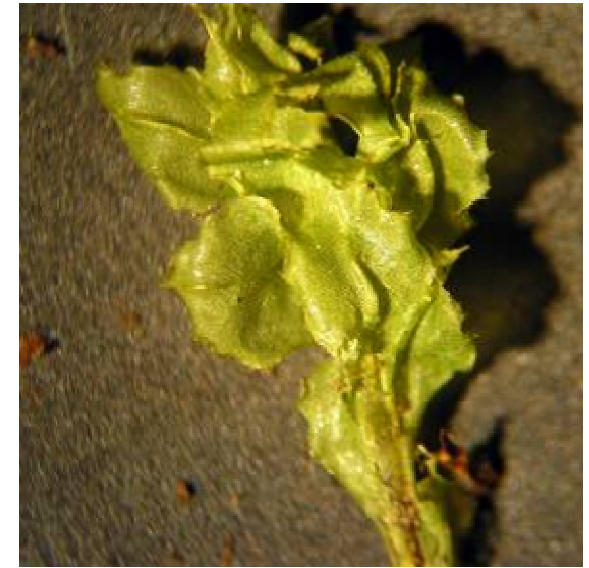
Mniaceae

Growth form: Acrocarpous

Habitat: Varies.

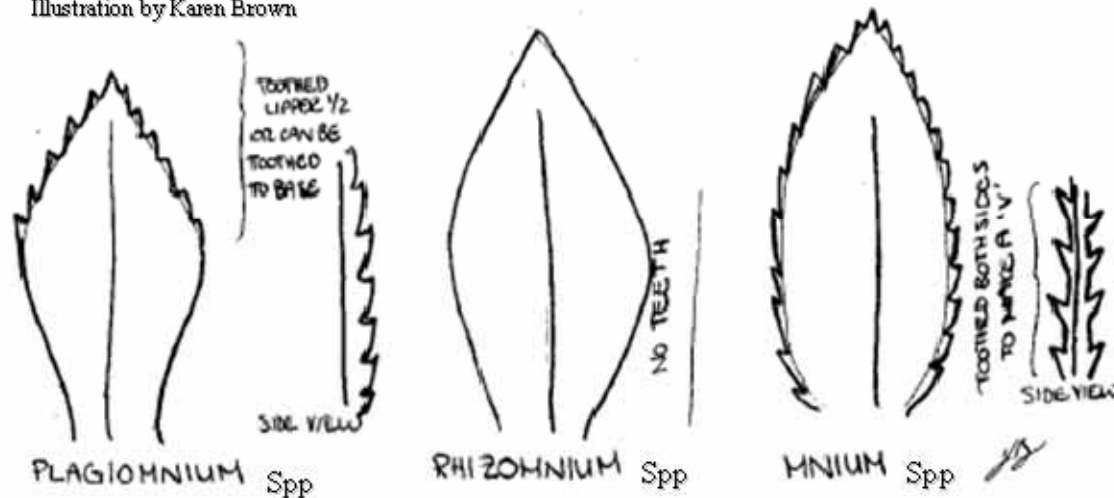
Field characters:

- **Leaves broad in relation to their length, and broader (when moist) than most other groups of moss, look like little plants.**
- Plagiotropic (creeping, sterile) shoots may be present
- Three genera to classify: Plagiomnium (toothed singly), Rhizomnium (no marginal teeth) and Mnium (double toothed along margin) see below.



Vitt et.al.: 73-76

Illustration by Karen Brown



Three genus's of this family differ by their teeth and marginal views



Brachythecium spp.

BRACH Sp.

Growth form: Pleurocarpous

Habitat: mesic to dry habitats, often on logs, humus and soil in montane-boreal forests.

Field characters:

- **shiny**
- Lanceolate leaves, strong single costa, acuminate, and often plicate leaves
- yellow-green color
- Indescript mosses, mostly when it doesn't look like anything else, it's a *Brachythecium*
- 15-20 species in Western Canada

Similar species:

- *Eurhynchium pulchellum* but these mosses are usually smaller in size and form dense colonies that have a frilly appearance.

Vitt et. al: 97 – 99

Notes:



Bryum spp. BRYU Sp.

Growth form: Acrocarpous

Habitat: various

Field characters:

- Capsules are cylindrical, smooth and nodding, positioned on long setae.
- **Almost all spp. have an excurrent costa**
- Not toothed
- **Usually with red stem**
- Leaves bordered by elongate cells
- About 50 varieties and species in Canada

Similar Species:

- *Pohlia* spp. but they have costa ending before apex and nonbordered leaves.

Notes:



Section 5: Advanced Moss I.D.

- *Dicranum* spp.
- *Polytrichum* spp.

Dicranum spp.

- Plants small to large
- In dense, tomentose tufts
- Stems simple or forked
- Leaves generally lanceolate, gradually acuminate, keeled or subtubulose, usually secund, sometimes crisped when dry, not bordered
- Costa well developed, narrow, ending near the apex to shortly excurrent
- Allar cells well differentiated, usually yellow-brown near the margins, hyaline within.



Dicranum polysetum

DICRPOL

Wavy dicranum, wavy broom moss, wavy tail moss

Growth form: Acrocarpous

Habitat: On humus or sometimes on soil, generally in (often coniferous) forests

Field characters:

- **Stem covered in mostly white/light tomentum**
- **Leaves shiny, almost translucent**
- Found on upland sites
- **Leaves stick out perpendicular to stem**
- Watch out for *D. scoparium*, *D. undulatum*



Similar Species:

- **Other Dicranums:** *D. undulatum* (electric eels), which (in contrast to *D. polysetum*) occupies generally much wetter habitats, and which has more erect leaves, forms denser colonies, and bears just one seta per plant, usually more wavy, leaves duller, with dark, rusty brown tomentum.
- *D. scoparium*: leaves lacking waves, leaves not spreading, dense white tomentum.

Vitt et.al.: 124

Notes:

Dicranum undulatum

DICRUND

Electric eels

Growth form: Acrocarpous

Habitat: Peatlands, especially bogs, often growing with *Sphagnum* and black spruce; in forests in northern boreal

Field characters:

- **Stems with brown tomentum**
- Leaves dull compared to *D. polysetum*
- Leaves clustered together and point upwards

Similar Species:

- *D. polysetum* (wavy dicranum), which (in contrast to *D. undulatum*) occupies generally much drier habitats, and which has wide-spreading leaves, forms loose colonies, and bears several setae per plant, tomentum whitish.

Vitt et.al.: 125

Notes:



Stem with brown tomentum

Dicranum flagellare

DICRFLA

Flagellate dicranum, Whip fork moss, Upright-fruited fork moss, Flagellate fork moss, Delicate hair tie moss, Flagella broom moss

Growth form: Acrocarpous

Habitat: Common on rotten wood or sometimes on humus, peaty soil, or tree bases in upland habitats.

Field characters:

- Clusters of flagellate (whip-shaped) branchlets among leaves
- Capsules (when present) erect
- Leaves narrow in relation to their length
- Watch out for similarity with other species of *Dicranum* in boreal Alberta.

Similar Species:

- other *Dicranum* spp. But only one with flagellate branches

Vitt et.al.: 126

Notes:



D. flagellare usually bears clusters of flagellate branches (indicated by arrows) among the leaves

Dicranum fragilifolium

DICRFRA

Fragile Dicranum Moss

Growth form: Acrocarpus

Habitat: found by rock and on wood, humus soils

Field Characters:

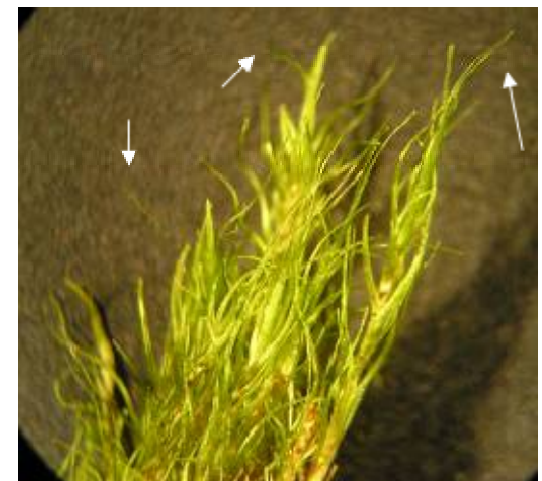
- **Leaves often broken at tip**
- **Leaves straight and rigid**
- Thick brown tomentum on stem base
- Really long thin leaves
- Grows on rotten wood or tree base

Similar Species:

- Like other *Dicranum* spp. But only one with fragile tips that break off.

Vitt et.al.: 126

Notes:



Polytrichum spp.

- Coarse and often robust
 - Rigid perennias in loose to dense, dark-green, yellowish-, bluish-, or brownish-green tufts
 - Radiculose only at the base, or sometimes well up the stems
 - Stem erect, sometimes from a decumbant base
 - Leaves erect or erect-spreading when dry, erect-to wide spreading and recurved when moist
 - Long-lanceolate to subulate-lanceolate from an enlarged, sheathing base, usually \pm awned
 - Costa usually excurrent, toothed awn (sometimes forming a hair point).
- Name refers to the dense hairs of the calyptra (thin structure enclosing the developing sporophyte)



Polytrichum juniperinum POLYJUN

Juniper hair-cap, juniper-leaved hair moss, juniper bear moss, juniper moss

Growth form: Acrocarpous

Habitat: On soil or humus, sometimes on stumps, characteristic of banks or trail sides in rather **dry, open woods or pastures**, but common in many habitats

Field characters:

- Plants resembling miniature conifers
- Capsules angled in cross-section
- **Leaf margins untoothed and folded in over ventral surface of leaf**

Similar Species:

Other common species of *Polytrichum* (all resembling miniature conifers and featuring angled capsules) in Alberta include:

P. commune (common hair cap) – has toothed leaf margins, and is usually taller than *P. juniperinum*

P. strictum (slender hair cap) – has shorter, finer leaves and taller plants than *P. juniperinum*, and grows in wet places

P. piliferum (awned hair cap) – has long, white hairs at the tip of each leaf



Vitt et.al: 57

Notes:

Polytrichum commune

POLYCOM

Common hair-cap, common hair moss, large bear moss

Growth form: Acrocarpous

Habitat: On soil, humus, and rocks in wet habitats, in pastures and meadows, and at the edges of bogs or coniferous swamps

Field characters:

- Plants look like miniature conifers
- Capsules angled in cross-section
- Plants large
- **Leaf margins toothed and erect**
- **Does not have tomentum**

Similar Species:

- Other *Polytrichum* species (none have toothed margins)
- *Pogonatum* species, which also have toothed margins, but rare, and is generally smaller in stature. Be especially careful in upland habitats.

Vitt et.al.: 56

Notes:



Polytrichum strictum

POLYSTR

Slender hair-cap, narrow-leaved hair moss, bog bear moss

Growth form: Acrocarpous

Habitat: Closely associated with *Sphagnum* in open and wooded bogs and poor fens, common in boggy heaths, typically found at the top of old hummocks.

Field characters:

- Plants resembling miniature conifers
- **Stems tall**
- **White tomentum**
- Leaf margins untoothed and folded in over ventral leaf surface

Similar species:

- like other *Polytrichum* spp., only one slender with dense white tomentum

Vitt et.al.: 57

Notes:



Polytrichum piliferum

Awned hair-cap, bristle-pointed hair moss, hair bear moss

POLYPIL

Growth form: Acrocarpous

Habitat: Pioneer of dry, sterile, sandy, or gravelly soil or rocks in exposed places, often at roadsides or in old fields.

Field characters:

- Leaves tipped with long, white hair points
- Leaves thick, fleshy, narrow
- Leaf margins untoothed and revolute

Similar species:

- *Tortula ruralis* but these leaves are spreading and wide.

Vitt et.al: 58

Notes:

