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A Guide to Alaskan Black Spruce Wetland Bryophytes

Species Specific to Delineation
for Interior and South Central Regions

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**A GUIDE TO ALASKAN BLACK SPRUCE WETLAND BRYOPHYTES:
Species Specific to Delineation for Interior and South Central Regions**

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INTRODUCTION

Currently, there is an effort underway to update and revise the U.S. Army Corps of Engineers (Corps) wetland delineation manual (Wakeley 2002) in support of Section 404 of the Clean Water Act (CWA) (33U.S.C.1344). As part of this updating, the United States has been divided into ten subregions. The new subregion boundaries follow an ecosystem-based region classification that has also been used in the development of national hydric soil indicators (NRCS 2006). As part of this effort, the State of Alaska has been designated as one of these 10 subregions.

During development of the Alaskan wetland supplement (U.S. Army Corps of Engineers 2007), the Vegetation Working Group, composed of advanced delineators who assisted in revising the new wetland supplement, decided to develop a cryptogam indicator for the black spruce vegetation type. This vegetation type was selected because it is usually considered to be hydrophytic but frequently extends beyond the wetland boundary. The occurrence of hydrophytic black spruce vegetation outside of wetlands is problematic and confusing for field delineators in Alaska who are trying to locate the wetland boundary using the three-factor approach of hydrophytic vegetation, hydric soils, and hydrology. The purpose of the cryptogam indicator is to assist in establishing a hydrophytic vegetation boundary within the black-spruce-dominated vegetation that aligns closer to the hydric soil and hydrology indicators. To develop the cryptogam indicator, a study was undertaken to select high-fidelity cryptogam species that could reliably locate that part of the black spruce community that closely aligns itself with hydric soils and hydrology indicators.

To develop and test this cryptogam indicator, a series of studies were undertaken during 2004 and 2005 in several black spruce community types in the Anchorage (South Central Alaska) and Fairbanks (Interior Alaska) areas. The aim of these studies was to survey cryptogam species occurring within wetland black spruce communities, reduce the list of cryptogams based on sampling, and test a select group of highly reliable species that occur only within the wetland boundary. If the high-fidelity wetland species were present at a certain abundance level at any given site, then it would meet the wetland hydrophytic vegetation criterion and could be used to establish the hydrophytic boundary within the black spruce community.

The 2004 and 2005 sampling results obtained from black spruce vegetation types in Anchorage and Fairbanks yielded 17 species of bryophytes that had a high fidelity for wetland conditions (Lichvar et al. 2008). Mushrooms were not included because of their ephemeral nature, and lichens were found to be responding to other environmental variables besides hydrologic conditions and therefore were also not considered further. During the testing phase, it was discovered that the bryophyte flora on the tops of hummocks within wetlands included both upland and wetland species, but only wetland bryophytes were found in the hollows at the base of the hummocks. Thus, the bryophyte species in hollows were selected as the model indicator organisms.

The Alaskan Vegetation Working Group (2005) proposed the following cryptogam indicator formula to meet the hydrophytic vegetation criterion for black spruce areas where the vascular flora has been altered by fire or disturbance (U.S. Army Corps Engineers 2007):

$$\text{Cryptogam Indicator} = \frac{\text{wetland bryophyte cover}}{\text{total bryophyte cover}} \times 100\%$$

where *wetland bryophyte cover* is the sum of the cover of the selected wetland bryophytes in the table below, and *total bryophyte cover* is the sum of all bryophyte cover. Hydrophytic vegetation is present if the cryptogam indicator is $\geq 50\%$.

To determine whether hydrophytic vegetation is present using the cryptogam layer, aerial cover estimates are recorded for all bryophytes within a plot. Sampling of cryptogams is restricted to the hollows between and at the base of the hummocks. A 10- by 10-in. (25- by 25-cm) quadrat is used. To ensure that the sampling plots adequately capture species diversity, three cryptogam quadrats are suggested and placed around the base of the hummock, if space is available. Data from these three plots can be combined and averaged to determine whether or not the cryptogam indicator is met.

2005 List Of Wetland Bryophytes

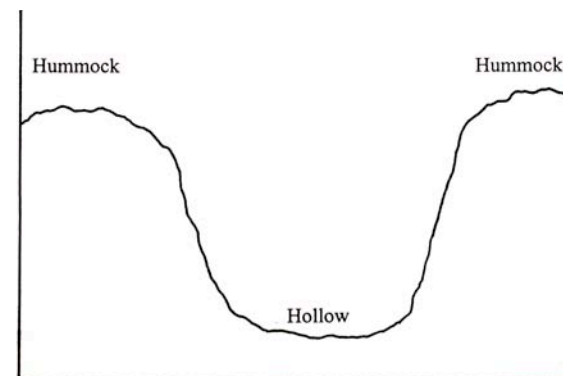
Mosses:

Aulacomnium palustre (Hedw.) Schwaegr.
Straminergon stramineum (Dicks. ex Brid.) Hedenas.
Drepanocladus aduncus (Hedw.) Warnst.
Meesia triquetra (L.) Aongstr.
Meesia uliginosa Hedw.
Pohlia prolifera (Kindb.) Broth.
Polytrichum strictum Menzies ex Brid.
Sphagnum angustifolium (Warnst.) C.E.O. Jensen
Sphagnum fuscum (Schimp.) Klinggr.
Sphagnum papillosum Lindb.
Sphagnum russowii Warnst.
Sphagnum squarrosum Crome.
Sphagnum warnstorffii Russ.
Tomentypnum nitens (Hedw.) Loeske

Hepatics:

Blepharostoma trichophyllum (L.) Dumort
Calypogeia sphagnicola (Arnell & Persson) Warnst. & Loeske
Mylia anomala (Hook.) S. Gray

Note: Nomenclature used in this document follows that in current use in the *Flora of North America: Mosses* and the TROPICOS Moss nomenclatural database (<http://mobot.mobot.org/W3T/Search/most.html>).



This field guide is intended to make identification of the seventeen wetland indicator bryophytes easier for field delineators using the cryptogam indicator. Keys used in this field guide were developed by students (See list of participants in Appendix 1) during a series of two-day sessions of wetland bryophyte identification classes taught at the University of Alaska campuses in Anchorage and Fairbanks in 2006. The keys are based on macro (easily discernible) features and are intended for field use. For each of the bryophytes keyed in this guide, illustrations of important field features are provided. In addition, other look-alike species are listed, and keys are provided to help distinguish them. A glossary of technical terms is at the end of this guide. As the species presented here are based on a high affinity to black spruce wetland communities, we do not encourage the use of these species in wetland delineation in other community types in Alaska.

WHAT ARE BRYOPHYTES?

Characteristics of Bryophytes

Bryophytes have traditionally included the Mosses (Musci), Liverworts (Hepatics), and Hornworts (Anthocerotales).

The sexual reproductive life cycle of a bryophyte has two alternating generations. The haploid (1n) generation begins from a germinating spore, resulting is a protonema that later gives rise to the gametophyte (1n) stages, which develops male antheridia and female archegonia. The diploid (2n) generation forms after fertilization and develops into a sporophyte. The sporophyte has a stalk (seta) and sporangium (capsule). Within the capsule, spore mother cells (2n) undergo meiosis, developing four (1n) spore tetrads. The cycle is completed with the germination of the 1n spores that again develop into 1n protonema. Asexual reproduction can also occur through the development of specialized propagules (e.g., gemmae, propagules, bulbils, tubers) or by "fragmentation."

The classification of Bryophytes is based on characteristics of both gametophyte and sporophyte generations. Often, however, sporophytes are either not available or, as with some bryophytes, not produced. Correct identification and taxonomic placement may, therefore, be both difficult and problematic. Careful, not cursory, observation is critical, as the plants themselves are generally small and the important features and structures may be difficult to see clearly.

In recent years, molecular genetic studies have provided another technique for examining the interrelationships of species, genera, and families. Molecular genetic studies have, in many instances, turned our traditional ideas of classification on their collective heads.

Field Identification

The species selected as wetland indicators should be readily identifiable using features visible with the aid of a 10× magnification hand lens using material without spore capsules. Additional clarifying characteristics can be checked using a microscope.

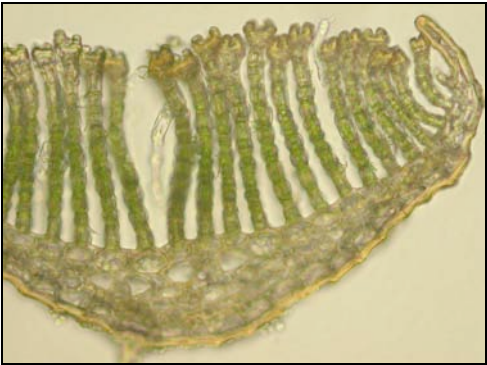
Moss Characteristics	Liverwort Characteristics
Gametophore is always leafy, generally with more than three rows of leaves.	Gametophore is leafy with 2–3 rows of leaves or is thallose (strap-like) without leaves.
Leaves of gametophore have a single layer of cells for the most part, except for the costa and occasionally elsewhere. Leaves are rarely lobed.	Leaves are generally a single layer of cells thick, often lobed, and lack a costa. Cells of the gametophore often contain complex oil bodies.
Sporangium opens usually by an apical lid (operculum).	Sporangium usually opens by four longitudinal slits and contains elaters (except in <i>Riccia</i>) that aid spore dispersal.
When the operculum falls loose, it usually exposes peristome teeth that are often hygroscopic.	There are no peristome teeth.
The seta elongates before the sporangium matures.	The seta is colorless, delicate, and short lived.

Mosses

In the field, it is mostly features of the gametophyte plant (stature, leaf characteristics) that are used in identification. *Sphagnum*, as a group, can be recognised by having many branches that are grouped together in clusters (fascicles). *Polytrichum* and related genera can be recognized by the lamellae of green photosynthetic tissue arranged vertically on the upper (adaxial) surface of the leaves. The number of rows of leaves and the leaf size, shape, and arrangement (overlapping, separated, flattened into one plane, curved, etc.) all provide useful key characters. Leaves may have a distinct marginal border or have toothed margins (both can usually be seen with a hand lens), or they may have longitudinal pleats (folds that look like lines). The stem length may vary considerably. However, whether or not the plants grow erect or prostrate, whether they are branched or not, the arrangement of branches (e.g., pinnate like a fern frond, close together, spread far apart, all around the stem or more or less in one flattened plane, etc.) are useful key identifying characters. Stems may bear rhizoids (hair-like filaments) at the base, all along the stem, or as clusters, and the rhizoids may be dense or sparse, colored or colorless (appearing white).



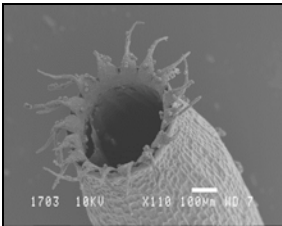
Characteristic appearance of *Sphagnum* plants and arrangement of branches in clusters (fascicles) as shown by *Sphagnum squarrosum*.



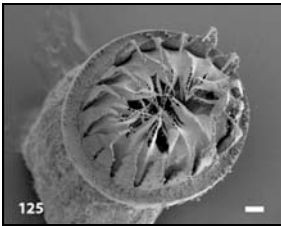
Characteristic appearance of *Polytrichum* species and arrangement of photosynthetic lamellae on leaves as shown in *Polytrichum commune*.

Details of the sporophyte, particularly the peristome teeth, can be critical in species identification. However, microscopic examination is often needed.

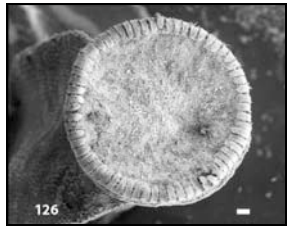
Apart from being a structure of great physical beauty, the peristome in mosses has great taxonomic significance. The peristome is located at the mouth of the spore-bearing capsule and is divided into 4, 8, 16, 32, or 64 teeth. The teeth are arranged in a single or double (rarely more than two) row. In some mosses there are no peristome teeth. The shapes and sizes of peristome teeth vary widely. The peristome in mosses serves to control the release of spores. The teeth are hygroscopic and move in response to moisture content. The teeth are usually held erect and closed together when moist, separating and spreading when drying out. Spores are able to freely escape when the peristome is dry.



Racomitrium – single peristome, each tooth split longitudinally into two filaments.



Bryum – double peristome.



Polytrichastrum – 64 small teeth covering small apertures in a membrane, which covers the capsule mouth.

Examples of moss peristomes.

Liverworts

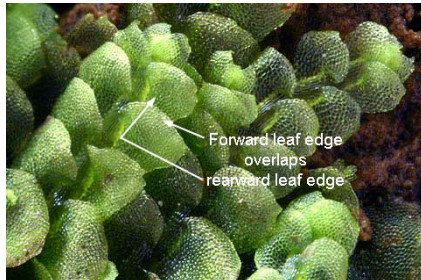
Many liverworts are small and less easy to see or recognize than the mosses. Some of the critical features (underleaves, oil bodies, sporophytes borne in a subterranean marsupium or sac) can be very difficult to see. Identification of the indicator species can be reasonably done using a hand lens.

The number of rows of leaves and their arrangement on the stem and shoots is a key taxonomic character of leafy liverworts. Leafy liverworts have leaves arranged in two or three rows along the stems or shoots. To determine the arrangement of the lateral leaves, examine the shoot from its upper (dorsal, away from the substrate) surface. Often the plants are lying horizontal or flat on the surface, and the dorsal surface is then obvious. If the shoots happen to be erect, examine the shoots for any fine, colorless rhizoids. They will only be present on the ventral side.

The leaf arrangement is called succubous when the forward edge of a leaf (as viewed from above) lies below the rearward edge of the next leaf towards the shoot apex. The leaf arrangement is called incubous when the side or edge of a leaf towards the shoot apex lies above the rearward edge of the next leaf towards the shoot apex.



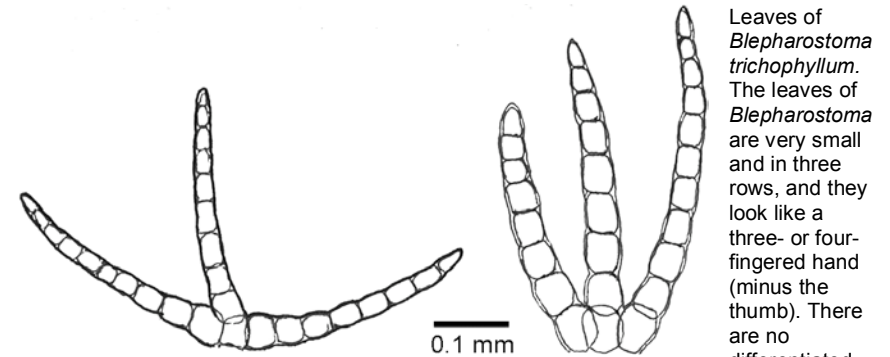
Succubous leaf arrangement in *Chiloscyphus*. (Image Jonathan Sleath, used with permission.)



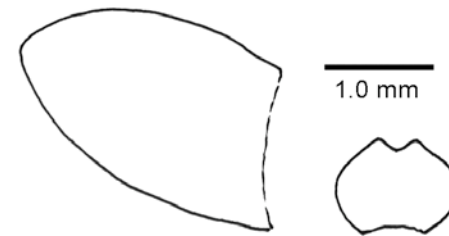
Incubous leaf arrangement in *Calypogeia*. (Image Des Callaghan, used with permission.)

Arrangement of lateral leaves in leafy liverworts.

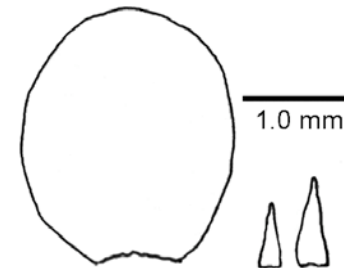
The leaves of liverworts may be all of similar morphology, or a third (ventral) row of leaves may be smaller and of different shape and referred to as underleaves. The underleaves may be only slightly smaller than the lateral leaves, or they may be considerably smaller or even reduced to just a few cells. Careful (microscopic) examination is needed to confirm their presence or absence. To search for underleaves, look carefully at the ventral or lower surface. Underleaves will be found on the stem at the base of the lateral leaves and may be camouflaged by rhizoids.



Leaves of *Blepharostoma trichophyllum*. The leaves of *Blepharostoma* are very small and in three rows, and they look like a three- or four-fingered hand (minus the thumb). There are no differentiated underleaves.



Lateral and underleaves of *Calypogeia sphagnicola*. The lateral leaves of *Calypogeia* are a pale whitish-green or light green and are wide-spreading from the stem. From above, the shoots look flat. The leaf tips are also slightly pointed, not round. The underleaves are smaller, rounded and notched at the apex.



Lateral and underleaves of *Mylia anomala*. The lateral leaves of *Mylia* are usually tinged with orange-brown or may be slightly purple-brown. They have rounded margins, closely overlap, and are often more or less vertically aligned (turned upwards and inwards towards the stem). The underleaves are lanceolate-triangular, very small, and difficult to see.

FIELD KEY TO ALASKAN WETLANDS DELINEATION BRYOPHTES

The following is specific to the 17 wetland bryophytes used for wetland delineation purposes in Alaska. Generally these 17 bryophytes are restricted to the hollows between hummocks in black spruce forests in the Anchorage and Fairbanks regions. Many other bryophyte species are similar in appearance to these wetland bryophytes and could be mistakenly keyed here; these similar species are described along with the species to which they are most similar.

1. Branches originating in groups (fascicles) along stems (*Sphagnum*).....2
1. Branches not originating in groups.....7
 2. Plants robust; branches fat; leaves with rounded hooded apices; outer stem cortical cells (use microscope) with fibrillar thickenings3
 2. Plants small to robust; branches relatively slender, the leaf apices channelled, not hooded; outer stem cortical cells without fibrillar thickenings4
3. Plants greenish-brown to golden- or pinkish-brown; spreading branches short and blunt-pointed; stems brown to greenish-brown; stem leaves rectangular to spade shaped (SE and SC AK)*Sphagnum papillosum*
3. Plants pinkish-red to wine-red; spreading branches short with tips pointed, not blunt; stems reddish; stem leaves rectangular to tongue-shaped (throughout AK)*Sphagnum magellanicum*
 4. Plants robust, pale green to yellowish-green; branches with upper part of leaves strongly squarrose (bent outwards at 90° to branch)*Sphagnum squarrosum*
 4. Plants small to medium-sized, green, brownish to pink, mottled pink and green to reddish; branches with leaves appressed or somewhat divergent but not squarrose.....5
5. Plants compact, with well-developed capitulum (cap), green to yellowish-green.....*Sphagnum angustifolium*
5. Plants compact to loose, capitulum small, green to mottled green and pink, or reddish6
 6. Plants green to yellow-brown to dark brown; stems greenish-yellow to pale to dark brown; stem leaves broadly fringed across apex*Sphagnum fuscum*
 6. Plants green to mottled pink and green to pink; stems pale pink; stem leaves fringed only across central part of apex.....*Sphagnum russowii*
7. Stems densely hairy8
7. Stems with few scattered hairs or hairs confined to base of stems.....12
 8. Leaves long, slender, flat needle-like.....9
 8. Leaves not flat needle-like.....11
9. Leaves with toothed margins*Polytrichum commune*
9. Leaves with margins appearing smooth, but hyaline and folded in over adaxial surface of leaf blade.....10
10. Stems with a dense felt of whitish to pale brown hairs; leaves green, not with waxy appearance.....*Polytrichum strictum*

10. Stems without hairs or, if present, sparse and brownish; leaves usually with bluish waxy appearance*Polytrichum juniperinum*
11. Shoots mostly horizontal, forming glossy green to (mostly) yellowish- or golden-brown mats, with many branches and appearing frond-like; stems with brown rhizoids on underside; leaves closely overlapping, narrowly triangular lance-shaped, longitudinally pleated, margins not or narrowly recurved.....*Tomentypnum nitens*
11. Shoots horizontal to mostly erect, in loose yellowish-green to brownish-green tufts; stem leaves erect-spreading, oblong-lanceolate, margins strongly recurved that, with costa, look like three longitudinal lines on leaf.....*Aulacomnium palustre*
 12. Leaves and plants very small, leaves consisting of a short base with three to four finger-like lobes*Blepharostoma trichophyllum*
 12. Leaves larger, of various sizes, not lobed.....13
13. Leaves broad oval-shaped to ± rounded in outline.....14
13. Leaves variously shaped but not rounded in outline15
 14. Plants green to dark green; leaves 3–6 mm long, 2–4 mm wide, with costa (midrib); stems black or brown*Rhizomnium pseudopunctatum*
 14. Plants green to yellow- to reddish-brown; leaves 1–1.5 mm long, lacking costa (midrib)*Mylia anomala*
15. Shoots usually flat on ground; plants flattened with two obvious rows of ovate triangular leaves, the third row of underleaves very small*Calypogeia sphagnicola*
15. Plants of various growth form, not flattened, with more than two obvious rows of leaves16
 16. Shoots elongate, with usually many side branches.....17
 16. Shoots short or somewhat elongate, not or seldom branched18
17. Plants green to dark or blackish-green; shoot and branch tips curved, pointing to one side; leaves with an oval base, then gradually tapering to a slender point*Drepanocladus aduncus*
17. Plants yellowish-green to light green; shoot and branch tips straight, blunt, finger-like*Straminergon stramineum*
 18. Leaves long, slender, flat needle-like*Polytrichum commune*
 18. Leaves not flat needle-like.....19
19. Leaves in three rows along stems, margins toothed.....*Meesia triquetra*
19. Leaves in more than three rows along stem, margins not obviously toothed.....20
 20. Leaf costa (midrib) wide, more than half the width of leaf base.....*Meesia uliginosa*
 20. Leaf costa (midrib) narrow, one quarter or less the width of base.....21
21. Leaves dark green, close together around stems, usually with reddish base, margins rolled over (recurved), apex mostly tapering to narrow tip ...*Bryum pseudotriquetrum*
21. Leaves bright green, close together near shoot apex, often somewhat separated along the stems, margins flat, not recurved, apex mostly broadly acute, not tapering to a narrow tip*Pohlia prolifera*

Aulacomnium palustre (Hedw.) Schwaegr.

Plants in loose to dense yellow-green to brownish-green tufts or extended patches.

Stems to 10 cm or more long, matted together below with brown tomentum.

Stem leaves to 4 mm long, crisped or slightly twisted when dry; erect-spreading when moist, keeled, oblong-lanceolate, tapering to an acute or somewhat obtuse apex, the basal angles of the leaf slightly decurrent; margins recurved below on one or both sides, entire to finely denticulate above; costa ceasing below the leaf apex; lamina cells thick-walled, irregular to quadrate, with one conical mamilla on each face.

Asexual gemmae, when present, borne on a terminal pseudopodium.

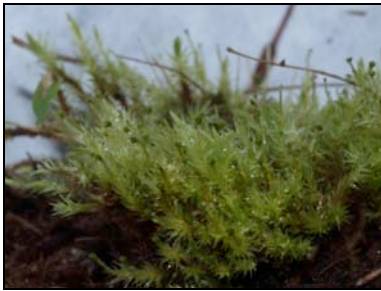
Seta copper brown, erect to more or less flexuose, to 4.5 cm long.

Capsules brown, inclined, curved, narrow ovate-ellipsoid, ribbed; strongly longitudinally pleated and contracted below the mouth when dry.

Key Field Identifiers:

- Stems densely hairy with brown hairs (so too in *Dicranum*).
- Abaxial surface of the leaves with three longitudinal lines (costa and recurved margins).

A common species found in wetter habitats. Sometimes found associated with *Aulacomnium turgidum*, but that species is usually in drier habitats and has imbricate (closely overlapping) and strongly concave leaves. The recurved margins of the leaves of *A. palustre* give, with the medial costa, the appearance of three longitudinal lines along the leaf—two at the edges and the costa in the middle.



A. palustre with gemmae on apical pseudopodia (shoot extensions).



A. palustre with gemmae. Image Michael Lüth, used with permission.



A. palustre stems showing dense brown tomentum. Image Des Callaghan, used with permission.

Species similar to *Aulacomnium palustre*

Aulacomnium turgidum (Wahlenberg) Schwaegr.

An arctic alpine species of wetter habitats, *Aulacomnium turgidum* is often found in association with the more common *A. palustre*. The rather turgid shoots and imbricate, concave leaves with rounded apices, and the usually light green rather than yellowish-green to brownish-green color, readily distinguish this species from *A. palustre*.



A. turgidum from drier, exposed habitat.



A. turgidum from moist habitat.

Plants robust, forming yellowish-green tufts.

Stems not tomentose.

Stem leaves imbricate, concave, elongate-ovate to obovate to ovate, with a rounded apex.

Key Field Identifiers:

- Closely overlapping and not spreading leaves with rounded tips.
- Stems without hairs.
- Rarely fruiting, but sporophyte similar to *A. palustre*.

Dicranum spp.

Many *Dicranum* species also have stems densely clothed in woolly tomentum that may be brown or white (often turning brown with age). Ireland (in *Moss Flora of North America*) includes 20 species with two varieties in the Alaskan flora. Of these, 14 are described as occurring occasionally in wet habitats (bogs, mires, swamps, fens, peatlands), with five described as found mostly in wetlands (*D. spadiceum*, *D. undulatum*, *D. bonjeanii*, *D. leioneuron*, and *D. drummondii*; the last is only known in North America from the Aleutians). In *Dicranum* the leaf margins are not recurved, the leaves are usually subulate, and they have distinct alar cells.



Dicranum polysetum, showing its densely tomentose stems.

Straminergon (Calliergon) stramineum (Brid.) Kindb.

Plants forming pale yellowish-green tufts, patches or straggling mats, or as scattered shoots.

Stems to 10 cm or more, long, simple or sparingly branched.

Stem leaves closely imbricate (overlapping) wet or dry, sometimes more or less distant below; concave, ovate to ovate-lanceolate, widest near the base, apex obtuse or rounded; margins entire, plane below, erect to slightly inflexed above; costa extending to about $\frac{3}{4}$ leaf length; basal laminal cells narrowly rectangular, alar cells inflated, hyaline, forming distinct decurrent auricles; cells above linear, incrassate, smooth, $5-8 \times 50-80 \mu\text{m}$; apical cells shorter and broader, forming a more or less distinct group just below the apex; branch leaves smaller than stem leaves.

Seta 3–5 cm long, reddish.

Capsules inclined to more or less horizontal, cylindrical, curved.

Key Field Identifiers

- Plants usually glossy, yellowish-green.
- Leaves of shoot and branch tips closely overlapping as a long, finger-like tip.

Occurs in a wide variety of wetland habitats from mineral rich to poor, with low to high pH, and nutrient poor to rather nutrient rich (Hedenas 1993). Formerly placed in *Calliergon* but now perhaps more appropriately placed in the monotypic genus *Straminergon*, although not universally accepted there. The pale, straw-yellow green shoots are characteristic.



Habit of *Straminergon stramineum*.



Detail of shoot apical region. Image Des Callaghan, used with permission.



Detail of habit of apical part of shoots. Image Michael Lüth, used with permission.

Species similar to *Straminergon stramineum*

There are a number of similar genera: *Warnstorfia*, *Calliergon*, *Calliergonella*, and *Drepanocladus*. These genera and their likely-to-be-encountered species can be distinguished in the following key:

1. Leaves with costa short and double or costa absent..... *Calliergonella cuspidata*
1. Leaves with costa to mid-leaf or longer.....2
2. Leaf apices rounded-obtuse to truncate3
2. Leaf apices acute4
3. Plants relatively long, sparsely branched, slender, glossy, green or more usually yellow to straw-colored; leaves oblong to oblong-ovate, crowded, erect-spreading below, erect and imbricate above, apices often with short brown rhizoids abaxially; alar cells inflated but not sharply demarcated, decurrent, hyaline *Straminergon stramineum*
3. Plants long, sparsely to irregularly pinnately branched, in green to yellow-green or brownish mats; stem leaves not crowded, erect or erect-spreading except at cuspidate shoot tips, broadly cordate-ovate, rounded and hooded at the apices, broadly decurrent; alar cells large, hyaline, abruptly differentiated in large, concave, decurrent auricles..... *Calliergon giganteum*
4. Stems irregularly to subpinnately branched, plants glossy green to golden-brown; leaves sickle-shaped, strongly curved and pointing to one side, narrowly long-acuminate from an ovate base; usually in drier habitats *Sanionia uncinata*
4. Stems irregularly to somewhat pinnately branched, plants $\pm$ glossy, in rather robust, green to yellow-green, golden, to brown or blackish-green mats, usually in wet places; leaves mostly curved and $\pm$ to one side, lanceolate to ovate-lanceolate, tapering gradually to a narrow apex5
5. Plants with leaves finely plicate; lamina cells linear-flexuose, basal cells shorter, thicker-walled, porose, not inflated, yellow in a few rows at the insertion *Drepanocladus vernicosus*
5. Plants with leaves not or rarely plicate; alar cells usually differentiated, often inflated6
6. Plants deep yellow to golden-brown; stems often branched; leaves strongly falcate-secund, ovate-lanceolate to lanceolate; costa reaching $\frac{2}{3}$ to near end of leaf; alar cells few, thick-walled, yellow, sometimes inflated *Drepanocladus sendtneri*
6. Plants green to yellow-green or brownish-green; stem leaves falcate to $\pm$ straight; ovate-lanceolate to lanceolate; costa ending from just beyond mid-leaf to near apex; alar cells $\pm$ inflated, hyaline7
7. Plants green, yellow or brown; leaves with margins serrulate at apex or base or both *Warnstorfia fluitans*
7. Plants green to blackish-green; leaves with margins entire throughout..... *Drepanocladus aduncus*

Species similar to *Straminergon stramineum* (cont.)

Warnstorfia differs in the characteristic and often cuspidate shoot and stem apices. The plants are green, yellow-green (not pale straw yellow-green as in *Straminergon*), brownish, red-brown, or with clear red colors.

Calliergon has the leaves broadly ovate to broadly rounded-triangular, and the plants are green, brownish-green, brown, or pinkish-brown.

Calliergon giganteum (Schimp.) Kindb.

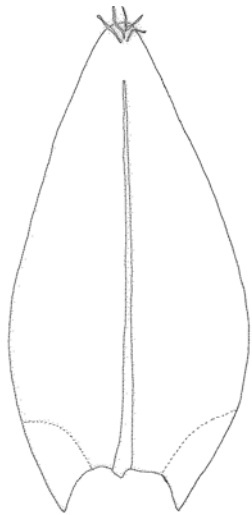
Plants in loose tufts or mats, dark green above, brown to reddish-brown below.

Stems to 20 cm or more long, frequently branched.

Stem leaves crowded and imbricate near apices, distant below, erect-spreading to spreading, cordate-ovate, often about as broad as long; margins plane or inrolled, entire; costa single, ending just below the apex; alar cells inflated, abruptly enlarged.

Key Field Identifiers:

- Occurs in wet, often calcareous habitats, in bogs, lake margins, etc.
- Branching in *Calliergon* is radial, the branches arising evenly all around the stem, most easily seen when the stem is viewed end on.



Leaf outline of *Straminergon stramineum*.



Leaf outline of *Calliergon giganteum*.

Species similar to *Straminergon stramineum* (cont.)

Warnstorfia sarmentosa (Wahlenberg) Hedenäs.

Plants medium-sized, with red or dark red secondary coloration, sometimes green; branch and shoot apices not pencil-like.

Stem leaves straight, loosely imbricate or erect-spreading, oblong, ovate or narrowly ovate, in distal portion $\pm$ suddenly narrowed to rounded- or acute-apiculate apex, short apiculus (rarely absent) often bent inwards over leaf, concave; margins entire or almost so; costa ending between $\frac{3}{4}$ leaf and just below the apex; alar cells in a triangular group, not or hardly decurrent.

Key Field Identifiers:

- Occurs in intermediately mineral-rich fens, often around springs or in late snow beds, sometimes submerged in lakes.

Calliergonella cuspidata (Hedw.) Loeske

Plants moderately large, in loose mats, somewhat glossy, yellowish-green to brownish-green. Both stem and branch tips cuspidate with closely appressed leaves.

Stems green to reddish-brown; branching irregular to $\pm$ pinnate.

Stem leaves erect-spreading (except at apices of stem and branches), ovate-triangular, widest at the base, concave, obtuse to rounded at the apex; margins entire, plane below, erect to somewhat incurved near the apex; costa absent or faint and very short and double; alar cells hyaline, inflated, forming decurrent auricles.

Key Field Identifiers:

- The costa in *Calliergonella* is only rudimentarily double. The plants are branched more or less in one plane.



Apical part of shoot of *Calliergonella cuspidata* showing radial branching and cuspidate (short pointed) shoot and branch apices. Image Michael Lüth, used with permission.

Drepanocladus aduncus (Hedw.) Warnst.

Plants slender to robust; stems pinnately or irregularly pinnately branched.

Stem leaves straight or usually falcate, ovate-lanceolate, triangular-ovate, gradually narrowed to an acute or sometimes obtuse, short to long acuminate apex; margin entire or occasionally very finely denticulate; costa single, ending in mid-leaf or above, well below the leaf apex; alar groups transversely triangular, reaching to the costa or almost so, not or hardly decurrent.

Key Field Identifiers

- Leaves straight or, more usually, curved.
- Leaves from an ovate base tapering to a narrow apex.
- Costa single, slender, ends above mid-leaf.
- Stems long and often sparsely branched.
- Plants green to dark green, sometimes blackened, never tinged red.

Rarely found fruiting. Occurs in more or less mineral-rich and nutrient-rich wetlands, such as eutrophic fens, shores, ditches, or occasionally submerged in pools and lakes, sometimes also in swampy forests.

Drepanocladus aduncus is the most common species in the genus. It is frequently confused with *Warnstorffia* species, but the latter frequently have red colors when growing in exposed habitats, whereas *D. aduncus* is never red.

In *Warnstorffia* species the shoots are radially branched (in sparsely branched specimens this may be difficult to see; distichously branched in *Drepanocladus*), and the margins are mostly distinctly denticulate in at least some parts of the leaves (most distinct just above the alar groups and/or near the leaf apex; entire or almost so in *D. aduncus*). Dark brown rhizoid initials are almost invariably found near the abaxial apex of at least some leaves of most *Warnstorffia* species, never in *Drepanocladus*.



Habit of apical part of shoots of *Drepanocladus aduncus*. Image Michael Lüth, used with permission.

Species similar to *Drepanocladus aduncus*

Warnstorffia (*Drepanocladus*) *fluitans* (Hedw.) Loeske

Plants in loose, green to yellow-green or brownish mats, glossy.

Stems sparsely branched.

Leaves rather distant on stems, falcate-secund (at least towards the shoot and branch tips), oblong-lanceolate, gradually narrowed to a long flexuose point, base not or only slightly decurrent; margins serrulate towards the apex; alar cells hyaline or yellowish, often slightly enlarged, not forming auricles.

Drepanocladus sendtneri (Schimp.) Warnst.

Plants in yellow-green to golden-green mats or tufts.

Stems often branched.

Leaves strongly falcate-secund, ovate-lanceolate to lanceolate, not plicate, concave; margins entire; costa strong and relatively broad at the base; alar cells differentiated, usually only a few inflated cells, walls yellowish.



Drepanocladus sendtneri. Image Michael Lüth, used with permission.

Drepanocladus vernicosus (Mitt.) Warnst.

Plants in green to yellowish or brownish (sometimes brownish-red) tufts;

Stems ± pinnately branched; leaves usually not crowded, striolate when dry, falcate-secund, lanceolate to ovate-lanceolate, gradually narrowed to a slender twisted apex; alar cells absent but lowermost one to two rows of basal cells colored across the insertion.



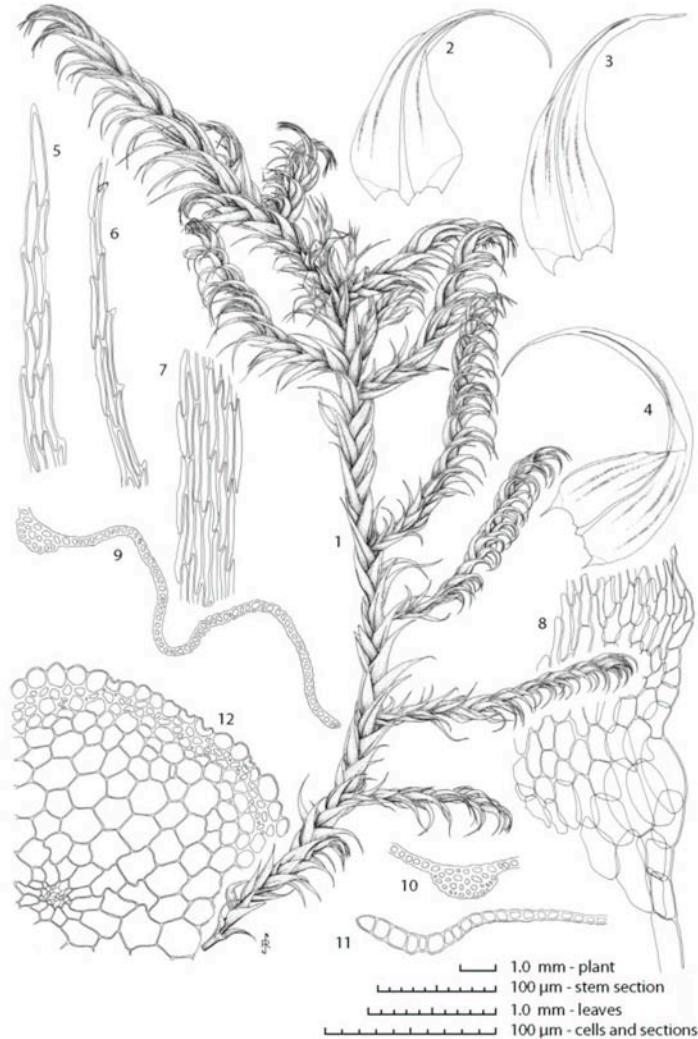
Habit of *Drepanocladus* (*Hamatocaulis*) *vernicosus*, showing typical brownish color. Image Michael Lüth, used with permission.

Species similar to *Drepanocladus aduncus* (cont.)

Sanionia uncinata (Hedw.) Loeske

Plants usually $\pm$ pinnately branched.

Stem leaves circinate or falcate, rarely $\pm$ straight, lanceolate from a rounded triangular or ovate base tapering to a long acuminate apex, plicate or strongly plicate, rarely smooth; margins plane or rarely partly recurved above, denticulate or finely denticulate above; costa extending well into the acuminate apex; alar cells in transversely triangular group.



Sanionia uncinata, showing habit, stem section with outer hyalodermis of larger thin-walled cells, leaf shape, leaf cells, and sections.

Species similar to *Drepanocladus aduncus* (cont.)



Leaf outlines of *Drepanocladus aduncus* (left), *Warnstorfia (Drepanocladus) fluitans* (center), and *Drepanocladus revolved/vernicosus* (right).

Meesia triquetra (L.) Aongstr.

Plants forming tufts or small patches.

Stems 2–14 cm high, not or sparsely branched.

Stem leaves in three rows, from an erect ovate hyaline sheathing base, contracting to a narrow triangular squarrose upper part; margins plane or sometimes recurved near the middle of the leaf, sharply serrate to near the base; costa strong, about $1/5^{\text{th}}$ width of the leaf base; lamina cells short rectangular, smooth, slightly incrassate, about 15 μm wide, larger and hyaline in the base.

Seta 4–10 cm long.

Capsules 3–6 mm long, including the neck, asymmetric, narrowly pyriform (pear-shaped).

Key Field Identifiers:

- Leaves in three rows around the stem.
- Leaves with a sheathing base contracting to a squarrose (wide-spreading) point.
- Margins of leaf strongly toothed.

Occurs in bogs, mires and wet woods. Easily distinguished from *Meesia uliginosa* by having leaves in three rows and with strongly serrate leaf margins. Leaves with the upper parts squarrose and the apices acute.



Habit of *Meesia triquetra* (dried specimen), showing long stems, very long seta, and typical capsules.



Shoots, showing arrangement of leaves in three rows, leaves with acute apices and strong marginal teeth. Image Michael Lüth, used with permission.

Meesia uliginosa Hedw.

Plants in dark green tufts.

Stems to 5 cm long, branched, tomentose below.

Stem leaves appressed, straight to slightly contorted when dry, erecto-patent when moist, linear-ligulate to linear-lanceolate, apex obtuse or rounded; margins strongly recurved below, entire; costa strong, occupying $1/3$ – $1/2$ width of the leaf base, ceasing shortly below leaf apex. Lamina cells rectangular, 9–13 μm wide in mid-leaf, more elongate below.

Seta slender, 2–10 cm long.

Capsules to 4 mm long including the neck, asymmetric, narrowly pyriform, curved.

Key Field Identifiers:

- Leaves erect-spreading all round the stem.
- Leaves all around the stem (not in three rows).
- Leaf margins not toothed and tips rounded, not pointed.

Occurs in bogs, rock fissures, usually arctic or alpine.

Meesia uliginosa differs from *M. triquetra* in having leaves not arranged in three rows, not squarrose, the leaf apices rounded obtuse, and in having smooth, not serrate, leaf margins.



Meesia uliginosa, showing typically shorter stems (than *M. triquetra*). Leaves arranged all around the stems and having blunt apices and smooth margins. Images Michael Lüth, used with permission.

Pohlia proligera (Kindb.) Broth.

Plants forming loose glossy green to yellow-green tufts or patches.

Stems to 2 cm high, green to reddish-green, with few rhizoids below.

Stem leaves imbricate, erecto-patent when moist, lanceolate to ovate-lanceolate, acute, the base somewhat decurrent on sterile stems; margins recurved below, plane above, denticulate or serrulate towards the apex; costa ending below the apex to percurrent.

Asexual bulbils abundant in axils of upper leaves, long and twisted, green, becoming yellowish-green to reddish with age, with one to two usually unicellular and often bent primordia at the apex.

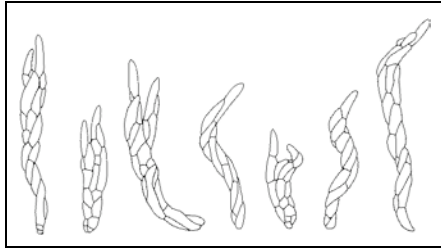
Seta 1–2.5 cm long, reddish-brown.

Capsules horizontal to pendent, light to dark brown, pyriform with a short neck, 1.5–2.5 mm long including the neck.

Key Field Identifiers:

- Plants glossy green to yellowish-green with green to reddish stems.
- When present, asexual bulbils numerous (>5) in upper leaf axils, narrow elongate with 1–2(–3) apical points.
- Occurs on moist soil.
- The abundant axillary bulbils are both obvious and characteristic.

There are two species of *Pohlia* occurring in North America that have long, filamentous axillary propagules. In *Pohlia proligera* the propagules are numerous, elongate and twisted, and have one to two (many only have one, rarely three) small apical leaf points. *Pohlia annotina* has the same type of axillary propagules, but there are only two to five per leaf axil and the propagules have two to four apical leaf points. Both species occur in Alaska.



Axillary propagules with zero to two apical leaf buds. Redrawn from Shaw (1981).



Shoots of *Pohlia proligera*, showing numerous (6–12) elongate axillary propagules.

Species similar to *Pohlia proligera*

Pohlia annotina (Hedw.) Lindb.

Plants in loose green to yellowish-green tufts.

Stems green above, reddish-brown below, with sparse tomentum below.

Stem leaves imbricate, erect-spreading, lanceolate, acuminate, the bases decurrent, 1–2.5 mm long, margins plane, serrulate at the apex; costa ceasing shortly below or in the apex.

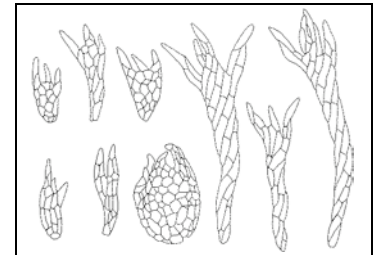
Asexual axillary gemmae yellow-green, two to five per leaf axil, linear to ovoid, twisted, with two to four apical leaf points.

Seta 1–2 cm long, yellowish brown; capsules horizontal to pendant, yellow-brown to brown, long-pyriform, 2–3 mm long, the neck about equal in length to the urn.

Occurs on moist soil. Morphologically, it is very close to *P. proligera*. The most useful distinguishing feature appears to be the axillary gemmae.



Pohlia annotina plants with few axillary propagules. Image Michael Lüth, used with permission.



Propagules of *Pohlia annotina*, showing two to four apical leaf buds. Redrawn from Shaw (1981).

Pohlia nutans (Hedw.) Lindb.

Plants forming dull dark green to yellowish-green tufts or patches.

Stems red above, dark brown below, with loose to dense reddish-brown tomentum below.

Stem leaves imbricate when dry, erect to erecto-patent when moist, concave, ovate to ovate-lanceolate, not or hardly decurrent at the base, apex acute; margins plane or narrowly recurved, entire to denticulate or serrulate above; costa reddish, ending in or just below the apex.

Seta 2–5 cm long, red when young, becoming brown, flexuose. Capsules 2–3.5 mm including the neck, yellow brown to brown, inclined to pendent, narrowly pyriform to ovate-ellipsoid, the neck conspicuous or not, less than ½ the length of the urn.

A common (probably the most common) species of many habitats. Often mixed with other bryophytes. Similar to both *P. proligera* and *P. annotina*, but differs in the leaf base that is not decurrent, the elongate-ovate capsule, and lack of gemmae.



Habit of *Pohlia nutans*. Image Des Callaghan, used with permission.

Polytrichum strictum Bridel

Plants slender, green to whitish-green, dark brownish with age, in deep, compact tufts.

Stems 6–12(–20) cm, simple, densely matted with woolly, whitish to light brownish tomentum.

Stem leaves 2–5(–6) mm, erect to closely appressed when dry, erect-spreading when moist; sheath oblong-rectangular, blade narrowly lanceolate, acuminate, flat, with sharply infolded margins; costa short-excurrent as a short, reddish-brown awn; lamellae five to eight cells high, the marginal cells in section pyriform, thick-walled, ending in a thickened knob. Dioicous.

Seta 2–4 cm, yellowish to reddish brown.

Capsules 2–3 mm, short rectangular to almost cubic (1–1.5:1), brownish, sharply four-angled and prismatic, suberect, becoming horizontal when ripe. Calyptra dirty white to light brown, enclosing the capsule.

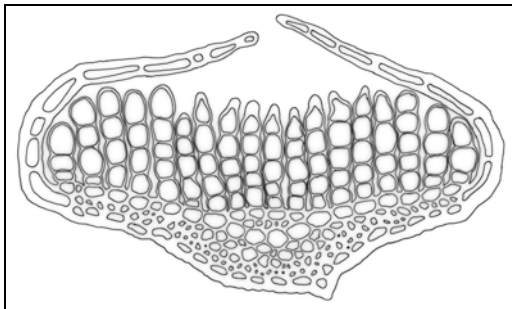
Key Field Identifiers:

- Dense white (sometimes pale brown) tomentum (hairs) on stems.
- Leaf blade with margin folded over the adaxial filaments.
- Leaves glossy green (not bluish or waxy green as in *P. juniperinum*).
- Capsule $\pm$ cubical (rectangular in shape in *P. juniperinum*).

Occurs in *Sphagnum* bogs, wet heaths and tundra, muskeg, sedge meadows, moist alpine tundra. *Polytrichum strictum* characteristic habitat is on hummocks in *Sphagnum* bogs, where it may form deep masses tightly bound together by dirty white, woolly tomentum. Also characteristic are the short, stiffly erect leaves and cubic capsules.



Habit of *Polytrichum strictum*, with mature sporophytes showing some capsules with hairy calyptras. Image Michael Lüth, used with permission.



Leaf section, showing margin curved inwards over the leaf lamina and shape of terminal cell of the photosynthetic lamellae.

Species similar to *Polytrichum strictum*

Key to *Polytrichum* species encountered in wetlands:

1. Leaf blade with the margins strongly toothed, not hyaline, and not folded in over the lamina.....*Polytrichum commune*
1. Leaf blade with the margins hyaline and folded in over the lamina 2
2. Stems usually with dense white or white turning brownish tomentum (hairs); leaves green, not with a bluish-waxy appearance.....*Polytrichum strictum*
2. Stems lacking tomentum or, if present, sparse and brownish, in wetlands occurring in mounds in more elevated sites; leaves usually with a bluish-waxy appearance*Polytrichum juniperinum*

Polytrichum juniperinum Hedwig

Plants small to medium to fairly robust, gray-green to bluish-green to reddish-brown with age, in loose tufts, often forming extensive patches.

Stems to 10 cm, simple, brownish tomentose only near the base.

Leaves 3–6(–8) mm, densely imbricate, $\pm$ erect and almost straight when dry, erect-spreading to widely spreading when moist; sheath oblong-rectangular; blade slender, bluish-green and shiny, rather flat, with sharply infolded margins; costa excurrent, forming a subulate, toothed reddish-brown awn slightly decolored at tip; lamellae 6–8 cells high, the marginal cells in cross section ovate to pyriform, thick walled, ending in a distinct knob, smooth or rarely faintly papillose.

Seta (1–)3–5 cm, stout, yellowish- to reddish-brown.

Capsules 2.5–5 mm, rectangular, longer than wide (1.5–2:1), reddish-brown to dark brown, glaucous when fresh, suberect, becoming horizontal when mature, sharply four-angled and prismatic. Calyptra whitish to light brown, completely covering the capsule before falling away.

According to Smith Merrill (North American Flora), *Polytrichum juniperinum* occurs on a variety of substrates, but primarily in drier situations than *Polytrichum commune* or *P. strictum*. It often forms extensive pure stands of a distinctive pale bluish-green color. The narrow leaf blades are widely spreading and have short, reddish awns.



Polytrichum juniperinum plants growing amongst *Pleurozium schreberi*.

Species similar to *Polytrichum strictum* (cont.)

Polytrichum commune Hedw.

Plants medium to robust, dark green to brownish with age, in loose or rather dense, tall tufts, often in extensive patches.

Stems to 10 cm or much longer, mostly simple or rarely forked.

Leaves 6–8(–12) mm, erect or erect-spreading when dry, flexuose, with distinctly recurved tips, spreading to broadly recurved when moist; sheath clasping the stem, abruptly contracted to the narrowly lanceolate blade; margin toothed from the base of blade to the apex; costa excurrent, ending in short, rough awn; lamellae 5–9 cells high, the margin distinctly grooved as seen from above, with two rows of paired, projecting knobs.

Seta 5–9 cm, stout, yellowish- to reddish-brown.

Capsules 3–6 mm, short rectangular to cubic, brown to dark reddish-brown, glaucous when fresh, sharply four-winged, inclined to horizontal. Calyptra golden-yellow to brownish, completely enveloping the capsule.

Polytrichum commune is easily recognised by cross sections of the leaves, particularly the greatly broadened costa and the notched marginal cells of the lamellae.



Habit of *Polytrichum commune*, showing wide-spreading leaves. Image Michael Lüth, used with permission.

Sphagnum

Sphagnum species are the dominant mosses, in terms of biomass, in peatlands. Most studies of peatlands, particularly those undertaken by ecologists, deal almost solely with the vascular plants. Peat mosses are excellent indicator species, and they can yield considerable useful information on the hydrology and nutrient status of peatlands.

The most recent comprehensive treatment for North American taxa is that for the new *Flora of North America* bryophyte volumes, by McQueen and Andrus (2007). In Alaska, a considerable number of species are represented. McQueen and Andrus include some 53 species with four subspecies in seven of the nine Sections they have recognized in North America. Field recognition takes a good deal of practice, an appreciation of ecological preference of individual species, and the realization that morphological variation can be considerable.

Key to wetland indicator and closely related species of *Sphagnum*

1. Plants robust; branches fat, turgid or chunky; branch leaves with rounded hooded apices; enlarged outer stem cortical cells with fibrillar thickenings..... 2
1. Plants small to robust; branches relatively slender, ± elongate; branch leaves with ± narrow channelled apices; outer stem cortical cells without fibrillar thickenings 3
2. Plants greenish-brown to golden- or pinkish-brown; spreading branches short and blunt; stems brown or greenish-brown; stem leaves erect, spreading or pendent, rectangular or spatulate (SE and S Central AK) *Sphagnum papillosum*
2. Plants pinkish-green to wine-red; spreading branches short with the tips pointed, not blunt; stems reddish; stem leaves erect, spreading or pendent, rectangular to lingulate (throughout AK) *Sphagnum magellanicum*
3. Plants robust, stiff, pale green to yellowish-green; stems green to reddish-brown; branches long, tapering, with leaves squarrose-spreading *Sphagnum squarrosum*
3. Plants small to medium-sized, green, brownish to pink, mottled pink and green, or red; branch leaves spreading or imbricate, never squarrose 4
4. Plants forming densely packed mats or hummocks, whitish green to ochre to orange- or pinkish-brown; branch fascicles close together, concealing the stem, the upper branches forced upwards; stem dark brown; stem leaves pendent, small, triangular, with ± eroded apices *Sphagnum compactum*
4. Plants loosely packed in mats or patches, green to yellowish-green, brownish-green, mottled green and red, to red; stem leaves erect to spreading, triangular to rectangular to lingulate 5
5. Plants mottled pink or red and green, or pink to deep red 6
5. Plants green, yellow-green, yellow-brown to dark brown, never with pink or red coloration 7

6. Plants mottled red and green or pink and green, rarely all green; branches in fascicles with two spreading and one pendent branch; stems pale pink; stem leaves erect, appressed, lingulate with parallel sides, the apex broadly rounded, truncate, fringed across the central part *Sphagnum russowii*
6. Plants usually deep pink to red, occasionally greenish pink; branches in fascicles with three (to four) spreading and one (to two) pendent branches; stems yellowish- to violet-red; stem leaves erect, appressed, lingulate to slightly triangular-lingulate, apex rounded to narrowly truncate *Sphagnum warnstorffii*
7. Plants small, compact, with a well-developed capitulum, green to yellowish-green; stem leaves pendent, short triangular; branch leaves closely imbricate, five-ranked, suberect to patent; branches in fascicles of two spreading and two pendent branches; stems green to pale yellow to pinkish *Sphagnum angustifolium*
7. Plants small to medium-sized, capitula small, green to brownish-green to brown; stem leaves erect to spreading, not pendent, triangular-ovate to rectangular to lingulate; branches in fascicles of two spreading and one (to two) pendent branches; stems green to brown to blackish-brown 8
8. Plants medium-sized to robust, green throughout or with a greenish-brown capitulum; stem pale green to brownish; stem leaves erect-appressed, rectangular to lingulate, apex broad, truncate, lacerate, the sides usually constricted or waisted *Sphagnum girgensohnii*
8. Plants small to medium-sized, slender, green (in shade) to yellow-brown to dark brown; stems greenish-yellow to pale to dark brown; stem leaves erect-appressed to suberect or spreading, triangular-lingulate to lingulate or slightly spatulate 9
9. Stem leaves spreading to suberect, triangular-ovate to shortly lingulate, concave, the apices rounded, notched *Sphagnum balticum*
9. Stem leaves erect-appressed, tongue-shaped to slightly wider above than at the base, apex broadly rounded with a wide resorption area across the apex *Sphagnum fuscum*

Sphagnum angustifolium (C. Jens. ex Russow) C. Jens.

Plants small, often slender, soft, lax to compact; green to pale yellow to golden-brown to brown; capitulum strongly convex in drier habitat forms to strongly five-radiate and flat in wetter habitat forms.

Stems pale green to pale brown, often with pinkish red patches, cortex undifferentiated.

Stem leaves triangular, small, less than 0.8 mm, mostly appressed to stem.

Branches straight to slightly curved, usually five-ranked; in fascicles with two spreading and two to three pendent branches.

Branch stems with cortex enlarged with conspicuous retort cells, often pinkish-red at proximal end.

Branch leaves narrowly ovate-lanceolate, 0.8–1 mm, straight; hyaline cells on convex (abaxial) surface with one (two to three) pore per cell at apical end of cell, on concave (adaxial) surface with round wall thinnings in cell ends and angles; chlorophyllous cells triangular in transverse section and just enclosed on concave (adaxial) surface.

Key Field Identifiers:

- Plants with a strong convex capitulum.
- Stems pale green to pale brown.
- Leaves of young branches divergent, giving a short bristly appearance to the branches.
- Stem leaves small, triangular, closely pressed to the stems.

A species occurring in a wide range of habitats. Distinguished by the small, triangular, obtuse and appressed stem leaves. *Sphagnum angustifolium* also often has a pink stem. *Sphagnum balticum* has stem leaves that are more lingulate-triangular as well as spreading from the stem.



Habit of *Sphagnum angustifolium*, showing the typical rough appearance of branches.



Detail of capitula and shoot tips. Image Michael Lüth, used with permission.

Species similar to *Sphagnum angustifolium*

Sphagnum balticum (Russow) C. Jens.

Plants small to moderate sized, brownish-green to yellow-green to golden-brown; capitulum typically flat and five-radiate.

Stems pale green to brown; cortical cells in two to three rows.

Stem leaves triangular-lingulate to lingulate, 0.8–1.1 mm, spreading, apex broadly obtuse.

Branches slender, tapering, in fascicles of two spreading and mostly one pendent branch.

Branch leaves ovate-lanceolate, 1–1.7 mm long, straight, slightly undulate and spreading; hyaline cells with one to five pores in cell ends on abaxial surface, with round wall thinnings in cell ends and angles on adaxial surface.

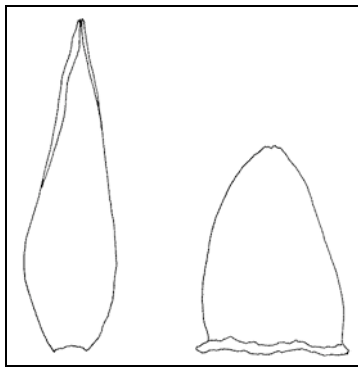
The species occurs in hollows and floating mats in raised bogs and poor fens. Distinguished from *S. angustifolium* by the stem leaves spreading at right angles to the stem and with fewer and weaker pendent branches (the stem and stem leaves are thus easier to see). *Sphagnum balticum* also lacks the paired pendent branch buds between the capitulum rays as seen in *S. angustifolium*.



Habit of *Sphagnum balticum*. Image Michael Lüth, used with permission.



Detail of shoot apices. Image Michael Lüth, used with permission.



Branch leaf and stem leaf.

Species similar to *Sphagnum angustifolium* (cont.)

Sphagnum girgensohnii Russow

Plants moderate sized to robust, open, stiff; capitulum large, flat, and stellate (sometimes this is not obvious); green to yellowish-brown (in open habitats).

Stems pale green to yellow-brown; cortical cells in two to three rows.

Stem leaves lingulate, 0.8–1.3 mm long; apex broad, truncate and lacerate.

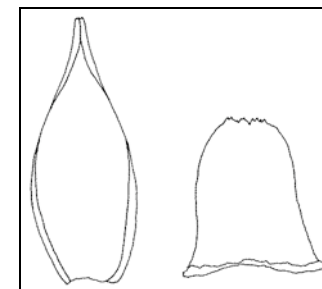
Branches mostly long and tapering, in fascicles of two spreading and one to two pendent branches.

Branch leaves ovate to ovate-lanceolate, 1–1.5 mm long, straight, apex strongly involute; hyaline cells with numerous elliptical pores along commissures on abaxial surface, with large round pores along the margins and base adaxially.

Usually readily recognized by its green color and stellate capitulum. The apex of the stem leaves is lacerate for about $\frac{3}{4}$ of its width.



Habit of *Sphagnum girgensohnii*, showing typical star-shaped appearance of shoot apices.



Branch leaf and stem leaf.

Sphagnum fuscum (Schimper) H. Klinggraff

Plants small and slender, stiff and usually compact; capitulum small and flat-topped; typically reddish-brown, greenish-brown in shaded habitats.

Stems dark reddish-brown; cortical cells in three to four rows.

Stem leaves lingulate, 0.8–1.3 mm; apex broadly rounded and entire to lacerate, sometimes slightly mucronate or slightly denticulate.

Branches long and slender to short and compact, in fascicles with two spreading and one to two pendent branches.

Branch leaves ovate-lanceolate, 1.1–1.3 mm, straight, concave, apex strongly involute; margins entire, hyaline cells on convex (abaxial) surface with round to elliptic pores along the commissures, concave (adaxial) surface with large round pores in proximal marginal regions of leaf.

Key Field Identifiers:

- Plants slender with a small capitulum.
- Stems typically reddish-brown (sometimes greenish-brown).
- Branches long and slender to short.
- Stem leaves tongue-shaped.

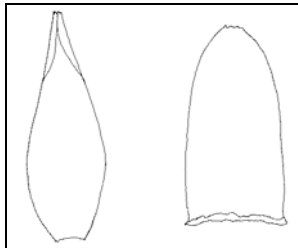
A common species in ombrotrophic mires where it may form small to large hummocks, more infrequently in weakly minerotrophic mires and richer fens. Very widespread, but generally easily recognized, it is the only small brown hummock-forming species of sect. *Acutifolia* over most of its range. The stem leaves can vary from having a rounded, entire apex to having a somewhat flat and lacerate apex. The branches also vary from being unranked and slender to five-ranked and blunt. The color can also vary from a light to a dark brown.



Habit of *Sphagnum fuscum*.



Detail of shoot apices. Images Michael Lüth, used with permission.



Branch leaf and stem leaf.

Species similar to *Sphagnum fuscum*

Sphagnum teres (Schimper) Ångström

Plants fairly slender, pale green to yellowish, or reddish-brown; forming loose to dense carpets.

Stems pale green to red-brown; cortex of three to four layers of cells.

Stem leaves generally larger than branch leaves, 1.3–1.8 × 0.8–1 mm; elliptic, widest above the middle.

Branches long cylindrical, in fascicles with (two to) three spreading and two pendent branches.

Branch leaves 1–1.4 mm, ovate to ovate-lanceolate, gradually narrowed to an involute tip, hyaline cells with four to eight large, elliptic, unringed pores per cell on convex (abaxial) surface and one to four irregularly rounded pores per cell on concave (adaxial) surface.

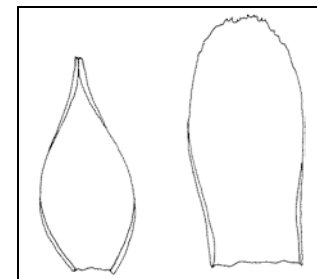
A characteristic species of rich, weakly acidic to slightly basic mires. Shade forms often have squarrose leaves, but these are usually considerably smaller than *S. squarrosum*.



Habit of *Sphagnum teres*.



Detail of shoot apices. Image Michael Lüth, used with permission.



Branch leaf and stem leaf.

Species similar to *Sphagnum fuscum* (cont.)

Sphagnum compactum Lamarck & de Candolle

Plants moderate-sized to large, dense and compact, pale green, brownish-white to golden-brown; forming compact cushions.

Stems brown; stem cortex of two to three layers.

Stem leaves small, 0.3–0.7 mm, triangular-lingulate with broad rounded apex.

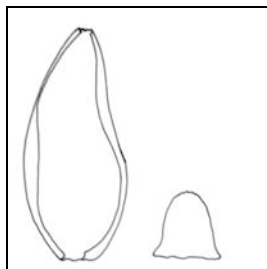
Branches short, crowded, with two to three spreading and two to three pendent per fascicle.

Branch leaves large, 1.4–3 mm, semi-squarrose to squarrose, ovate and abruptly involute in distal portion, appearing cucullate with toothed apex; hyaline cells with five or more ringed, round to elliptical pores on convex (abaxial) surface, numerous pseudopores on concave (adaxial) surface with ringed pores occurring in threes at adjacent cell angles; chlorophyllous cells elliptic in transverse section, entirely included by hyaline cells, slightly nearer to convex (abaxial) surface.

A species of ombrotrophic to weakly minerotrophic habitats. *Sphagnum compactum* is usually easily recognized by its combination of golden-brown color and involute, cucullate branch leaves.



Detail of shoot apices of *Sphagnum compactum*. Image Michael Lüth, used with permission.



Branch leaf and stem leaf.

Sphagnum papillosum Lindberg

Plants moderate-sized to fairly robust; strong stemmed and generally compact, capitulum usually not much enlarged; greenish brown to deep golden-brown.

Stems brown, cortical cells in three to four layers with spiral reinforcing fibrils, and usually one to two pores per cell.

Stem leaves erect, spreading or hanging, rectangular to spatulate, to 1.5×0.7 mm; hyaline cells non-ornamented, mostly septate.

Branches generally short and blunt, in fascicles with two spreading and two to three pendent branches, the leaves spreading.

Branch leaves broadly ovate, 1.7×1 mm; hyaline cells on convex (abaxial) surface with round to elliptic pores along the commissures, hyaline cell walls covered with papillae where overlying chlorophyllous cells; chlorophyllous cells trapezoidal to truncate elliptic in transverse section, equally exposed on both surfaces.

Key Field Identifiers:

- Plants greenish-brown to golden-brown or sometimes pinkish-brown.
- Stems brown.
- Stem leaves erect to spreading or pendent, $\pm$ rectangular.
- Branches short, blunt pointed.
- Coastal species, not interior.

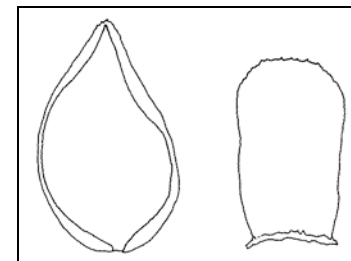
A common species in very poor to poor fen and mire. Usually easily identifiable by its golden-brown to dark brown or pinkish-brown color and short, blunt branches. The papillae on the branch leaf chlorophyllous cells need examination by microscopy to be seen. The species appears to be coastal and not found in interior locations.



Habit of *Sphagnum papillosum*.



Detail of shoot apices.



Branch leaf and stem leaf.

Species similar to *Sphagnum papillosum*

Sphagnum magellanicum Bridel

Plants moderate-sized to robust, somewhat lax in shade forms to compact and stiff in open grown forms; green to pinkish-green to reddish-purple.

Stems green to purplish-red, superficial cortical cells with spiral reinforcing fibrils clearly visible, usually one or two pores per cell.

Stem leaves to 2×0.7 mm, hyaline cells non-ornamented, mostly non-septate.

Branches long and tapering to short and pointed, in fascicles with two to three spreading and two to three pendent branches, leaves loosely imbricate.

Branch leaves broadly ovate, to 2×1 mm or more wide, hyaline cells non-ornamented, convex (abaxial) surface with round to elliptic pores along the commissures; chlorophyllous cells short-elliptic in transverse section and well enclosed on both surfaces.

Key Field Identifiers:

- Plants green to pinkish-green to reddish-purple.
- Stems green to red.
- Branches long, tapering to a point.
- Stem leaves erect, spreading to pendent, rectangular to tongue-shaped.
- Coastal and interior.

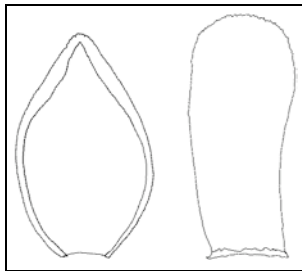
A species with very wide ecological amplitude, in ombrotrophic to rich fen peatlands and in forested and open mires. Could be confused with *Sphagnum papillosum* in coastal regions. The absence of ornamentation on the hyaline cell walls around the chlorophyllous cells will separate the species from *S. papillosum*.



Habit of *Sphagnum magellanicum*.



Detail of shoot apices. Images Michael Lüth, used with permission.



Branch leaf and stem leaf.

Sphagnum russowii Warnstorf

Plants moderate-sized, stiff and open, compact in exposed sites, capitulum flat-topped and often stellate; green or variegated red and green.

Stems typically mixed green and red; superficial cortical cells in two to four layers.

Stem leaves lingulate, 1.3–1.6 mm long, apex broadly rounded or pointed and notched (sometimes denticulate), border strong and broadened at base (more than $\frac{1}{4}$ width); hyaline cells short sinuosa-rhombic, mostly fibrillose, no to one (to two) septate.

Branches long and slender, in fascicles with two spreading and one to two pendent branches.

Branch leaves ovate-lanceolate, 1.3–1.6 mm, concave, straight, apex strongly involute; hyaline cells on convex (abaxial) surface with numerous round to elliptic pores along the commissures, concave (adaxial) surface usually with large round pores throughout.

Key Field Identifiers:

- Plants green to (usually) mottled green and red, or pink.
- Capitulum flat-topped.
- Stems mottled green and red.
- Stem leaves tongue-shaped.

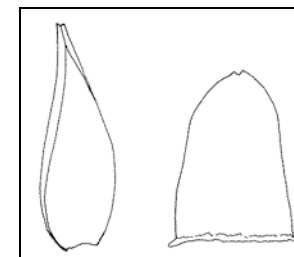
A species of minerotrophic habitats and shade tolerant. *Sphagnum russowii* is probably the most frequently misidentified *Sphagnum* species. Morphological characters vary considerably. The combination of the flat, stellate capitulum, unranked branch leaves, and lingulate stem leaf will usually suffice to identify this species. *Sphagnum capillifolium* has a rounded capitulum and a pointed stem leaf. In montane and arctic mires it can be confused with *S. warnstorffii*, but the latter species usually has conspicuously five-ranked branch leaves.



Habit of *Sphagnum russowii*.



Pink and green color forms. Image Des Callaghan, used with permission.



Branch leaf and stem leaf.

Species similar to *Sphagnum russowii*

Sphagnum capillifolium (Ehrhart) Hedw.

Plants small to moderate-sized, compact to fairly slender; capitulum typically hemispherical; in exposed sites red, mottled red and green in shaded sites; without metallic lustre when dry.

Stems green to red; cortex of three to four rows of cells, superficial layer aporose.

Stem leaves lingulate-triangular, 1.2–1.6 (–1.8) mm, apex $\pm$ involute; border entire and broadened to about $\frac{1}{4}$ width of the base; hyaline cells S-shaped, zero to one septate, usually fibrillose in distal portion of leaf.

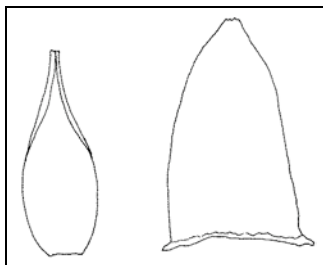
Branches terete, in fascicles with two spreading and one to two pendent branches.

Branch leaves ovate-lanceolate, 1–1.4 mm, imbricate to moderately spreading, concave, straight, strongly involute near apex; hyaline cells on convex (abaxial) surface with elliptic pores along commissures, concave (adaxial) surface with large round pores away from commissures in proximal portions of leaf.

A species of ombrotrophic habitats in a broad range of acidic environments. Can be distinguished from most other red species of sect. *Acutifolia* by its lack of five-ranking in the branches.



Habit of *Sphagnum capillifolium*. Image Michael Lüth, used with permission.



Branch leaf and stem leaf.

Sphagnum squarrosum Crome

Plants robust, stiff; green, pale green, yellow-green; terminal bud large.

Stems green to red-brown; with two to three rows of cortical cells.

Stem leaves shorter than branch leaves, ovate-lingulate to oblong-lingulate, 1.6–1.8 $\times$ 1–1.2 mm; hyaline cells mostly non-septate.

Branches long and tapering with distinct squarrose spreading leaves, occurring in fascicles with two spreading and two to three pendent branches.

Branch leaves larger than stem leaves, 1.9–2.8 mm, conspicuously squarrose from ovate-hastate base and abruptly narrowed $\frac{1}{2}$ – $\frac{1}{3}$ distance from apex into involute concave acumen; hyaline cells with non-ringed pores at ends and corners of cells, ringed pores on concave (adaxial) surface (four to eight per cell) and non-ringed pores (two to four per cell) on convex (abaxial) surface; chlorophyllous cells ovate-triangular with widest part at or close to the convex (abaxial) surface.

Key Field Identifiers:

- Robust green to pale green to yellowish-green plants.
- Branches long with usually strongly squarrose leaves.

In its typical robust form with strongly squarrose branch leaves, *S. squarrosum* is unmistakable.



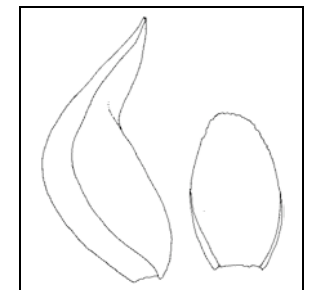
Sphagnum squarrosum plants bearing capsules. Typical squarrose leaves clearly visible.



Plants from an exposed site.



Plants from a moist, shaded site.



Branch leaf and stem leaf.

Sphagnum warnstorffii Russow

Plants small to moderate-sized, slender; capitulum flat-topped, stellate; green or dark purplish-red and green, often with a bluish cast when dry.

Stems red to green; cortex of three to four layers of cells, superficial layer aporose.

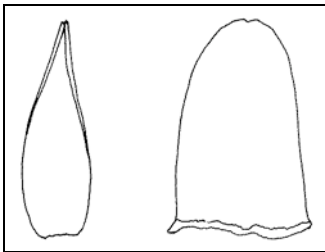
Stem leaves triangular-lingulate to lingulate, 1–1.4 mm long, apex broadly rounded to narrowly truncate, border very broad at the base ($> \frac{1}{3}$ width); hyaline cells without fibrils, rhombic, one-septate, sometimes non-septate.

Branches long and tapering, usually strongly five-ranked, in fascicles of two spreading and one to two pendent branches. Branch leaves ovate-lanceolate, 0.9–1.4 mm long, concave, straight, apex involute; hyaline cells on convex (abaxial) surface with very small ringed pores along commissures near apex, abruptly becoming large

One of the most minerotrophic species in the North American *Sphagnum* flora.



Habit of *Sphagnum warnstorffii*, showing branch leaves in five distinct rows.



Branch leaf and stem leaf.

Tomentypnum nitens (Hedw.) Loeske

Plants glossy, yellowish-green to golden-brown, forming patches or occasionally as scattered shoots.

Stems 5–15 cm long, ascending to erect, tomentose with brown rhizoids, irregularly branched.

Stem leaves erect to erect-spreading, strongly plicate wet or dry, bearing rhizoids on the abaxial side towards their base; stem and branch leaves of similar size, lanceolate-triangular, gradually acuminate; margins plane or narrowly recurved, entire or faintly sinuose; costa reaching to $\frac{3}{4}$ leaf length; median lamina cells thick-walled, long and narrow, $50\text{--}90 \times 5\text{--}6 \mu\text{m}$, a few rows at the leaf base rounded-rectangular, incrassate, porose, with a few alar cells larger but not forming distinct auricles; bases not decurrent.

Seta purple-brown, 2–5 cm long, smooth.

Capsules horizontal, 2–3 mm long, curved and zygomorphic, contracted below the mouth when dry.

Key Field Identifiers:

- Glossy green to golden-brown plants with frequently branched shoots.
- Leaves triangular lance-shaped, closely overlapping, longitudinally plicate.

A common species of bogs and other wet places. Fruiting plants are rarely found. The glossy, mostly golden-brown shoots are characteristic. Sometimes, however, the plants can be green in deep shade or very moist situations. The closely overlapping, lanceolate-triangular and longitudinally plicate leaves are found in all habitats.



Tomentypnum nitens plants typical of exposed sites, showing glossy brown shoots.



Plants from a partly shaded site.



Plants from a wetter shaded site.

HEPATICAE:

Blepharostoma trichophyllum (L.) Dumort.

Plants small, in small pale green to bright green patches or mats, or as scattered stems amongst other bryophytes.

Shoots to 2 cm long to 1 mm wide including the leaves.

Leaves in three rows, transversely inserted, distant to imbricate, patent to suberect, divided almost to their base into three to four uniseriate lobes 7–15 cells long, gradually tapering to an acute apex, the cells rectangular, cell walls usually uniformly thickened, cuticle faintly to strongly papillose-striate. Oil bodies four to nine per cell, subspherical. Underleaves similar to lateral leaves.

Key Field Identifiers:

- Plants very small, pale to dark green.
- Leaves in three rows with three to four finger-like lobes.



Habit of *Blepharostoma trichophyllum*.



Detail of shoots, showing deeply lobed leaves in three rows along the stems. Image Michael Lüth, used with permission.

Calypogeia sphagnicola (Arnell & Persson) Warnst. & Loeske

Plants in small patches or as isolated shoots, green to pale green to yellowish-green, often slightly yellowish-brown in older parts; translucent.

Shoots to 3 cm long, often shorter, to 2 mm wide including the leaves, prostrate to weakly ascending, simple or sparingly branched.

Leaves in three rows. Lateral leaves distant to imbricate, to 0.8×1.0 mm, broadly ovate-triangular, insertion very oblique, incubous, almost plane to slightly convex, apex entire and subacute to narrowly rounded or occasionally weakly bidentate; mid-lamina cells $20\text{--}25 \times 25\text{--}35$ μm , thin-walled, the cuticle smooth. Oil bodies 2–12 per cell, simple. Underleaves orbicular to orbicular-ovate, patent, distant to approximate, convex and slightly wider than the stems, to 0.5×0.5 mm, $\frac{1}{3}$ -bilobed to $\frac{3}{4}$ -bifid, the lobes acute to subacute or rounded, the sinus acute to rounded at its base; rhizoids arising from base of underleaves.

Key Field Identifiers:

- Plants usually pale green, translucent.
- Two rows of lateral leaves and a row of much smaller underleaves.
- Lateral leaf arrangement incubous.



Habit of *Calypogeia sphagnicola*, with clusters of pale green gemmae borne on an extension of the main shoot.

Species similar to *Calypogeia sphagnicola*

Schofield (unpublished checklist) reports four species of *Calypogeia* from Alaska: *C. azurea* Stotl. & Crotz., *C. integristipula* Steph., *C. muelleriana* (Schiffn.) Müll. Hal., and *C. sphagnicola*.

These *Calypogeia* species are distinguished as follows:

1. Underleaves orbicular to kidney-shaped, wider than long, margin entire; lateral leaf cells with small to slightly bulging trigones *Calypogeia integristipula*
1. Underleaves deeply bilobed; lateral leaf cells lacking trigones 2
2. Underleaves slightly wider than stem, as wide as long, mostly without lateral teeth; median leaf cells 22–35 × 25–42 µm *Calypogeia sphagnicola*
2. Underleaves more than twice as wide as stems; median leaf cells 32–45 × 34–70 µm 3
3. Leaf cells with colorless oil bodies; plants green when dry *Calypogeia muelleriana*
3. Leaf cells with bluish oil bodies; plants azure blue at the shoot apices when moist, with a bluish cast when dry *Calypogeia azurea*

When viewed from the dorsal or upper side, *Chiloscyphus* and *Lophocolea* species have leaves that may appear similar, but their arrangement is succubous and the leaves lack the ventral lobe of *Calypogeia*. Both genera also have a terminal perianth and sporophyte, whereas *Calypogeia* has the gynoeceum borne in a ventral marsupium (pouch-like structure). *Geocalyx*, like *Calypogeia*, also has an incubous leaf arrangement and the sporophyte borne in a ventral marsupium, but the leaves are shortly bilobed to bidentate without a ventral lobe.

Mylia anomala (Hooker) Gray

Plants with shoots 20–30 mm long × 2.4–3 mm wide, prostrate, forming mats over peat or occurring intermingled with moss, green to yellowish- or reddish-brown.

Stems ca. 10–12 cells in diameter, branches few, most arising beneath perianths.

Leaves contiguous to imbricate, spreading to erect, orbicular to ovate, ca. 1400 × 1450 µm, narrowed at the insertion, concave; leaves on gemmiferous shoots progressively narrower toward stem apex, becoming lanceolate (ca. 1400–1500 × 1100–1150 µm) with subacute apex; median leaf cells large, 50–60 × 45–50 µm, basal cells larger, 50–55 × 65–75 µm; cuticle smooth; trigones large, bulging; oil bodies 6–18 per cell, ovoid, 7–8 × 5–7 µm, granular botryoidal with protruding globules, hyaline.

Underleaves distinct, lanceolate, large (to 500–600 µm), often hidden among rhizoids.

Gemmae often present on distal lanceolate leaf margins, spherical to elliptical, 30–40 × 45–50 µm, two-celled, green.

Key Field Identifiers:

- Plants green to yellowish- or reddish-brown.
- Leaves closely overlapping, mostly rather erect (particularly near shoot tips), concave.
- Leaves in two obvious rows, the underleaves mostly small, lance shaped and difficult to see.
- Often found growing on or in dense *Sphagnum* hummocks.

Occurs in peat bogs or on moist peaty soil. *Mylia anomala* is commonly found in northern *Sphagnum* bogs. In these habitats it is often encountered growing in or on *Sphagnum*. It can be confused with *Jamesoniella* or *Jungermannia*, but *Mylia* has large bulging trigones in the leaf cell corners and the oil bodies contain only a few large spherical globules. *Mylia anomala* differs from the closely related *M. taylorii* in having a smooth cuticle and shoots 2–3 mm wide (3–5 mm in *M. taylorii*).



Habit of *Mylia anomala* growing amongst a hummock of *Sphagnum*.

References

- Hedenäs, L. 1993. A generic revision of the *Warnstorfia-Calliergon* group. *Journal of Bryology* 17(3): 447–479.
- Koponen, T. 1973. *Rhizomnium* (Mniaceae) in North America. *Annales Botanici Fennici* 10: 1–26.
- Lichvar, R., G. Laursen, R. Seppelt, and W. Ochs. 2008. Selecting and testing cryptogam species for use in wetland delineation in Alaska. *Arctic*. (In review)
- McQueen, C.B., and R.E. Andrus. 2007. Sphagnaceae. In: *Flora of North America North of Mexico*. Flora of North America Editorial Committee. 27 (1): 445–101. New York, Oxford: Oxford University Press. (<http://www.mobot.org/plantscience/bfna/V1/SphaSphagnaceae.htm>)
- Natural Resources Conservation Service. 2006. *Field Indicators of Hydric Soils in the United States, Version 6.0*. G.W. Hurt and L.M. Vasilas, ed. USDA NRCS in cooperation with the National Technical Committee for Hydric Soils, Fort Worth, TX. (<http://soils.usda.gov/use/hydric/>)
- Shaw, A.J. 1981. A taxonomic revision of the propaguliferous species of *Pohlia* (Musci) in North America. *Journal of the Hattori Botanical Laboratory* 50: 1–81.
- Smith, A.J.E. 2004. *The Moss Flora of Britain and Ireland*. 2nd Edition. Cambridge: Cambridge University Press.
- Wakeley, J.S. 2002. *Developing a “Regionalized” version of the Corps of Engineers Wetlands Delineation Manual: Issues and recommendations*. ERDC/EL TR-02-20. Vicksburg, MS: U.S. Army Engineer Research and Development Center, Environmental Laboratory.
- U.S. Army Corps Engineers. 2007. *Regional supplement to the Corps of Engineers Wetland Delineation Manual: Alaska Region*. J.S. Wakeley, R.W. Lichvar, and C.V. Noble, ed. ERDC/EL TR-07-24. Vicksburg, MS: U.S. Army Engineer Research and Development Center, Environmental Laboratory.

Glossary

- Abaxial:** Of a leaf, the side facing away from the main shoot axis (cf. adaxial)
- Acrocarpous:** Of mosses, where the sporophyte is produced at the apex of the main stem or main branch (cf. Pleurocarpous)
- Acumen:** A slender tapering point
- Acuminate:** Narrowly tapered with an angle less than 45° (longer than acute)
- Acute:** Sharp pointed, with a terminal angle less than 90° but greater than 45°
- Adaxial:** Of a leaf, the side adjacent to the shoot axis (cf. abaxial)
- Alar cells:** Referring to cells at the basal margins or angles of a moss leaf, the cells often differing in size, shape or color from other leaf cells
- Antheridium (pl: -a):** The male gametangium of bryophytes; a multicellular cylindric to broadly globular, stalked structure containing the spermatozooids
- Apiculate:** Having an abrupt short point (mucronate is shorter; cuspidate is longer and stouter)
- Apiculus:** A short abrupt point
- Apophysis:** In mosses, a strongly differentiated neck at the base of the capsule, between the top of the seta and base of the urn
- Appressed:** With the leaves lying close to the stem
- Archegonium (pl: -a):** The female gametangium or sex organ of bryophytes; a multicellular flask-shaped structure
- Arcuate:** Curved like an arch
- Ascending:** Pointing obliquely upwards or away from the substrate
- Axil:** The angle between the adaxial surface of a leaf and the stem
- Bipinnate:** With both primary and secondary stems or branches pinnate
- Bordered:** Having the margins differentiated from the remainder of the structure in shape, size, color or thickness
- Botryoidal:** Like a bunch of grapes
- Calyptra:** Of mosses, a membranous covering of the developing sporophyte
- Capitulum:** A head, as of the terminal cluster of branches in *Sphagnum*
- Capsule:** The terminal spore-producing part of the sporophyte
- Clustered:** Occurring close together in the same small area of the substrate
- Comal tuft:** A tuft of leaves at the apex of the stem
- Commissure:** In *Sphagnum*, the junction of a hyaline cell and a chlorophyllous cell
- Complanate:** Flattened or compressed; having leaves more or less flattened in one plane
- Concave:** Curved inwards, like the interior of a circle
- Contorted:** Irregularly curved or twisted
- Convex:** Curved outward, like the exterior of a circle
- Cordate:** Heart shaped; a leaf with large rounded angles at the base or point of attachment
- Cortex:** The outer layer or layers of a stem or branch, differentiated from the tissues within
- Costa:** In mosses, the “nerve” or “midrib” of a leaf, always more than one cell thick; in liverworts, the longitudinal multi-stratose median region of the thallus
- Crisped:** Wavy, variously curved, twisted or contorted
- Cuspidate:** Ending abruptly in a stout, rigid point
- Cylindric (-al):** Elongate and circular in transverse section
- Decurrent:** With the basal margins of the leaf extending down the stem beyond the leaf insertion or attachment to the stem

Dendroid:	Like a tree; with a cluster of branches above a distinct trunk like stipe or stem
Dentate:	With sharp teeth directed outwards
Denticulate:	Finely toothed
Dioicous:	With the antheridia and archegonia on separate plants (cf. monoicous)
Diploid:	A cell, individual, or generation with two sets of chromosomes (2n); the typical chromosome set of the sporophyte generation
Distal:	Away from the base or point of attachment; towards the apex of a leaf or stem
Distant:	Well spaced
Dorsal:	Of leaves, the abaxial or lower surface; of stems or thalli, the upper surface away from the substrate
Elaters:	Of liverworts, elongate unicellular structures intermingled with the spores in a capsule, mostly with spirally coiled thickened bands
Ellipsoid:	An oval solid
Elongate:	Stretched out, linear
Entire:	Without teeth, more or less smooth on the margin
Erect:	With the leaves directed towards the stem apex; with the leaf margins curved upwards or adaxially; with the capsules straight, not curved; oriented perpendicularly to the substrate or to a horizontal axis
Erectopatent:	Spreading at an angle of 45° or less from the stem
Erose:	Irregularly notched or eroded
Excurrent:	Extending beyond the apical margin
Exserted:	Projecting beyond and exposed
Falcate:	Curved like a sickle
Falcate secund:	Strongly curved and turned to one side
Fascicle:	A group, cluster or bundle of branches (as the branches of <i>Sphagnum</i>)
Fibril:	Fine, fiber-like wall thickenings
Filamentous:	Thread like
Filiform:	Slender and elongate, filamentous, thread like
Flexuose:	Slightly and irregularly bent or wavy
Foliose:	Leafy or leaf like
Frond:	The branched or foliose part of an erect stem, including branches, of a dendroid or frondose moss
Fusiform:	Narrow and tapered at both ends like a spindle
Gametangium:	The structure bearing gametes (e.g., archegonium, antheridium)
Gamete:	A reproductive cell
Gametophyte:	Of bryophytes, the haploid (n) sexual generation bearing antheridia and/or archegonia; the dominant generation in bryophytes
Gemma (pl: -ae)	Asexual reproductive structures; uni- or multicellular, filamentous or variously shaped, relatively undifferentiated structures serving in vegetative reproduction
Globose:	Spherical; having the general form or shape of a ball
Gregarious:	Occurring relatively close together in the same general area of the substrate but not clustered
Gynoeceium:	The female gametoeceium, consisting of archegonia and the surrounding bracts
Habit:	The general appearance
Habitat:	The local environment
Haploid:	A cell, structure, or organism having a single set of chromosomes (n); the normal chromosome level of the gametophyte generation
Hyaline:	Colorless or transparent

Hyalodermis:	The stem cortex or its outer layer when it consists of relatively large, usually more or less thin-walled cells, which are often hyaline
Hypophysis:	A strongly differentiated neck between the apex of the seta and the base of the urn of the capsule of mosses (cf. apophysis, neck)
Imbricate:	Closely appressed and overlapping
Immersed:	Enclosed
Inclined:	Bent down; of mosses, capsules that are between the erect and the horizontal positions
Incrassate:	With thickened cell walls
Incubous:	Of liverworts, the arrangement of leaves where the leaves are inserted obliquely on the stem and in which the leading (distal) margin of a leaf is nearer the stem apex and often overlaps or covers the trailing (proximal) margin of the leaf in front or towards the apex (cf. succubous)
Incurved:	Curved upward (adaxially) and inward
Inflated:	Swollen, puffed up; having a somewhat rounded or swollen shape
Inflexed:	Bent upwards (adaxially) and weakly inwards
Inrolled:	Rolled upwards (adaxially) and tightly inwards, applied to the leaf margins
Insertion:	Refers to the line or point of attachment of an appendage
Involute:	Of liverworts, a short complete or incomplete tube protecting one or more antheridia or archegonia, or a developing sporophyte, replacing the perianth or rarely additional to it
Involute:	Rolled upwards (adaxially) and tightly inwards, applied to the leaf margins
Keel:	A ridge formed along a sharp fold
Keeled:	Sharply folded along the middle; V-shaped in cross section
Lamella:	Parallel photosynthetic ridges or plates along a leaf blade or costa
Lamina:	The flattened, generally unistratose and green part of the leaf blade, excluding the costa and border
Lamina cells:	Cells of the leaf lamina
Lanceolate:	Lance shaped; narrow and tapered from near the base to a long point; narrowly ovate acuminate
Lateral:	At the sides
Lax:	Loose; referring to large thin walled cells as well as to the nature and spacing of leaves on a stem, or of stems in a tuft
Lenticular:	Lens shaped; convex on both sides and more or less circular in outline
Limb:	The leaf blade above a differentiated leaf base
Linear:	Very narrow, elongate with nearly parallel sides; narrower than lingulate
Lingulate:	Tongue shaped; oblong with a slightly broadened apex; long and narrow with the two longest sides more or less parallel and the distal end rounded
Lobe:	One of the divided distal segments or an appendage or thallus
Macronemata:	Of mosses, large and freely branched rhizoids restricted to the leaf axils and branch insertions on a stem (cf. micronemata)
Mamilla:	A strongly bulging surface of a cell
Mamillose:	Having mamillae
Marsupium:	Of liverworts, a bulbous to cylindrical structure developed at an angle to the stem and protecting the developing sporophyte, bearing rhizoids and more or less buried in the substratum

Meristem:	A localized region of growth or potential growth by cell division
Micronemata:	Of mosses, short and fine, not or only sparingly branched rhizoids that arise randomly along the stems or leaf bases (cf. macronemata)
Monoicous:	Bisexual; with antheridia and archegonia borne on the same plant (cf. dioicous)
Multistratose:	Of tissue, consisting of several to many layers of cells
Neck:	Of mosses, the sterile basal portion of a capsule, sometimes considerably differentiated (cf. apophysis, hypophysis)
Oblique:	Slanted
Oblong:	Rectangular with rounded corners or ends
Obovate:	Egg shaped, with the apex broader than the base
Obovoid:	An inversely ovoid solid
Obtuse:	Broadly pointed, more than 90°; sometimes referring to blunt or rounded
Oil body:	Of liverworts, intracellular bodies containing oil globules and bound by a delicate membrane, seldom persistent on drying
Opaque:	Dense, impervious to light
Operculum:	Of mosses, a lid covering the mouth of most moss capsules
Ovate:	Egg shaped, with the base broader than the apex
Ovoid:	An egg shaped solid
Papillae:	Of cell ornamentation, a solid microscopic protuberance (cf. mamillae)
Papillose:	Having papillae
Paraphyllia:	Small green outgrowths of various shapes (filiform, lanceolate, scale like, branched), produced randomly on the stems or branches of many pleurocarpous mosses (cf. pseudoparaphyllia)
Patent:	Leaves spreading from the stem at an angle of 45° or more
Pendent:	Hanging downwards
Pendulous:	Pendent or hanging
Pecurrent:	Extending to or disappearing in the apex
Perianth:	Of liverworts, a tube surrounding a developing sporophyte
Perichaetial leaf:	A modified leaf associated with the gynoeceium, collectively forming the perichaetium
Perichaetium:	The gynoeceium; the sheathing cluster of modified leaves surrounding the archegonia
Peristome:	Of mosses, a circular structure, generally divided into 4, 8, 16, 32, or 64 teeth, arranged in a single or double row around the mouth of the capsule (absent in some mosses)
Persistent:	Not falling, or not deciduous; remaining for a long time
Pinnate:	With numerous spreading branches on opposite side of the axis
Pit:	A small depression or cavity in a cell wall
Plane:	Flat, not curved or wavy, referring to the leaf margin or leaf blade
Pleurocarpous:	Of mosses, producing sporophytes laterally from a perichaetial bud or short lateral branch, rather than at the stem tip (cf. acrocarpous); with the stems usually prostrate, creeping and freely branched and growing in mats rather than tufts
Plicate:	With longitudinal furrows or pleats
Polymorphic:	Variable, of more than one form
Pore:	A small aperture; in <i>Sphagnum</i> , a round or oval opening in the outer wall of the stem cortical cells or of a hyaline leaf cell; of liverworts, a small aperture in the dorsal epidermis of a thallus surrounded by specialized cells

Porose:	Having pores
Procumbent:	Spreading, prostrate
Propagule:	A bud, branch, or leaf serving in vegetative reproduction
Prostrate:	Creeping, lying flat
Protonema:	Of bryophytes, a filamentous, globose, or thalloid structure arising from the germinating spore and including all stages of development up to the production of one or more gametophores (leafy shoots)
Proximal:	Near the base or point of attachment; the internal face of a spore (as opposed to distal)
Pseudoparaphyllia:	Small, unistratose, filiform or foliose structures resembling paraphyllia but restricted to areas of a stem around a branch primordium; often found in pleurocarpous mosses
Pseudopodium:	A shoot-like extension of the stem
Pyriform:	Pear shaped
Rectangular:	Shortly elongated cells with parallel sides and square ends
Recurved:	Curved downwards (abaxially) and inwards; with the upper part curved away from the axis; in leaves, referring to the margins, apices, marginal teeth
Reflexed:	Bent backwards so that the apex points away from the axis apex; referring to the leaf margins or to leaves on a stem (as opposed to inflexed)
Revolute:	Rolled downwards (abaxially) and backwards, referring to a leaf margin (opposite to involute)
Rhizoid:	Hair-like structure that functions in water absorption and anchorage
Rhomboid:	Diamond shaped
Secund:	Turned or curved to one side, e.g., the leaves on a stem
Serrate:	Saw-toothed; with the marginal teeth pointing forwards or towards the apex
Serrulate:	Minutely serrate
Seta:	The elongated portion of the sporophyte between the capsule and the foot, or point of attachment to the gametophyte plant; a bristle
Sheathing:	Surrounding and clasping the stem, the base of the seta or capsule
Simple:	Unbranched
Sinuose:	Wavy
Sinus:	A notch or indentation between two lobes
Sporangium:	See capsule
Spore:	A general term for a reproductive unit in fungi, bacteria and cryptogamic plants; commonly one-celled, but in fungi, often multi-celled; usually minute and on germination giving rise to a protonema (in bryophytes) or hyphae (in fungi)
Sporophyte:	The spore-bearing generation; in bryophytes, developing from the fertilized egg, remaining attached to and partially dependent on it
Spreading:	Forming an angle of 45° or more
Squarrose:	Spreading at right angles (90°), with the upper part bent back abruptly
Squarrose recurved:	Spreading at right angles (90°), with the tips curved downwards
Stellate:	Star shaped
Striate:	Marked with fine ridges or lines
Strumose:	With a goiter-like swelling on one side at the base of some moss capsules
Subula:	A long slender point
Subulate:	Slenderly long acuminate

Succubous:	Of liverworts, the arrangement of leaves that are usually obliquely inserted on the stem and in which the leading (distal) margin of a leaf nearer the apex of a stem is overlapped by the trailing (proximal) margin of the next leaf nearer to the shoot apex, often lying beneath it (cf. incubous)
Terete:	Round in cross section
Tomentose:	Woolly, with a tomentum
Tomentum:	A felt-like covering of rhizoids on some stems or, rarely, leaves
Tooth:	A small, unicellular or composed of several cells, more or less triangular projection on the margin or apex
Transverse:	Across, perpendicular to the long axis
Trigones:	Thickenings of the corners of cells where thin or somewhat thickened walls meet; minute to convex or nodular in shape
Truncate:	Abruptly cut off or squared off at the apex
Tubulose:	Tube like, usually referring to leaves with strongly incurved or broadly overlapping leaf margins
Underleaves:	Of liverworts, the third row of leaves along the undersurface of a stem or branch, often smaller or much smaller than and differing from the two rows of lateral leaves
Undulate:	Of a surface or margin, wavy alternately up and down
Unipapillose:	With single papilla per cell
Urn:	The spore-bearing portion of the capsule (as distinct from the neck)
Ventral:	Of leaves, the adaxial, top, or upper surface; of stems or plants, the lower surface next to the substrate (cf. dorsal)
Wide spreading:	Spreading at a wide angle but less than 90°

APPENDIX 1. Instructor Listing for Anchorage and Fairbanks Course Participants in Biology 485-301 & 393/693 (Wetland Delineation Bryology)

Name	Affiliation
Anchorage: Biol. 485-301: Wetland Delineation Bryology	
Hank Baij	U.S. Army Corps of Engineers
Terry Carpenter	U.S. Army Corps of Engineers
Leah Durocher	U.S. Army Corps of Engineers
Lisa Gibson	U.S. Army Corps of Engineers
Beatrice Gybejimba	Alaska Department of Transportation and Public Facilities
Marcia Heer	U.S. Army Corps of Engineers
Angela Hunt	U.S. Army Corps of Engineers
Gary Laursen	University of Alaska Fairbanks / Institute of Arctic Biology
Robert Lichvar	U.S. Army Corps of Engineers / Engineer Research and Development Center
Sarah Lindberg	Alaska Department of Transportation and Public Facilities
Forest McDaniel	U.S. Army Corps of Engineers
Jennifer Mitchell	U.S. Army Corps of Engineers
Rod Seppelt	Australian Antarctic Division
Julie Woodke	U.S. Army Corps of Engineers
Fairbanks: Biol. 393/693: Wetland Delineation Bryology	
Megan Boldenow	Alaska Department of Natural Resources
Christy Everett	U.S. Army Corps of Engineers
Gary Laursen	University of Alaska Fairbanks / Institute of Arctic Biology
Robert Lichvar	U.S. Army Corps of Engineers / Engineer Research and Development Center
Debby McAtee	U.S. Army Corps of Engineers
Mary Romero	U.S. Army Corps of Engineers
Sharon Seim	U.S. Army Corps of Engineers
Rod Seppelt	Australian Antarctic Division
Ben Soiseth	U.S. Army Corps of Engineers
Chris Wrobel	Henningson, Durham and Richardson, Inc.

