



1

Subgenus *Sphagnum*

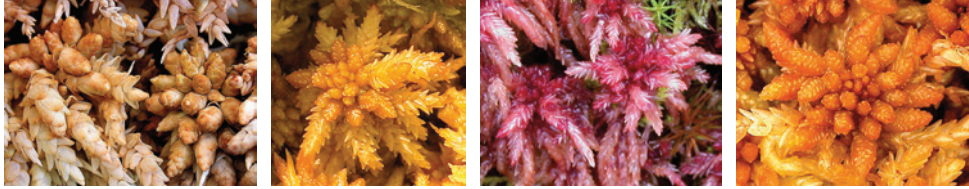


Main traits

Macroscopic field traits

The size and shape of the branch leaves make it easy to relate a specimen to the *Sphagnum* subgenus.

- **Capitulum** well developed, large (all the species in this subgenus are among the most robust of the whole genus *Sphagnum*).



- Cucullate **branch leaves** (spoon shaped), 1.0 to 2.0 mm long
- Lingulate **stem leaves** (tongue shaped), with broadly rounded apex, 1.0 to 2.0 mm long.

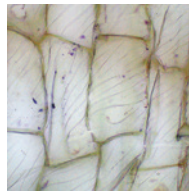
Microscopic traits

Caution: Microscopic observations of the *Sphagnum* subgenus species (except the species of the *Sphagnum magellanicum* complex) are made without staining, with only water or glycerol.

- **Stem** (cross-section) showing a well-differentiated cortex, formed of 3-4 layers of cells; outer layer (flat view) reinforced with spiral fibrils.
- **Cucullate branch leaves** showing a resorption furrow at the margin (cross-section); chlorocysts (whole leaves, seen flat) with smooth walls, or decorated with papillae in *Sphagnum papillosum*, or with pectinations in species of the *Sphagnum imbricatum* complex.
- Lingulate **stem leaves** (entire, viewed flat); hyalocysts without fibrils or pores or very rarely with incomplete or rudimentary fibrils; chlorocysts with an ornate wall of pectinations in species of the *Sphagnum imbricatum* complex.



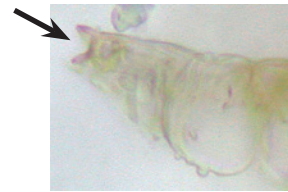
Stem (cross-section)



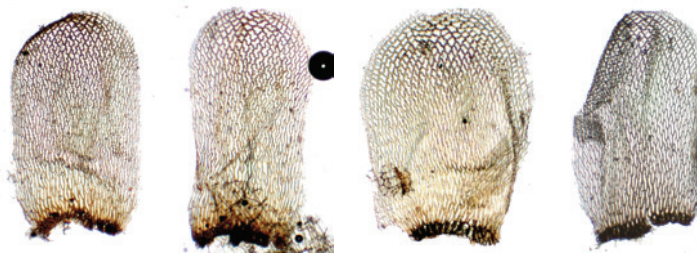
Cortex (stem) with fibrils (viewed flat)



Cucullate branch leaves

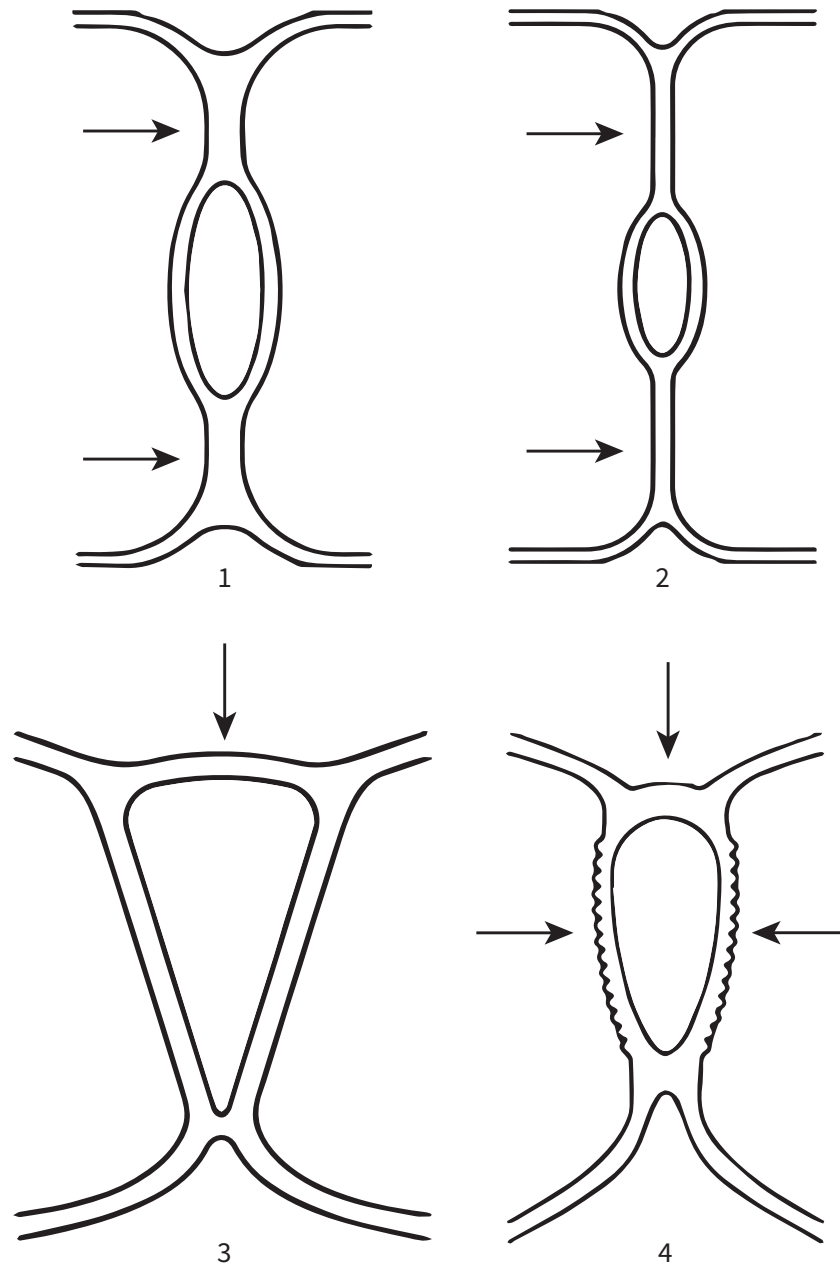


Branch leaf (cross-section, resorption furrow)



Lingulate stem leaves

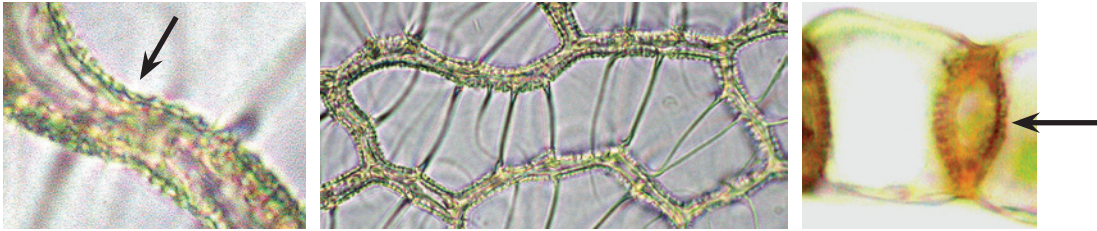
Note: The following illustrations may be useful when using the dichotomous key.



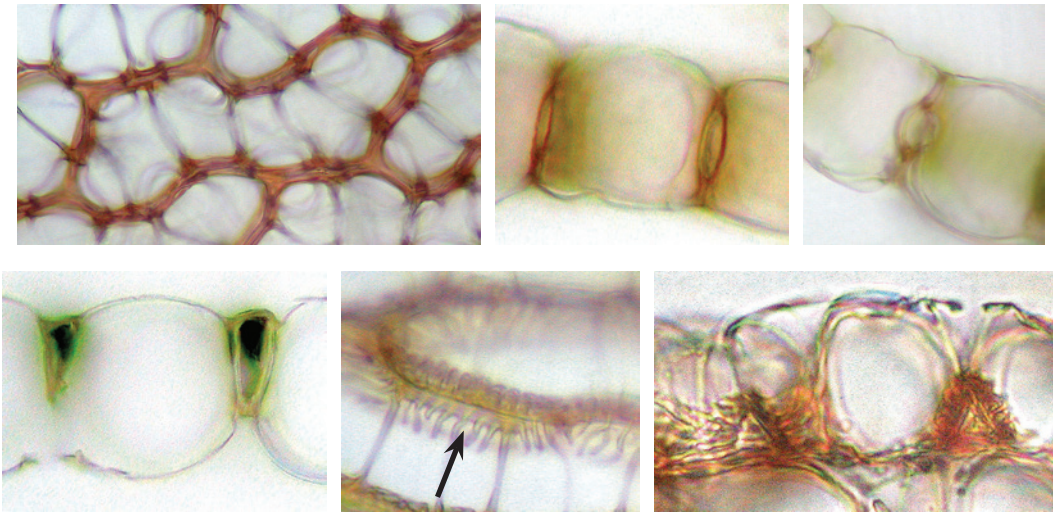
1. *Sphagnum centrale*: thick walls at the ends of elliptic chlorocysts.
2. *Sphagnum magellanicum* (the complex): thin walls at the ends of short-elliptic chlorocysts.
3. *Sphagnum palustre*: triangular to ovate-triangular chlorocysts, more broadly exposed on the concave leaf surface.
4. *Sphagnum papillosum*: ovate chlorocysts, more broadly exposed on the concave leaf surface, and papillae present on the inner wall.

Key to species

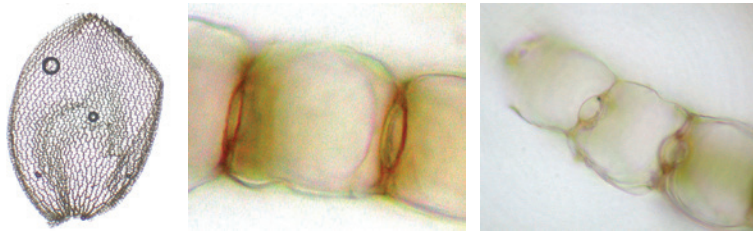
1. **Branch leaves** (viewed flat or in cross-section) with chlorocyst walls papillose (with papillae)..... *Sphagnum papillosum* (in part)



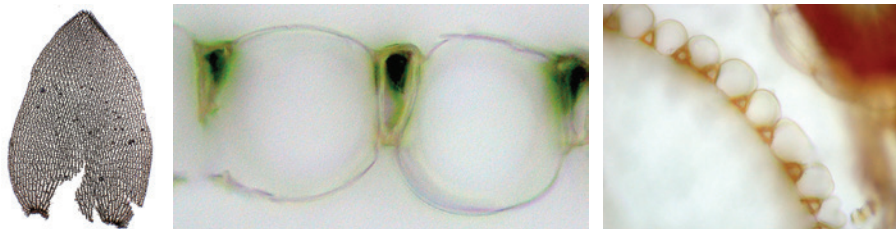
1. **Branch leaves** (viewed flat or in cross-section) with chlorocyst walls smooth or with pectinations..... **2**



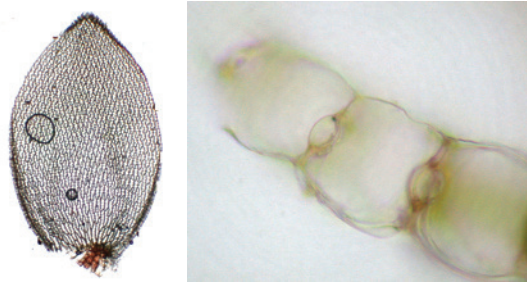
2. **Branch leaves** (cross-section) with chlorocysts elliptic or oval..... **3**



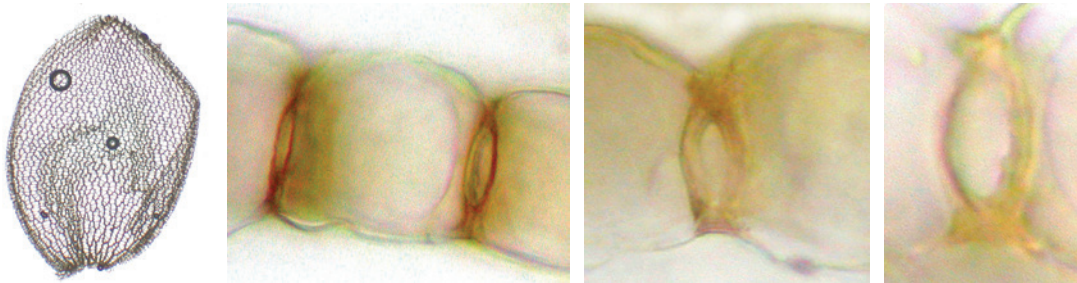
2. **Branch leaves** (cross-section) with chlorocysts isosceles-triangular or equilateral-triangular..... **5**



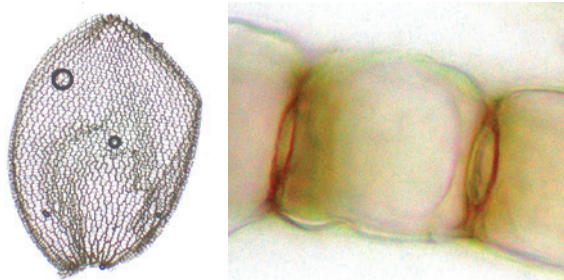
3. **Branch leaves** (cross-section) with oval chlorocysts, not reaching the concave and convex surfaces (completely enclosed between the two contiguous hyalocysts)
 **the *Sphagnum magellanicum* complex**



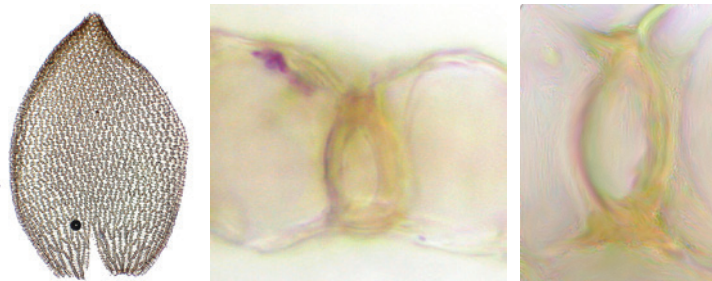
3. **Branch leaves** (cross-section) with elliptic chlorocysts, reaching the concave and convex surfaces (isolating or separating the two contiguous hyalocysts from each other) **4**



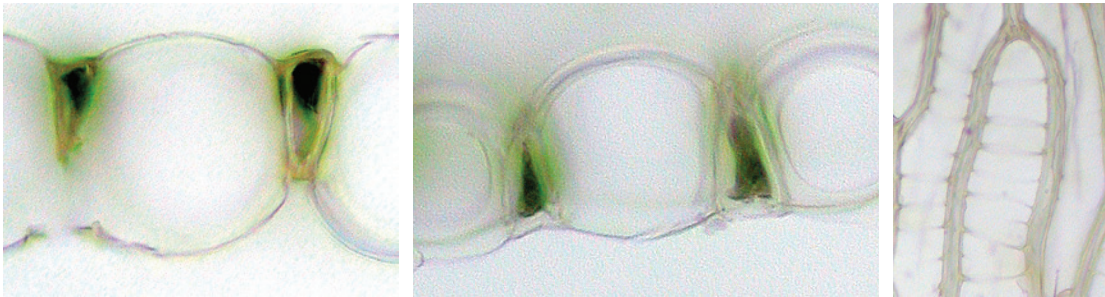
4. **Branch leaves** (cross-section) with narrowly elliptic chlorocysts, base the same width as the apex (rich fen species only) ***Sphagnum centrale***



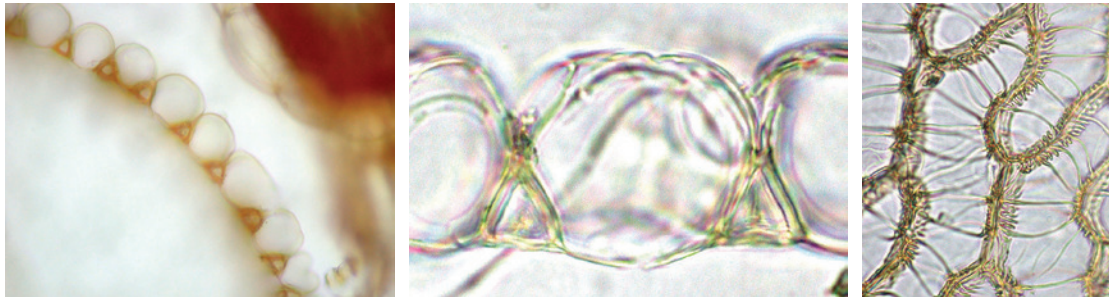
4. **Branch leaves** (cross-section) with broadly elliptic chlorocysts, base significantly wider than the apex ***Sphagnum papillosum*** (in part)



5. **Branch leaves** (cross-section) with chlorocysts shaped like an isosceles triangle, clearly separating the two contiguous hyalocysts from each other. (Other useful trait: stem leaves and branch leaves [entire, viewed flat] with chlorocysts without pectinations).....***Sphagnum palustre***



5. **Branch leaves** (cross-section) with chlorocysts shaped like an equilateral triangle, not clearly separating the two contiguous hyalocysts from each other. (Other useful trait: stem leaves or branch leaves [entire, viewed flat] with chlorocysts generally with pectinations [Note: the pectinations may be absent from the stem and branch leaves in *S. affine*].).....
 **the *Sphagnum imbricatum* complex 6**



6. **The *Sphagnum imbricatum* complex** (adapted from Maximov 2007):

Thingsgaard (2002) confirmed the specific rank, using genetic tools, of the four subspecies or varieties of the *Sphagnum imbricatum* complex recognized by Flatberg (1984a):

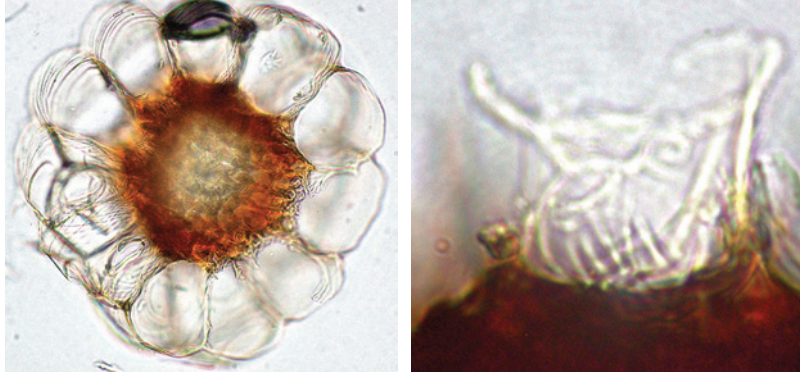
- *Sphagnum affine* Renaud & Cardot (= *S. imbricatum* ssp. *affine* (Renaud & Cardot) Flatberg)
- *Sphagnum austinii* Sullivant (= *S. imbricatum* subsp. *austinii* (Sullivant) Flatberg)
- *Sphagnum imbricatum* Hornsch. ex. Russow
- *Sphagnum steerei* R.E. Andrus (= *S. imbricatum* ssp. *austinii* var. *arcticum* Flatberg)

Three of these four species occur in the area covered by this guide: *Sphagnum affine*, *S. austinii* and *S. steerei*.

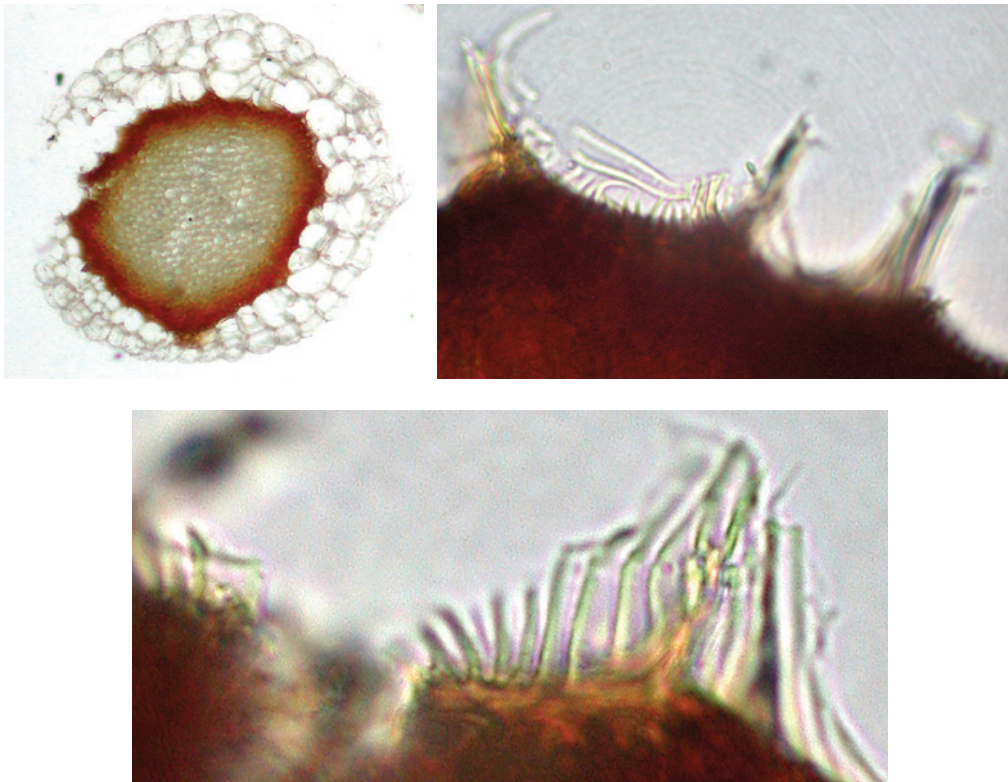
The type species, *Sphagnum imbricatum* (*sensu stricto*), is found only in Asia.

Reminder: The pectinations in the hyalocysts of the branch leaves and stem leaves are observed on entire leaves mounted flat, in a drop of water or ideally in a drop of glycerol, without staining.

The **pectinations** in the hyalocysts of **branches** (cross-section) can be observed using a light microscope; they are arranged perpendicularly or obliquely to the length of the branch, whereas the spiralled fibrils are oriented in all directions. These pectinations are present in all species of the *Sphagnum imbricatum* complex, but are easily observed only in *Sphagnum affine* and *S. austinii*. They are impossible to observe in *S. steerei* without special preparation.



The **pectinations** in the **stem** hyalocysts are more difficult to observe. Many cross-sections must be made which are then placed in a drop of glycerol between slide and coverslip. The outer surface of the scleroderm is observed where it touches the cortex.



6. The *Sphagnum imbricatum* complex (key to species: see p. 38) 6

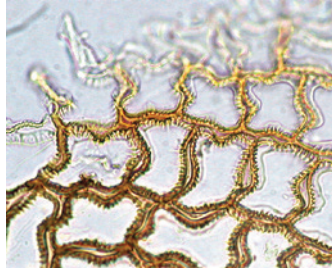
6. The *Sphagnum imbricatum* complex

Reminder: The following observations are made in a drop of water, or ideally in a drop of glycerol.

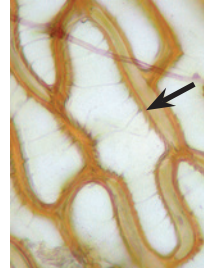
6. **Stem leaves** (viewed flat) with chlorocysts having well developed and easily observable pectinations; hyalocysts usually once septate..... *Sphagnum austinii*



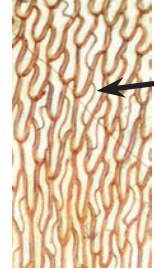
Stem leaf



Stem apex

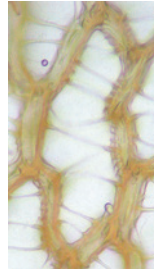
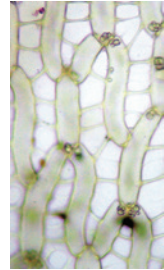


Pectinations

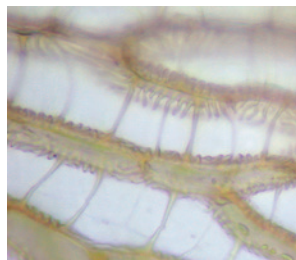
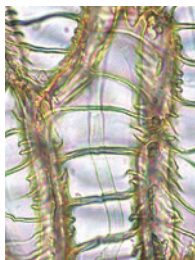


Septum

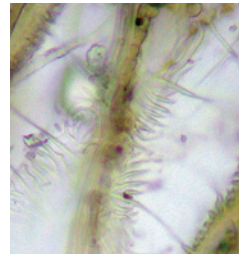
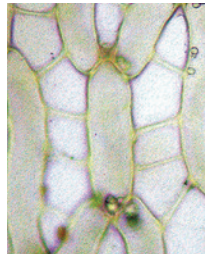
6. **Stem leaves** (viewed flat) with chlorocysts without pectinations or with indistinct and poorly developed pectinations; hyalocysts without septum..... 7



7. **Branch leaves** (viewed flat) with chlorocysts with pectinations over almost the entire length of the leaf..... *Sphagnum steerei*



7. **Branch leaves** (viewed flat) with chlorocysts without pectinations or pectinations restricted to the leaf base *Sphagnum affine*





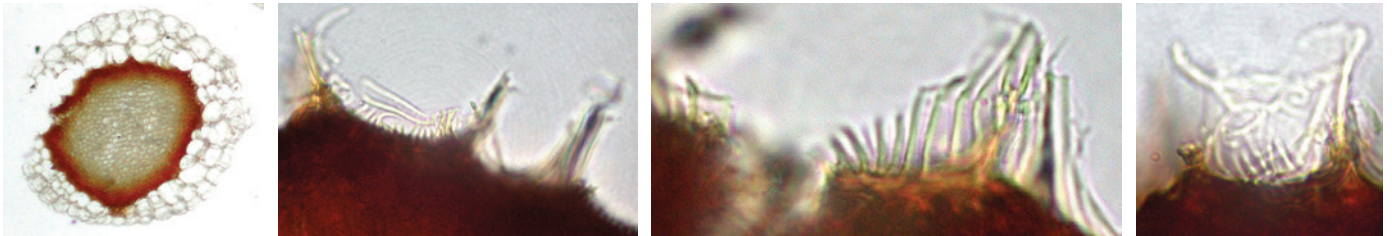
1. *Sphagnum affine* Renauld & Cardot

Microscopic traits

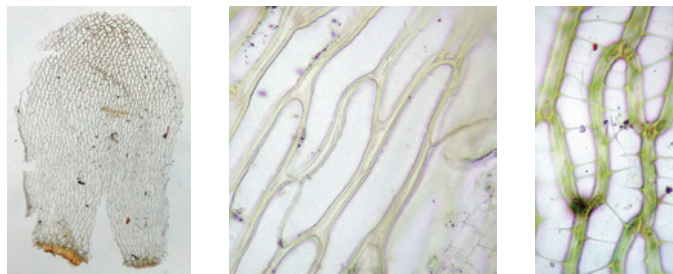
Observations are made in a drop of water or glycerol, without staining.

- **Stem** (cross-section) with internal cortical cells with pectinations where they touch the scleroderm.

Note: With this single trait, *Sphagnum affine* may be distinguished from other species of the *Sphagnum imbricatum* complex and even from all other *Sphagnum* species.

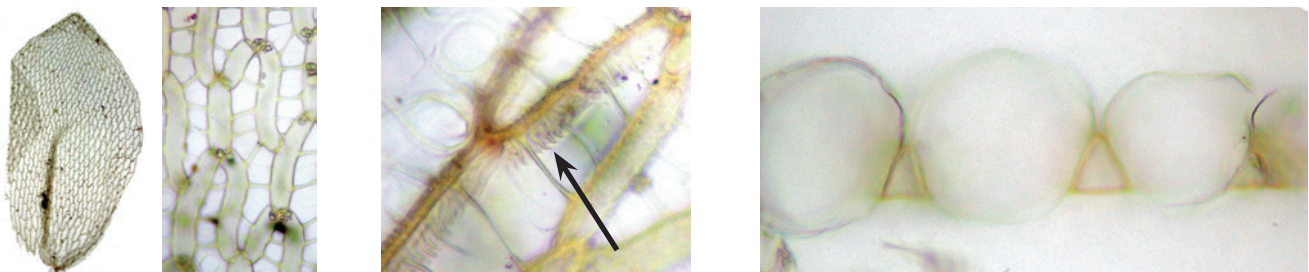


- **Stem leaves** (entire, viewed flat) with chlorocysts usually without pectinations in the upper half of the leaf.



Stem leaf (viewed flat)

- **Branch leaves** (entire, viewed flat) with chlorocysts without pectinations, or pectinations restricted to the leaf base; (cross-section) chlorocysts broadly triangular and well enclosed on the convex surface (the tip of the triangle does not always reach the convex surface as it is covered by the two contiguous hyalocysts).



Branch leaf

pectinations

(cross-section)



Differences between similar species

- The individual stems of *Sphagnum affine* do not separate as easily from the colony as those of *S. papillosum*.



Biotope

- Mats and low hummocks. Not aquatic.



Habitat

- Present in a variety of minerotrophic habitats, growing with sedges or with lichens in more exposed areas; swampy lakeshores, contact zones between fens and a till outcrops. *Sphagnum affine* and *S. papillosum* often grow together.



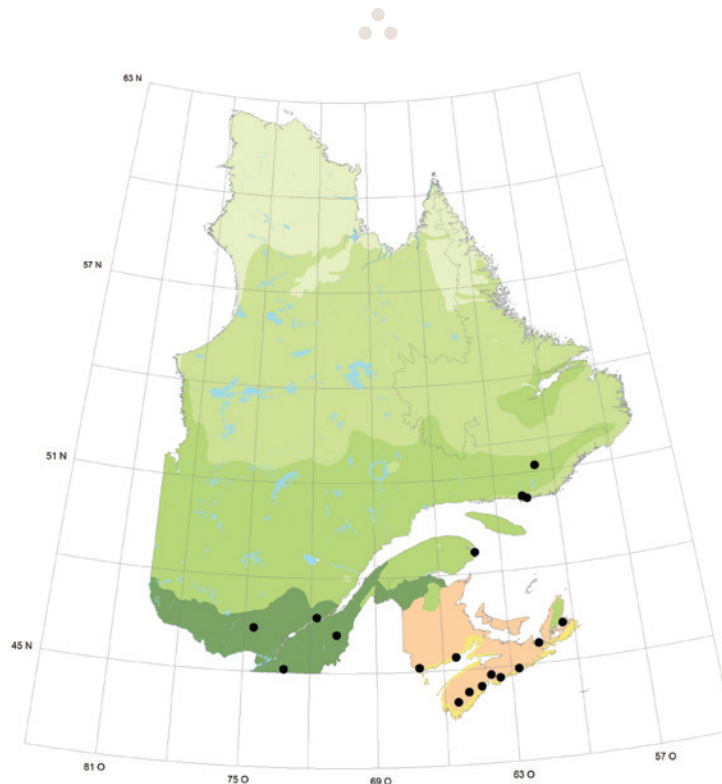
Distribution

- Amphi-Atlantic species, mainly in temperate regions (requires a warm growing season).



Macroscopic field traits

- Generally a small **plant**, with a small **capitulum** for a species of the subgenus *Sphagnum*.
- **Branch leaves** well imbricated around the branch.
- **Capitulum** green to golden brown, with a touch of red.

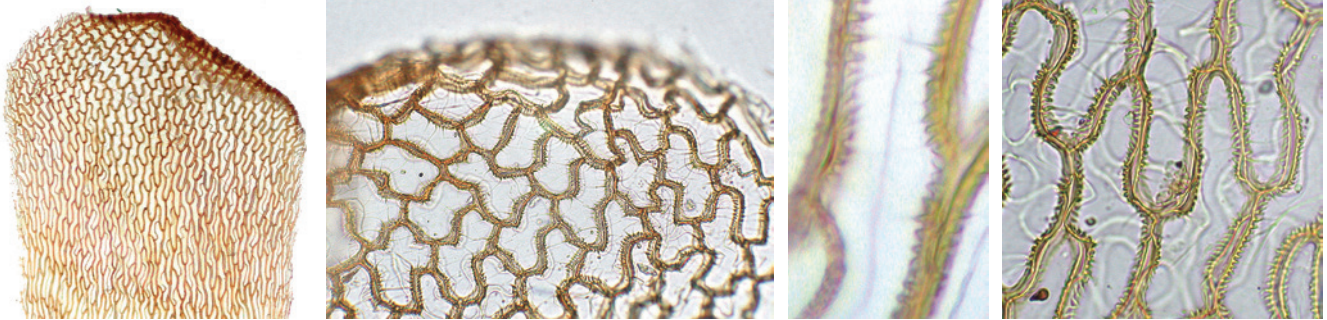


2. *Sphagnum austinii* Sullivant

Microscopic traits

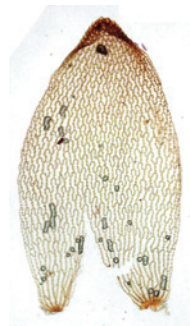
Observations are made in a drop of water or glycerol, without staining.

- **Stem leaves** (entire, viewed flat) with 1-septate hyalocysts; chlorocyst walls with well-developed and easily observable pectinations that often extend over the entire leaf length or nearly so.

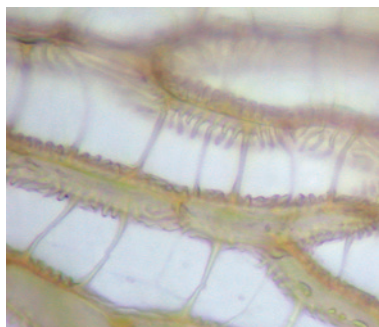


Stem leaf

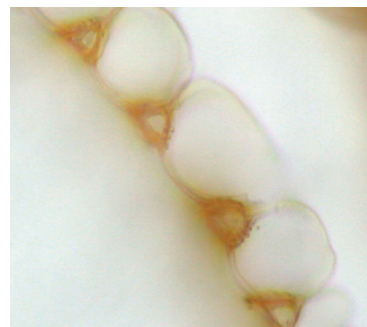
- **Branch leaves** (entire, viewed flat) with chlorocysts whose walls have pectinations; (cross-section) chlorocysts largely triangular and well enclosed on the convex surface (the tip of the triangle does not always reach the convex surface as it is covered by the two contiguous hyalocysts).



Branch leaf



(viewed flat)



(cross-section)



Differences between similar species

- The length and width of *Sphagnum austinii* stem leaves are relatively more equal than in *S. papillosum*.



Biotope

- Dense hummocks or little lawns formed of very compact capitula, yellowish-brown with shades of red.



Habitat

- Maritime bogs or poor fens with pools, often in association with *Sphagnum fuscum*, *S. magellanicum* (the complex), *S. flavicomans*, *Rubus chamaemorus*, *Empetrum nigrum*, *Gaylussacia baccata* and *Cladina* spp.



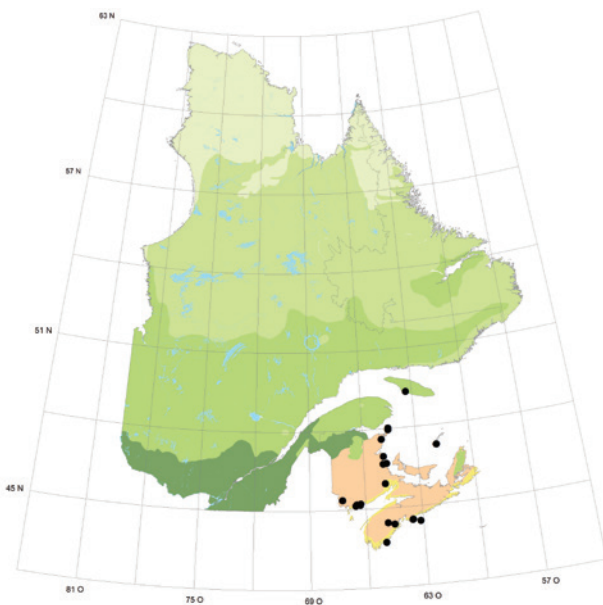
Distribution

- Boreal amphi-Atlantic species.



Macroscopic field traits

- **Capitulum** very compact, with a few long, slender **branches**.
- The only species of the subgenus with a single pendent **branch**.
- Generally grows in dense, very compact cushions which form tall, broad, flat-topped hummocks.
- The fascicles are densely structured and the individuals cannot be easily separated.
- Never completely brown, often with an orange-brown tint.

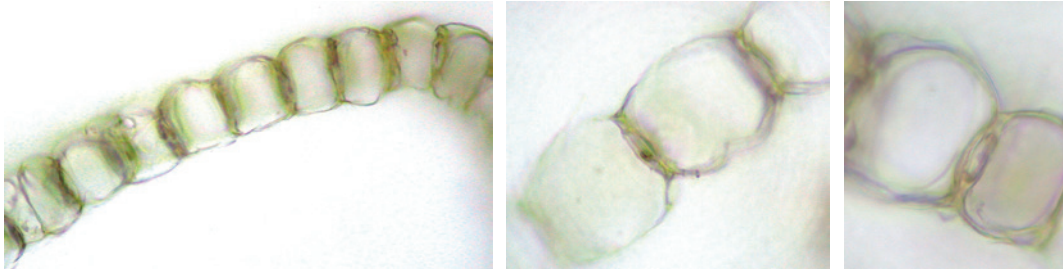


3. *Sphagnum centrale* Arnell & C. E. O. Jensen

Microscopic traits

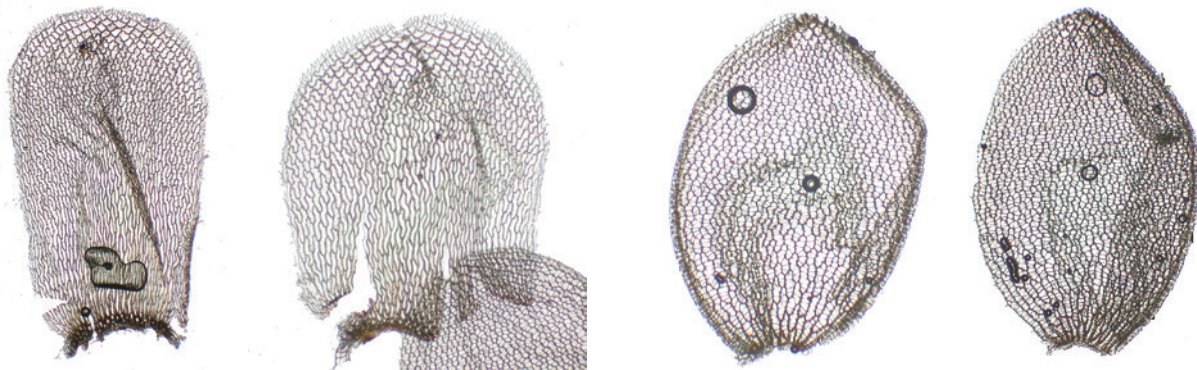
Observations are made in a drop of water or glycerol, without staining.

- **Branch leaves** (cross-section) with smooth chlorocysts (walls without papillae nor pectinations), narrowly elliptic, reaching the concave and convex surfaces (isolating or separating the two contiguous hyalocysts from each other).



Branch leaf (cross-section)

Note: The stem and branch leaves have no useful diagnostic traits other than those previously described.



Stem leaves

Branch leaves



Differences between similar species

- The chlorocysts of the *Sphagnum magellanicum* complex (cross-section) do not reach the concave and convex leaf surfaces: they are completely enclosed between the two contiguous hyalocysts.
- *Sphagnum centrale* has longer branches than *S. palustre* and the outer branches of the capitula thin narrowly.
- Capitulum flatter and somewhat better organized into 5 ranks than those of *S. palustre*.
- *S. centrale* is only found in fens, whereas *S. palustre* is present in various habitats other than rich fens.



Biotope

- Hummocks or extended mats, often found in shady wet conditions.



Habitat

- A species of moderately-rich to rich fens, particularly present in coniferous fens (swampy forests) and sedge fens. Also found in the following types of stands or forests: alder, birch, cedar, maple, ash, larch, spruce-*Sphagnum*, hemlock, pine, fir, willow, aspen. Sometimes in riparian wetlands.

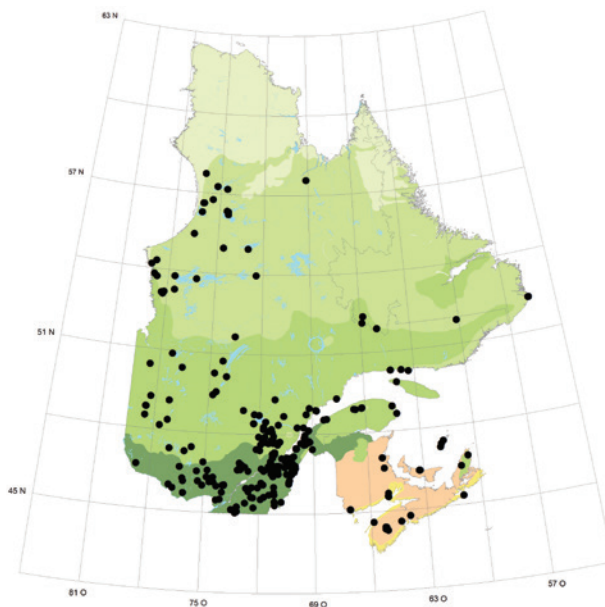


Macroscopic field traits

- One of our biggest *Sphagnum* mosses.
- Often appears shiny, light green, rose-tinted in the shade.



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Sphagnum magellanicum (the complex)

Our knowledge of this species, at the time of publication of this guide, has recently been completely revolutionized by the following article:

Hassel, K., M. O. Kyrkjeide, N. Yousefi, T. Prestø, H. K. Stenøien, J. A. Shaw & K. I. Flatberg. 2018. *Sphagnum divinum* (sp.nov.) and *S. medium* Limpr. and their relationship to *S. magellanicum* Brid. Journal of Bryology 40(3): 197-222.

It is mentioned that *Sphagnum magellanicum* is in fact a complex of three taxa, including *Sphagnum divinum*, a species new to science, and *Sphagnum medium*, which is now reinstated as a distinct species. As *Sphagnum magellanicum*, *sensu stricto*, is absent from North America, we only retain in the key below the two species of the complex present in the territory covered by the guide.



Microscopic traits

Species key

Exceptionally here, unlike other species of the subgenus *Sphagnum*, observations should be made with a strong coloration of the branch leaves of the pendent branches. These **branch leaves** should be taken from the middle portion of a branch.

4. Branch leaves of the **pendent branches** with hyalocysts of one of the sides (well flat; middle part) with pores occupying less than half the cell width ***Sphagnum divinum*** Flatberg & Hassel
5. Branch leaves of the **pendent branches** with hyalocysts of one of the sides (well flat; middle part) with large pores occupying half or more of the cell width ***Sphagnum medium*** Limprecht



Macroscopic field traits and



Habitat

- There is always red colour in the *Sphagnum magellanicum* complex. To observe this colour in green populations, scratch away the leaves and stem cortex, then hold the stem to the light.
- There is a very wide ecological amplitude for the *Sphagnum magellanicum* complex, from bogs to moderately rich fens and in forested or open natural peatlands. Also found in the following types of stands or forests: spruce-*Sphagnum*, larch, alder, cedar, wet maple, fir, and logged-over forests.

Field traits and habitat for the two species present in North America, as discussed with Blanka Aguaro (Duke University Herbarium) from preliminary observations and concordant with Hassel et al. (2018) article:

Sphagnum divinum

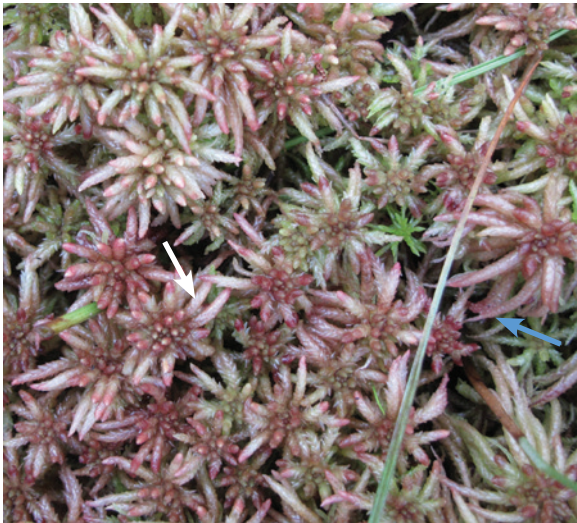
Morphology: *S. divinum* tends to have longer spreading and rather more narrow-tapering branches than *S. medium*. Upward branch leaves are more imbricated (<45° from branch stem). Shoots and capitula can be both purple-red or in shadier habitat wholly or partly greenish.

Habitat: Preference for shaded habitats such as those that can be found in lags (peatland margins) or forested peatlands. Consequently the capitula of the species can be partly to wholly greenish.

Sphagnum medium

Morphology: *S. medium* would have shorter and more blunt-tapering branches than *S. divinum*. Upward branch leaves are spreading ($>45^\circ$ from branch stem). Shoots and capitula are more consistently purple-red/wine-red.

Habitat: Preference for open expanses such as nice open well-developed bogs.



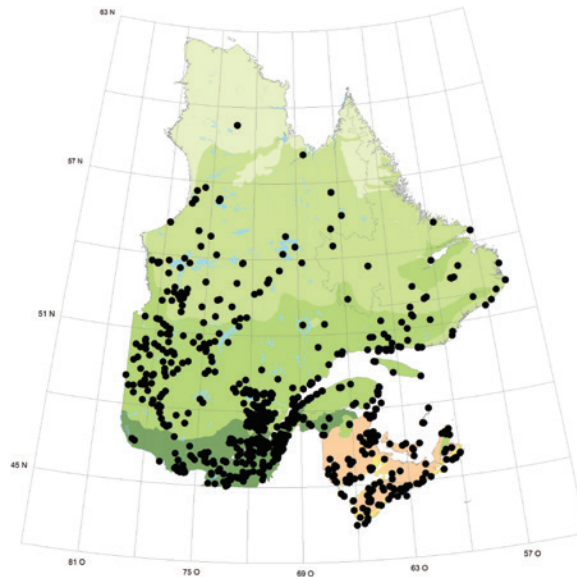
Sphagnum divinum

White arrow = imbricated upward branch leaves
Blue arrow = longer branches and rather narrow-tapering



Sphagnum medium

White arrows = spreading upward branch leaves
Blue arrows = shorter branches and blunt-tapering



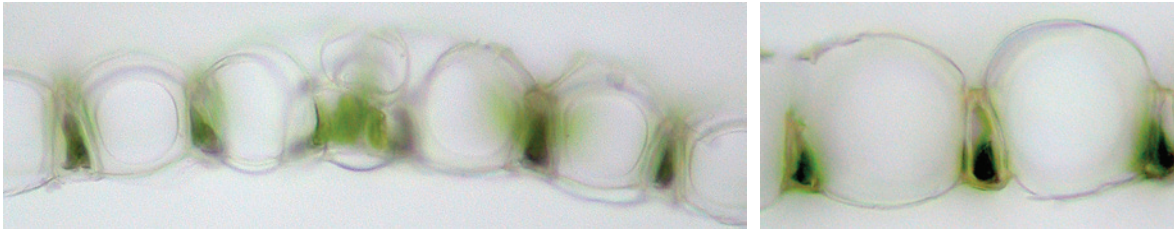
Distribution map for the *Sphagnum magellanicum* complex
(including both *S. divinum* and *S. medium*)

6. *Sphagnum palustre* Linnaeus

Microscopic traits

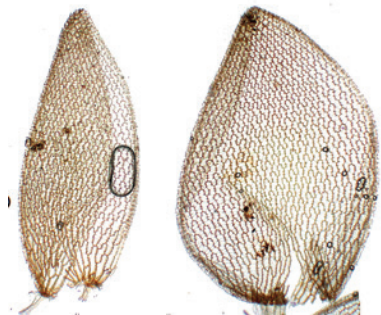
Observations are made in a drop of water or glycerol, without staining.

- **Branch leaves** (cross-section) with chlorocysts (with neither fibrils nor pectinations) shaped like isosceles triangles which clearly separate the two contiguous hyalocysts from each other.



Branch leaf (cross-section)

- **Branch leaves** cucullate (entire, viewed flat) with chlorocysts with smooth walls (with neither papillae nor pectinations).
- **Stem leaves** lingulate (entire, viewed flat) with chlorocysts with smooth walls (with neither papillae nor pectinations).



Branch leaves



Stem leaf



Differences between similar species

- The outer branches of the capitulum of *Sphagnum palustre* are more obtuse than those of *S. centrale*.



Biotope

- Usually grows in extensive, loose mats, occasionally forming hummocks and dense mats.



Habitat

- Often in shady conditions in forested peatlands, swamps (alder stands) and wet woodlands; laggs (peatland-forest ecotones) that are shrubby; also in weakly minerotrophic *Sphagnum* peatlands (poor fens).



Macroscopic field traits

- **Capitulum** disorderly, slightly convex.
- **Capitulum** bright green, but in the autumn the central parts of the capitulum become darker (brownish) than the **spreading branches**.

