FIELD GUIDE
to
MOSSES & LIVERWORTS
of
MINNESOTA's
CALCAREOUS FENS

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Introduction

Minnesota's Calcareous Fens and their Bryophyte Record

The native plant community (NPC) classes here considered to cover Minnesota's calcareous fens (CF) include Prairie Extremely Rich Fen (**OPp93**), Prairie Extremely Rich Fen (spring pool) (**OPp94**), Prairie Wet Meadow/Carr (**WMp73**), and Southern Seepage Meadow/Carr (**WMs83**) (DNR 2003-2006, Janssens 2005, 2010). The number of CF ecotopes (see Janssens 2007 for definition of ecotope) of the Minnesota bryophyte database assigned to these NPC classes equals 133 (retrieved on August 2010, Janssens 2010; Janssens 2005[1]). Table 1 lists 72 bryophyte species recorded from those ecotopes. To limit the number of species in the key to the most significant ones, I calculated the follow-ing IPV^{CF} (CF importance value)

for each species *x* IPV^{CF}_x equals

$$((nEcotCF_x)^2 / nEcotTot_x) \ / \ (nEcotCF \times 10^4)$$

where

$nEcotCF_x$ = number of CF ecotopes in which the species occurs

$nEcotTot_x$ = total number of MN ecotopes in which the species occurs

nEcotCF = total number of CF ecotopes = 133

The IPV^{CF} values can hypothetically range from 0 to 10,000[2]. Selected values of IPV^{CF} and numbers of ecotopes are used to divide the 72 CF-species set in four groups: (1) 19 species with **high** and **medium** IPV^{CF} with values above 500 (n = 12) and between 500 and 200 (n = 7); (2) nine species with **low** IPV^{CF} between 200 and 50 and recorded in five or more CF ecotopes; and (3) 44 **remaining** species with $IPV^{CF} < 50$ or, if higher, occurring in fewer than five CF ecotopes.

The Key

I selected 25 species for this field key of CF mosses and liverworts: (1) **18** species with **high** and **medium** IPV^{CF} within CF mesohabitats[3]. To produce a workable bryophyte key covering look-alikes (see below), I also added: (2) **three** species with **low** IPV but that have a unique field character-state set (*Helodium blandowii, Scorpidium scorpioides*, and *Tomentypnum nitens*) and thus can be differentiated easily from other species occurring in CF; (3) **three** species of the **remaining** species set that again are easily distinguished in the field (*Aulacomnium palustre, Lophocolea heterophylla,* and *Thuidium delicatulum*); and (4) **one** species (*Atrichum crispulum*) that hasn't been recorded yet for CF, but has a close look-alike found once in CF, the rare *A. crispum*.

The 47 species not covered by the key (look-alikes) are listed separately in Tables 2 & 3: Table 2 lists keyed species with potential look-alikes; Table 3 lists look-alikes with keyed species that most closely resembles them.

[1]Janssens (2005), an earlier analysis of the bryophytes of Minnesota's extreme rich fens, also included the class **OPn93** (Northern Extreme Rich Fen, also described as 'spring-fens', these more restricted to the forested regions of the state). The 13 indicator species proposed in Janssens (2005) for extreme rich-fen validation are also found in the more restricted calcareous fen set (highlighted here in Table 1).

[2]The maximal value of 10,000 would be assigned to the perfect indicator, a species occurring in **all** CF ecotopes and in **none** of the non-CF ecotopes; the actual maximal value, for *Drepanocladus aduncus*, equals 3453 ($108^2 / 254 / 133 \times 10^4$). The IPV^{CF} used here is different from IV_{max} in Janssens (2005): IPV^{CF} also weighs overall abundance of the species in the state.

[3]*Campylium protensum*, a medium IPV^{CF} species, is indistinguishable from *C. stellatum* in the field and not present in the key, but rather discussed as a look-alike in the latter's fact sheet.

The keys focus on characters visible in the field with the naked eye or a 10x to 20x handlens. The photographs I selected to illustrate a species in the key and its fact sheet are representative of its field aspect. The key, without the images, is presented again after the illustrated version, for an easier overview. The structures and character states that are indicated in bold in the key dichotomies are defined in a narrative glossary in the Appendix of '*Noteworthy Mosses and Liverworts of Minnesota, Part I*' (Janssens 2014a). Additional glossary illustrations of field attributes can be found in Janssens (2013).

Fact Sheets

The fact sheet of a species covers its MN distribution, its field aspect and habitat preferences, gives structural details as an aid to identification, and lists look-alike and associated species. It also includes photographs of field aspect. Fact sheets of 21 keyed species and 11 look-alikes, marked by an '*' in the key-status field in Table 1, are found in '*Noteworthy Mosses and Liverworts of Minnesota, Part II*' (Janssens 2014b). Appended here are fact sheets for the four remaining keyed CF pleurocarps. Nomenclature and color coding of the banners used in Janssens (2014a) and other details of their construction is explained in the introductions to Janssens (2014a&b):

Main-Key Species: *Fissidens adianthoides, Plagiothecium denticulatum*
Thalloid Liverworts: *Aneura pinguis, Marchantia polymorpha, Riccia fluitans*
Leafy Liverworts: *Lophocolea heterophylla*
Other Acrocarps: *Aulacomnium palustre, Plagiomnium cuspidatum, P. ellipticum, Ptychostomum pseudotriquetrum*
Polytrichales: *Atrichum crispulum*
Feather Mosses: *Thuidium delicatulum*, *T. recognitum*
Costate Wetland Pleurocarps: *Brachythecium rivulare, B. salebrosum, Drepanocladus aduncus, Helodium blandowii, Hygroamblystegium varium* mod. *'varium', H. varium* mod. '*tenax', Scorpidium cossonii, Tomentypnum nitens*
Costate Upland Pleurocarps: *Brachythecium acuminatum, Leskea gracilescens, L. polycarpa*
Ecostate Pleurocarps on Peat: *Calliergonella cuspidata, Campylium stellatum*, *Hypnum lindbergii, H. pratense, Scorpidium scorpioides*
Ecostate Pleurocarps on Bark, Wood, or Rocks: *Callicladium haldanianum, Entodon cladorrhizans, Platygyrium repens*
Calcareous-Fen Pleurocarps: *Amblystegium serpens* mod. *'juratzkanum', Cratoneuron filicinum, Drepanocladus polygamus, Oxyrrhynchium hians*

The remaining 38 species are discussed in the fact sheets of keyed species, as listed in Table 2 & 3.

Acknowledgments

I thank Jeanette H. Leete for her encouragement and for providing funding and field help to study Minnesota's calcareous fens. I greatly appreciate the feedback I received from workshop participants when we used '*Noteworthy Mosses and Liverworts of Minnesota*' on which this field guide is partly based.

Literature Cited

Note: All Janssens publications are available as PDF files from the author (janss008@umn.edu) or the Minnesota Department of Natural Resources (Jeanette.Leete@state.mn.us).

Janssens, J.A. 2005. Classification of the Bryophyte Assemblages of Minnesota's Extreme Rich Fens and the Bryophyte Criterion for the Evaluation of Potential Calcareous-Fen Ecotopes.

Janssens, J.A. 2007. Description of Bryophyte Assemblages of Mesohabitats.

Janssens, J. A. 2010. MS Access® Database on Minnesota Bryophytes.

Janssens, J.A. 2013. Illustrated Glossary to the Field Guides of the Mosses & Liverworts of Minnesota.

Janssens, J.A. 2014a. Noteworthy Mosses & Liverworts of Minnesota, Part I: Illustrated Field Keys.

Janssens, J.A. 2014b. Noteworthy Mosses & Liverworts of Minnesota, Part II. Species Fact Sheets.

Minnesota Department of Natural Resources. 2003-2006. Field Guides to the Native Plant Communities of Minnesota. Ecological Land Classification Program, Minnesota County Biological Survey, and Natural Heritage and Nongame Research Program. MNDNR St. Paul, MN.

Table 1. Bryophytes occurring in Calcareous Fens

See text for derivation of the CF Importance Value (IPV^{CF}). Species labeled 'keyed' are found in the key, those labeled 'look-alike' are covered in fact sheets of keyed species, see Tables 2 & 3. Key status marked by '*' indicates that the fact sheet for the species is found in Janssens (2014a&b). The highlighted species are used in Janssens (2005) as indicators for validation of the calcareous-fen criterion.

	nEcotCF	nEcotTot	IPV^{CF}	key status
Amblystegium serpens	7	54	68	look-alike
Amblystegium serpens mod. *'juratzkanum'*	16	37	520	keyed
Aneura pinguis	56	93	2535	*keyed
Atrichum crispulum	0	60	0	*keyed
Atrichum crispum	1	2	38	look-alike
Aulacomnium palustre	4	274	4	*keyed
Brachythecium acuminatum	7	70	53	*look-alike
Brachythecium erythrorrhizon	2	79	4	look-alike
Brachythecium oxycladon	1	20	4	look-alike
Brachythecium rivulare	58	139	1820	*keyed
Brachythecium salebrosum	53	203	1040	*keyed
Brachythecium velutinum	1	48	2	look-alike
Bryoerythrophyllum recurvirostrum	1	25	3	look-alike
Callicladium haldanianum	1	229	0	*look-alike
Calliergon giganteum	1	55	1	look-alike
Calliergonella cuspidata	30	68	995	*keyed
Campyliadelphus chrysophyllus	7	53	70	look-alike
Campylium protensum	5	7	269	look-alike
Campylium stellatum	60	158	1713	*keyed
Campylophyllum hispidulum	2	47	6	look-alike
Catoscopium nigritum	1	6	13	look-alike
Climacium americanum	1	13	6	look-alike
Conardia compacta	4	20	60	look-alike
Cratoneuron filicinum	11	26	350	keyed
Drepanocladus aduncus	108	254	3453	*keyed
Drepanocladus polygamus	38	83	1308	keyed
Entodon cladorrhizans	2	32	9	*look-alike
Entodon seductrix	1	7	11	look-alike
Fissidens adianthoides	20	65	463	*keyed
Fissidens dubius	3	26	26	look-alike
Fissidens taxifolius	1	6	13	look-alike
Frullania bolanderi	1	20	4	look-alike
Helodium blandowii	10	64	117	*keyed
Helodium blandowii var. *helodioides*	3	7	97	look-alike

Table 1. Bryophyte species occurring in Calcareous Fens. Cont'd.

	nEcotCF	nEcotTot	IPV^{CF}	key status
Hygroamblystegium varium var. *humile*	5	18	104	look-alike
Hygroamblystegium varium mod. *'tenax'*	6	36	75	*look-alike
Hygroamblystegium mod. *'varium'*	57	132	1851	*keyed
Hymenostylium recurvirostrum	1	11	7	look-alike
Hypnum lindbergii	23	171	233	*keyed
Hypnum pratense	18	114	214	*keyed
Leptobryum pyriforme	1	24	3	look-alike
Leptodictyum riparium	4	34	35	look-alike
Leskea gracilescens	3	23	29	*look-alike
Leskea polycarpa	1	6	13	*look-alike
Lophocolea heterophylla	2	137	2	*keyed
Marchantia polymorpha	1	27	3	*look-alike
Moerckia hibernica	2	24	13	look-alike
Orthotrichum obtusifolium	1	27	3	look-alike
Oxyrrhynchium hians	14	31	475	keyed
Philonotis fontana	1	6	13	look-alike
Philonotis marchica	1	2	38	look-alike
Plagiomnium ciliare	1	41	2	look-alike
Plagiomnium cuspidatum	26	197	258	*keyed
Plagiomnium ellipticum	78	249	1837	*keyed
Plagiothecium denticulatum	2	87	3	*look-alike
Platydictya jungermannioides	1	8	9	look-alike
Platygyrium repens	2	144	2	*look-alike
Pohlia wahlenbergii	1	10	8	look-alike
Pseudocalliergon trifarium	3	23	29	look-alike
Pseudocalliergon turgescens	2	4	75	look-alike
Pseudocampylium radicale	8	40	120	look-alike
Ptychostomum creberrimum	1	14	5	look-alike
Ptychostomum pseudotriquetrum	80	216	2228	*keyed
Riccia fluitans	1	10	8	*look-alike
Ricciocarpos natans	1	2	38	look-alike
Sciuro-hypnum oedipodium	2	71	4	look-alike
Sciuro-hypnum plumosum	2	17	18	look-alike
Scorpidium cossonii	25	69	681	*keyed
Scorpidium scorpioides	6	38	71	*keyed
Taxiphyllum deplanatum	1	20	4	look-alike
Thuidium delicatulum	3	108	6	*keyed
Thuidium recognitum	5	102	18	*look-alike
Tomentypnum nitens	8	54	89	*keyed

Table 2. Keyed species with look-alikes

Two easily keyed species (*Atrichum crispulum* and *Aulacomnium palustre*) have low or 0 IPV^{CF}, are similar to some rare CF look-alikes, and are commonly recorded outside CF.

keyed species and its potential look-alikes	IPV^{CF}
Amblystegium serpens* mod. *juratzkanum	**520**
Pseudocampylium radicale	120
Hygroamblystegium varium subsp. *varium* var. *humile*	104
Amblystegium serpens	68
Conardia compacta	60
Platydictya jungermannioides	9
Campylophyllum hispidulum	6
Brachythecium velutinum	2
Aneura pinguis	**2535**
Ricciocarpos natans	38
Moerckia hibernica	13
Riccia fluitans	8
Marchantia polymorpha	3
Atrichum crispulum	**0**
Atrichum crispum	38
Aulacomnium palustre	**4**
Catoscopium nigritum	13
Hymenostylium recurvirostrum	7
Ptychostomum creberrimum	5
Leptobryum pyriforme	3
Orthotrichum obtusifolium	3
Brachythecium acuminatum	**53**
Brachythecium oxycladon	4
Brachythecium rivulare	**1820**
Sciuro-hypnum plumosum	18
Climacium americanum	6
Sciuro-hypnum oedipodium	4
Brachythecium salebrosum	**1040**
Brachythecium acuminatum	53
Sciuro-hypnum plumosum	18
Sciuro-hypnum oedipodium	4
Brachythecium erythrorrhizon	4
Calliergonella cuspidata	**995**
Pseudocalliergon trifarium	29
Entodon cladorrhizans	9
Calliergon giganteum	1
Campylium stellatum	**1713**
Campylium protensum	269
Pseudocampylium radicale	120
Campyliadelphus chrysophyllus	70
Drepanocladus aduncus	**3453**
Hygroamblystegium varium mod. *'tenax'*	75
Leptodictyum riparium	35
Drepanocladus polygamus	**1308**
Campylium protensum	269
Hygroamblystegium varium mod. *'tenax'*	75
Campyliadelphus chrysophyllus	70
Leptodictyum riparium	35

Table 2. Keyed species with look-alikes. Cont'd.

Fissidens adianthoides	**463**
Fissidens dubius	26
Fissidens taxifolius	13
Helodium blandowii	**117**
Helodium blandowii var. *helodioides*	97
Hygroamblystegium* mod. *'varium'	**1851**
Hygroamblystegium varium subsp. *varium* var. *humile*	104
Hygroamblystegium varium subsp. *varium* var. *varium* mod. *'tenax'*	75
Hypnum lindbergii	**233**
Pseudocalliergon turgescens	75
Hypnum pratense	**214**
Taxiphyllum deplanatum	4
Plagiothecium denticulatum	3
Platygyrium repens	2
Callicladium haldanianum	0
Lophocolea heterophylla	**2**
Frullania bolanderi	4
Oxyrrhynchium hians	**475**
Leskea gracilescens	29
Sciuro-hypnum plumosum	18
Leskea polycarpa	13
Sciuro-hypnum oedipodium	4
Plagiomnium ellipticum	**1837**
Plagiomnium ciliare	2
Ptychostomum pseudotriquetrum	**2228**
Philonotis marchica	38
Catoscopium nigritum	13
Philonotis fontana	13
Pohlia wahlenbergii	8
Ptychostomum creberrimum	5
Bryoerythrophyllum recurvirostrum	3
Scorpidium cossonii	**681**
Pseudocalliergon turgescens	75
Scorpidium scorpioides	**71**
Pseudocalliergon turgescens	75
Pseudocalliergon trifarium	29
Entodon seductrix	11
Thuidium delicatulum	**6**
Thuidium recognitum	18

Table 3. Look-alikes

To be considered when using the calcareous-fen bryophyte key. Only *Campylium protensum* has a significant higher IPV^{CF}, but is so similar to *C. stellatum* as to be indistinguishable in the field. Look-alikes marked by '*' have also their own fact sheets in Janssens (2014b).

IPV^{CF}	look-alike species found discussed in fact sheet of this keyed species
68	***Amblystegium serpens***
	Amblystegium serpens mod. *juratzkanum*
38	***Atrichum crispum***
	Atrichum crispulum
53	****Brachythecium acuminatum***
	Brachythecium salebrosum
4	***Brachythecium erythrorrhizon***
	Brachythecium salebrosum
4	***Brachythecium oxycladon***
	Brachythecium acuminatum
2	***Brachythecium velutinum***
	Amblystegium serpens mod. *juratzkanum*
3	***Bryoerythrophyllum recurvirostrum***
	Ptychostomum pseudotriquetrum
0	****Callicladium haldanianum***
	Hypnum pratense
1	***Calliergon giganteum***
	Calliergonella cuspidata
70	***Campyliadelphus chrysophyllus***
	Campylium stellatum
	Drepanocladus polygamus
269	***Campylium protensum***
	Campylium stellatum
	Drepanocladus polygamus
6	***Campylophyllum hispidulum***
	Amblystegium serpens mod. *juratzkanum*
13	***Catoscopium nigritum***
	Aulacomnium palustre
	Ptychostomum pseudotriquetrum
6	***Climacium americanum***
	Brachythecium rivulare
60	***Conardia compacta***
	Amblystegium serpens mod. *juratzkanum*
9	****Entodon cladorrhizans***
	Calliergonella cuspidata
11	***Entodon seductrix***
	Scorpidium scorpioides
26	***Fissidens dubius***
	Fissidens adianthoides
13	***Fissidens taxifolius***
	Fissidens adianthoides
4	***Frullania bolanderi***
	Lophocolea heterophylla
97	***Helodium blandowii var. helodioides***
	Helodium blandowii
104	***Hygroamblystegium varium* var. *humile***
	Amblystegium serpens mod. *juratzkanum*
	Hygroamblystegium mod. *'varium'*
75	****Hygroamblystegium varium* mod. *'tenax'***
	Drepanocladus aduncus
	Drepanocladus polygamus
	Hygroamblystegium mod. *'varium'*
7	***Hymenostylium recurvirostrum***
	Aulacomnium palustre

Table 3. Look-alikes. Cont'd.

3	***Leptobryum pyriforme***
	Aulacomnium palustre
35	***Leptodictyum riparium***
	Drepanocladus aduncus
	Drepanocladus polygamus
29	**Leskea gracilescens*
	Oxyrrhynchium hians
13	**Leskea polycarpa*
	Oxyrrhynchium hians
3	**Marchantia polymorpha*
	Aneura pinguis
13	***Moerckia hibernica***
	Aneura pinguis
3	***Orthotrichum obtusifolium***
	Aulacomnium palustre
13	***Philonotis fontana***
	Ptychostomum pseudotriquetrum
38	***Philonotis marchica***
	Ptychostomum pseudotriquetrum
2	***Plagiomnium ciliare***
	Plagiomnium ellipticum
3	**Plagiothecium denticulatum*
	Hypnum pratense
9	***Platydictya jungermannioides***
	Amblystegium serpens mod. *juratzkanum*
2	**Platygyrium repens*
	Hypnum pratense
8	***Pohlia wahlenbergii***
	Ptychostomum pseudotriquetrum
29	***Pseudocalliergon trifarium***
	Calliergonella cuspidata
	Scorpidium scorpioides
75	***Pseudocalliergon turgescens***
	Hypnum lindbergii
	Scorpidium cossonii
	Scorpidium scorpioides
120	***Pseudocampylium radicale***
	Amblystegium serpens mod. *juratzkanum*
	Campylium stellatum
5	***Ptychostomum creberrimum***
	Aulacomnium palustre
	Ptychostomum pseudotriquetrum
8	**Riccia fluitans*
	Aneura pinguis
38	***Ricciocarpos natans***
	Aneura pinguis
4	***Sciuro-hypnum oedipodium***
	Brachythecium rivulare
	Brachythecium salebrosum
	Oxyrrhynchium hians
18	***Sciuro-hypnum plumosum***
	Brachythecium rivulare
	Brachythecium salebrosum
	Oxyrrhynchium hians
4	***Taxiphyllum deplanatum***
	Hypnum pratense
18	**Thuidium recognitum*
	Thuidium delicatulum

Notes

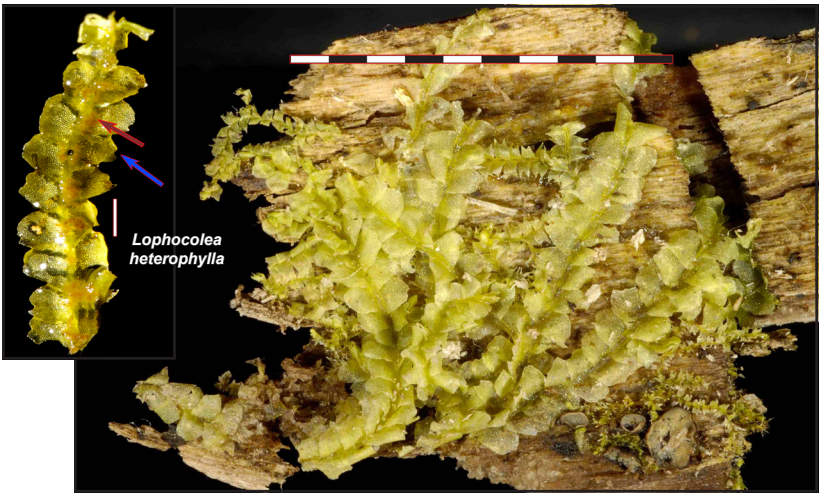
Illustrated Field Key to Calcareous-Fen Bryophytes

The species marked by '*' are also keyed in Janssens 2014a and their fact sheets are found in Janssens 2014b. The words in bold type font are explained in its narrative glossary and in Janssens (2013). The species highlighted are those used in Janssens (2005) for validation of the extreme rich-fen criterion.

1a. Plants **thalloid** . . . . . **Aneura pinguis*
1b. Plants **leafy** . . . . . (leafy liverworts and mosses) 2.

2a. Leafy liverwort, with leaves in two parallel rows, obliquely inserted (and a ventral row of very small leaves, use 20x handlens); leaves rounded-rectangular and either **truncate** or **retuse**, or with two **lobes** . . . . . **Lophocolea heterophylla*
2b. Moss, with leaves radially arranged, or if in two parallel rows, vertically inserted; leaves orbicular to narrowly **lanceolate**, but never lobed . . . . . (Mosses) 3.

thalloid liverwort: no differentiation in stem and leaves, the thallus with a fleshy and greasy look



leafy liverwort: obliquely-inserted leaves in two parallel rows as seen from above, nearly always on rotten wood (inset, showing clustered rhizoids and retuse leaf apex)

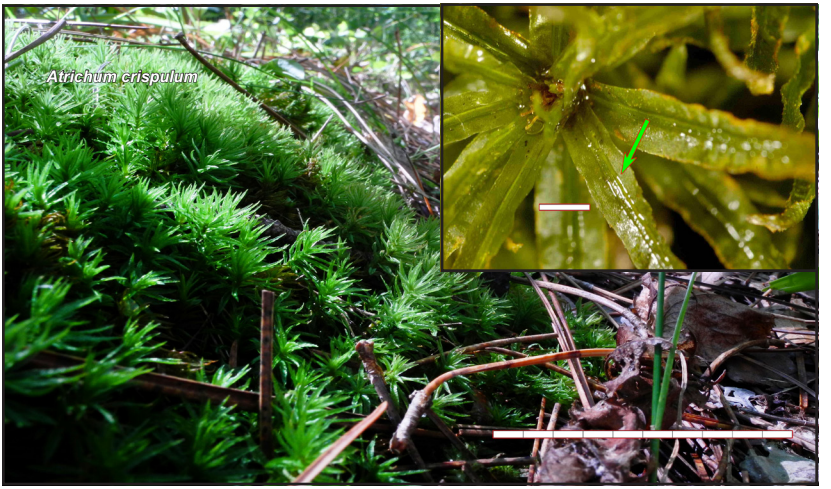
3a. Leaves **distichously** inserted, of the *Fissidens* type (leaves alternate, in two opposite rows, giving the plants the aspect of small fern fronds, with an apical and **abaxial** lamina and two **adaxial** vaginant laminae, forming a boat-shaped structure inserted on the stem) . . . . . **Fissidens adianthoides*

3b. Leaves spirally inserted along stems and branches (even when plants have a **complanate** (= flattened) aspect, the leaf insertions are still helically arranged around the stem) . . . . . 4.

4a. Leaves with adaxial costal **lamellae** (low, upright cell plates implanted in longitudinal direction on the **costa**, visible as darker green lines from above) . . . . . **Atrichum crispulum*

4b. Costa without adaxial lamellae . . . . . 5.

***Fissidens*-type leaf: boat-shaped and distichous; plants appear as small fern leaf, forming small clones in shaded microhabitat**



costal lamellae: low cell walls visible as dark lines along adaxial surface of strap-like leaves; plants often forming large clones in drier and exposed microhabitat

5a. Leaves large (often > 3 mm) and orbicular, **elliptic** to **ovate** or **obovate**, distinctly narrowed near the insertion on the stem; plants often with creeping stems, **prostrate** and then leaves **complanate**, or sometimes with upright unbranched fertile stems . . . . . 6.

5b. Leaves usually smaller, long-lanceolate to widely ovate-lanceolate, but not distinctly narrowed near the insertion on the stem; plants either in small **turfs** of upright stems, or in **mats** or **wefts** of interwoven stems and branches . . . . . 7.

6a. Leaves obovate, distinctly **decurrent**, **serrate** in upper half only . . . . . **Plagiomnium cuspidatum*

6b. Leaves orbicular, elliptic, to ovate, not decurrent, serrate along the entire margin or **entire** . . . . . **Plagiomnium ellipticum*

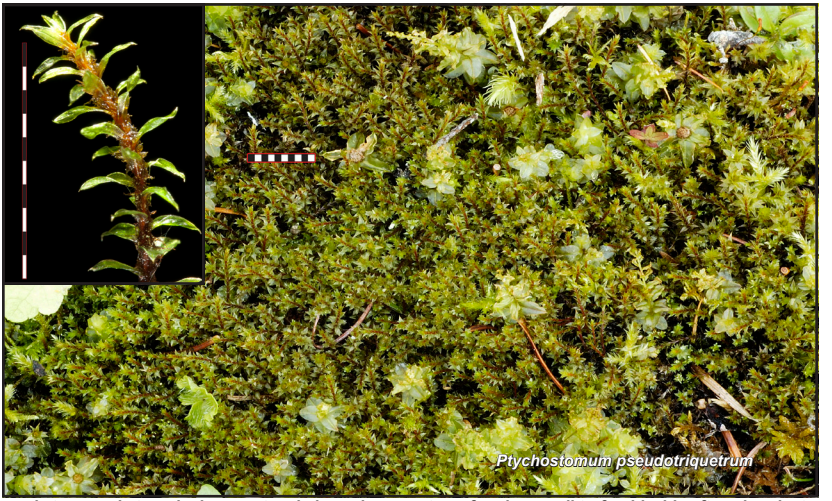
prostrate plants with complanate and decurrent leaves: the sterile stems are growing parallel to the substrate and the complanate leaves are distinctly decurrent (white arrows) and serrate only along the distal margin (blue arrow)

fertile plants: the fertile stems are growing upright, but sterile stems are very similar to those of *P. cuspidatum*; the leaves, however, are not decurrent (white arrows) and nearly entire

7a. Plants with upright stems with sparse branching (**turfs**: the branches or **innovations** are soon similar to the main stems and replace them) . . . . . (Acrocarps) 8.
7b. Plants either with mostly **prostrate** irregularly interwoven stems (**mats**), or with upright stems with many side branches of a permanent distinct 2nd order (**wefts**) . . . . . (Pleurocarps) 9.

8a. Leaves not obviously **decurrent**, when dry crinkled and distinctly matte; stem often covered by brown to brown-black **tomentum**; **gemmae** stalks sometimes present . . . . . **Aulacomnium palustre*
8b. Leaves distinctly decurrent along red stems, when dry twisted and **incurved**, but not crinkled, not obviously matte; stem sometimes with many **rhizoids**, but usually not forming a dense tomentum; no specialized gemmae stalks present . . . . . **Ptychostomum pseudotriquetrum*

tomentum & gemmae stalks, leaves matte: stems are growing upright and branching is by innovation (the branch, white arrow, soon overtops the main stem); rhizoids form a dense darker cover (tomentum) along the stem, in the fall nearly black; gemmae are clustered at the tip of a naked stalk



red stems and strongly decurrent and glossy leaves: stems forming small turfs; rhizoids often abundant but usually still clearly show the red stem and the longly-decurrent leaves

9a. Leaves **ecostate** (without a costa or with a short double costa, hardly visible with a handlens). . . . . (Ecostate Pleurocarps) 10.
9b. Leaves **costate** . . . . . (Costate Pleurocarps) 14.

10a. Leaves ovate and strongly concave, and at the end of the branches **enrolled**, apex either **obtuse** or with a very small apiculus (**apiculate**) . . . . . .11.
10b. Leaves ovate-lanceolate apex **acute** to narrowly **acuminate** . . . . . 12.

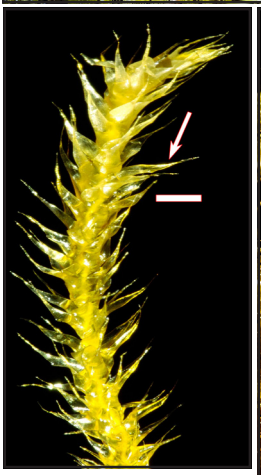
11a. Leaves straight, usually with an obtuse apex; stems with a slightly complanate (flattened) aspect; young branch tip forming **sharp point** with **enrolled leaves** . . . . . **Calliergonella cuspidata*
11b. Leaves **curved-secund** at the tip of branches and stems, usually with an **apiculate** apex; stems **rounded**; young branches with **hooked** tips formed by the **enrolled** leaves . . **Scorpidium scorpioides*

enrolled leaves forming sharp tips: stems have a somewhat flattened aspect

enrolled leaves forming hooked tips: plants turgid looking with strongly concave and somewhat curved-secund leaves; single plants floating in pools can become very large, sometimes nearly black

12a. Leaves **straight, stiffly erect-spreading**, upper part distinctly differentiated, **subulate** . . . . . *Campylium stellatum*

12b. Leaves always **curved- to falcate-secund**; upper part of leaf not abruptly differentiated from lower . . . 13.



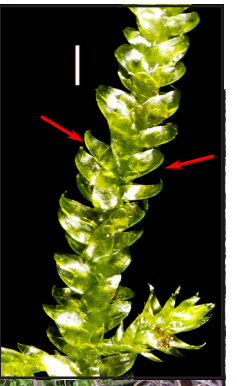
leaves stiffly erect-spreading, with subulate apex (arrow): a hummock forming species, usually the most highly elevated species along the hollow-hummock gradient in open rich fens

13a. Plants usually not complanate, leaves **falcate-secund** and **radially inserted**, not wrinkled . . . . . **Hypnum lindbergii*

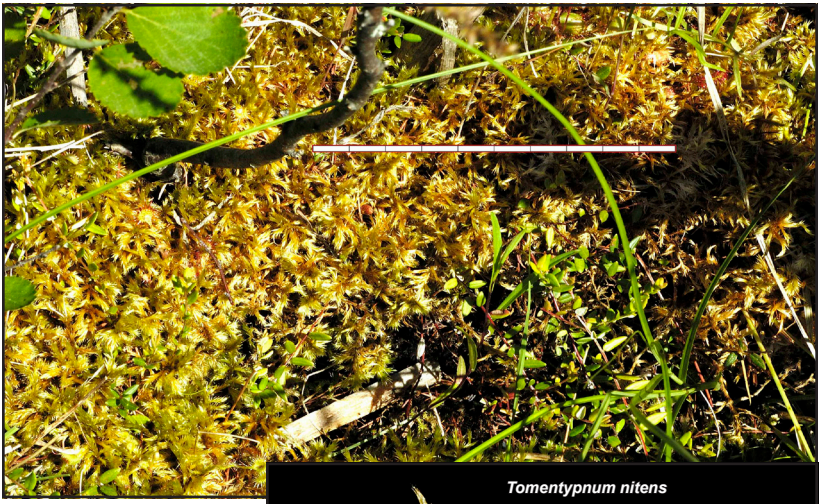
13b. Plants usually with a more **complanate** aspect, leaves often curved rather than falcate, **curved downward in two rows**, often wrinkled . . . . . **Hypnum pratense*

falcate-secund leaves: the species might look similarly in aspect to *Drepanocladus aduncus*, the most common calcareous-fen indicator, but its leaves are ecostate; forming sometimes large clones near the local water table

decurved leaves: usually the leaves are distinctly in two parallel rows, complanate, and curved downward to the substrate (arrows); plants in small clones under thatch or as scattered stems



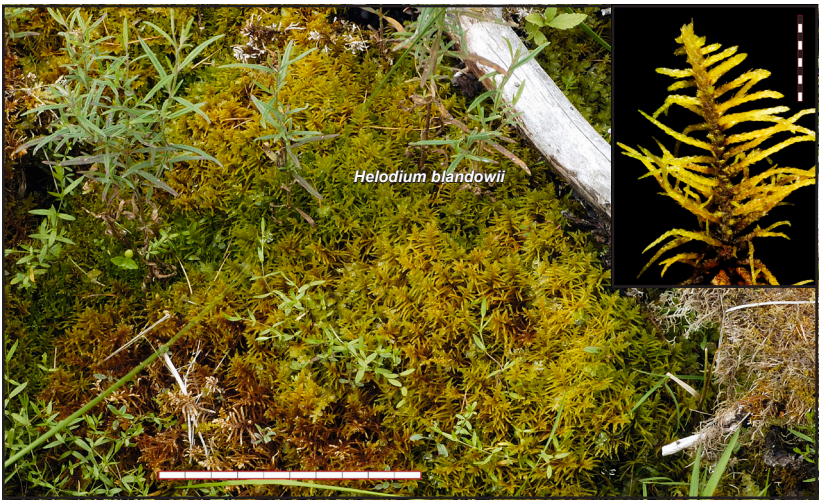
14a. Plants with **brown tomentum** along the stem, mainly on the underside . . . . . **Tomentypnum nitens*
14b. Plants without tomentum . . . . . 15.



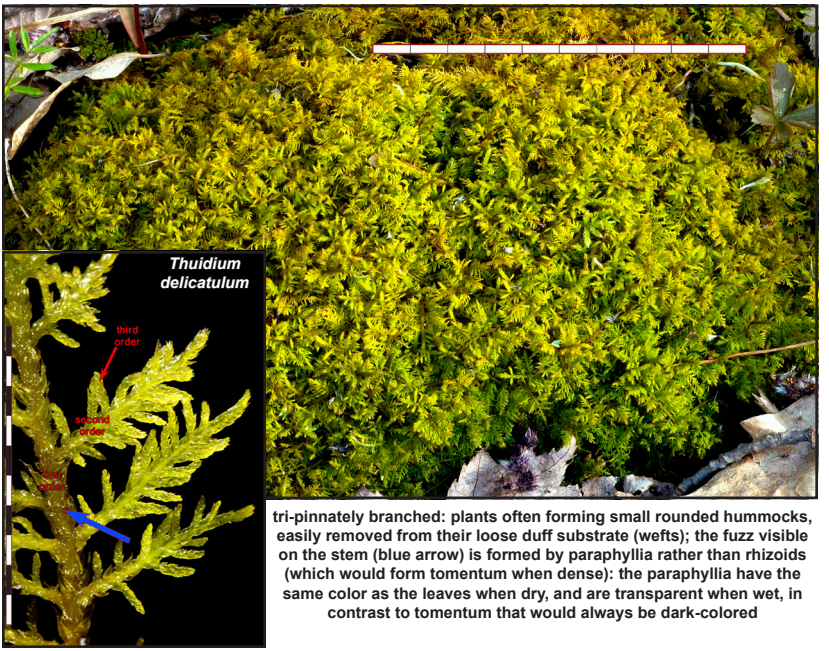
brown tomentum on underside: the plants form large, low hummocks or carpets, and when growing densely together, are often upright; however, they are still distinctly pinnately branched (as a good pleurocarp should be), and their tomentum (a dense felt-like layer of dark-brown rhizoids) is then covering one of the lateral sides of the main stem

15a. Stem covered with abundant **paraphyllia** . . . . . 16.
15b. Stem without paraphyllia or paraphyllia not obvious . . . . . 17.

16a. Plants uni-pinnately branched . . . . . **Helodium blandowii*
16b. Plants tri-pinnately branched . . . . . **Thuidium delicatulum*



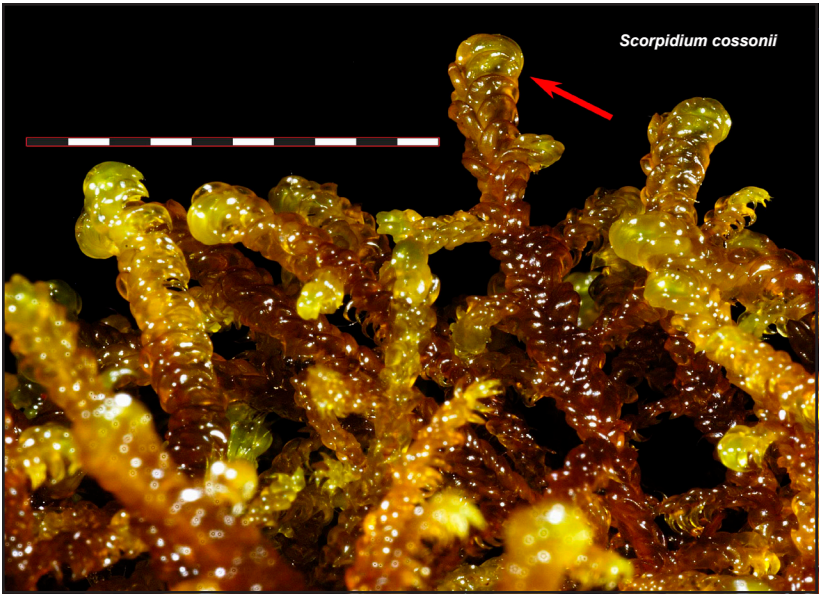
uni-pinnately branched: plants often growing densely together forming low hummocks, the largest ones upright and often with a somewhat swollen stem apex with large, slightly curved-secund stem leaves



tri-pinnately branched: plants often forming small rounded hummocks, easily removed from their loose duff substrate (wefts); the fuzz visible on the stem (blue arrow) is formed by paraphyllia rather than rhizoids (which would form tomentum when dense): the paraphyllia have the same color as the leaves when dry, and are transparent when wet, in contrast to tomentum that would always be dark-colored

17a. Leaves curved, **falcate-secund** to **circinate** . . . . . 18.
17b. Leaves **straight** . . . . . 20.

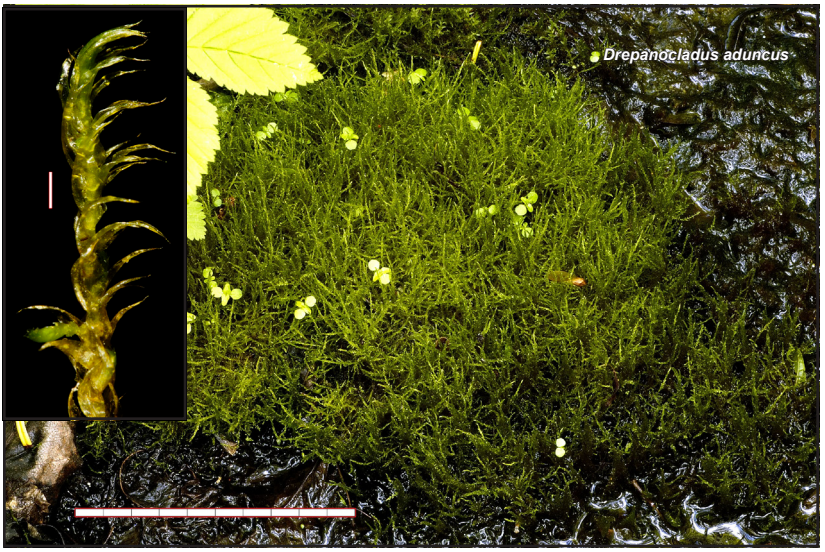
18a. Leaves strongly **falcate-secund** to **circinate**; plants **yellow-brown** to **reddish-brown, turgid** looking . . . . . **Scorpidium cossonii*
18b. Leaves **curved** to **falcate-secund**; plants green or yellow-green without a swollen aspect . . . . . 19.



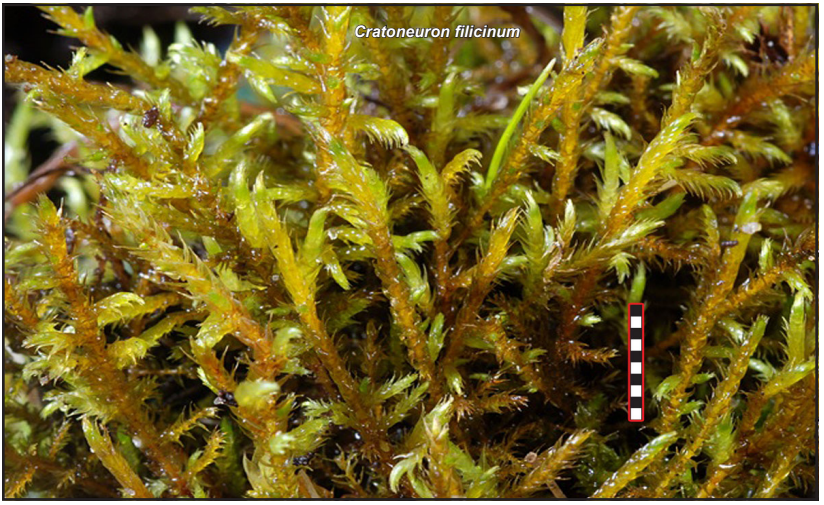
circinate leaves: the plants are turgid looking, quite similar to those of *S. scorpioides*, but their leaves are distinctly costate, and they usually grow slightly higher above the local water table, along the edges of the pools rather then in the open water

19a. Plants usually with straggling irregularly branched stems in untidy **mats** under dense thatch, with a soft feel; leaves **entire**, weakly costate and no stem **paraphyllia** . . . . . **curved-leaved modification** of **Drepanocladus aduncus*

19b. Plants growing erect, somewhat pinnately branched, in dense **carpets** in exposed seepage, with a coarse feel of encrusted $CaCO_3$; leaves **denticulate**, with a stout costa, and sometimes a few paraphyllia present on the stem. . . . . *Cratoneuron filicinum*

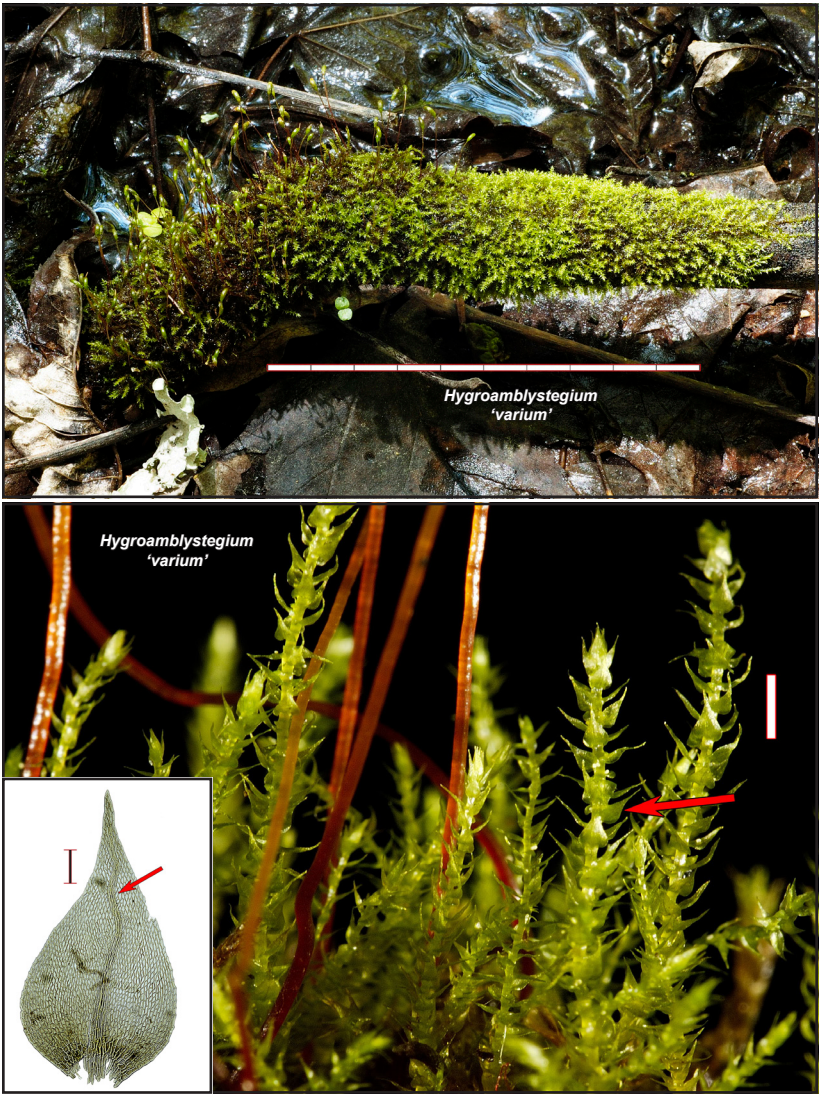


curved-secund leaves: the most common and diagnostic species for calcareous-fen mesohabitat, but extremely variable in field aspect; here a typical semi-emergent carpet, without much covering litter or thatch, and with curved-secund leaves



leaves are often curved-secund, but not as strongly so as in typical *Drepanocladus aduncus*, wider and with a stout costa (© Limburgse Bryologische Werkgroep)

20a. Leaves with **costa** often reaching the apex, often with a slight curvature above (study this carefully with 20x handlens). . . . . **Hygroamblystegium varium* mod. *'varium'*
20b. Leaves with costa not reaching the apex, straight . . . . . 21.



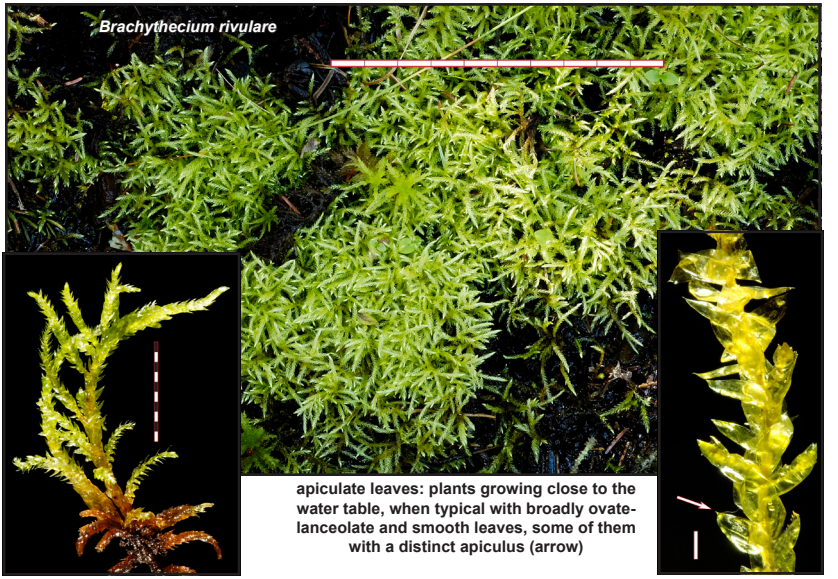
percurrent costa: plants in small clones, usually on small pieces of rotten wood, with leaves erect to spreading-erect, with a costa nearly percurrent and with a curve near the end (use 20x handlens)

21a. Leaves distinctly **plicate**; plants distinctly glossy . . . . . **Brachythecium salebrosum*
21b. Leaves smooth; plants moderately glossy to matte . . . . . 22.

22a. Leaves broadly **ovate-lanceolate** . . . . . 23.
22b. Leaves narrowly ovate-lanceolate to **subulate** . . . . . 24.

23a. Leaves **appressed** to **erect-spreading**, apex often **apiculate**; large differentiated **alar-cell** groups (20x handlens) . . . . . **Brachythecium rivulare*

plicate and glossy leaves: plants in straggly clones in somewhat drier microhabitat, with narrowly lanceolate and distinctly plicate leaves (arrow), with a characteristic yellow-green gloss



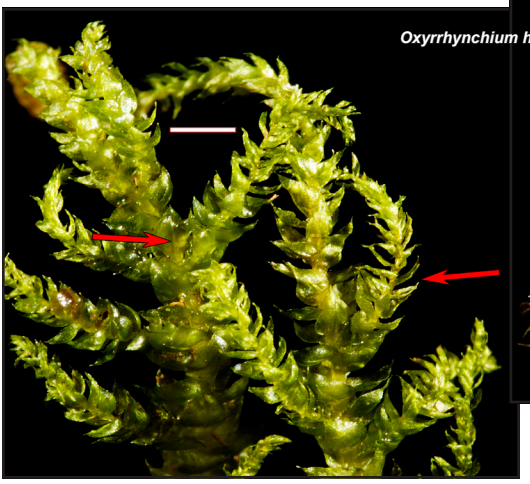
apiculate leaves: plants growing close to the water table, when typical with broadly ovate-lanceolate and smooth leaves, some of them with a distinct apiculus (arrow)

23b. Leaves somewhat **complanate**, **spreading**, apex **acute**; **alar cells** not abruptly differentiated (20x handlens) . . . . . *Oxyrrhynchium hians*

24a. Leaves narrowly **ovate-lanceolate** below with distinct shoulder and **subulate** above . . . . . *Drepanocladus polygamus*

Note: no suitable photos are available yet for *Drepanocladus polygamus*, but this species is similar in field aspect to *Campylium stellatum* (see above), but its leaves are costate

acute, somewhat complanate leaves: plants growing usually in somewhat drier microhabitat, often on humus; shortly pointed (acute) rather than apiculate leaves, slightly complanate and stem leaves with a stout costa; the seta is distinctly papillose (right), but this is also the case with the one of the *Brachythecium rivulare*, a species with similar field aspect but usually found in wetter microhabitat

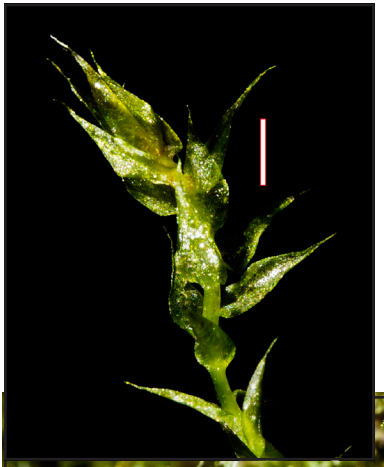


24b. Leaves **lanceolate** to short ovate-lanceolate but without a shoulder and subulate acumen . . . . . 25.

25a. Large plants, leaves often > 2 mm long, **erect** to **erect-spreading**; **alar cells** enlarged in distinct groups (20x handlens) . . . . . orthophyllous modification of **Drepanocladus aduncus*

25b. Small plants, leaves < 1 mm long, wide-**spreading**; alar cells not abruptly differentiated . . . . . *Amblystegium serpens* mod. *'juratzkanum'*

Note: no suitable photos are available yet for A*mblystegium serpens* mod. *'juratzkanum'*, but this species is similar in field aspect to a very small *Hygroamblystegium 'varium'* (see above) with a shorter costa.



large plants, erect spreading leaves: plants growing usually under dense thatch in straggly, untidy clones, often bleached because of lack of light; some leaves have a curved tendency, but most are straight (ortho-phyllous); the alar-cell groups are visible with the 20x handlens)

The species marked by '*' are also keyed in Janssens 2014a and their fact sheets are found in Janssens 2014b. The words in bold type font are explained in its narrative glossary and in Janssens (2013). The species highlighted are those used in Janssens (2005) for validation of the extreme rich-fen criterion.

1a. Plants **thalloid** . . . . . **Aneura pinguis*
1b. Plants **leafy** . . . . . (leafy liverworts and mosses) 2.

2a. Leafy liverwort, with leaves in two parallel rows, obliquely inserted (and a ventral row of very small leaves, use 20x handlens); leaves rounded-rectangular and either **truncate** or **retuse**, or with two **lobes** . . . . . **Lophocolea heterophylla*
2b. Moss, with leaves radially arranged, or if in two parallel rows, vertically inserted; leaves orbicular to narrowly **lanceolate**, but never lobed . . . . . (Mosses) 3.

3a. Leaves **distichously** inserted, of the *Fissidens* type (leaves alternate, in two opposite rows, giving the plants the aspect of small fern fronds, with an apical and **abaxial** lamina and two **adaxial** vaginant laminae, forming a boat-shaped structure inserted on the stem) . . . . . **Fissidens adianthoides*
3b. Leaves spirally inserted along stems and branches (even when plants have a **complanate** (= flattened) aspect, the leaf insertions are still helically arranged around the stem) . . . . . 4.

4a. Leaves with adaxial costal **lamellae** (low, upright cell plates implanted in longitudinal direction on the **costa**, visible as darker green lines from above) . . . . . **Atrichum crispulum*
4b. Costa without adaxial lamellae . . . . . 5.

5a. Leaves large (often > 3 mm) and orbicular, **elliptic** to **ovate** or **obovate**, distinctly narrowed near the insertion on the stem; plants often with creeping stems, **prostrate** and then leaves **complanate**, or sometimes with upright unbranched fertile stems . . . . . 6.
5b. Leaves usually smaller, long-lanceolate to widely ovate-lanceolate, but not distinctly narrowed near the insertion on the stem; plants either in small **turfs** of upright stems, or in **mats** or **wefts** of interwoven stems and branches . . . . . 7.

6a. Leaves obovate, distinctly **decurrent**, **serrate** in upper half only . . . . . **Plagiomnium cuspidatum*
6b. Leaves orbicular, elliptic, to ovate, not decurrent, serrate along the entire margin or **entire** . . . . . **Plagiomnium ellipticum*

7a. Plants with upright stems with sparse branching (**turfs**: the branches or **innovations** are soon similar to the main stems and replace them) . . . . . (Acrocarps) 8.
7b. Plants either with mostly **prostrate** irregularly interwoven stems (**mats**), or with upright stems with many side branches of a permanent distinct 2nd order (**wefts**) . . . . . (Pleurocarps) 9.

8a. Leaves not obviously **decurrent**, when dry crinkled and distinctly matte; stem often covered by brown to brown-black **tomentum**; **gemmae** stalks sometimes present . . . . . **Aulacomnium palustre*
8b. Leaves distinctly decurrent along red stems, when dry twisted and **incurved**, but not crinkled, not obviously matte; stem sometimes with many **rhizoids**, but usually not forming a dense tomentum; no specialized gemmae stalks present . . . . . **Ptychostomum pseudotriquetrum*

9a. Leaves **ecostate** (without a costa or with a short double costa, hardly visible with a handlens). . . . . (Ecostate Pleurocarps) 10.
9b. Leaves **costate** . . . . . (Costate Pleurocarps) 14.

10a. Leaves ovate and strongly concave, and at the end of the branches **enrolled**, apex either **obtuse** or with a very small apiculus (**apiculate**) . . . . . 11.
10b. Leaves ovate-lanceolate apex **acute** to narrowly **acuminate** . . . . . 12.

11a. Leaves straight, usually with an obtuse apex; stems with a slightly complanate (flattened) aspect; young branch tip forming **sharp point** with **enrolled leaves** . . . . . **Calliergonella cuspidata*
11b. Leaves **curved-secund** at the tip of branches and stems, usually with an **apiculate** apex; stems **rounded**; young branches with **hooked** tips formed by the **enrolled** leaves . . **Scorpidium scorpioides*

12a. Leaves **straight, stiffly erect-spreading**, upper part distinctly differentiated, **subulate** . . . . . *[redacted]
12b. Leaves always **curved- to falcate-secund**; upper part of leaf not abruptly differentiated from lower . . . . . 13.

13a. Plants usually not complanate, leaves **falcate-secund** and **radially inserted**, not wrinkled . . . . . *Hypnum lindbergii*
13b. Plants usually with a more **complanate** aspect, leaves often curved rather than falcate, **curved downward in two rows**, often wrinkled . . . . . *Hypnum pratense*

14a. Plants with **brown tomentum** along the stem, mainly on the underside . . . . . *Tomentypnum nitens*
14b. Plants without tomentum . . . . . 15.

15a. Stem covered with abundant **paraphyllia** . . . . . 16.
15b. Stem without paraphyllia or paraphyllia not obvious . . . . . 17.

16a. Plants uni-pinnately branched . . . . . *Helodium blandowii*
16b. Plants tri-pinnately branched . . . . . *Thuidium delicatulum*

17a. Leaves curved, **falcate-secund** to **circinate** . . . . . 18.
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18a. Leaves strongly **falcate-secund** to **circinate**; plants **yellow-brown** to **reddish-brown, turgid** looking . . . . . *[redacted]
18b. Leaves **curved** to **falcate-secund**; plants green or yellow-green without a swollen aspect . . . . . 19.

19a. Plants usually with straggling irregularly branched stems in untidy **mats** under dense thatch, with a soft feel; leaves **entire**, weakly costate and no stem **paraphyllia** . . . . . **curved-leaved modification** of *[redacted]
19b. Plants growing erect, somewhat pinnately branched, in dense **carpets** in exposed seepage, with a coarse feel of encrusted $CaCO_3$; leaves **denticulate**, with a stout costa, and sometimes a few paraphyllia present on the stem. . . . . *Cratoneuron filicinum*

20a. Leaves with **costa** often reaching the apex, often with a slight curvature above (study this carefully with 20x handlens). . . . . *Hygroamblystegium varium* mod. *'varium'*
20b. Leaves with costa not reaching the apex, straight . . . . . 21.

21a. Leaves distinctly **plicate**; plants distinctly glossy . . . . . *Brachythecium salebrosum*
21b. Leaves smooth; plants moderately glossy to matte . . . . . 22.

22a. Leaves broadly **ovate-lanceolate** . . . . . 23.
22b. Leaves narrowly ovate-lanceolate to **subulate** . . . . . 24.

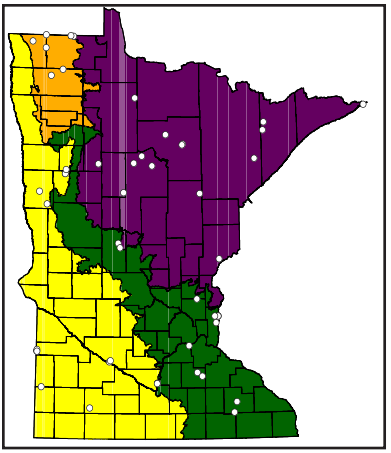
23a. Leaves **appressed** to **erect-spreading**, apex often **apiculate**; large differentiated **alar-cell** groups (20x handlens) . . . . . *[redacted]
23b. Leaves somewhat **complanate**, **spreading**, apex **acute**; **alar cells** not abruptly differentiated (20x handlens) . . . . . *Oxyrrhynchium hians*

24a. Leaves narrowly **ovate-lanceolate** below with distinct shoulder and **subulate** above . . . . . *[redacted]
24b. Leaves **lanceolate** to short ovate-lanceolate but without a shoulder and subulate acumen . . . . . 25.

25a. Large plants, leaves often > 2 mm long, **erect** to **erect-spreading**; **alar cells** enlarged in distinct groups (20x handlens) . . . . . orthophyllous modification of *[redacted]
25b. Small plants, leaves < 1 mm long, wide-**spreading**; alar cells not abruptly differentiated . . . . . *Amblystegium serpens* mod. *'juratzkanum'*

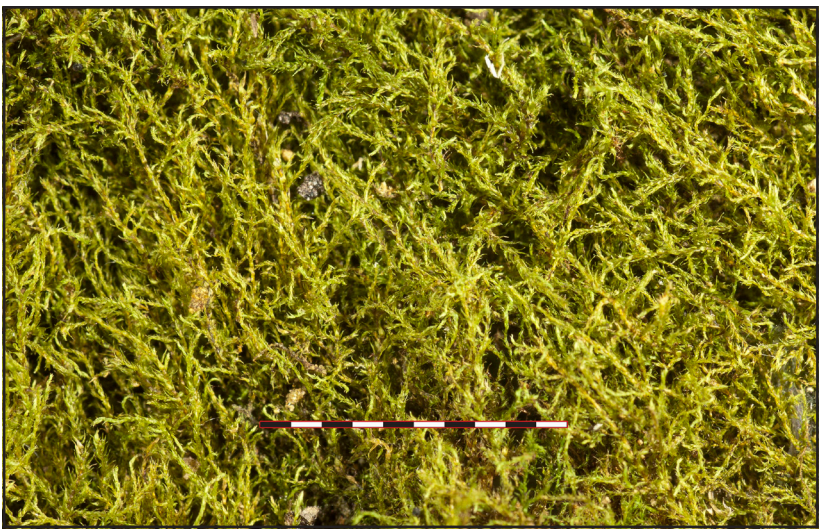
Calcareous-Fen Pleurocarps

Amblystegium serpens mod. '*juratzkanum*'



Synonym: *Amblystegium serpens* var. *juratzkanum.*
Abundance: Frequent (F_{20}).
Habitat and field aspect: Frequent in southern seepage meadow/carr and prairie extreme rich fen. Occasional in northern wet meadow/carr, rich fen, and alder swamp. Recorded from several fire dependent forest/woodland classes throughout the state, and in northern wet ash, rich spruce, cedar/fir, and poor conifer swamp, in terrace forest and mesic prairie. Also found in central wet-mesic hardwood forest. **Small non-descript clones**, often attached to the base of graminoid culms, **or as scattered plants** among other bryophytes.
Aid to Identification: **Minute plants with leaves usually smaller than 0.5 mm**, but characteristically closely spaced and **erect-spreading to nearly squarrose-spreading**. The upper part of the leaf is narrowly acuminate. However, microscopic confirmation is necessary to differentiate the taxon critically from look-alikes.

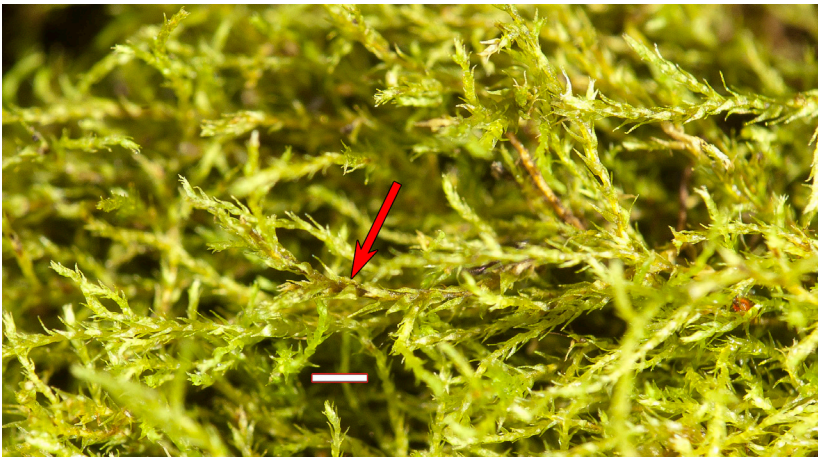
Look-Alike Species: In the habitat frequented by *A. serpens* mod. '*juratzkanum*' many other species of the large, previously traditionally circumscribed, pleurocarpous families of the Amblystegiaceae, Brachytheciaceae, and Hypnaceae have a similar aspect (fen species also designated called 'brown mosses'). Few of them, however, are as small or smaller than *A. serpens* mod. '*juratzkanum*'. Small etiolated shoots of other species, in shaded microhabitat under thatch, sometimes do, but than their leaves are usually more distant, showing long internodes. Most of this material is nearly impossible to identify except when well-developed patches are found nearby. Typical *Amblystegium serpens* (F_{21}) is smaller than the mod. '*juratzkanum*', and the leaves are more erect and less spreading. The photos shown here are from this taxon rather than from its modification '*juratzkanum*'. It usually grows in drier microhabitat, often attached to bark or rock. Among the smaller wetland species occasionally found in rich and calcareous fens: *Pseudocampylium radicale* (F_{18}) has distant leaves which are clearly decurrent; *Hygroamblystegium varium* subsp. *varium* var. *humile* (F_{11}) somewhat



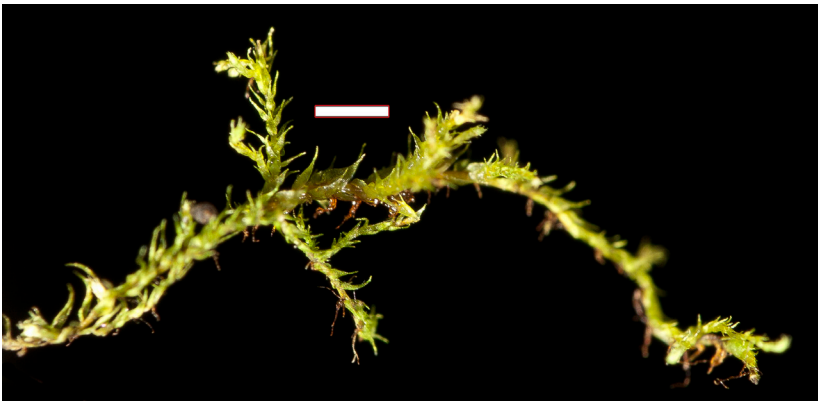
straggly plants, note their very small size (this and following photos are from the typical *A. serpens* modification)

larger, with less channeled apiculus; *Conardia compacta* (F_{14}) with a stout percurrent costa, sometimes with gemmae attached to the tip of the leaves; *Platydictya jungermannioides* (O_6), ecostate and even smaller than *A. serpens* mod. '*juratzkanum*' (*Platydictya* contains our smallest Minnesota pleurocarpous species, with leaves only about 0.25 mm long); *Campylophyllum hispidulum* (F_{20}) is ecostate; and *Brachythecium velutinum* (C/F_{20}), with sharply serrate and plicate leaves.

Associated Species: MesoHab: *Drepanocladus aduncus, Brachythecium salebrosum, Plagiomnium ellipticum*; Pop: *Brachythecium salebrosum, Plagiomnium ellipticum, Campylium stellatum, Ptychostomum pseudotriquetrum*.

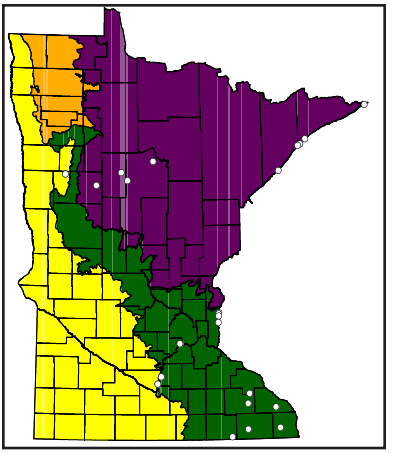


small ovate-lanceolate leaves, costate:
in the '*juratzkanum*' modification they are more erect-spreading, and the internodes are usually longer



irregular branching and leaves <, often << than 1 mm:
in the '*juratzkanum*' modification they are more erect-spreading, and the internodes are usually longer

Cratoneuron filicinum

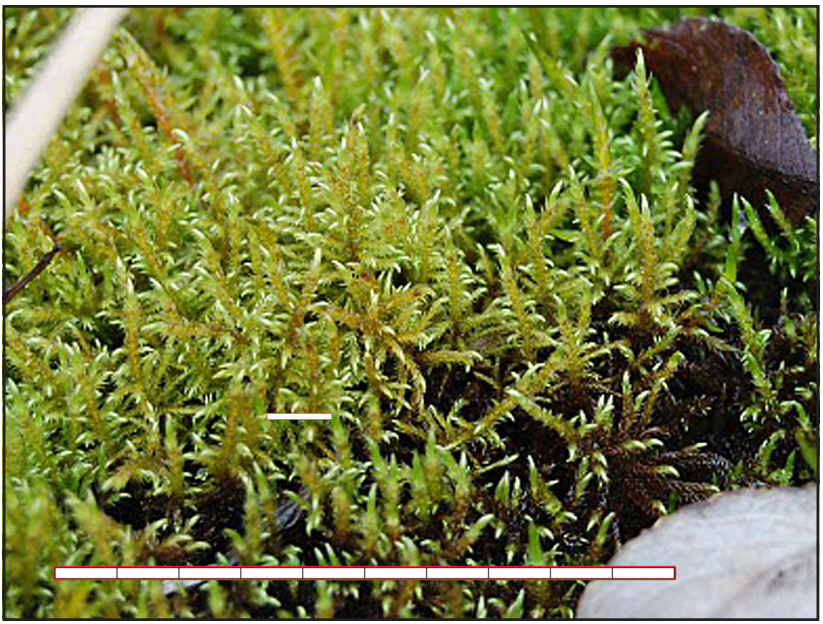


Abundance: Frequent (F_9).

Habitat and field aspect: Frequent in prairie rich fen and southern seepage meadow/carr. Occasional in northern rich and extreme rich fen and cedar/fir swamp. Recorded from southern wet cliff and open and algific talus slope, and from northern wet cliff and wet conifer forest. Also found along Lake Superior and river rocky shore. Usually growing upright in **dense carpets**, with interlocking horizontal branches, in seeps. The plants are often encrusted with $CaCO_3$ below.

Aid to Identification: Most typical with **long erect stems, lower down pinnately branched, with dense rhizoids and variable paraphyllia cover**. The **costae are stout**, and the **alar cells enlarged in well-defined groups**, visible with a 20x handlens, as well as the **crenulate-denticulate margins**.

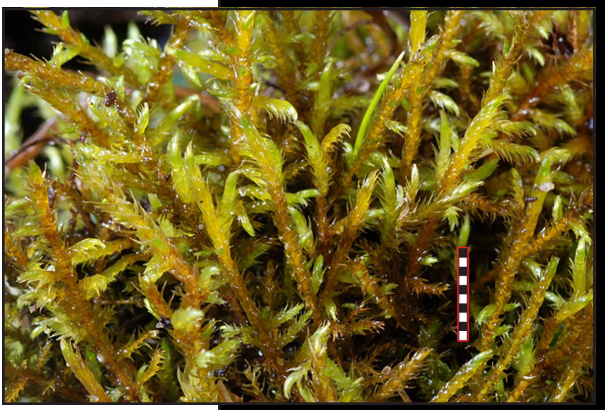
Look-Alike Species: Surprisingly similar in field aspect to a near-orthophyllous (straight-leaved) modification of *Drepanocladus aduncus* (C_{23}) which also grows in similar seepage habitat. Actually most collections from seeps suspected to be *C. filicinum* turns out to be this modification of *D. aduncus* after critical identification using microscopic characters. The entire leaves of typical *D. aduncus* are usually more strongly falcate than those of *C. filicinum*, and those of a close relative, *D. sordidus* (O_5), clearly so. The paraphyllia are missing in the *Drepanocladus* species, but their number is quite variable from population to population in *C. filicinum*, and sometimes hard to demonstrate. *Cratoneuron* is also more matte when dry, most likely because of a shorter cell-type and the crenulate leaf margins.



dense carpet of upright stems, often without branching above, but clearly pinnately branched below (© Biopix JC Schou)

Cratoneuron filicinum

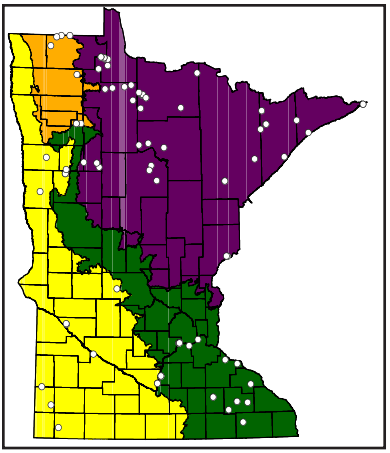
Associated Species: MesoHab: *Brachythecium rivulare, Ptychostomum pseudotriquetrum, Drepanocladus aduncus*; Pop: *Plagiomnium ellipticum, Campylium stellatum, Drepanocladus aduncus, Ptychostomum pseudotriquetrum*.



top left: leaves are often curved-secund, but not as strongly so as in typical *Drepanocladus aduncus* (© Limburgse Bryologische Werkgroep)

right: note the stout costa (white arrow); rarely some paraphyllia are visible along the stem (red arrow)

Drepanocladus polygamus



Synonym: *Campylium polygamum*.

Abundance: Frequent/Common (F/C_{19}).

Habitat and field aspect: Common in prairie extreme rich fen (calcareous fen) and the adjacent southern seepage meadow/car. Frequent in northern extreme rich fen and rich-fen water track, wet meadow/car, rich spruce and tamarack swamp. Occasional in northern cedar/fir, alder, and poor conifer swamp. Recorded from northern poor, shrub-shore, and transitional fen, bulrush-spikerush marsh, wet conifer forest, and very wet ash swamp. Also from southern open talus and dry-mesic oak forest, and from prairie rich fen and Lake Superior rocky and clay/mud river shore. **Small clones forming low hummocks**, above the local water table, often hidden underneath graminoid thatch.

Aid to Identification: The erect-spreading to squarrose leaves are **narrowly ovate-lanceolate and their acumen is sharp and pointed**, giving the plants a **stellate appearance**. The **costa is single**, often reaching high into the apex.

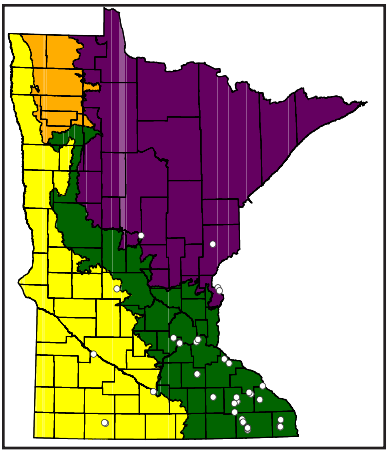
Look-Alike Species: The species is very similar in aspect to *Campylium stellatum* (C_{21}) and in the south of the state nearly as common. It is usually somewhat smaller and less robust, and as such very hard to tell from *C. protensum* (O/U_7). It is hard to differentiate from these two *Campylium* species unless a good view can be obtained of the single costa (see the photos of the *Campylium stellatum* fact sheet to obtain an idea of the aspect of this species; the only macroscopic difference would be to find a number of leaves with a single costa). The alar cells can only be studied properly with the compound microscope. Orthophyllous (straight-leaved) modifications of costate *Drepanocladus aduncus* (C_{23}), also commonly found in calcareous fens and surrounding meadows, have a more untidy aspect, and the leaf apices are less sharply pointed. *Campyliadelphus chrysophyllus* (F_{16}) has costate leaves as in *D. polygamus*, but is somewhat more of a upland species, and the younger leaves are often subsecund. Again only the alar cells are the critical character, and need to be studied with the microscope. *Leptodictyum riparium* (F_{17}) has narrowly ovate-lanceolate costate leaves, but without the narrowed acumen. Its leaves are often somewhat compressed in a single plain, and the species is usually found associated with flowing water in ditches and similar habitat. *Hygroamblystegium varium* mod. '*tenax*' (F_{14}) is also associated with seepage, and its costae are stout and obvious.

Associated Species: MesoHab: *Ptychostomum pseudotriquetrum, Campylium stellatum, Drepanocladus aduncus, Plagiomnium ellipticum*; Pop: *Drepanocladus aduncus, Ptychostomum pseudotriquetrum, Aneura pinguis*.

Drepanocladus polygamus

a single weak costa differentiates *Drepanocladus polygamus* from the ecostate leaf of *Campylium stellatum*, most likely impossible to observe in the field, even with a 20x lens. Otherwise the species are very much alike in field aspect: see the fact-sheet photos of the latter species

Oxyrrhynchium hians



Synonym: *Eurhynchium hians*.

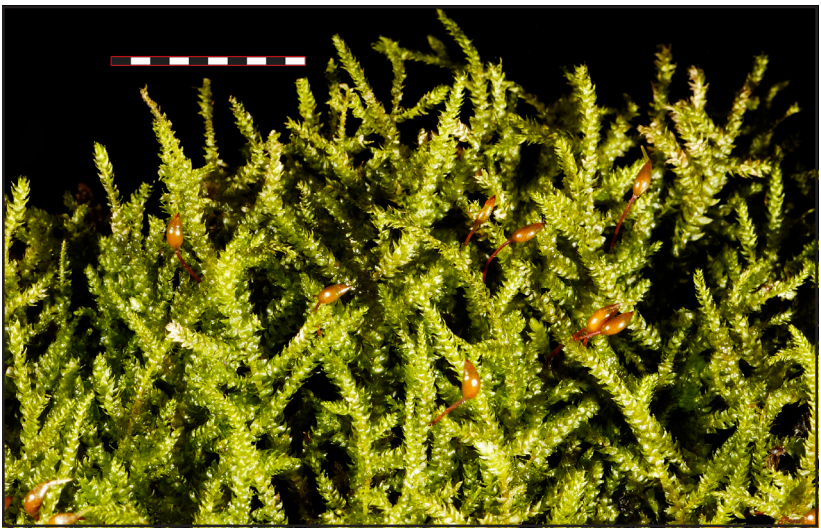
Abundance: Frequent (F_8).

Habitat and field aspect: Frequent in southern seepage meadow/carr (on the perimeter of extreme rich-fen or calcareous fen ecotopes). Occasional in southern mesic maple-basswood forest and on open talus, and in some northern wet meadow/carr. Found in southern terrace and wet-mesic hardwood forest. Recorded from southern mesic cliff, dry-mesic oak woodland and floodplain forest, and along rocky river shore. Usually on highly humified organic substrate in seepage or under graminoid thatch. Forming **small clones** with a somewhat **sub-dendroid habit**.

Aid to Identification: **Broadly ovate-lanceolate, erect spreading, somewhat complanate, and costate leaves with short acute apices. Setae papillose throughout.**

Look-Alike Species: The short cell type lends a **somewhat matte field aspect** to the plants, unlike species of the highly glossy genus *Brachythecium*. *Brachythecium rivulare* (C_{21}) branching is similarly frequently subdendroid, but its leaves have no complanate tendency and are shortly apiculate when typical. *Eurhynchiastrum pulchellum* (C/F_{19}), the northern vicariant of *O. hians,* is similar in microscopic leaf structure, but its branch leaves are strongly reduced in size and most are distinctly obtuse. When sporophytes are present, the setae of both of the previously mentioned species are smooth, while those for *O. hians* are papillose along their entire length. Other species that occur less frequently in calcareous fens with somewhat of the field aspect of *O. hians* are *Leskea gracilescens* (C/F_{15}) and *L. polycarpa* (F/O_{11}), strict bark epiphytes; and *Sciurohypnum oedipodium* (C/F_{19}) and *S. plumosum* (O/F_{11}), more glossy and with plicate leaves.

Associated Species: MesoHab: *Hygroamblystegium varium* mod. *'varium', Plagiomnium cuspidatum, Brachythecium acuminatum, Plagiomnium ellipticum, Brachythecium rivulare*; Pop: *Plagiomnium cuspidatum, Hygroamblystegium* mod. *'varium', Brachythecium acuminatum*.



rough mats with a sub-dendroid aspect; sporophytes often prolific

Oxyrrhynchium hians

above: the leaves are distant from each other and erect-spreading to spreading; they are wide ovate-lanceolate, and there is a little difference in shape between stem and branch leaves (arrows)

below and right: the large capsules are supported by a seta distinctly papillose (arrow) along its entire length and distally capped by a beak-like operculum