

# Illustrated Moss Flora of Minnesota 2

based on the Flora of North America, Volume 27,  
limited to the species occurring in Minnesota, and illustrated by J.A. Janssens  
*Andreaeaceae, Buxbaumiaceae, Diphysciaceae, Encalyptaceae,*  
*Funariaceae, Polytrichaceae, Tetraphidaceae, Timmiaceae*



2017 Minneapolis

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## INTRODUCTION

This chapter of the *Illustrated Moss Flora of Minnesota* illustrates species of the Andreaeaceae, Buxbaumiaceae, Diphysciaceae, Encalyptaceae, Funariaceae, Polytrichaceae, Tetraphidaceae, and Timmiaceae. These families are treated by the *Flora of North America* in volume 27 (FNA 2007), pp. 102-199. Five of the above listed families are monospecific for Minnesota: Andreaeaceae (*Andreaea rupestris*), Buxbaumiaceae (*Buxbaumia aphylla*), Diphysciaceae (*Diphyscium foliosum*), Tetraphidaceae (*Tetraphis pellucida*), and Timmiaceae (*Timmia megapolitana*), and the key to those species is found in the Introduction to the *Illustrated Moss Flora of Minnesota* — *Main Key*. The Encalyptaceae, Funariaceae, and Polytrichaceae have one to several genera with one to multiple species occurring in Minnesota and individual genera keys are provided below.

**Keys:** I eliminated species without properly annotated Minnesota vouchers, and dropped those key characters that are not needed to differentiate the remaining species. However, species recorded in the *Consortium of North American Bryophyte Herbaria* (CNABH) or plotted in FNA for Minnesota but that I have not been able to check with vouchers, are kept in the keys, and their names are enclosed in square brackets. More specific details about these records are provided in notes.

The names of species treated in the field guide *Noteworthy Mosses and Liverworts of Minnesota* (Janssens 2014) are printed in bold. These common species are also keyed using characters suitable for field use in Part I of this field guide, and their field aspect and diagnostic characters have been illustrated in Part II.

**Species plates:** follow in alphabetic order by species name. For each species the illustrations consist of a set of drawings of diagnostic anatomical structures, grouped into a single plate, and a habit close-up (more photos of the common species are available from the field guides mentioned above). The most critical diagnostic character states<sup>1</sup> are underlined in the legend and indicated with arrows on the smaller caption plate; legend to scales are found in the Introduction to the *Illustrated Moss Flora of Minnesota* — *Main Key*. All figures used in each plate are interpreted from material derived from Minnesota voucher specimens<sup>2</sup>.

**Maps:** I provide dot-distribution maps with Minnesota counties outlined, and Ecological Classification System subsections (MN DNR 2003-2007) color-coded. Only properly vouchered and sited material is plotted; the total number of vouchers is given (n). For some species, additional county records—still unconfirmed—are found in CNABH. The names of these counties are listed in the map captions.

I thank B. Murray for evaluating the plate of *Andreaea rupestris* and B. Allen for those of *Diphyscium foliosum* and *Encalypta* species; L. Gerdes and J. Pollard for providing a new record of *Buxbaumia aphylla* with photographs and voucher specimen, and O. Gockman and J. Thayer the new state record of *Diphyscium foliosum* with photographs and voucher specimen; R. Ireland for checking and suggesting many corrections and additions to the plates and the keys of the Polytrichaceae and its genera, and also his much valued comments on other plates. I appreciate the help of P. Rogers at MICH and J. Doubt at CANM for checking and making available their records of Minnesota collections; of R. Lawrenz, J. Hoff, and R. Newberry for providing excellent herbarium facilities for my collections at the Science Museum of Minnesota; of G. Weiblen, D. Stanton, and K. Noren for loans of specimens from the herbarium of the Bell Museum of Natural History (MIN); and of B. Allen and J. Atwood for a loan from the herbarium of the Missouri Botanical Garden (MO).

1 Consult Malcolm, B. and N. Malcolm (2006), a marvelous illustrated glossary.

2 Vouchers are listed in the legend to the left of each plate; they are deposited in my personal herbarium, and in the bryophyte collections of the Science Museum of Minnesota (SMM) or of the Bell Museum of Natural History (MIN).

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## ENCALYPTACEAE

### *Encalypta*

Modified for Minnesota from the Flora of North America, Volume 27, p. 173.

Stems covered with dense mass of rhizoidal gemmae; [calyptra papillose, lacerate at base; peristome double; spores 14-24  $\mu\text{m}$ , granulate] (so far no specimens with sporophytes have been found in Minnesota) . . . . . *E. procera*

Stems without rhizoidal gemmae; calyptra smooth, broadly fringed at base; peristome single; spores 30-40  $\mu\text{m}$ , plicate and pitted . . . . . *E. ciliata*

## FUNARIACEAE

### KEYS TO MINNESOTA GENERA AND SPECIES OF THE FAMILY FUNARIACEAE

Modified for Minnesota from the Flora of North America, Volume 27, p. 181.

#### To genera and species of Minnesota monospecific genera (see also Illustrated Main Key)

1 Calyptra large and four-angled, completely enclosing the mature capsule . . . . . *Pyramidula tetragona*

1 Calyptra smaller than mature capsule, not angled or persistent . . . . . 2

2 Capsules immersed . . . . . 3

2 Capsules emergent or long-exserted . . . . . 5

3 Capsules rupturing irregularly; exothelial cells delicate, thin-walled . . . . . *Physcomitrella patens*

3 Capsules operculate; exothelial cells firm, thick-walled or collenchymatous . . . . . 4

4 Exothelial cells collenchymatous; spores spiculose-papillose . . *Aphanorrhagma serratum* (see note below)

4 Exothelial cells not collenchymatous; spores papillose . . . . . *Physcomitrium immersum* (see note below)

5 Capsules inclined and asymmetric; peristome double, endostome well developed to somewhat rudimentary . . . . . *Funaria*

5 Capsules erect and more or less symmetric, urn-shaped, broadly pyriform to cupulate; peristome either single, rudimentary, or absent . . . . . *Physcomitrium* (in part)

### *Funaria*

Modified for Minnesota from the Flora of North America, Volume 27, p. 189.

Annulus absent . . . . . *F. americana*

Annulus large, revoluble . . . . . *F. hygrometrica*

### *Physcomitrium*

Modified for Minnesota from the Flora of North America, Volume 27, p. 197.

1 Capsules immersed . . . . . *P. immersum*

1 Capsules exserted . . . . . 2

2 Leaves entire, rarely with somewhat uneven margins distally; annulus revoluble, deciduous . . . . . *P. hookeri*

2 Leaves sometimes toothed distally; annulus not evident . . . . . *P. pyriforme*

**Note:** *Physcomitrium immersum* and *Aphanorrhagma serratum* are highly similar and each is quite variable, judging from the few Minnesota specimens that I have seen and illustrated. Additional specimens of these rare species is needed for further study to differentiate between them.

# POLYTRICHACEAE

## KEYS TO MINNESOTA GENERA AND SPECIES OF THE FAMILY POLYTRICHACEAE

Modified for Minnesota from the Flora of North America, Volume 27, p. 123-125, 134-135, 148-150.

### To genera (see also Illustrated Main Key)

- 1 Lamellae 10 or fewer and confined to median portion of blade, often loosely spreading and wavy *Atrichum*
- 1 Lamellae 20 or more, occupying most of the leaf width, compact and usually straight . . . . . 2
- 2 Top margins of lamellae papillose . . . . . *Polytrichastrum alpinum*
- 2 Top margins of lamellae smooth . . . . . 3
- 3 Costa rounded in cross-section, forming a low ridge on back of blade, the arc of guide cells narrow (8-12 cells wide); median sheath cells short-rectangular (to 5:1) to rhomboidal; marginal lamina narrow . . . . .  
 . . . . . *Polytrichastrum*
- 3 Costa in cross-section broad and flat, the arc of guide cells 18-24 cells wide; median sheath cells linear (as long as 20:1); marginal lamina narrow, or broad and overfolding . . . . . *Polytrichum*

### *Atrichum*

- 1 Leaves narrow, usually less than 1 mm wide at midleaf; median leaf cells 8 to <20  $\mu\text{m}$  wide, bulging-mammillose on adaxial surface, often distinctly papillose; lamellae 4-9(-12), widely spreading, to 8(-15) cells high . . . . . *A. angustatum*
- 1 Leaves broader, mostly 1.5-2 mm wide; median leaf cells often >20  $\mu\text{m}$  wide, merely convex, smooth or finely striate-papillose; lamellae 0-2(-7),  $\pm$  straight, 0-6(-9) cells high . . . . . 2
- 2 Leaves distinctly undulate; lamina with many abaxial teeth in oblique rows . . . . . 3
- 2 Leaves not or weakly undulate; lamina with at most a few scattered abaxial teeth . . . . . 4
- 3 Plants small to medium, 1-3 cm; leaves narrowly lanceolate to lingulate; lamellae 4-6 cells high or higher . . . . . *A. altecristatum*
- 3 Plants medium to robust, to 6 cm; leaves ovate-lanceolate to broadly elliptic-lanceolate; lamellae mostly 2-4 cells high . . . . . *A. crispulum*
- 4 Marginal cells and teeth finely striate papillose (use high magnification) . . . . . *A. crispum*
- 4 Marginal cells and teeth smooth . . . . . *A. tenellum*

### Notes:

The first three species in the key are quite common in Minnesota, while the last two are rare. These rare species are, however, immediately recognized as obvious *Atrichum* species when the adaxial lamellae are observed. Great care has to be taken to differentiate them, using the character mentioned in the key dichotomy. This key differs significantly from the one in FNA.

A number of Minnesota-collected specimens at NYBG are identified as *A. undulatum* from Cass, Clearwater, Pipestone, and Winona Counties. The species has not been verified as occurring in Minnesota, so these collections need to be examined in order to confirm if they are *A. undulatum*, or—more likely—one of the three common species here documented for the state.

***Polytrichastrum***

- 1 Top margins of lamellae papillose ..... *P. alpinum*  
 1 Top margins of lamellae smooth ..... 2
- 2 Lamellae crenulate in profile ..... *P. pallidisetum*  
 2 Lamellae entire in profile ..... 3
- 3 Marginal cells of lamellae in section wider than those beneath, transversely elliptic, the free wall conspicuously thickened, often brownish ..... *P. ohioense*  
 3 Marginal cells of lamellae ovate to elliptic, usually slightly taller than wide, not or evenly thickened ..... 4
- 4 Marginal lamina 5-9(-20) cells wide, somewhat incurved when dry; median sheath cells rectangular (3-5:1).  
 ..... *P. longisetum*  
 4 Marginal lamina 2-5 cells wide, ± erect; median sheath cells elongate (5-9:1) ..... [*P. formosum*]

**Note:** FNA records *P. formosum* var. *densifolium* is recorded for Minnesota. So far I have not seen any convincing Minnesota material of this species or its variety. There are no specimens in the MIN herbarium. A specimen in the MICH herbarium, which was collected in Beltrami County (W. Buck B307) and also listed in the NYBG website, was examined and I identified it as *P. longisetum*. A specimen located at CANM (W.A. Olson 537) and identified tentatively by H.A. Crum as '*P. formosum*?' is considered by us (J. Doubt, R. Ireland, and J. Janssens, pers. comm.) to be a poorly developed *P. pallidisetum*.

***Polytrichum***

- 1 Marginal lamina narrow, mostly erect, the margins sharply toothed ..... *P. commune*  
 1 Marginal lamina broad, membranous, sharply inflexed and overlapping, enclosing the lamellae ..... 2
- 2 Leaf blade abruptly contracted to a long, hyaline awn ..... *P. piliferum*  
 2 Leaf blade tapering to a short brownish or bicolored awn ..... 3
- 3 Stems brownish tomentose only near base, 2-8 (-10) cm long; capsules oblong, rarely cubic, 2-5 mm long .  
 ..... *P. juniperinum*  
 3 Stems densely whitish tomentose, 3-15 (-20) cm long; capsules cubic, sometimes shortly oblong, 2-3 mm long ..... *P. strictum*

**Notes:**

FNA describes a taxon called *P. commune* var. *perigoniale*. Some Minnesota specimens could be considered to belong to this variety, even if it is not recorded as occurring in Minnesota. I agree with Crum & Anderson (1981), at least for the putative Minnesota specimens, that this variety is probably only a dry land modification of *P. commune*.

Some *P. juniperinum* and *P. strictum* specimens are hard to tell apart using structural features. I think *P. strictum* might be a xerophytic bog-hummock modification with longer stems, well-developed tomentum, and smaller leaves than the upland *P. juniperinum*. Cedar-swamp specimens in Minnesota are clearly in between *P. strictum* and *P. juniperinum*, suggesting both might belong to a highly plastic species. The attributes of leaf-length (longer in *P. juniperinum*) and capsule-shape (more cubic in *P. strictum*) given in FNA do not correlate well with the field aspect (tomentum) and habitat situation (upland vs. wetland) of a number of my Minnesota collections. In addition, Crum & Anderson (1981) consider *P. strictum* a variety of *P. juniperinum*, while other authors consider it a subspecies.

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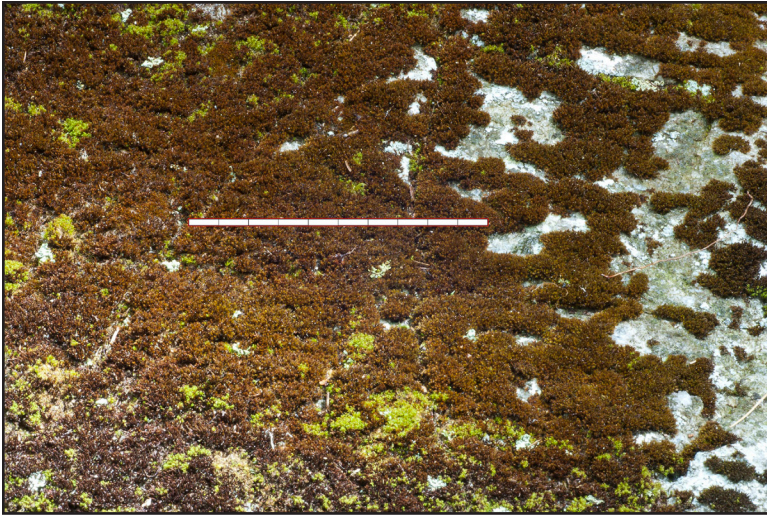
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FNA 2007. *Flora of North America north of Mexico*. Volume 27, Bryophyta, part 1, 2007. New York and Oxford, Oxford University Press. 713 pp.

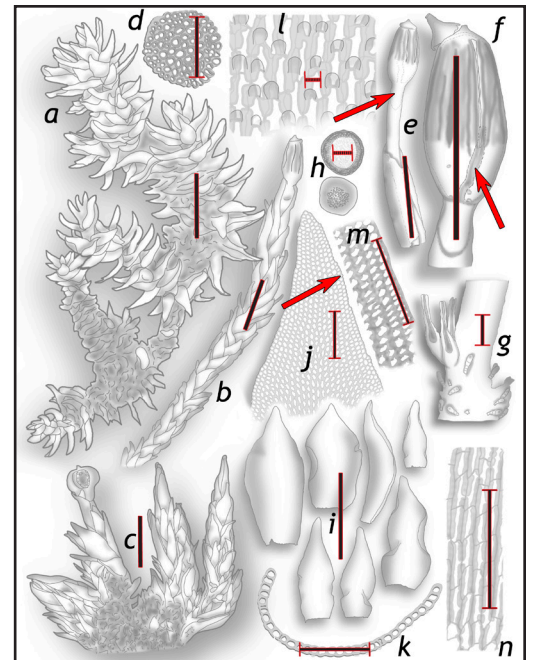
Janssens, J.A. 2014. *Noteworthy Mosses & Liverworts of Minnesota*, Part I: Illustrated Field Keys 176 pp, and Part II: Species Fact Sheets 208 pp. PDF available from [www.dnr.state.mn.us/eco/mbs/mnbryophytes.html](http://www.dnr.state.mn.us/eco/mbs/mnbryophytes.html).

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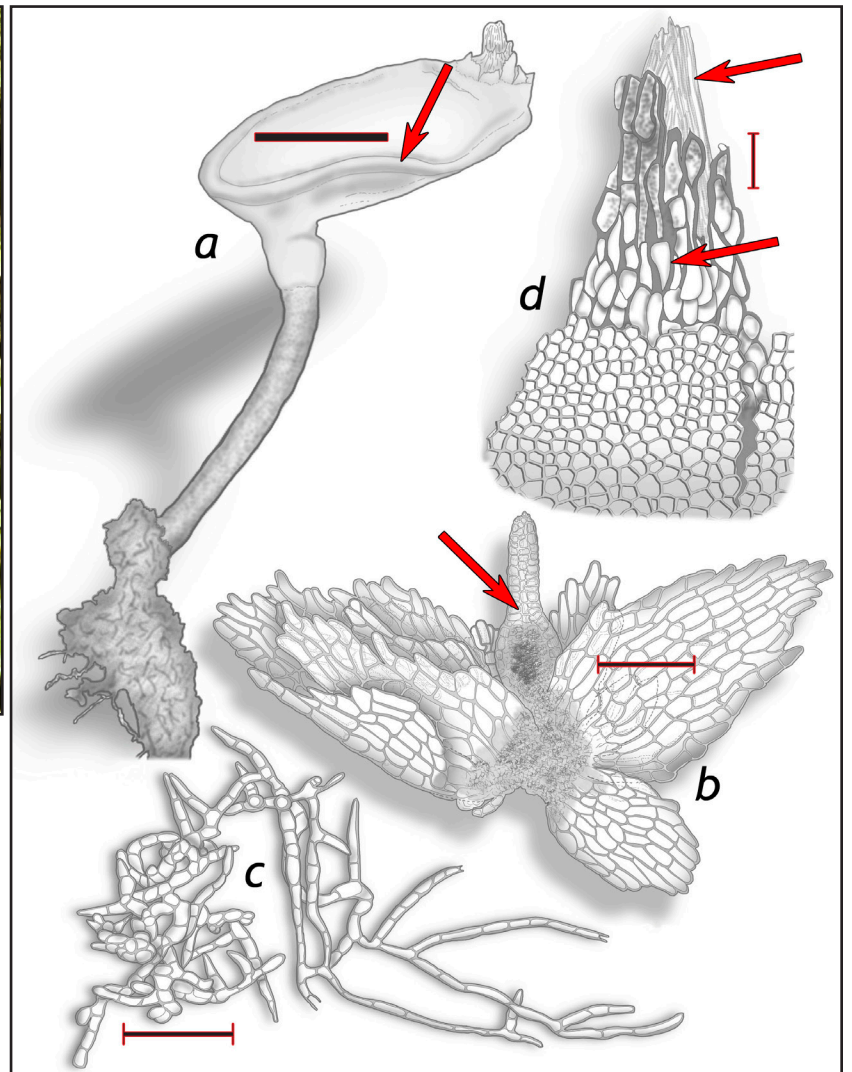
vouchers *Janssens 43806, 45421, 45435, 54168, 54607, 54627; Wheeler 30158 & 30182*:

- a* gametophore
- b & c* gametophore with sporophyte: valves of capsule closed (*b*) or open (*c*)
- d* stem tr. s.
- e* perichaetial leaves, pseudopodium, and sporophyte: foot of sporophyte embedded in pseudopodium
- f* sporophyte and calyptra (embedded in top of pseudopodium): calyptra small, just released from top of sporophyte; shrunk columella, not attached to distal top of capsule
- g* archegonia and axillary hairs (near base of pseudopodium)
- h* spores (surface and optical transection)
- i* leaves: ovate to short-lanceolate, only faintly panduriform and with slightly curving shape; costae absent
- j* leaf – apex: with smooth, faintly crenulate margin
- k* branch leaf tr.s.
- l* leaf – medial cell region (adaxial surface): thick-walled and deeply pitted cells with large papillae
- m* leaf – marginal cell region
- n* leaf – basal cell region: thick-walled and deeply pitted cells



*Andreaea rupestris*

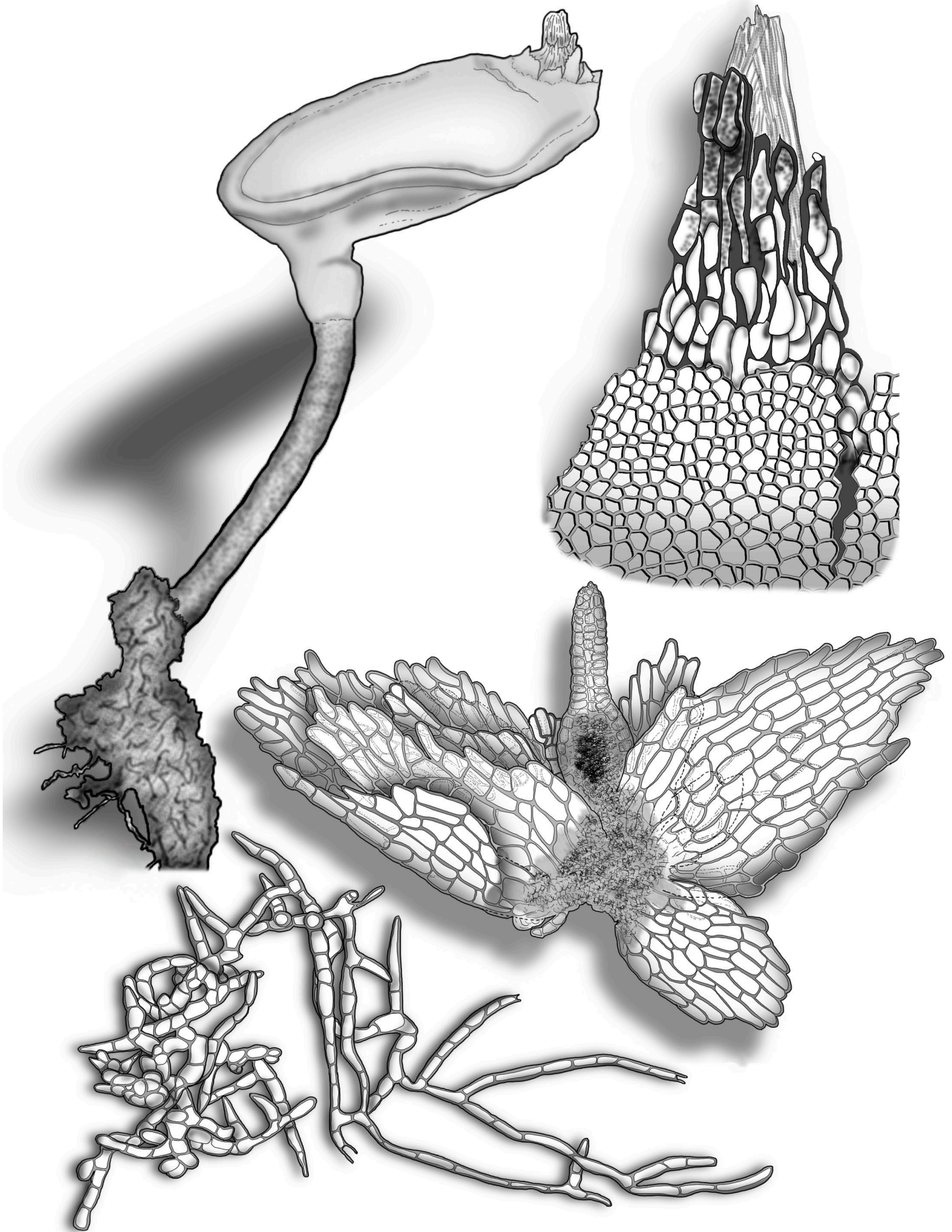




voucher *Gerdes 992*:

- a* **sporophyte:** with glossy brown rim (see also photos); seta papillose
- b* **female gametophore:** with single central archegonium
- c* **protonemata:** persistent
- d* **peristome:** with inner pleated endostome and outer exostome with thick-walled cells; torn theca

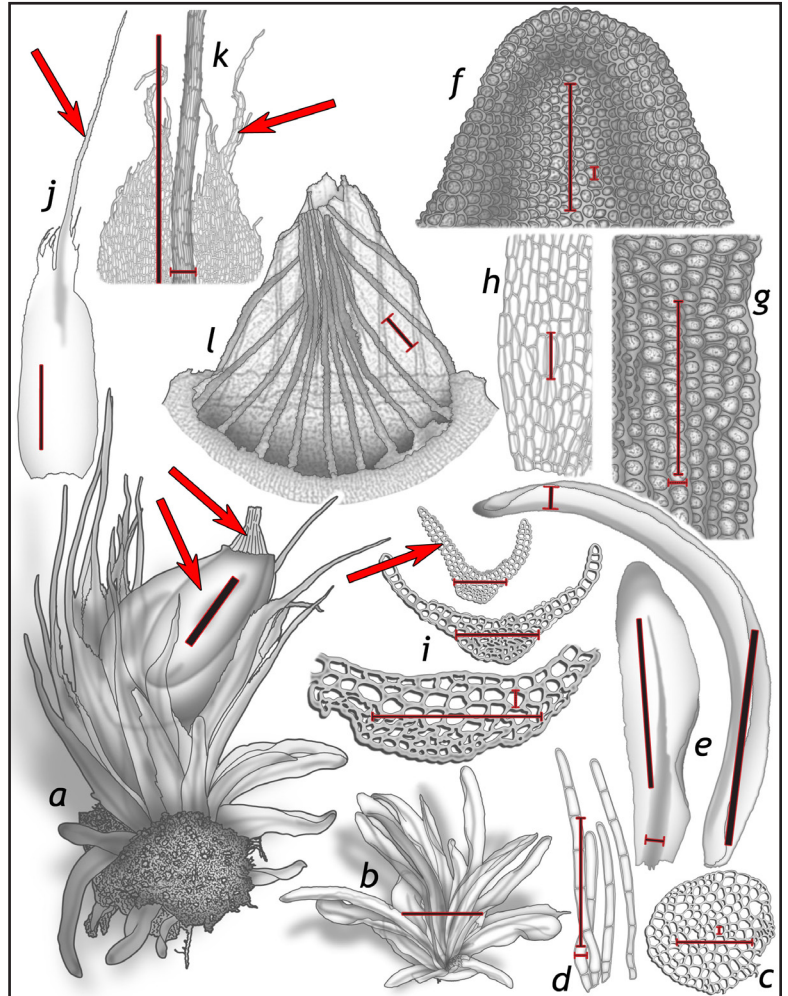
*Buxbaumia aphylla*



*Buxbaumia aphylla*

voucher *Gockman 10056*:

- a* **gametophore with sporophyte**: stem short, strongly radiculose, adhering tightly to mineral substratum; seta short (contrast with *Buxbaumia aphylla*); capsule broadly ovoid, oblique and asymmetric, enveloped by perichaetial leaves, upper side strongly bulging, with narrow mouth and upturned whitish peristome (see also photo)
- b* **gametophore**: leaves (blackish and crisped when dry), (dark-green), spreading when moist; lower leaves smaller
- c* **stem tr.s.:** central strand absent, cortical cells poorly differentiated
- d* **axillary hairs** (adnate to leaf bases)
- e* **non-perichaetial leaves**: radially enrolled, linguulate to linguulate-subulate, margin entire, costa strong (see also *i*), but merging with multistratose upper lamina (contrast with similar strap-like leaves of Pottiaceae)
- f* **non-perichaetial leaf – apex**: rounded-obtuse and often cucullate, consisting of multi-stratose costa and 2-stratose lamina (see also *i*); margin crenulate
- g* **non-perichaetial leaf – upper marginal cell region**: lamina 2-stratose; cells mamilliose-pluripapillose (see also *i*)
- h* **non-perichaetial leaf – marginal basal cell region**: cells 1-stratose, hyaline and smooth; alar cells not differentiated
- i* **non-perichaetial leaf tr.s.:** costa well developed, extending into 2-stratose lamina in upper part of leaf, broad in lower part, weakly differentiated internal cells
- j* **perichaetial leaf**: with long spinulose awn (brownish); lamina at base of awn lacerate and membranaceous (see also *k*)
- k* **perichaetial leaf – apex fringe**: lamina at base of awn lacerate or ciliate, hyaline, cell with thickened cross-walls; awn long-excurrent, (brown)
- l* **peristome**: white semi-transparent 16-pleated twisted endostome forming open cone; (exostome rudimentary and often absent, as here)

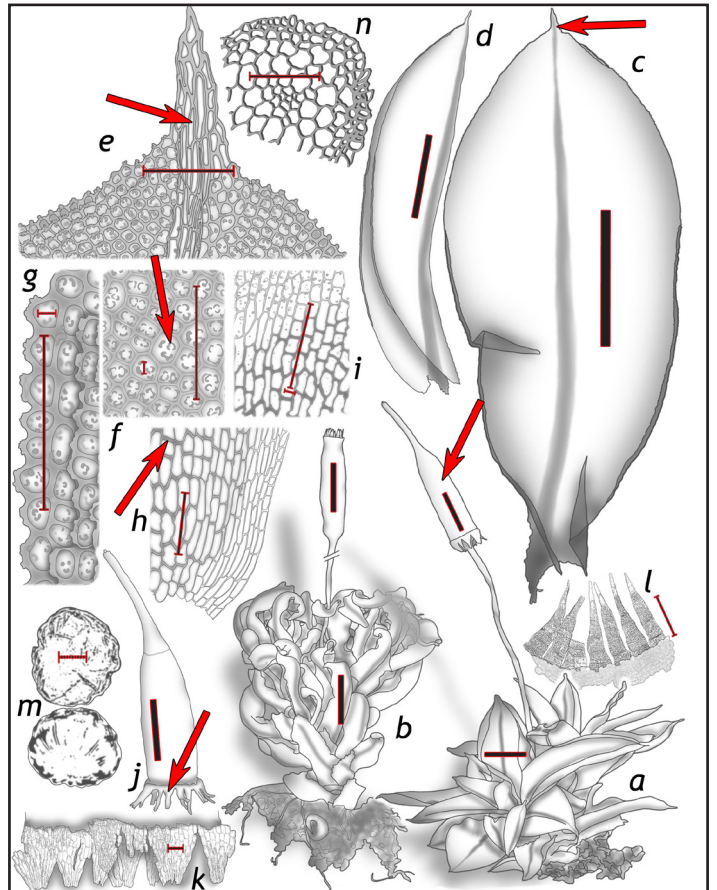




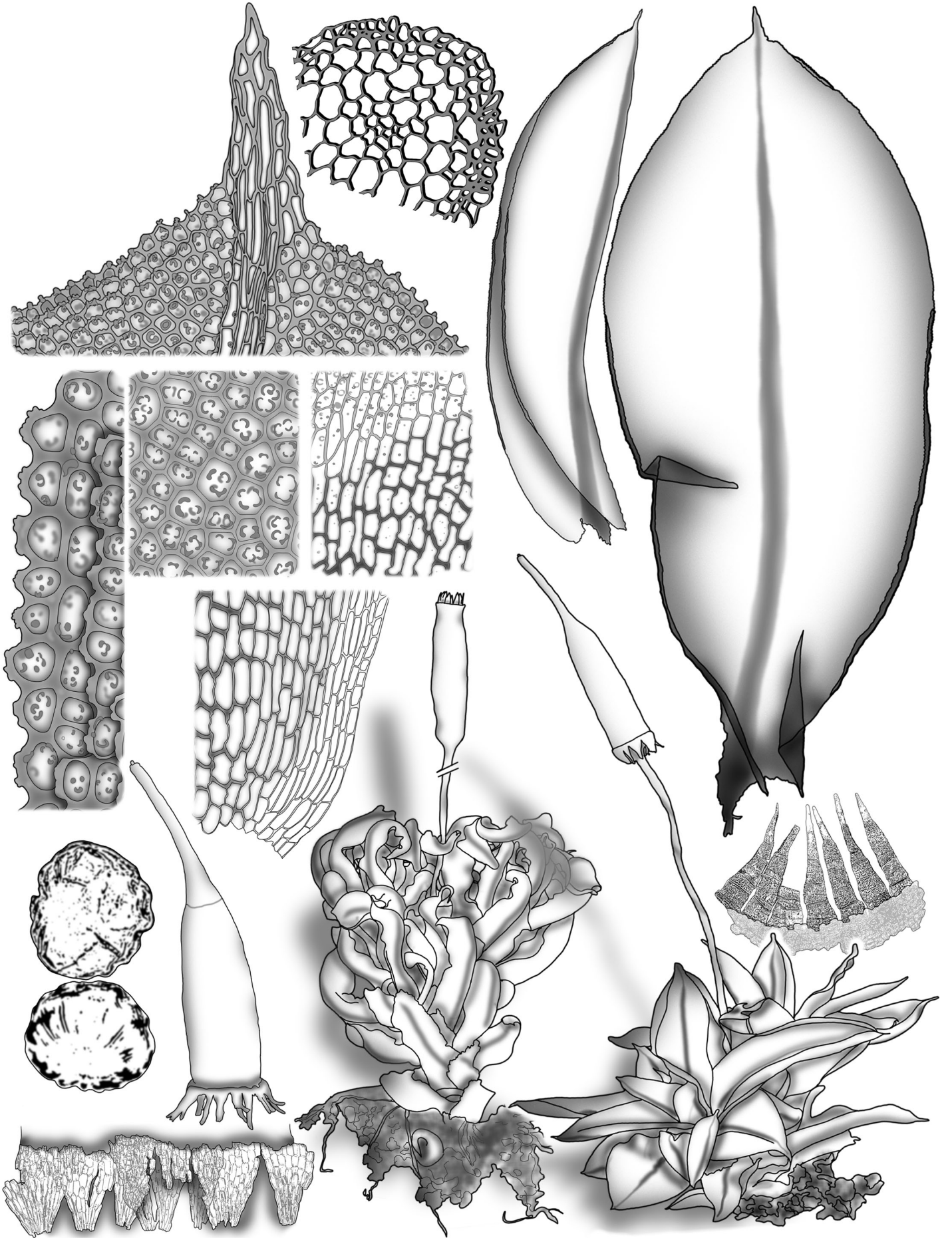


vouchers *Janssens 29308, 36874, 41917, 54391, 55932*:

- a* **gametophore and sporophyte** (wet): short plant, tomentose below; twisted seta (yellow or brown), with capsule completely covered by calyptra
- b* **gametophore and capsule** (dry): contorted and incurved leaves; capsule long-narrow, straight (yellow to brown), smooth except when old
- c-d* **leaves**: elliptic to oblong-obovate shape, some deeply folded over or incurved, margins partly narrowly recurved below; costa shortly excurrent
- e* **leaf – apex**: broadly acute shape, with abrupt smooth apiculus (yellow)
- f* **leaf – medial cell region**: dense hexagonal, firm-walled cells, with forked or C-shaped papillae on both surfaces
- g* **leaf – marginal cell region**: curved aspect only a few cells in width, densely papillose
- h* **leaf – basal cell region**: smooth, linear, thin-walled cells at margin, grading into wider lax cells with thickened (and brown-colored) transverse walls
- i* **leaf – transition of basal cells to medial cells**: gradual transition, with increase in papillae
- j* **calyptra**: perfect mitrate shape (glossy and straw-colored) with long-rostrate operculum remaining inside; at base fringed with deep, broad lobes
- k* **calyptra – fringe**: broad lobes (flattened view)
- l* **peristome**: single row of teeth (brown), finely papillose and somewhat striolate below
- m* **spores – distal face (above) and proximal face (below)**: irregular coarse wrinkles (distally) and narrowly striate plicae and partly finely papillose surface (proximally)
- n* **stem tr.s.:** only weakly developed central strand (often absent all together)



### *Encalypta ciliata*

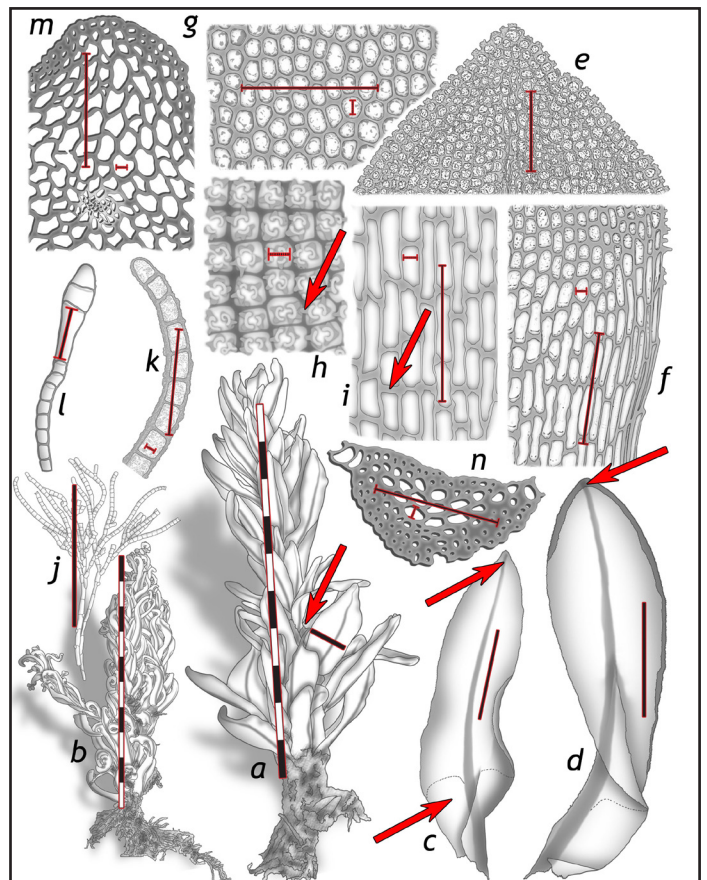


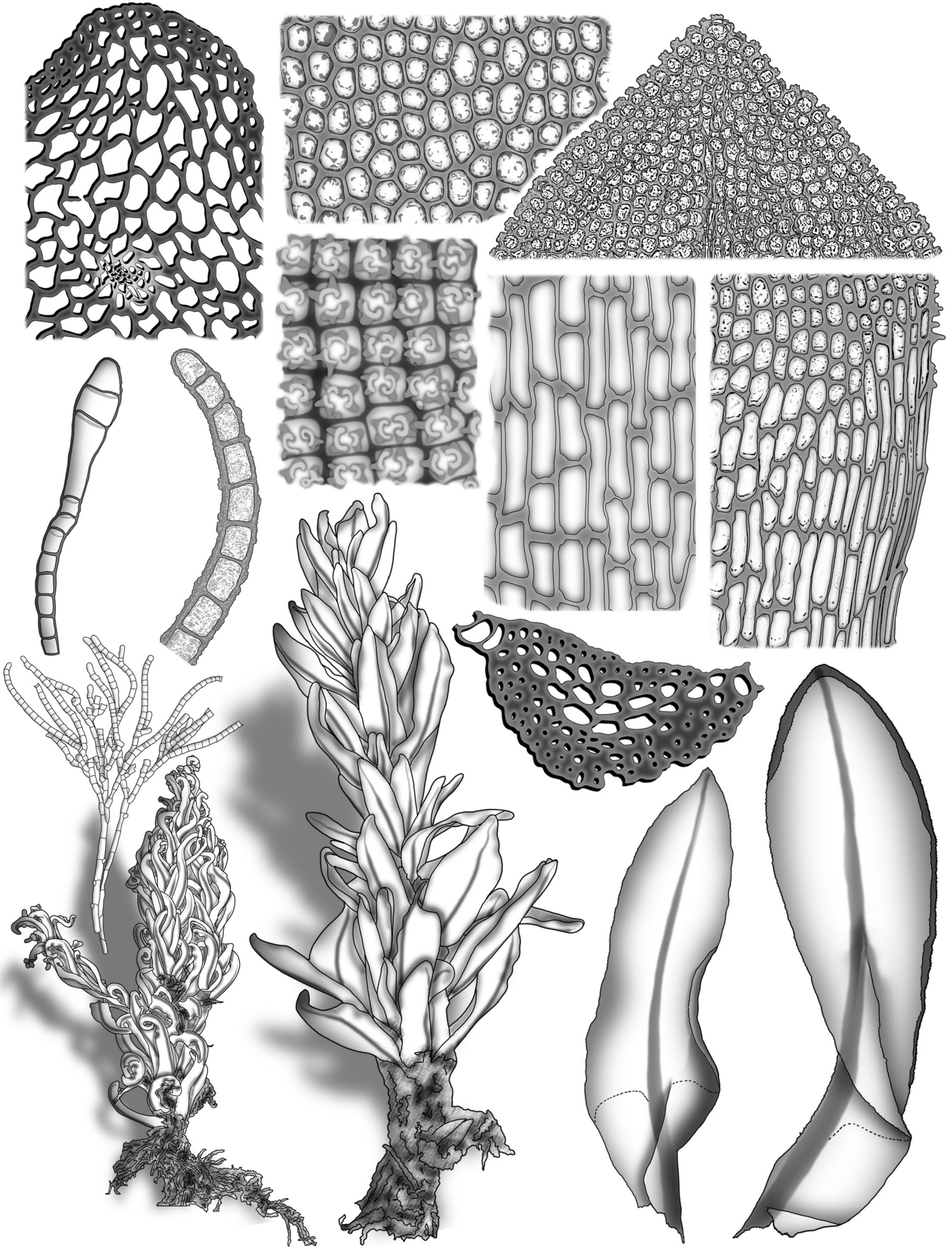
*Encalypta ciliata*



vouchers *Janssens 41981, 43268, 43274* (no specimens with sporophytes recorded from Minnesota):

- a* **gametophore** (wet): erect-spreading to spreading leaves, somewhat flexuose; stems tomentose below
- b* **gametophore** (dry): incurved and twisted leaves (see also photo: plants with bluish aspect); gemmae clusters along stem near base of leaves
- c-d* **leaves**: variable apex shape, broadly acute in *c*, while obtuse and cucullate in *d* (perichaetial leaves are generally awned); margins occasionally narrowly recurved (*d*), entire; cells at base lax and thin-walled
- e* **leaf – apex**: subpercurrent costa (regular cauline leaf) and somewhat cucullate aspect
- f* **leaf – transition of basal cells to medial cell**: gradual differentiation between inner basal cells (mostly smooth) and medial cells (papillose), and between basal cells and narrower marginal cells
- g* **leaf – medial cell region**: thick-walled isodiametric cells (papillose on both surfaces)
- h* **leaf – medial-cell papillae detail**: C-shaped papillae with distinct horns
- i* **leaf – basal cell region**: thin-walled, smooth, and usually long-rectangular cells, but with thickened cross walls (these also distinctly brown-colored)
- j* **gemmae cluster**: rhizoidal aspect (oblique cell walls) near base; (gemmae easily released, but clusters abundant on some stems)
- k-l* **gemmae**: filiform shape, either smooth with bulbous tip (*l*) or with somewhat roughened cuticle (*k*)
- m* **stem tr.s.:** distinctly differentiated central strand (not seen in all tr.s.)
- n* **leaf costa tr.s.:** thick-walled abaxial and adaxial cell layers, no separate stereid bands



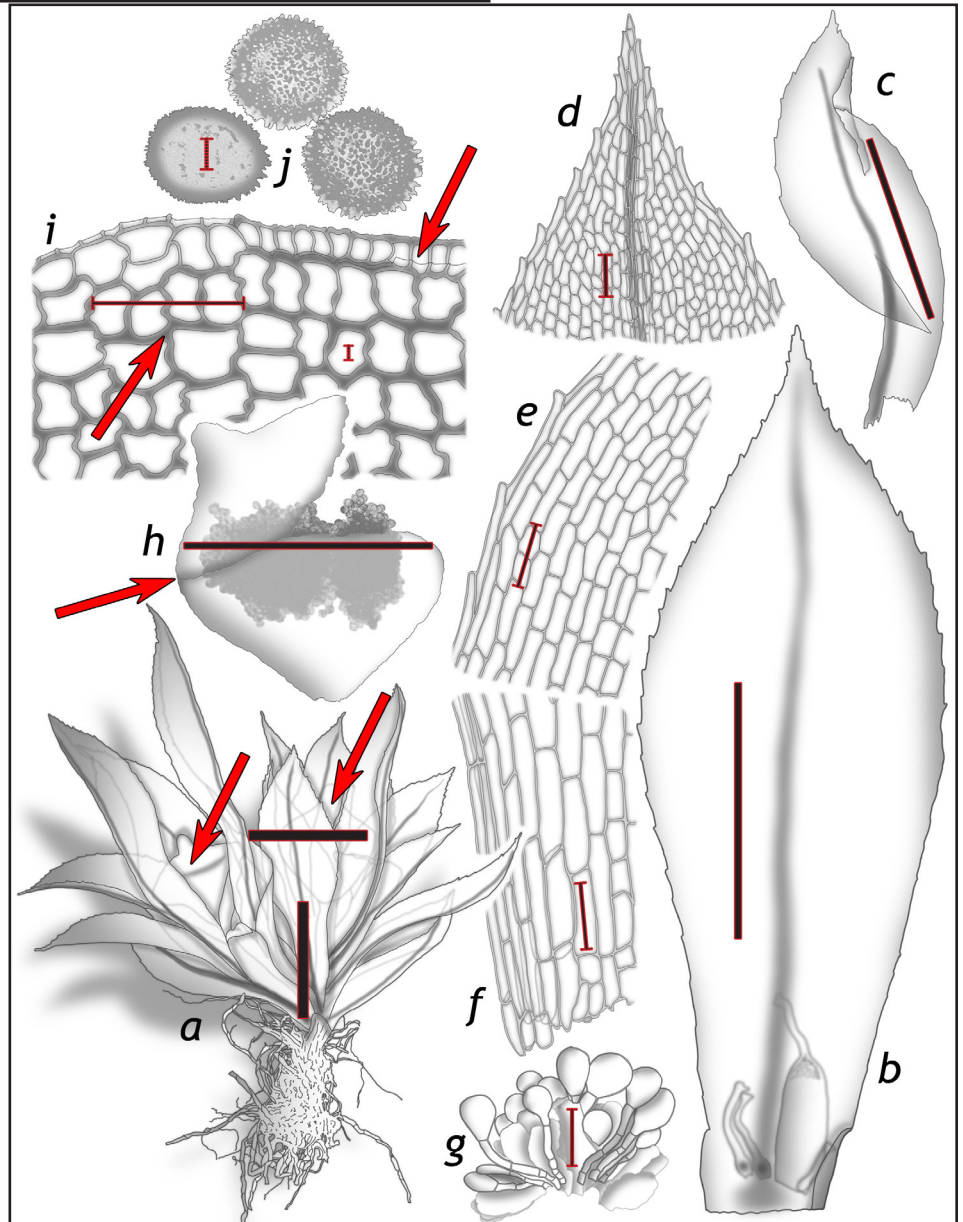


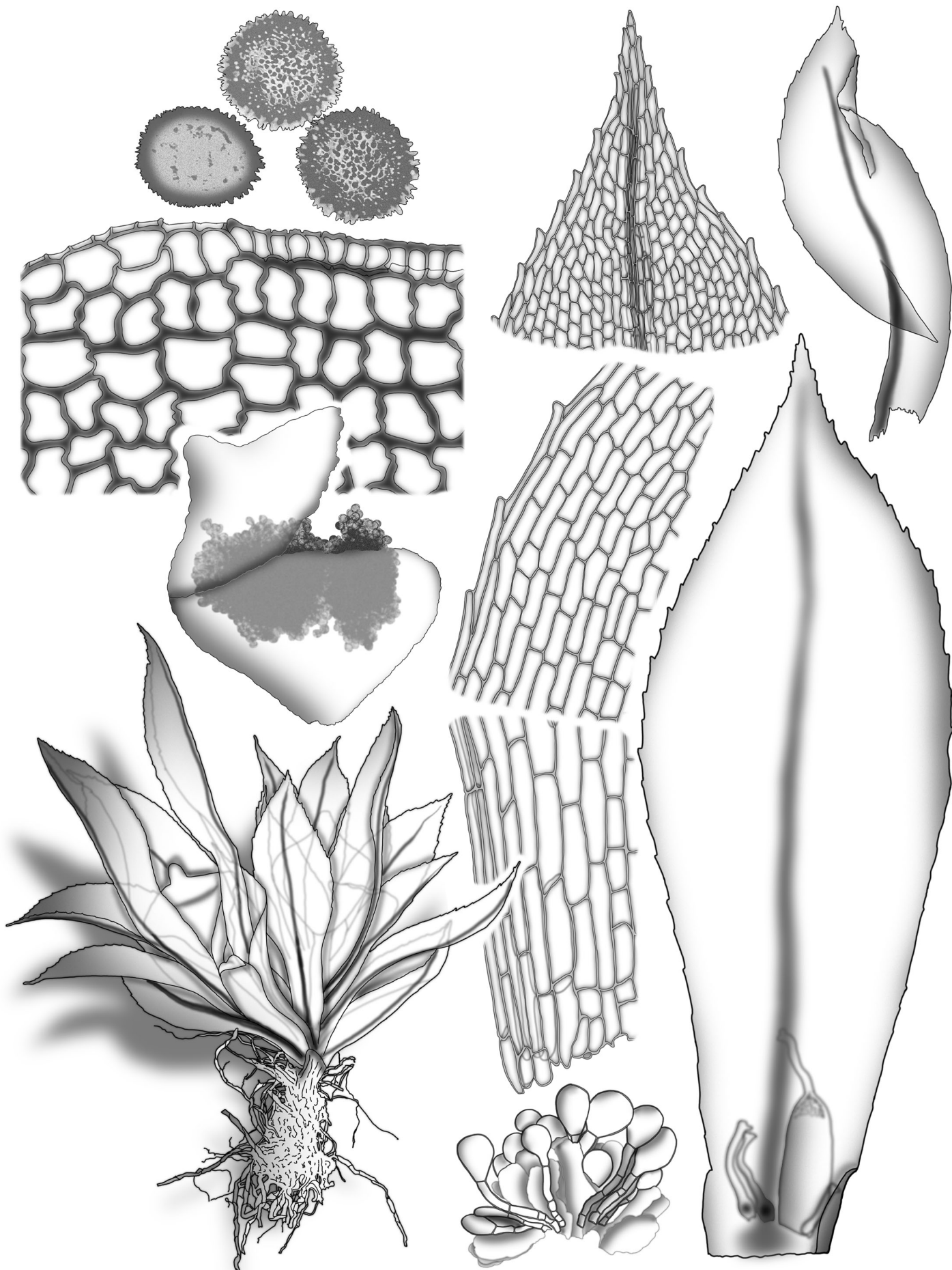
*Encalypta procera*



voucher *Janssens 45751*:

- a* **two forked gametophores with sporophytes** (wet): immersed capsules (short setae, see also photo above), partially exposed by erect-spreading leaves when plants are wet
- b-c* **leaves**: serrate distal margins; (*b*) perichaetial leaf with axillary archegonia
- d* **leaf – apex**: percurrent costa, some cell nearly quadrate
- e* **leaf – marginal cell region**: indistinct border formed by narrow-elongated cells
- f* **leaf – basal cell region**: *ib.*
- g* **antheridia and paraphyses**: bulbous end-cells of paraphyses and ovate antheridia (plants are paroicous)
- h* **capsule**: large operculum dehiscent near middle; no peristome evident
- i* **capsule – theca** (near rim): narrow annulus of delicate, small cells, persistent; exothelial cells isodiametric and collenchymatous
- j* **spores** (median optical section, proximal and distal surface): spiculose-papillose surface



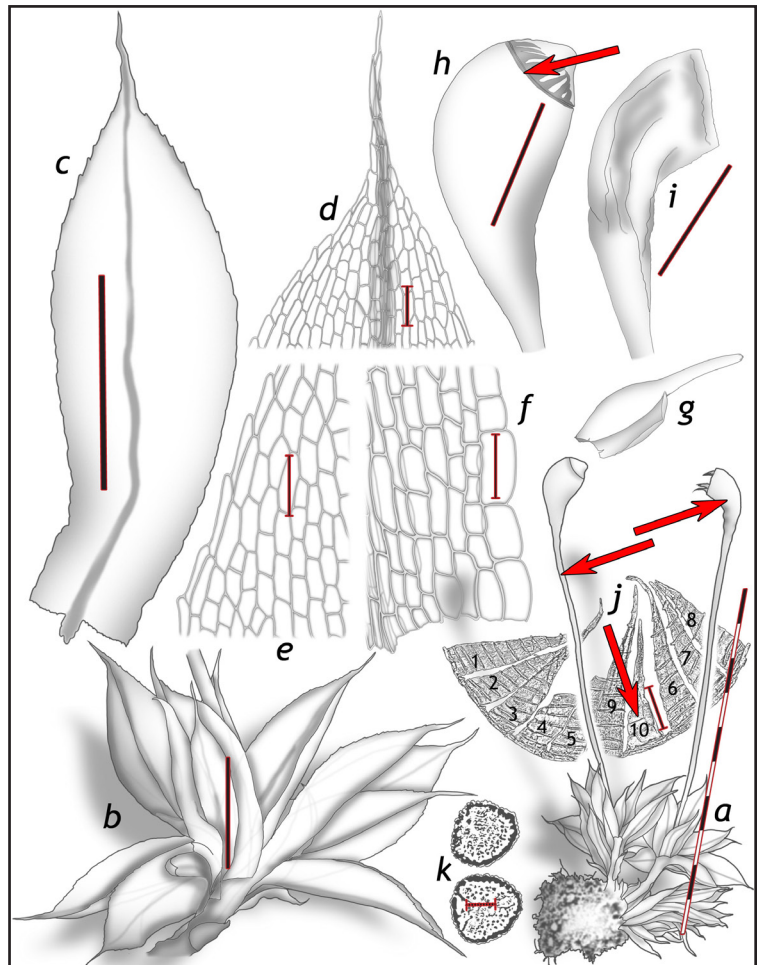


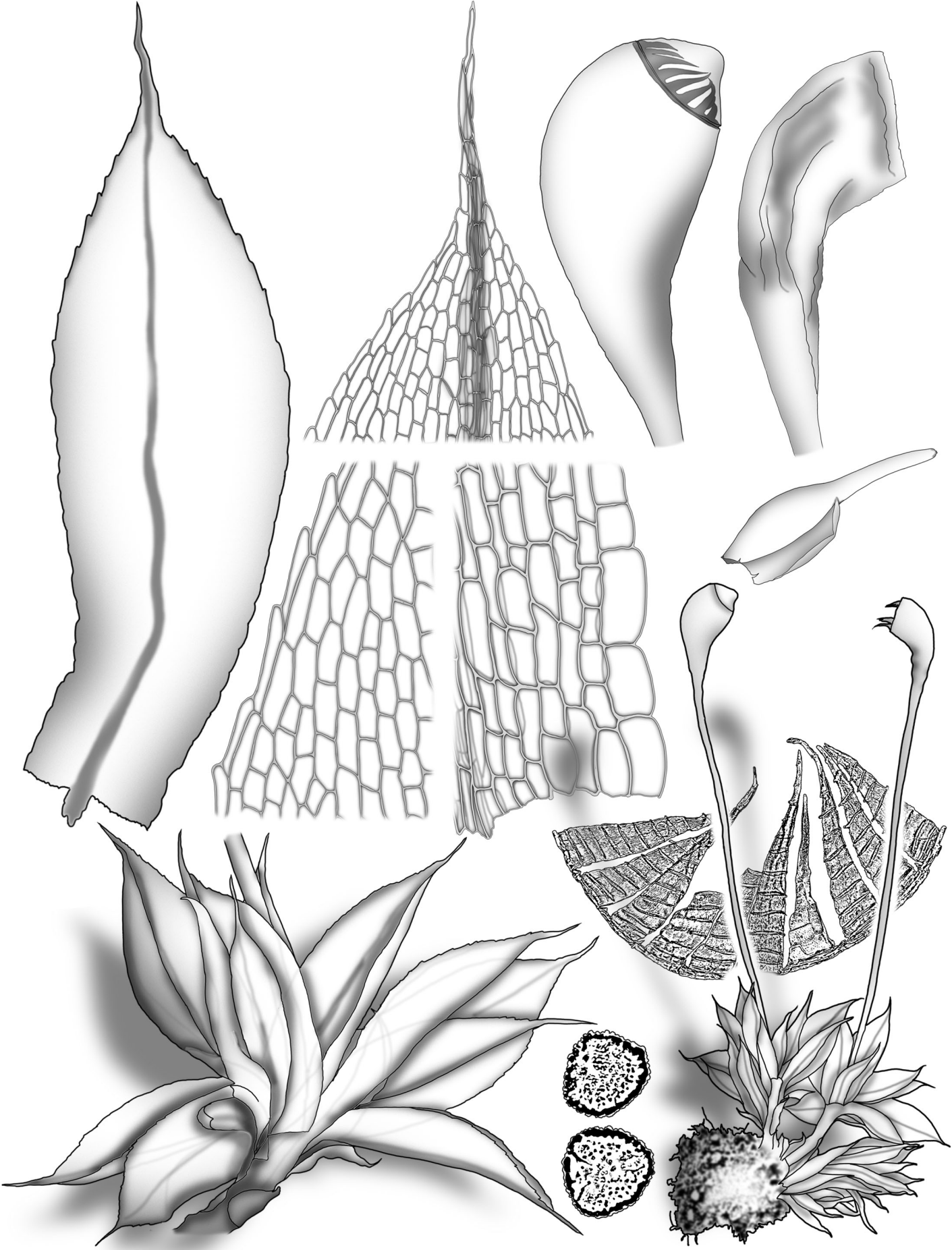
*Aphanorrhegma serratum*



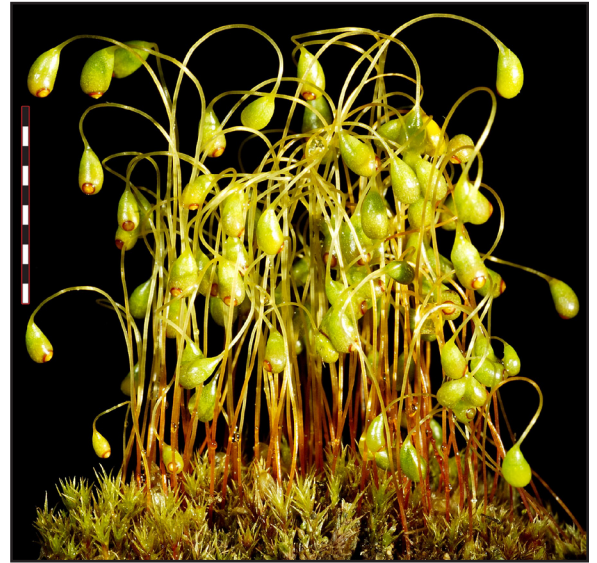
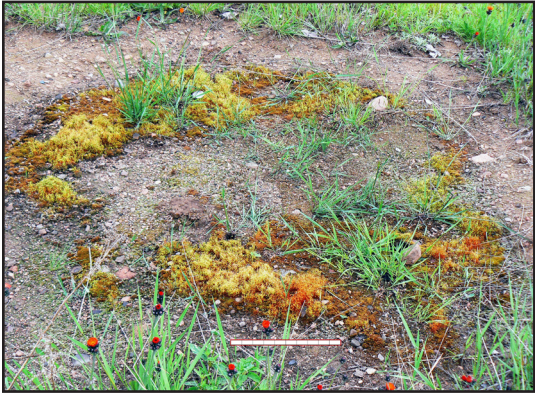
vouchers *Holzinger s.n.*, May 1 & 15, 1901 (MIN 112996 & 112997)

- a* **gametophores with sporophytes** (wet): crowded leaves at tip of short stems; asymmetric, elongate-pyriform capsules with long neck, exserted
- b* **gametophore** (wet): smaller leaves below
- c* **leaf**: margins weakly serrulate distally, entire proximally (sometimes completely entire)
- d* **leaf – apex**: filiform apiculus with an apparently excurrent narrow costa
- e* **leaf – medial & marginal cell region**: cells often narrowed near margin, serrulate
- f* **leaf – basal and marginal cell region**: large rectangular, sometime swollen cells near margin
- g* **calyptra**: long-rostrate and cucullate, inflated at base
- h-i* **capsules**: mature (*h*), with transparent operculum covering peristome, and old (*i*, operculum and peristome lost; short-conic osperculum; neck shrunken when dry; annulus absent
- j* **peristome**: 1-8 are exostome teeth, 9 is an exostome tooth overlying an endostome tooth, 10 is an exposed endostome tooth; endostome teeth approximately 2/3 the length of exostome teeth and opposite to them
- k* **spores** (proximal above and distal surface below): verruculose exine



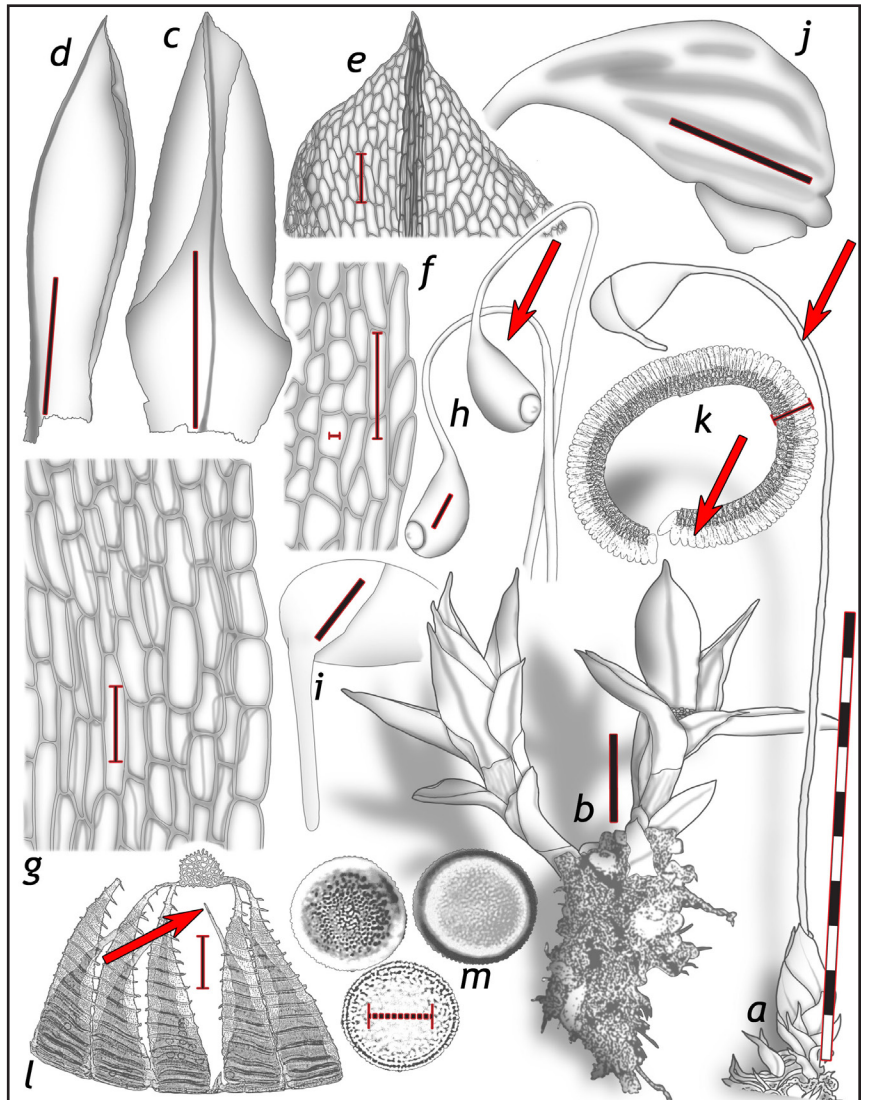


*Funaria americana*

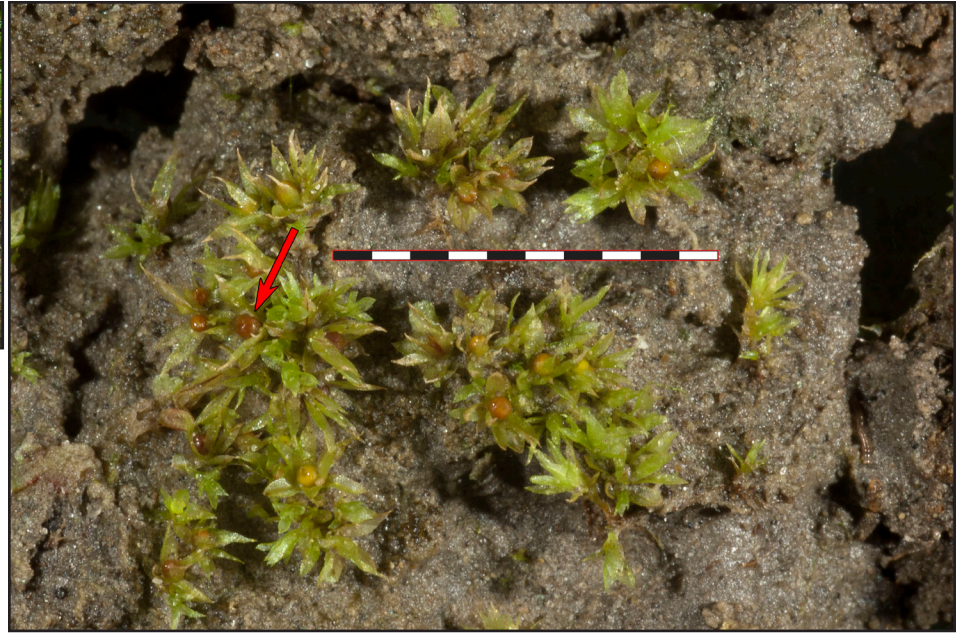


vouchers *Janssens 46392, 53978, 55166, 55442, 55443; Wheeler 30088, 30684, 30817*:

- a* **gametophore with sporophyte** (wet): bulbous distal perichaetial leaf cluster with imbricate leaves; capsule long exserted
- b* **gametophores** (wet): smaller proximal leaves (plants sometimes laxly foliate throughout)
- c-d* **leaves**: deeply concave or enrolled shape (not keeled), not decurrent
- e* **leaf – apex**: only weakly serrulate margins; costa usually percurrent
- f* **leaf – medial & marginal cell region**: weakly serrulate margin formed by somewhat elongated cells; large thin-walled medial cells, of highly variable shape and size
- g* **leaf – basal and marginal cell region**: long-oblong cells, thin walled, somewhat bulging in alar region
- h* **sporophytes** (mature): slender and flexuose setae (usually hygroscopic and highly variable in length); capsules, when mature but not yet dry, asymmetric pyriform, curved and pendent (bright green and abundantly produced, see photo above); small slightly convex opercula
- i* **calyptra** (covering capsule on right): smooth, narrowly cucullate shape, with long rostrum pointing downward
- j* **capsule** (old): when dry becoming sulcate with deep longitudinal grooves, mouth strongly oblique; small conic operculum
- k* **annulus**: deciduous, large and with highly revolvable shape
- l* **peristome**: appendiculate exostome with pronounced trabeculae, teeth fused above by a latticed central disk; endo-stome well developed, segments thinly transparent, finely papillose, nearly as long as exostome teeth, fused at lower third with exostome teeth and opposite rather than alternating with them
- m* **spores** (median optical section, proximal, and distal surface): minutely papillose surface

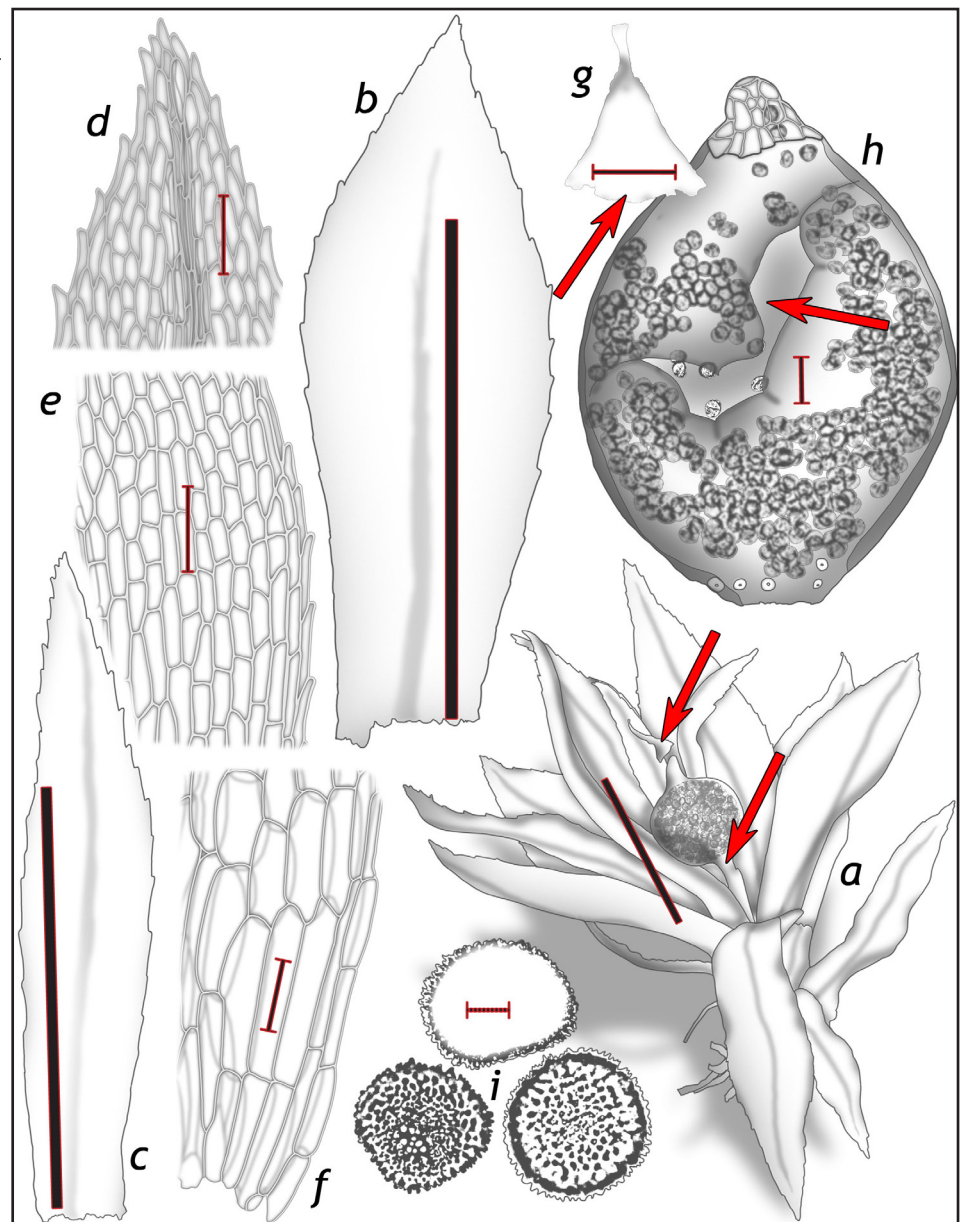


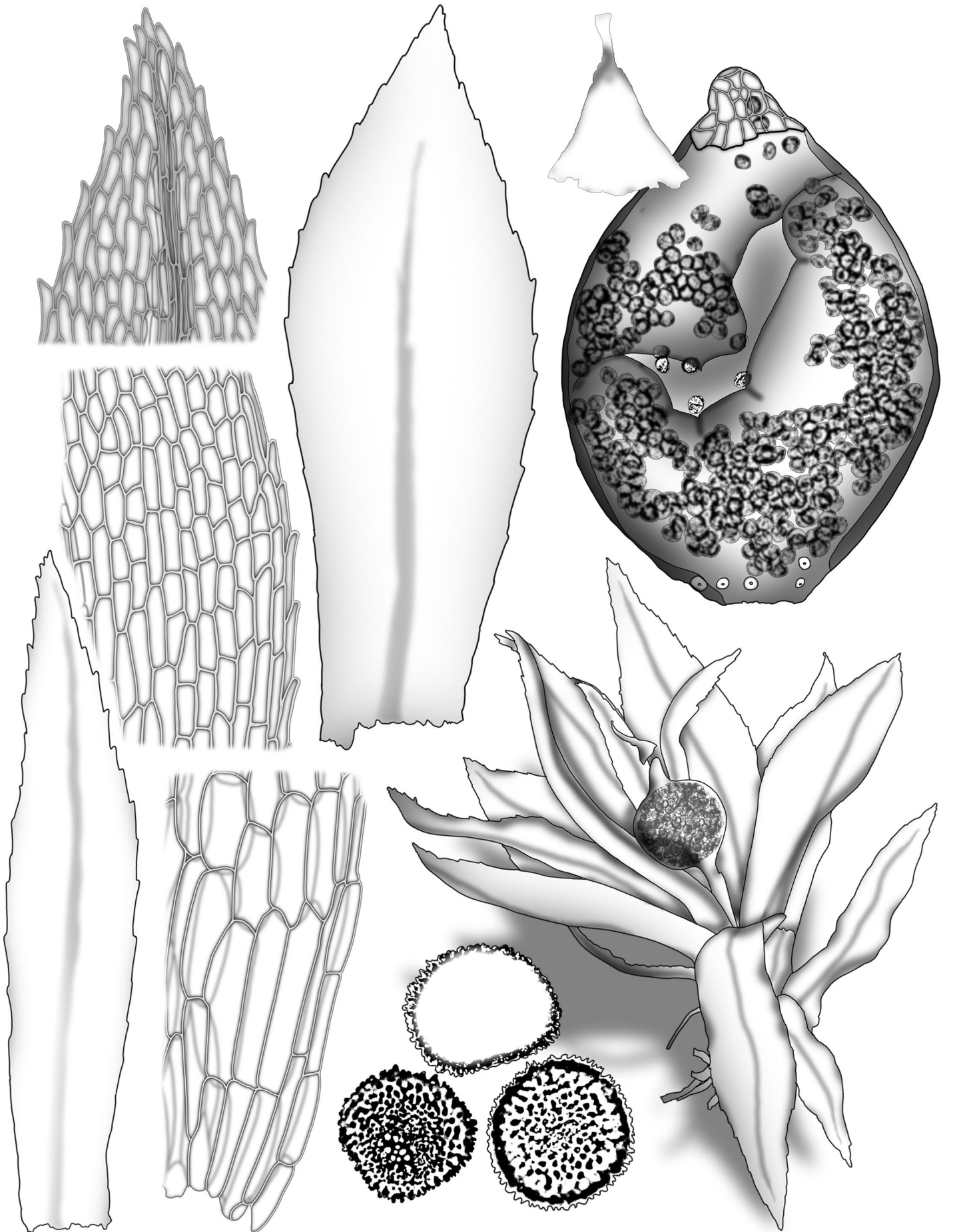




vouchers *Janssens 55984*; *Moyle s.n.*,  
 Sept. 30, 1937 (MIN 1151061); *Sheldon*  
*s.n.*, Oct. 1, 1894 (MIN 1151062):

- a* gametophore with sporophyte (wet): leaves only weakly concave; distal leaves narrowly lanceolate (see also *c*); immersed capsule on short seta but easily visible among leaves (see also photo above), variable in diameter, from 0.5 to 1 mm (see also *h*); calyptra minute (see also *g*)
- b-c* leaves: serrulate margins in upper 2/3; costa > 3/4 leaf length to percurrent, sometimes slightly forked above
- d* leaf – apex: percurrent but weak costa, serrulate marginal cells
- e* leaf – marginal cell region: serrulate marginal cells, narrowed, forming an indistinct border
- f* leaf – basal cell region: cell quite elongated compared with medial ones (see *e*)
- g* calyptra: minute size and entire base, unlobed (see also *a*)
- h* capsule: dehiscence through irregular tears of theca wall, operculum and peristome absent (cleistocarpous); thin theca cell walls except for apiculus; superficial stomates only at base consisting of a single guard cell with a circular opening
- i* spores (median optical section, proximal and distal surfaces): rounded to subreniform; densely papillose to spinulose exine



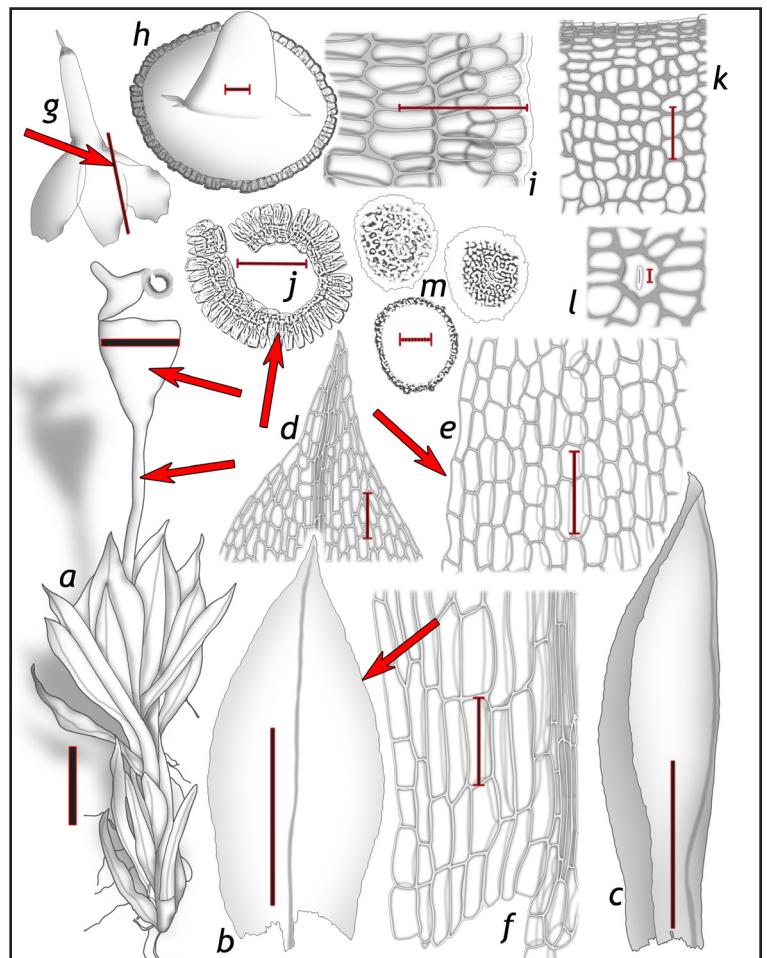


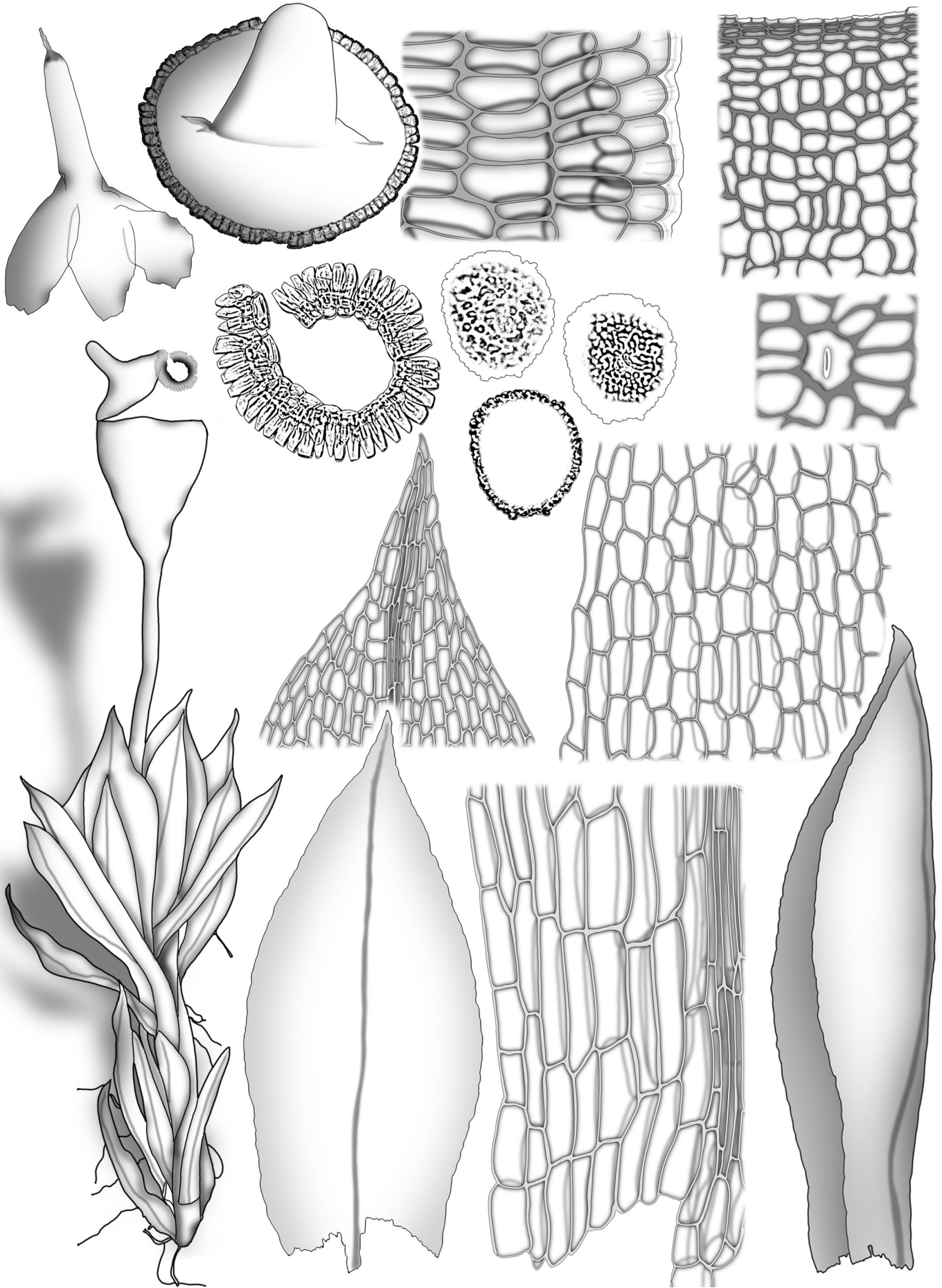
*Physcomitrella patens*



vouchers *Holzinger s.n.*, April-May 1890 (MO 2607578);  
1890 (MO 2607575):

- a* **gametophore with sporophyte:** capsule exserted, erect, with distinct neck, campanulate when mature (see also photo above), with revolvable annulus; larger leaves crowded above
- b-c* **leaves:** sometimes slightly cucullate (see *c*), margins mostly entire, costae subpercurrent
- d* **leaf – apex:** subpercurrent costa and smooth margins
- e* **leaf – medial and marginal cell region:** margin uneven from slightly bulging cells, but never clearly toothed
- f* **leaf – basal cell region:** elongate-rectangular and greatly enlarged cells
- g* **calyptra:** mitrate, deeply split in large lobes, smaller than mature capsule
- h-i* **operculum** (and magnified margin): distinct rostrum and a rim of large remaining cell walls that fit with those separated with annulus
- j* **annulus:** highly revolvable, with large persistent and inflated cells
- k* **theca** (near mouth of capsule): irregular isodiametric cells, become narrowly oblate in several rows toward mouth
- l* **stomate:** single circular guard cell (typical for *Funariaceae*), with slit-like opening
- m* **spore** (proximal and distal surfaces, median optical section): bluntly papillose exine



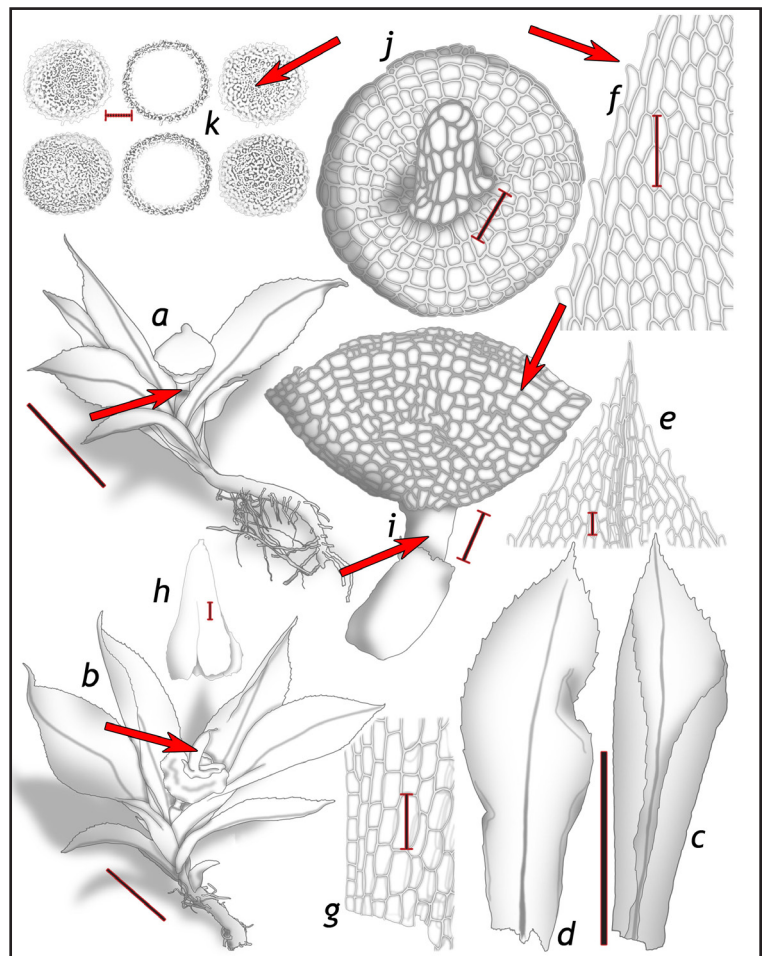


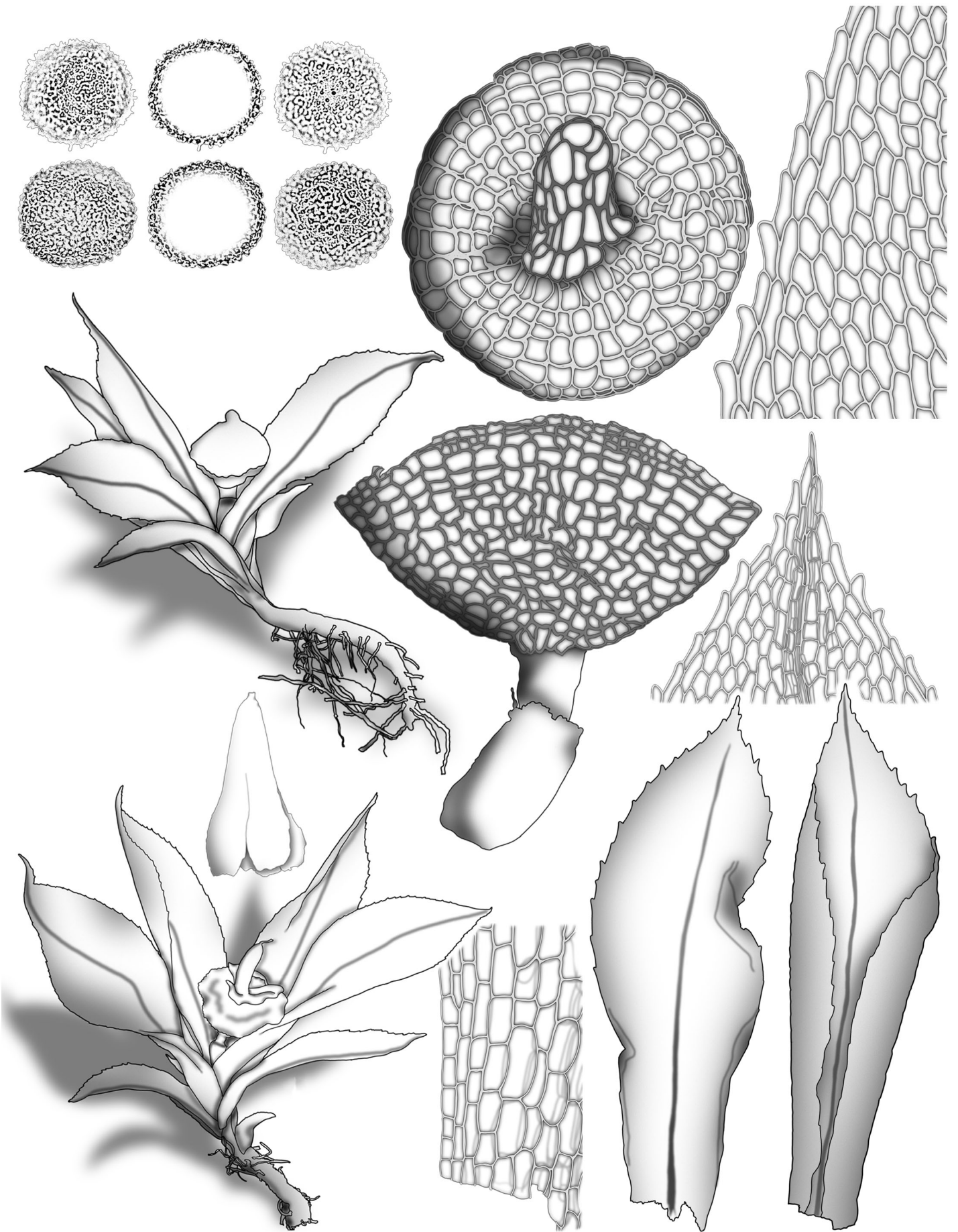
*Physcomitrium hookeri*



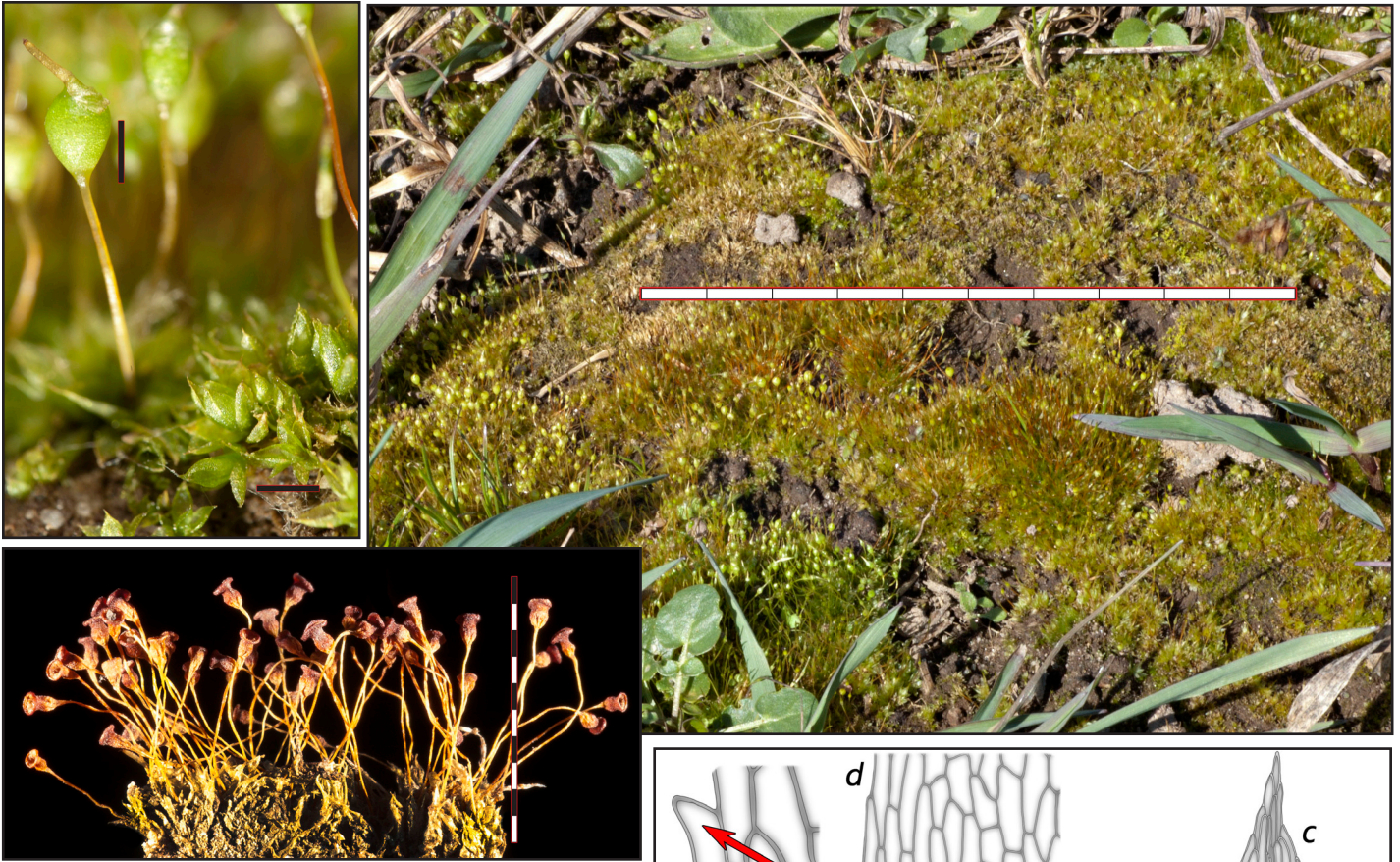
vouchers *Holzinger s.n.*, Oct. 19, 1889 (MIN 1151080);  
*Musci Acrocarpi Boreali-Americani* No. 242, (MIN  
 1151078):

- a-b* **gametophore with sporophyte**: larger distal leaves and immersed sporophyte with short seta (see also *i* and photo above); relatively small calyptra only covering rostrum and partially lid of operculum (*b*)
- c-d* **leaves**: distal serrate margins
- e* **leaf – apex**: toothed margin and near-percurrent costa
- f* **leaf – medial and marginal cell region**: marginal cells forming teeth, not particularly narrowed
- g* **leaf – basal cell region**: marginal cells short-rectangular
- h* **calyptra** (young): conic-mitrate shape, compare with mature calyptra in *b*
- i* **capsule, seta, and vaginula**: cupulate, originally globose (see also *a*), capsule shape with unevenly thickened (but not collenchymatous), irregular exothelial cells, and a few intermittent rows of small cells near opening; short stout seta; and obvious vaginula
- j* **operculum**: well-developed rostrum
- k* **spores** (proximal surface, optical section, and distal surface): upper row illustrating a spore with a somewhat more spiculose exine (overall most spores are papillose)



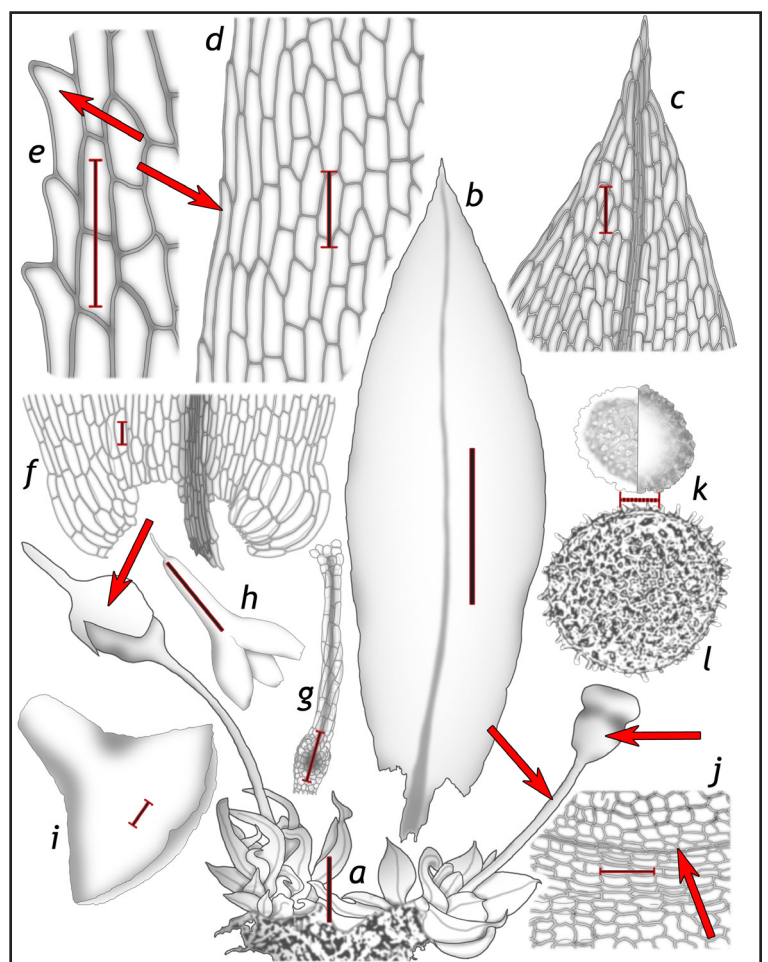


*Physcomitrium immersum*

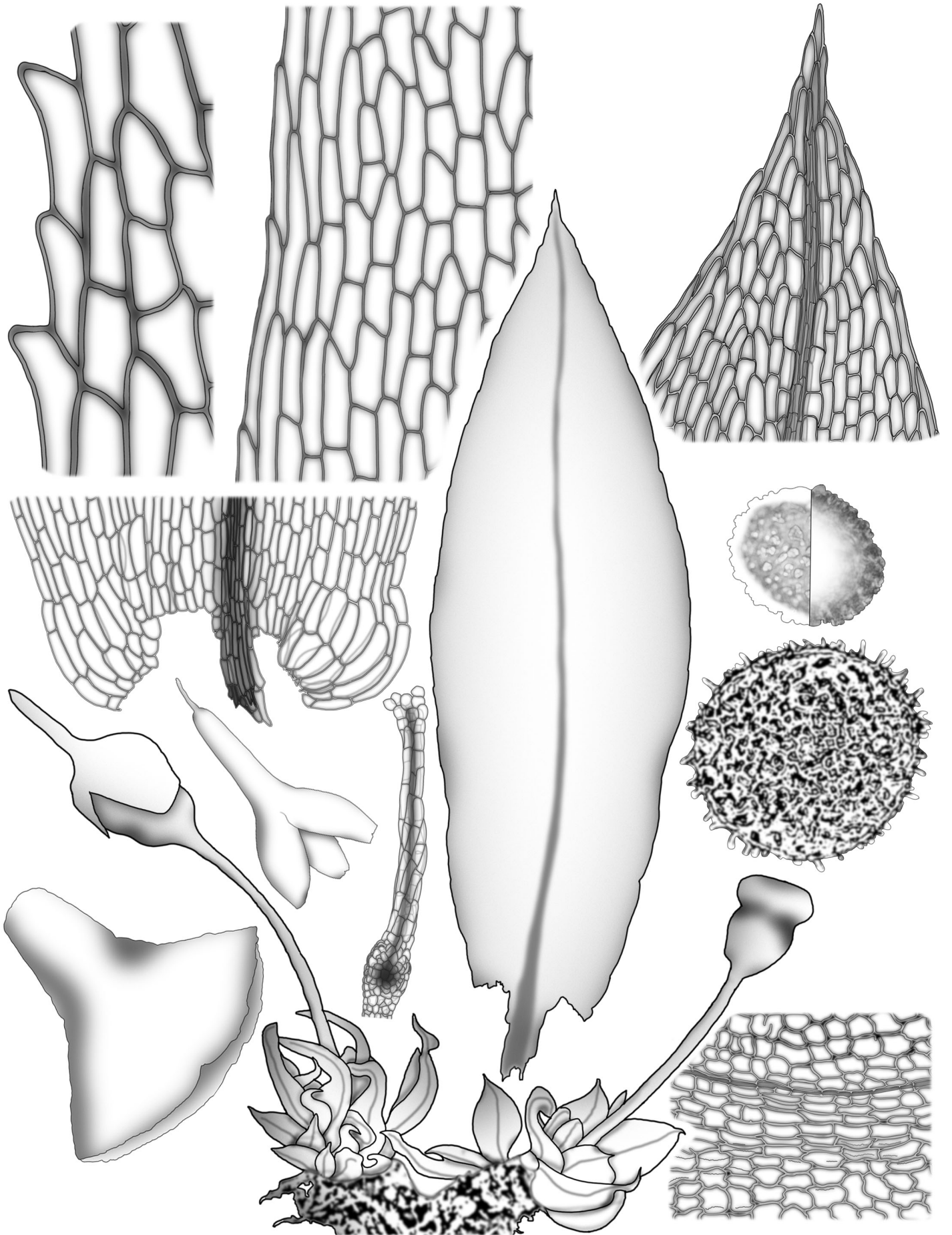


vouchers *Janssens-Verbelen 32; Janssens 38713B, 44274, 54885, 55967; Wheeler 31559*:

- a* **two gametophores with sporophyte**: upper leaves larger; seta length highly variable, usually fairly short as here (< 10 mm, but in some specimens up to 30 mm); capsules exserted, erect, top-shaped when young (left plant and left top photo), often urceolate when dry and old (right plant and left photo below); calyptra smaller than capsule
- b* **leaf**: plane margins
- c* **leaf – apex**: a percurrent, nearly excurrent costa
- d* **leaf – medial and marginal cell region**: nearly smooth margin of narrower, elongated cells, forming a pale, indistinct border; medial cells thin-walled and smooth
- e* **leaf – marginal cells** (modification ‘*var. serratum*’): some specimens with more obviously toothed margin
- f* **leaf – basal cell region**: somewhat enlarged and inflated alar cells (not on all leaves)
- g* **archegonium** (found naked at base of upper leaf)
- h* **calyptra**: large and mitrate, deeply split in three lobes and inflated at base
- i* **operculum**: short-rostrate
- j* **theca and operculum cell pattern**: irregular hexagonal, slightly collenchymatous cells, those near operculum/theca edge oblate in several rows; revolvable annulus absent
- k-l* **spores**: highly variable in size, either papillose or spinulose



***Physcomitrium pyriforme***

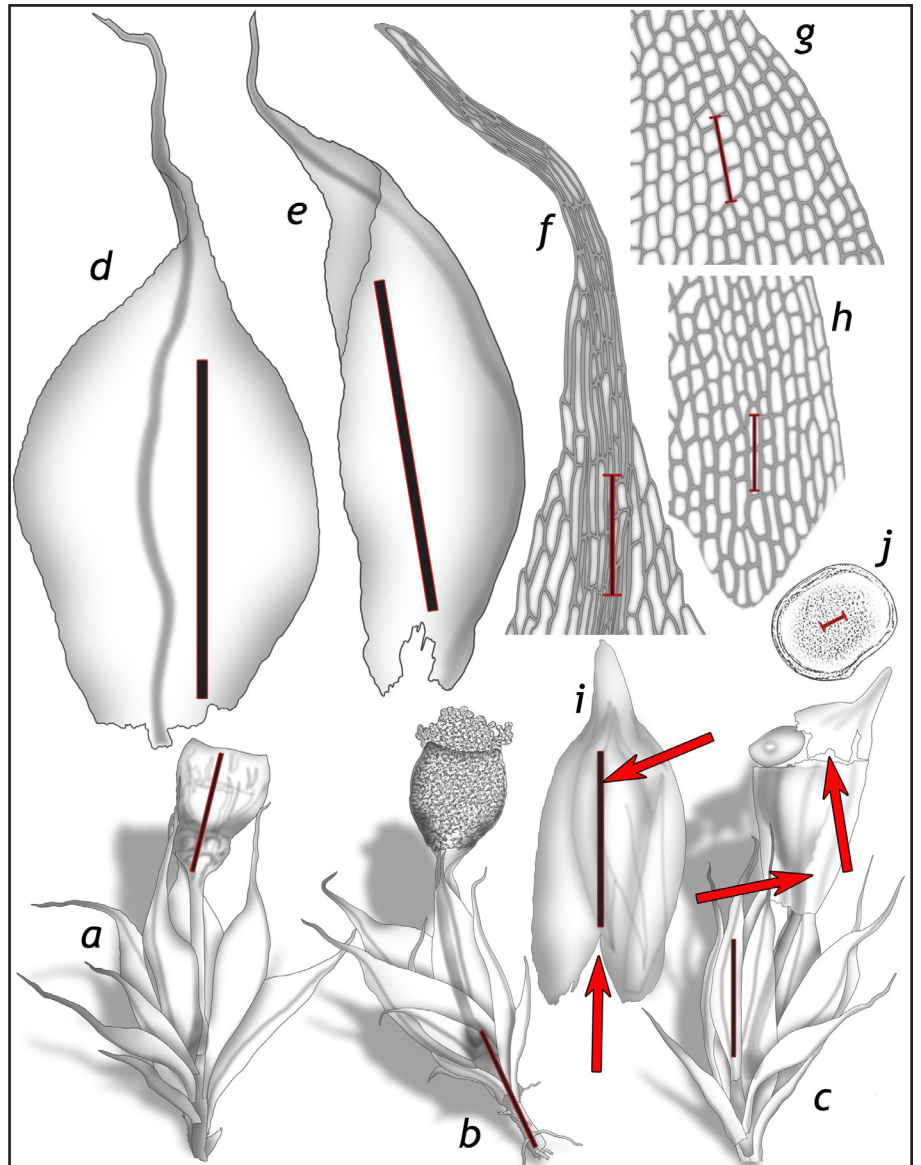


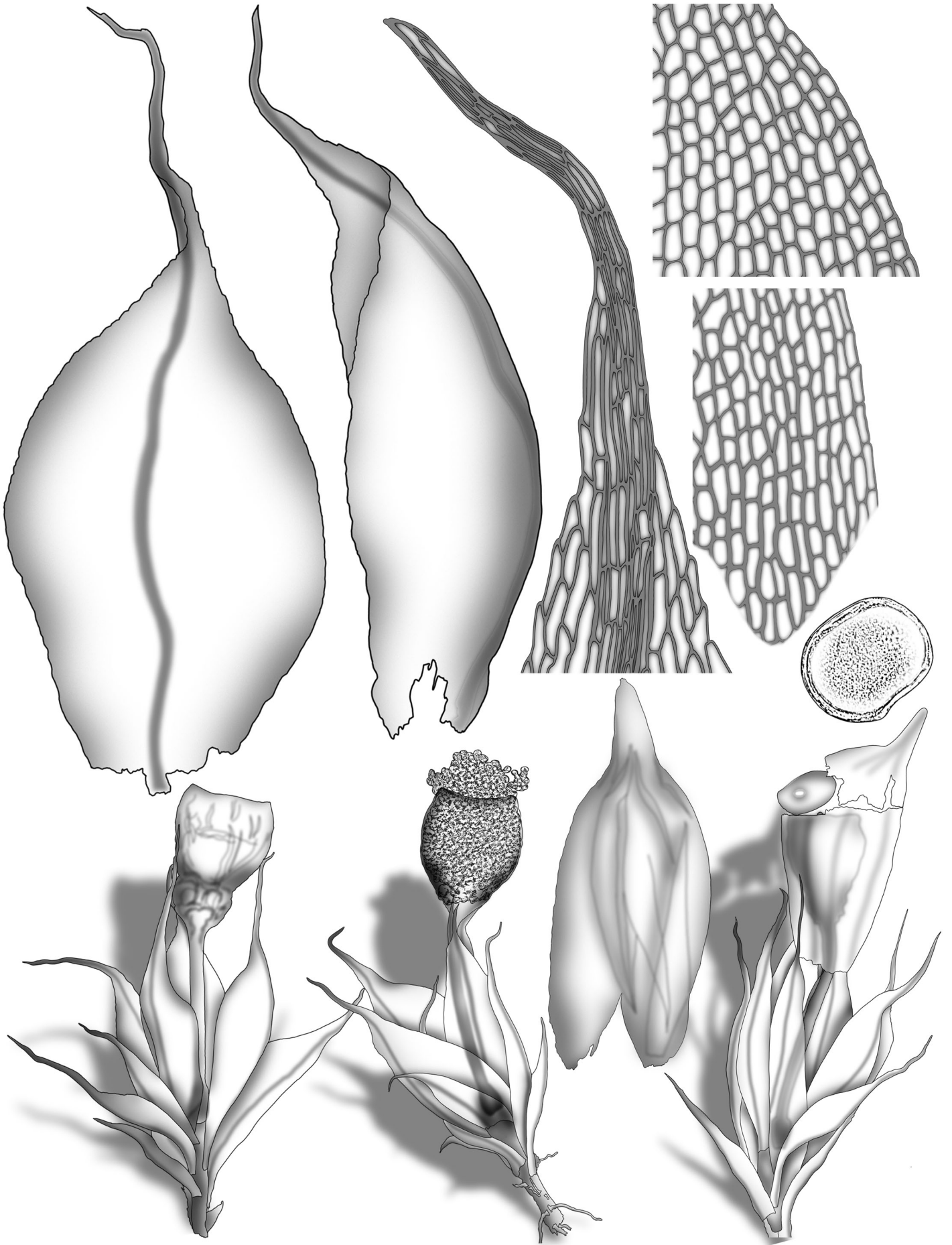
*Physcomitrium pyriforme*



vouchers *Holzinger s.n.*, June 15 to 21, 1901 (MIN 1160394); June 14, 1901 (MIN 1160392):

- a-c* **gametophores with sporophytes** (wet): short stems (< 1 mm), but setae often longer; upper leaves larger, giving bud-like aspect to plants; capsules nearly exerted, stegocarpous, with distinct wrinkled inflated neck when mature and dry (*a*); no annulus or peristome; operculum (*c*) small, not rostrate; calyptra (see also *i*) beaked and large, enclosing entire capsule and clasping seta (*c*), angled, persistent, spores released through slits
- d-e* **leaves**: subentire margins (see also *g* and *h*) and long-acuminate apices (see also *f*); costae percurrent
- f* **leaf – apex**: excurrent costa, filling most of acumen
- g* **leaf – upper and marginal cell region**: smooth margin and smooth, relatively small (for Funariaceae) cell size
- h* **leaf – basal cell region**: smooth margin
- i* **calyptra**: large size, covering entire capsule; regularly opening through longitudinal slits
- j* **spore** (median optical section and superimposed surface): angular (or round), nearly smooth, only finely verruculose under high magnification



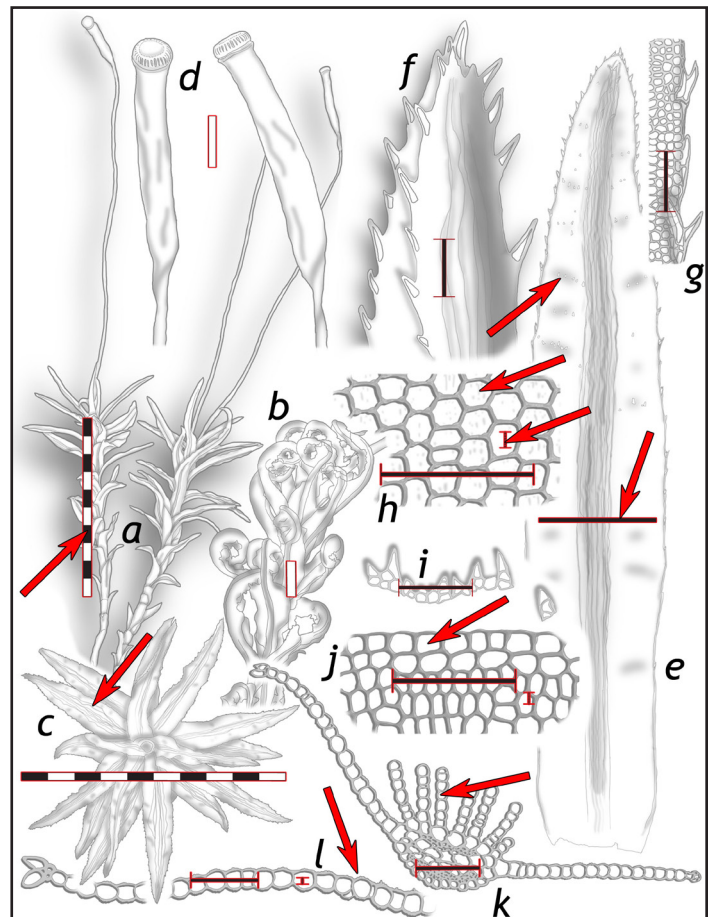


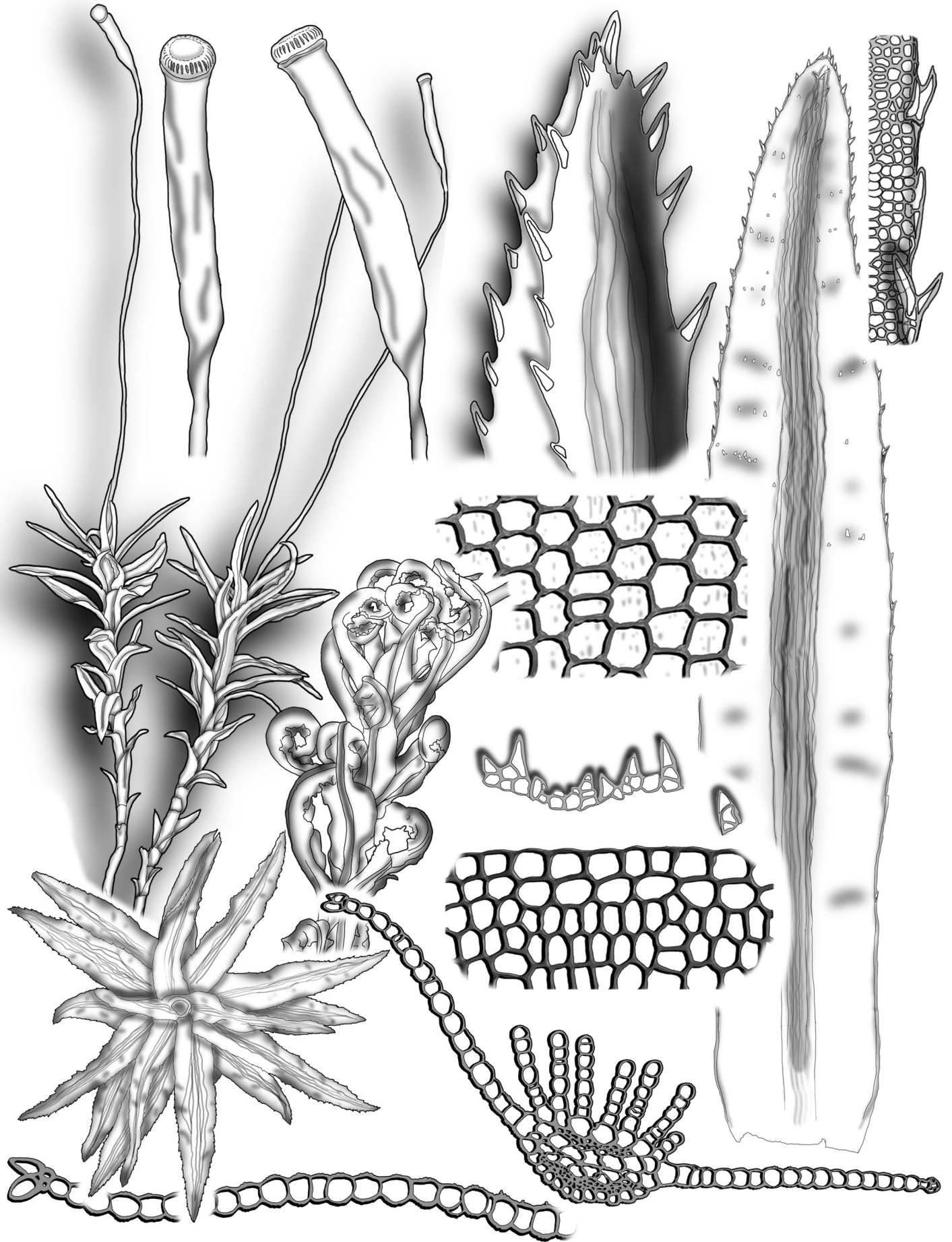
*Pyramidula tetragona*



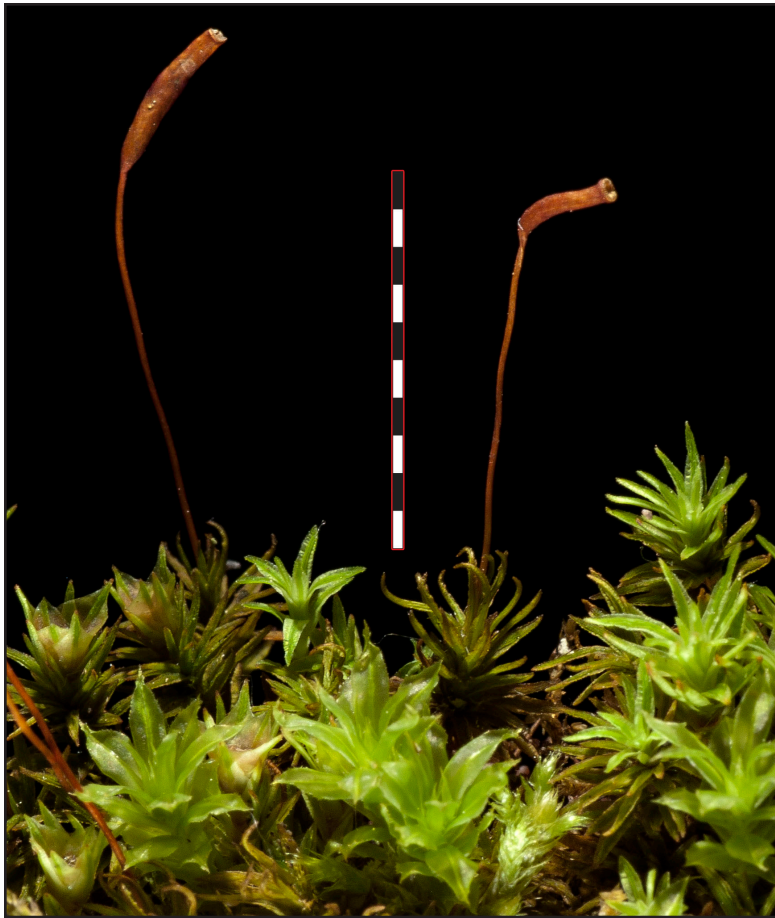
vouchers *Janssens 39179, 39634, 39236, 54255, 55930*:

- a* gametophore with sporophytes: small stature of plants
- b* gametophore (dry): with strongly crisped leaves
- c* gametophore (wet, seen from above): lamellae obvious, fewer than 10
- d* capsules (mature dry): wrinkled (when wet they are smooth)
- e* leaf: narrow lanceolate shape, width > 1 mm, with sharply toothed and well defined border, undulate with oblique rows of abaxial teeth
- f* leaf – apex: large teeth on abaxial side of costa
- g* leaf – marginal teeth: some double
- h* leaf – lamina: hexagonal, firm-walled, collenchymatous cells, approximated 20 μm in diameter, with faint striate papillae oriented in leaf-longitudinal direction
- i* leaf – teeth on abaxial surface: in row or separate
- j* leaf – adaxial lamellae (side view of adaxial leaf lamella): undifferentiated marginal top cells
- k* leaf tr.s. : tall lamellae, fewer than 10, up to 7 cells high
- l* leaf – lamina, tr. s.: moderately convex abaxial and adaxial surface of cells, papillae scarce



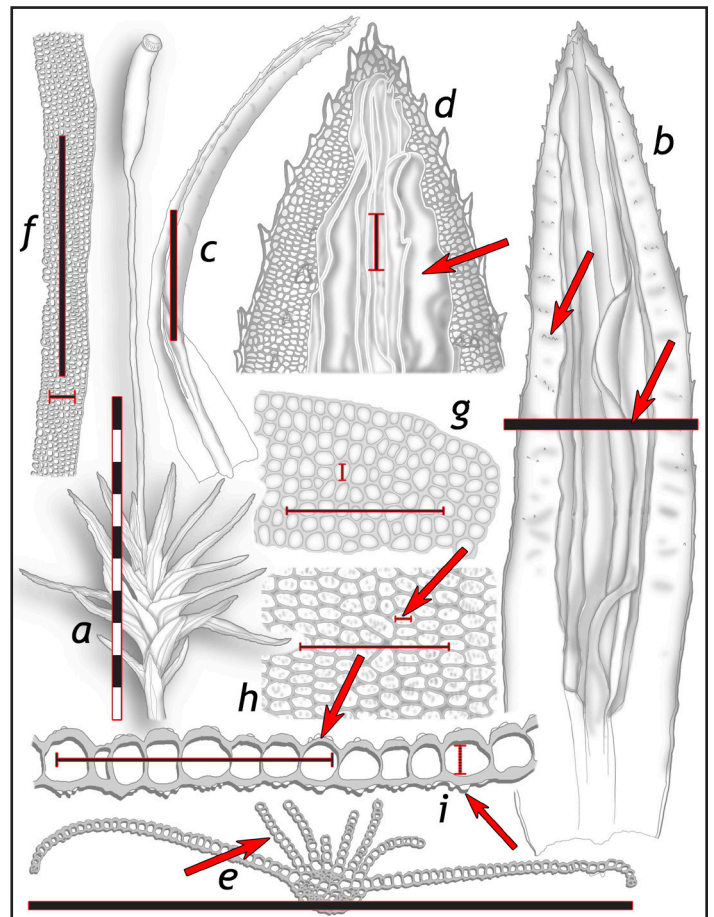


*Atrichum altecristatum*

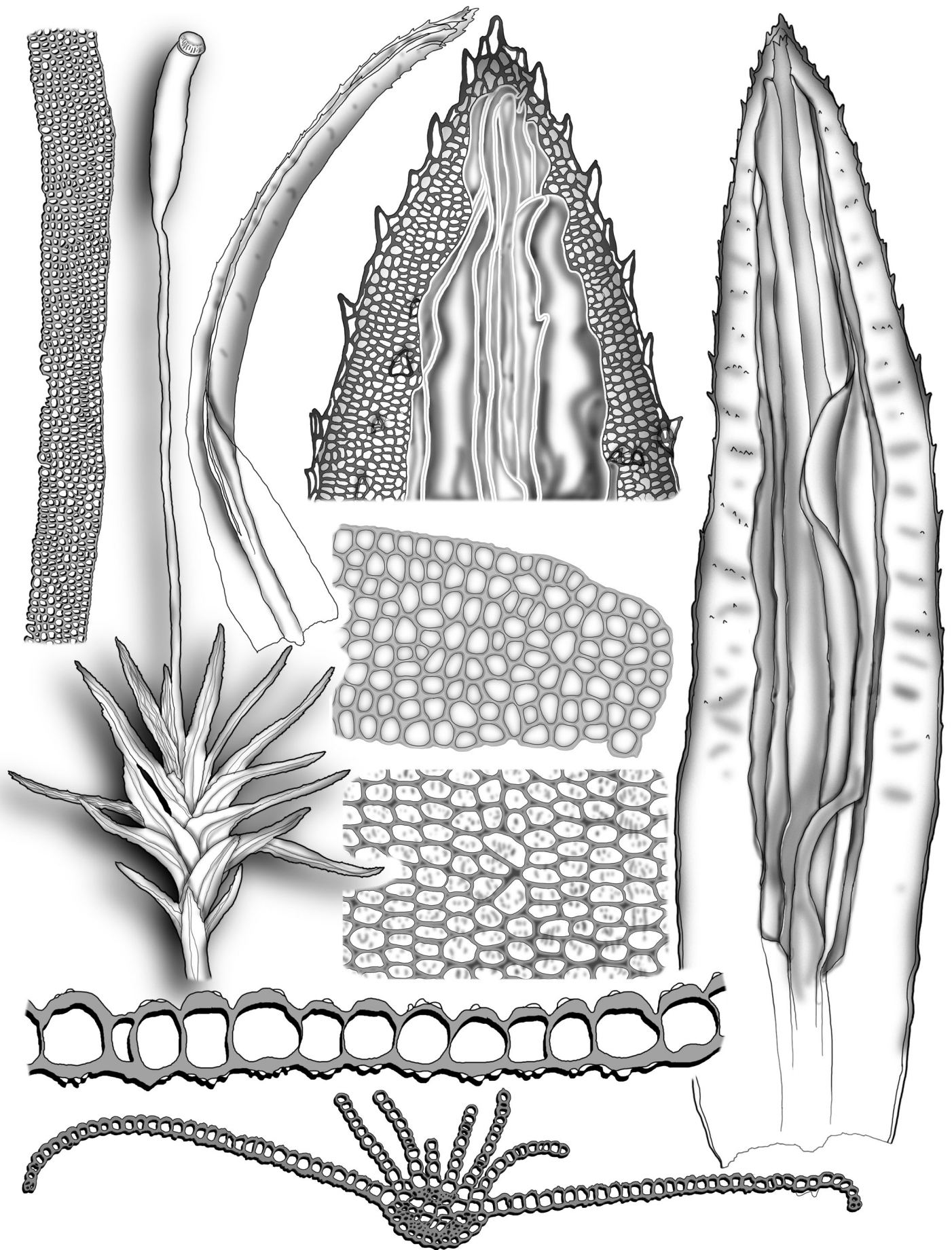


vouchers *Janssens 30672, 45031, 54889, 55969; Wheeler 17831; Holzinger s.n., June 2, 1942 (MIN 1099593)*:

- a* **gametophore with sporophyte**: small stature of plant (male plants: see both photos above, left-hand side)
- b* **leaf (large)**: tall lamellae (small rows of laminal teeth on abaxial surface), usually < 1 mm wide, undulate
- c* **leaf (typical)**: narrow
- d* **leaf – apex**: widely spreading, wavy adaxial lamellae; abaxial laminal teeth visible through transparent lamina
- e* **leaf tr.s.** (across lower half of leaf): lamellae about 10 cells high
- f* **leaf – lamella** (stripped off)
- g* **leaf – lamella** (distal rounded end to right)
- h* **leaf – lamina medial cells**: small cell diameter, widest transverse cells < 20 μm
- i* **leaf – lamina, tr.s.**: bulging-mammillose adaxial surface with papillae on both sides



*Atrichum angustatum*



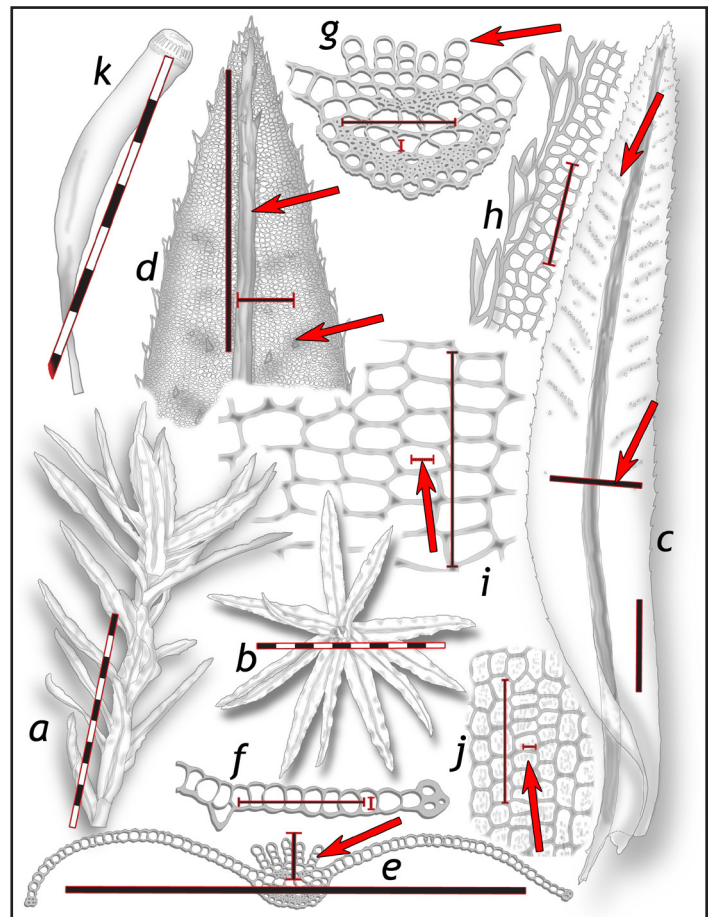
*Atrichum angustatum*



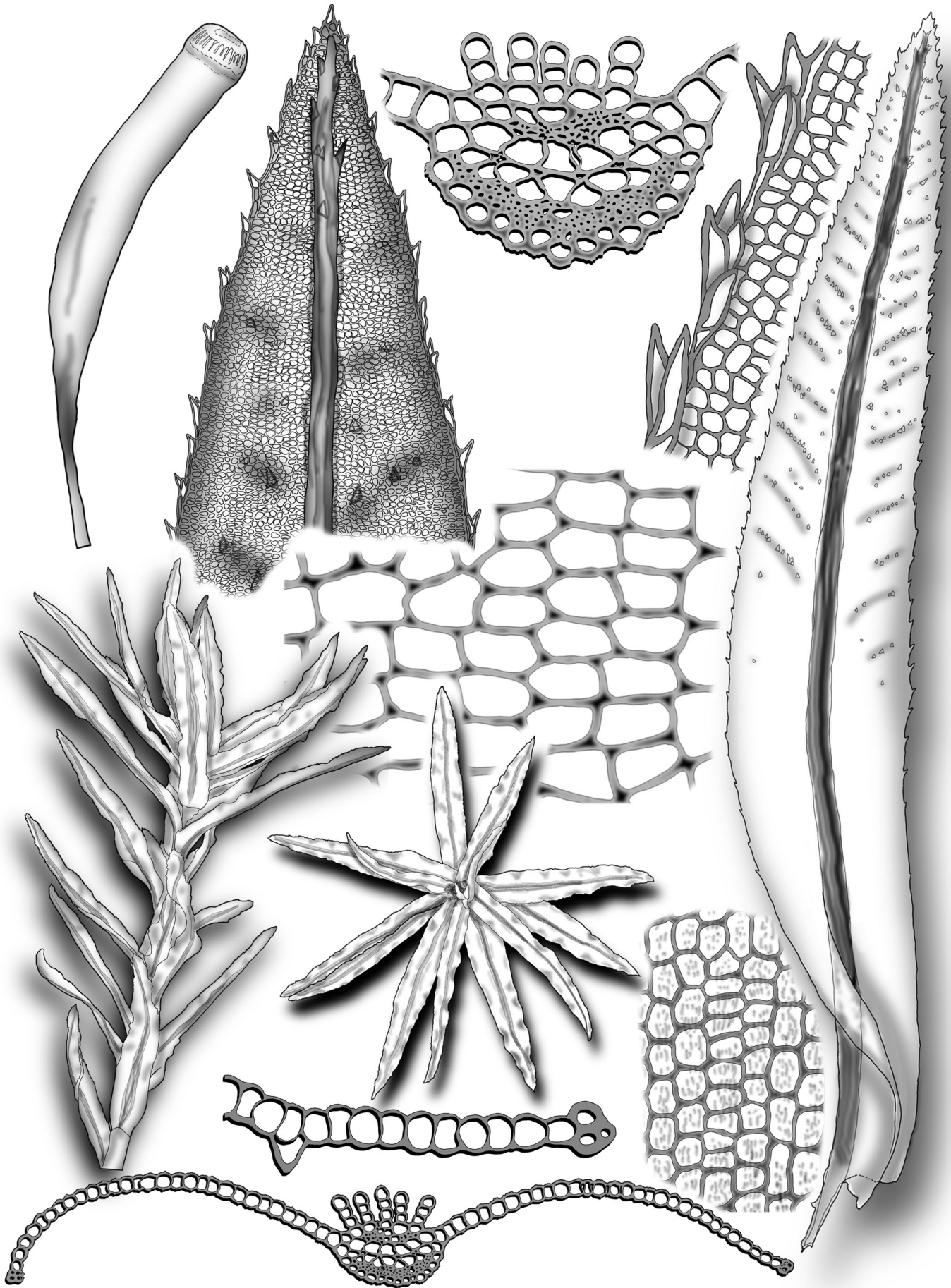
dried plants typically highly crisped and shriveled

vouchers *Janssens 30694, 38104, 38129, 38317, 41298, 52550*:

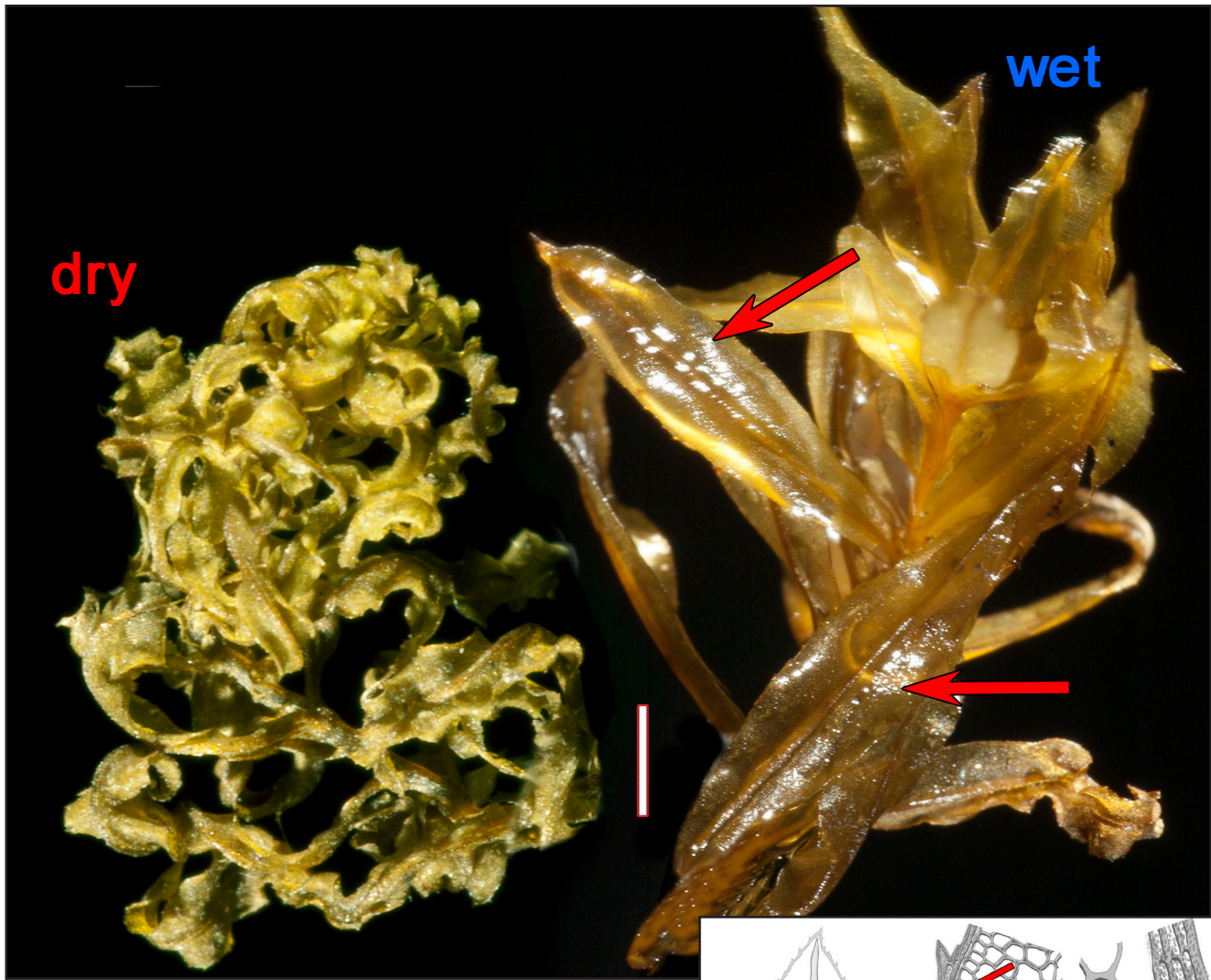
- a* gametophore (profile view)
- b* gametophore (top view)
- c* leaf: undulate with abaxial teeth; width > 1 mm
- d* leaf – apex (transparent): sharp abaxial costal and laminal teeth; low adaxial lamellae
- e* leaf tr.s. (across widest part of leaf): low lamellae, maximal 4 cells high
- f* leaf – lamina tr.s.: cells about 20  $\mu\text{m}$  in diameter
- g* leaf – lower costa tr.s.: lamellae 2 cells high
- h* leaf – border teeth: large sharp multiple teeth
- i* medial leaf cells: firm walls and trigones, longest diameter about 20  $\mu\text{m}$
- j* basal leaf – cells: finely striate papillae
- k* capsule (mature with exposed peristome)



*Atrichum crispulum*

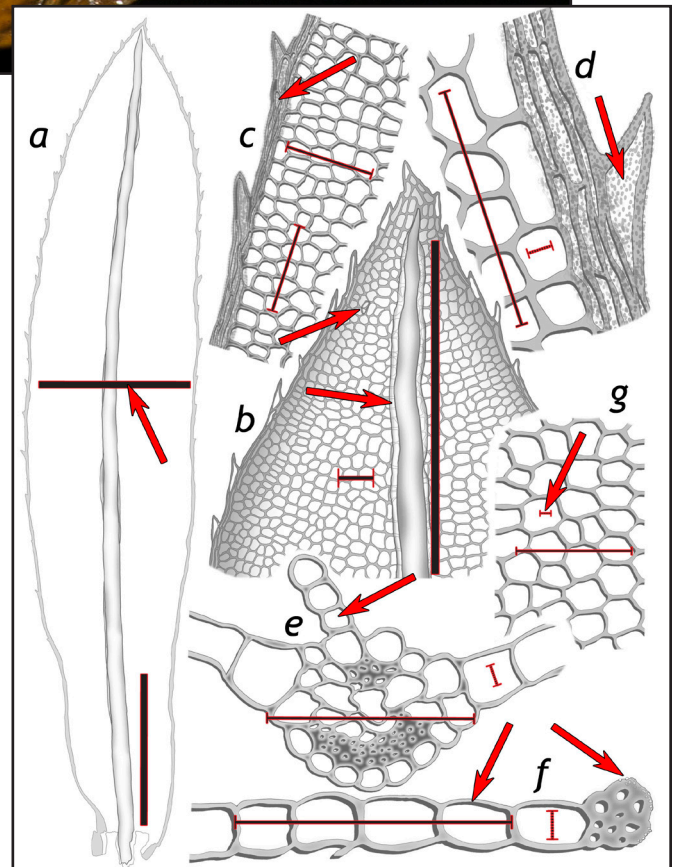


*Atrichum crispulum*

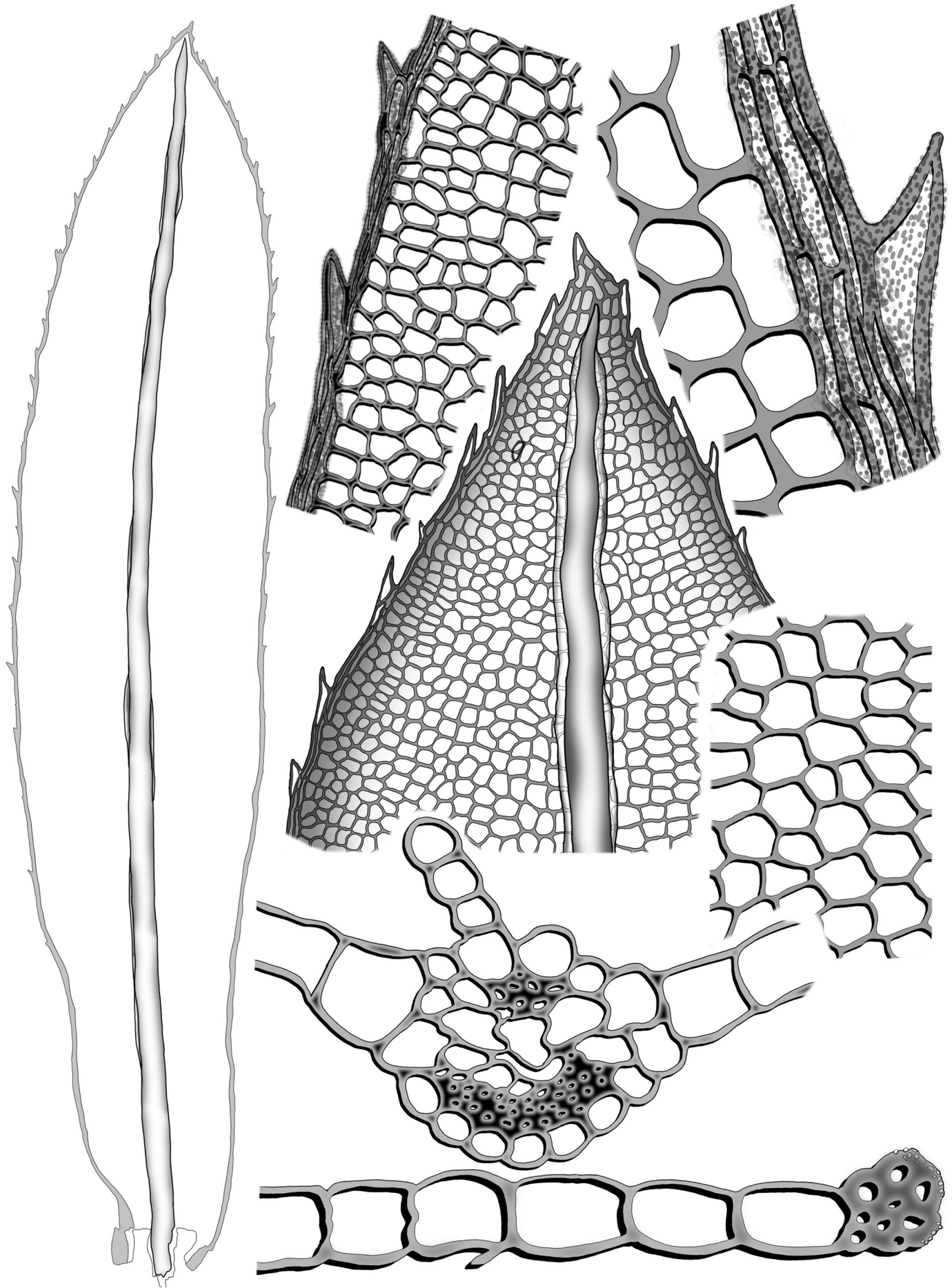


vouchers *Janssens 45844*:

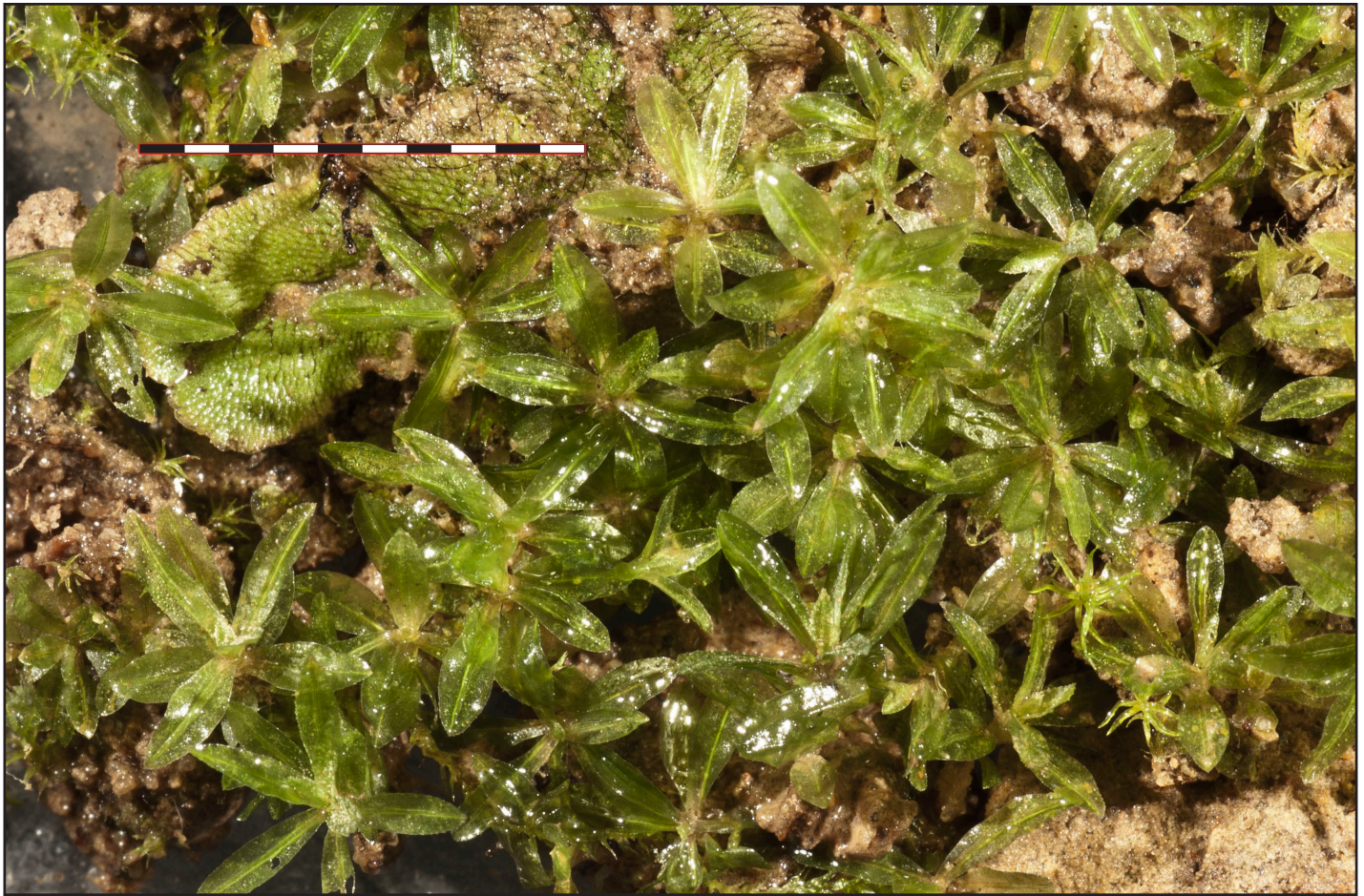
- a* leaf: undulations absent; usually > 1 mm
- b* leaf – apex: single rare abaxial tooth; lamellae few
- c* leaf – border: minute striate papillae on both teeth and border cells
- d* leaf – border tooth: verrucose or striate papillose
- e* leaf – costa tr.s.: lamellae are few, often interrupted, here only a single one remaining
- f* leaf – lamina and border tr.s.: papillae on heavy-walled border cells, laminal cells smooth
- g* leaf – medial cell region near costa: large cell size, many > 30  $\mu\text{m}$



*Atrichum crispum*



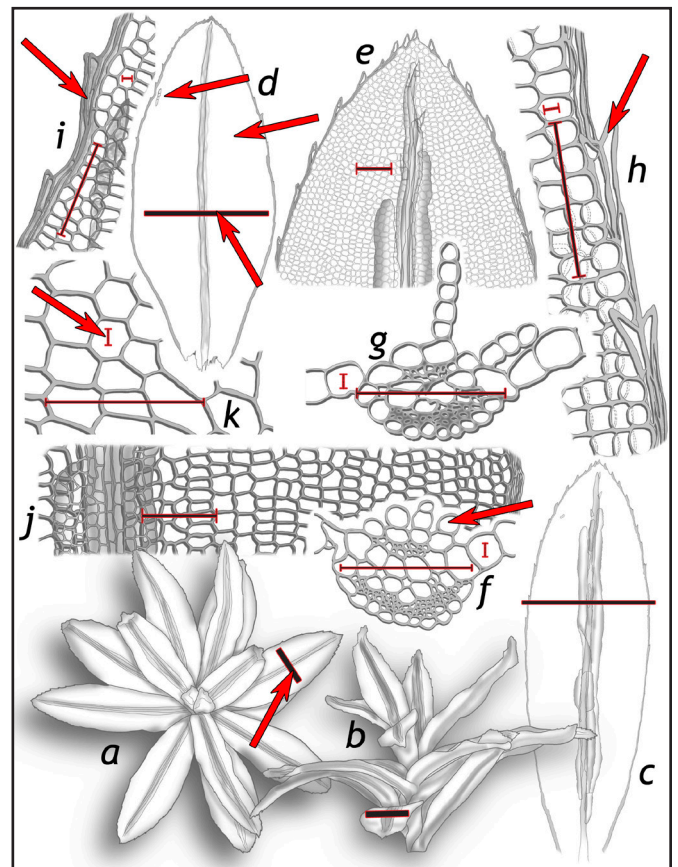
*Atrichum crispum*



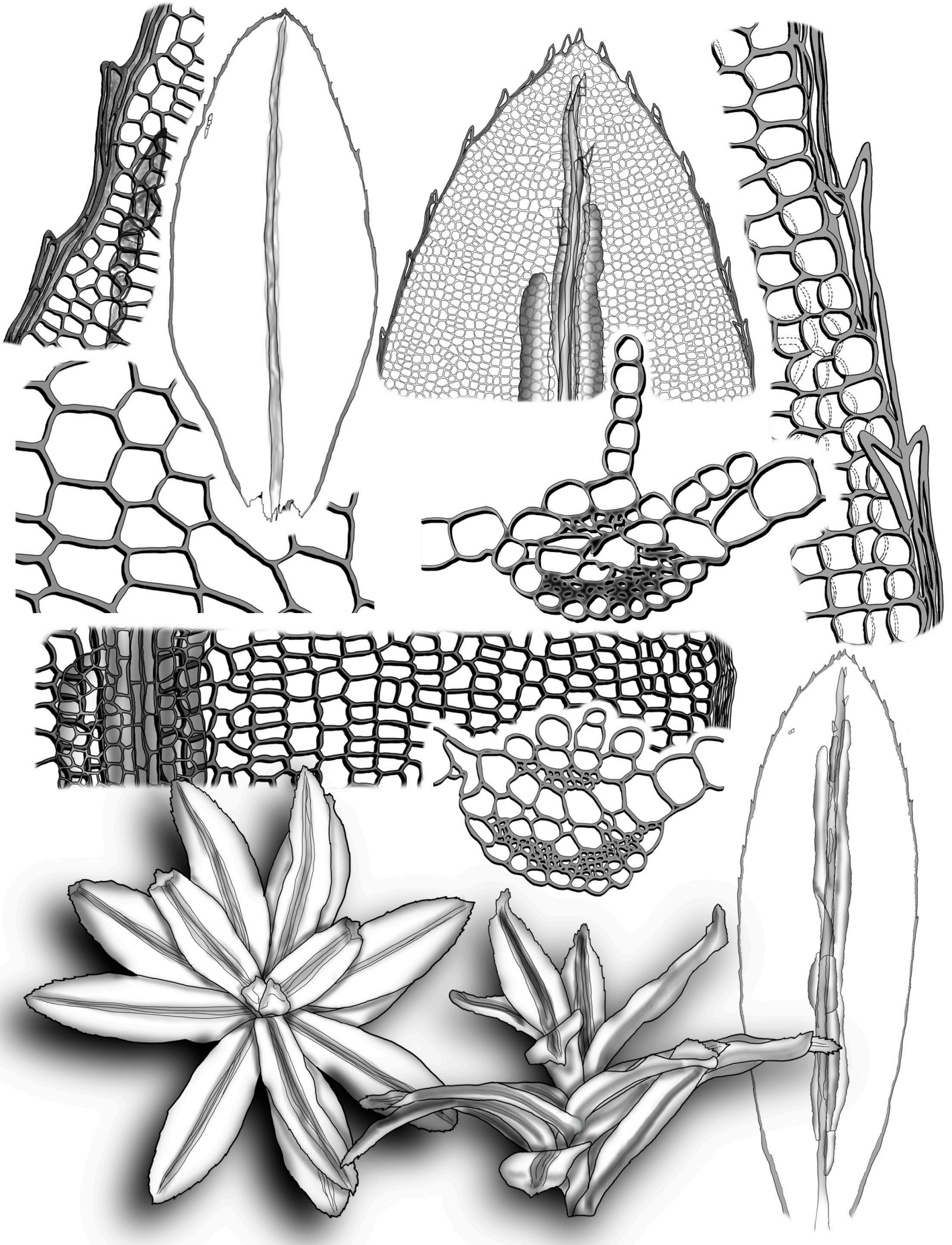
small, delicate and transparent plants, leaves without undulations

vouchers *Bowers 22644; Janssens 55647*:

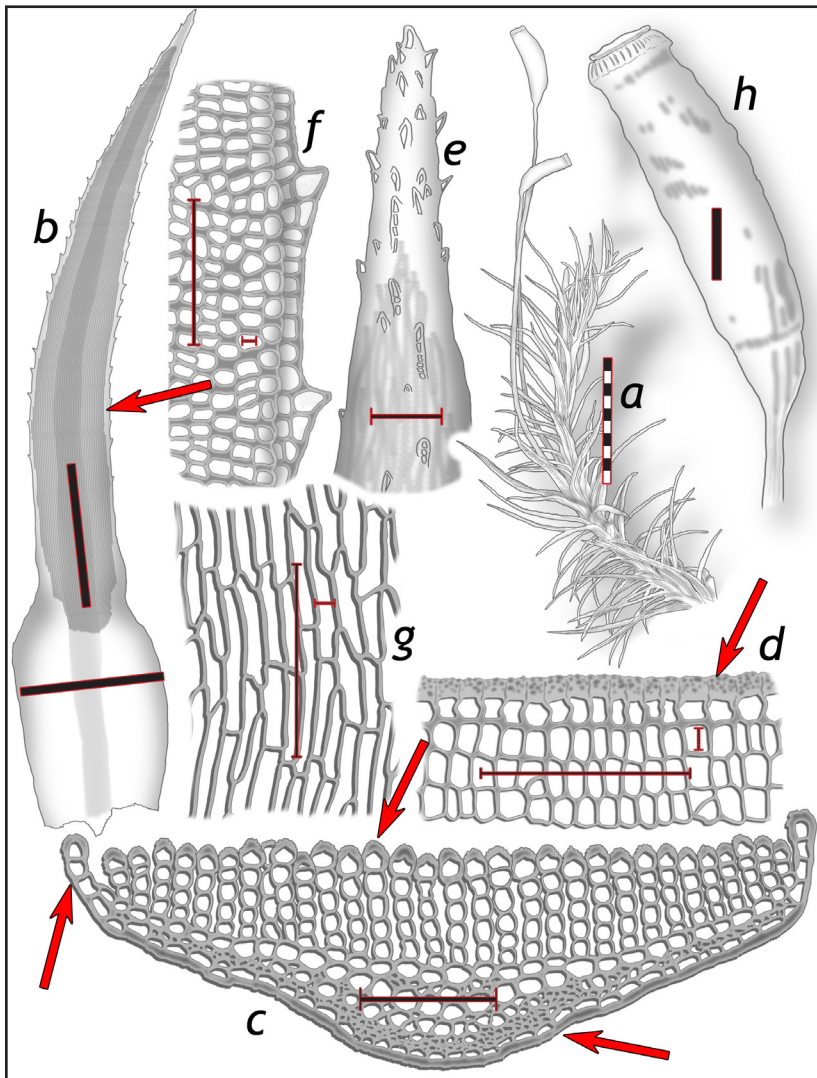
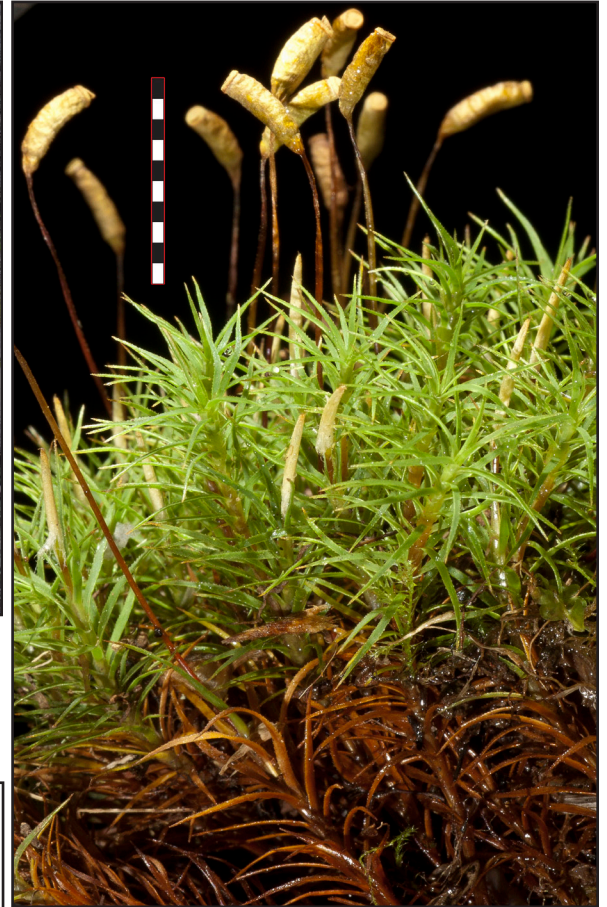
- a* gametophore (top view): leaves > 1 mm wide
- b* gametophore (profile view): small delicate plant
- c* leaf: undulations absent; lamellae discontinuous
- d* leaf: usually > 1 mm; undulations absent; low lamellae; scattered laminal teeth
- e* leaf – apex: abaxial costal spines; interrupted, partly detached lamella
- f* leaf – costa tr.s.: few low lamellae
- g* leaf – costa tr.s.: few taller lamellae, irregularly placed
- h* leaf – marginal cell region and border: teeth and border cells smooth
- i* leaf – marginal cell region and laminal tooth: smooth
- j* leaf – medial cell region from margin to costa: cells becoming larger toward costa
- k* leaf – medial cell region near costa: large size, most > 20 μm, smooth



*Atrichum tenellum*



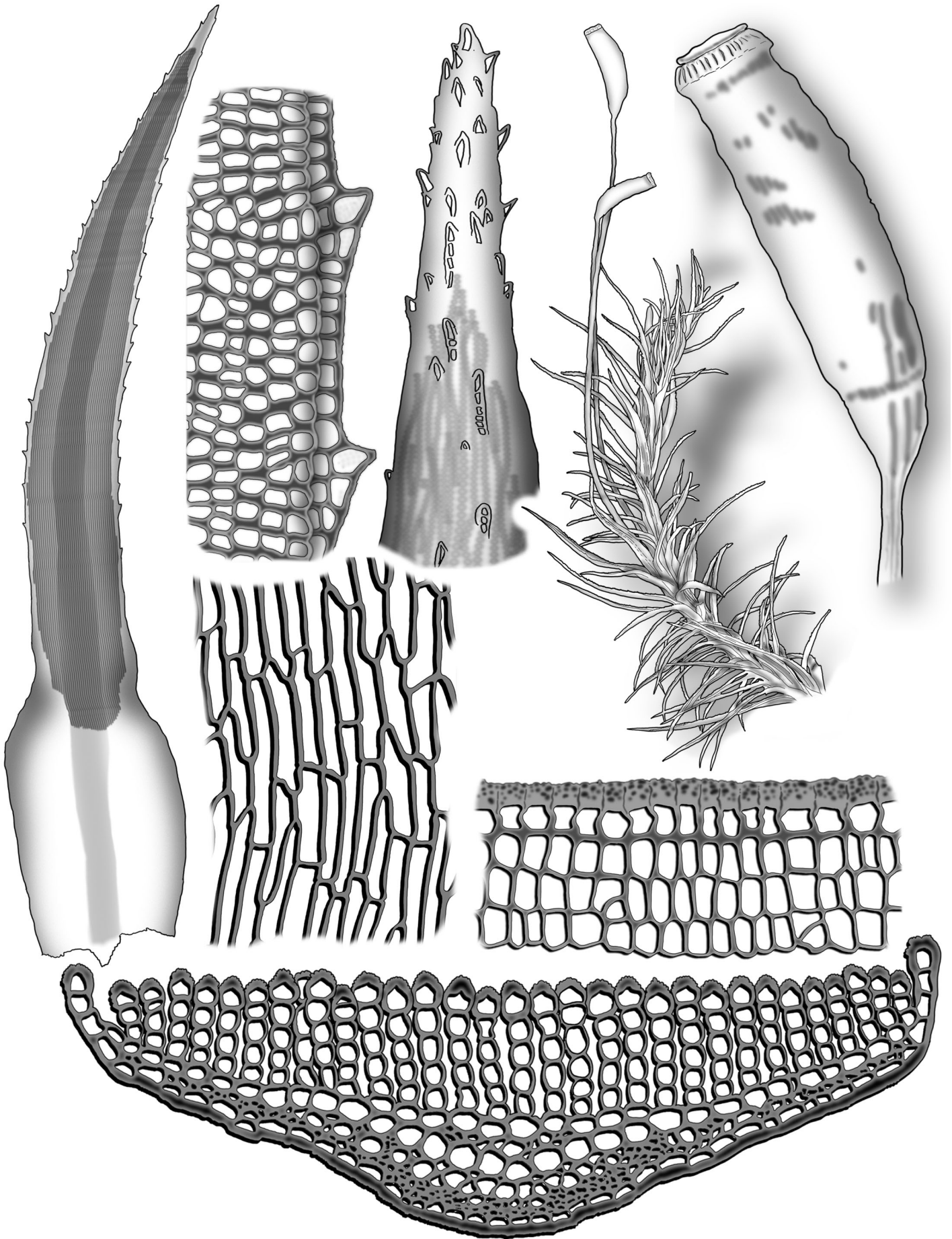
*Atrichum tenellum*



vouchers *Janssens 28811, 28852, 29248, 29271, 54387*:

- a* **gametophore with sporophytes**: relatively short setae (contrast with other *Polytrichastrum* and *Polytrichum* species)
- b* **leaf**: contracted shoulder region of basal sheath at transition to limb, with marginal teeth variably placed along narrow lamina (contrast with *P. longisetum*, see also *c*)
- c* **leaf tr.s.**: pentagonal lumen of top cells of lamellae and papillae covering upper, thickened surface; lamina narrow (contrast with *P. longisetum*); costa forming discreet ridge on abaxial surface (contrast with *Polytrichum* species)
- d* **leaf – lamella** (profile view): greatly thickened and papillose top cells (contrast with other *Polytrichastrum* species, see p. 52, and with *Polytrichum commune*)
- e* **leaf – apex** (abaxial surface): toothed awn
- f* **leaf – marginal teeth** (abaxial view): thick walled laminal cells and multicellular marginal teeth
- g* **leaf – basal sheath cells**: narrowly elongate rectangular cells
- h* **capsule**: overall narrowly cylindrical shape (not angular); tapering, poorly defined hypophysis

*Polytrichastrum alpinum*

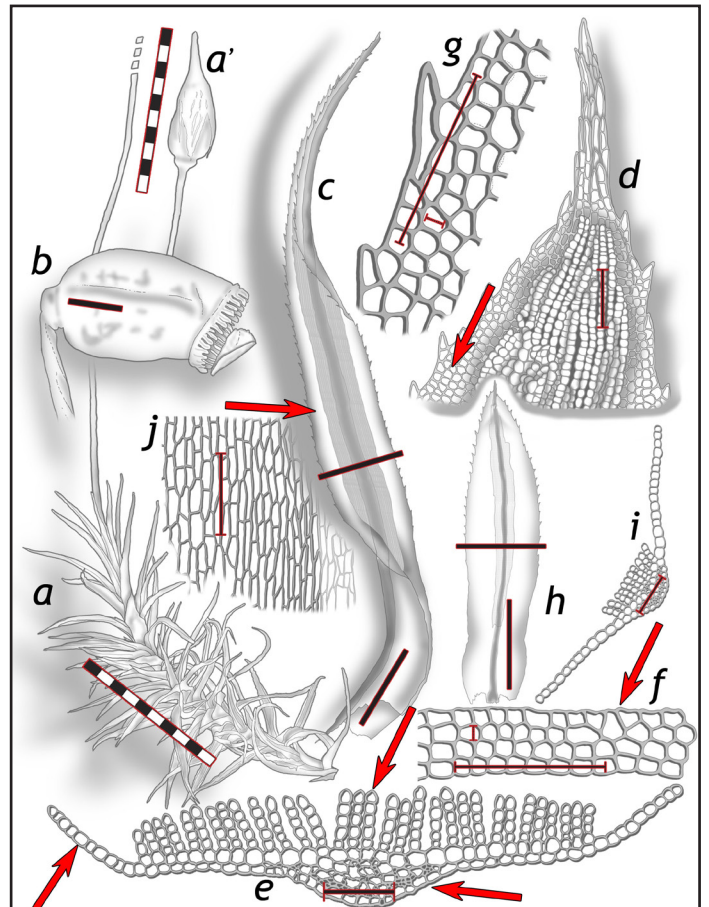


*Polytrichastrum alpinum*

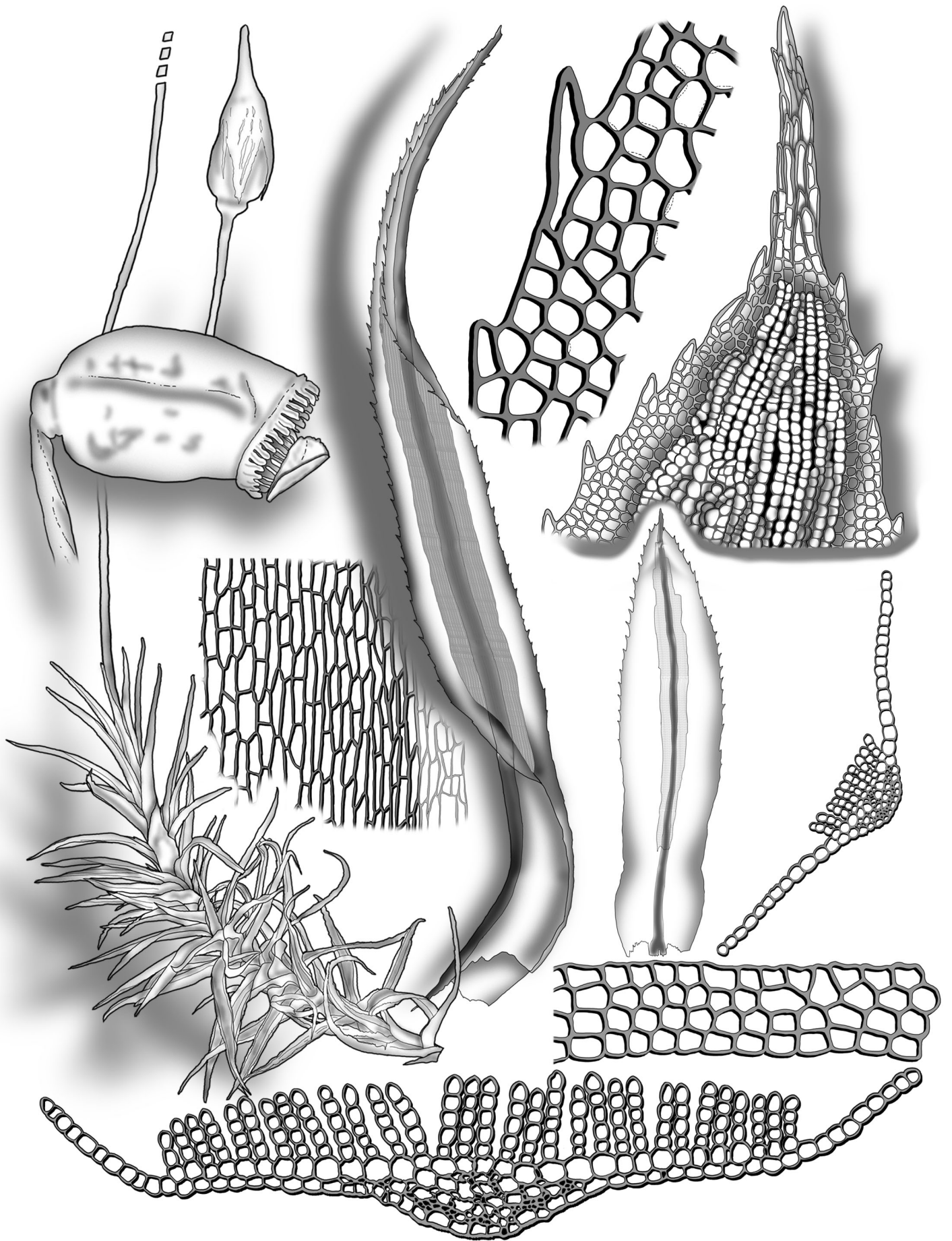


vouchers *Buck 307; Frelich-Reich 145A4; Janssens 21643, 27919, 28785, 41901, 54553, 54696:*

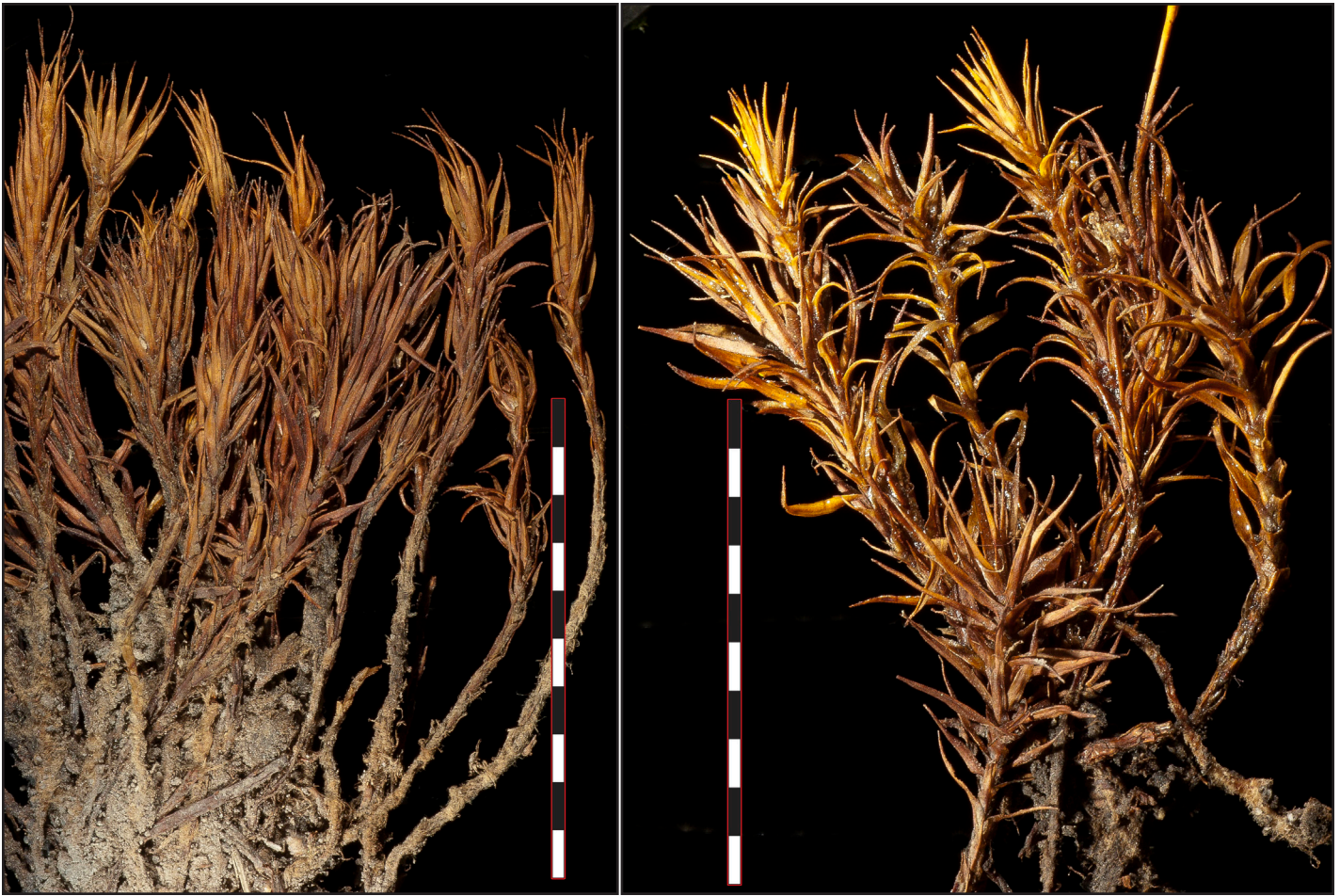
- a* & *a'* **gametophore with sporophyte:** extremely long seta (here interrupted to fit)
- b* **capsule:** angular, box-like shape and constricted hypophysis
- c* **leaf:** incurved margins (more strongly so when dry; transparent costal outline and wide lamina (frequently extreme as in *h* & *i*))
- d* **leaf – apex and awn:** widely exposed lamina (contrast with all other *Polytrichastrum* and *Polytrichum* species)
- e* **leaf tr.s.:** restricted costa (contrast with *Polytrichum* species); wide, somewhat incurved laminae; top cells of lamellae are only slightly enlarged with smooth non-thickened walls (contrast with other *Polytrichastrum* species, see p. 52)
- f* **leaf – lamella (profile):** smooth to slightly crenulate outline
- g* **leaf – lamina and marginal teeth:** several rows of laminal cells exposed (highly variable but often > 5); single-celled marginal teeth, also variably developed
- h* & *i* **leaf and leaf tr.s. (common *Atrichum*-like modification):** restricted number of low lamellae (nearly as in *Atrichum*), but with border absent and a proximal restricted leaf sheath
- j* **leaf – sheath medial and marginal cells:** elongate rectangular shape and hyaline and thin-walled marginal cells



*Polytrichastrum longisetum*

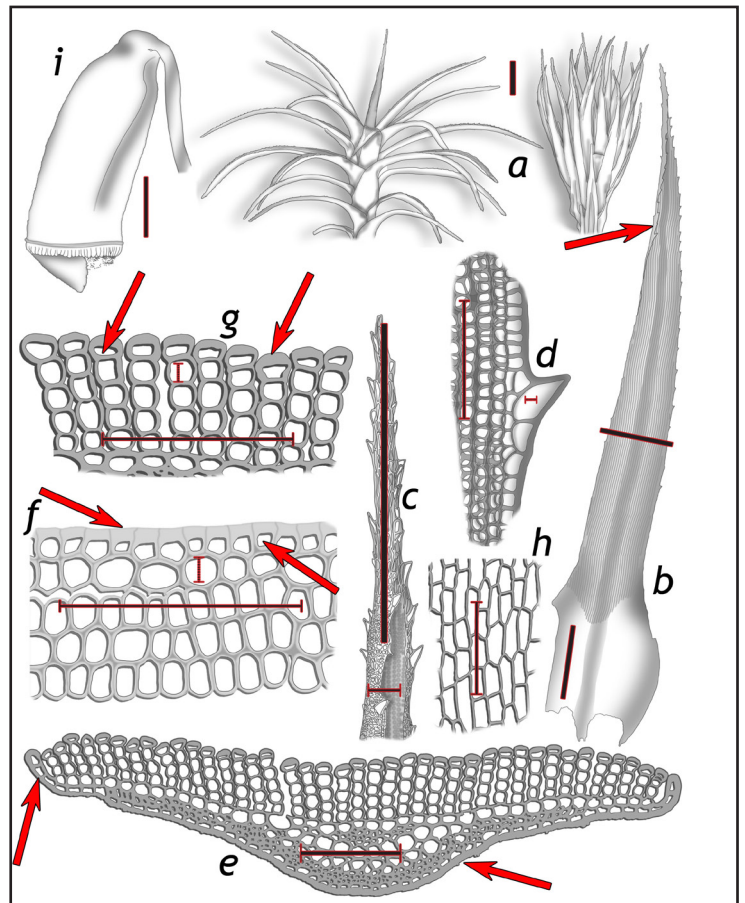


*Polytrichastrum longisetum*

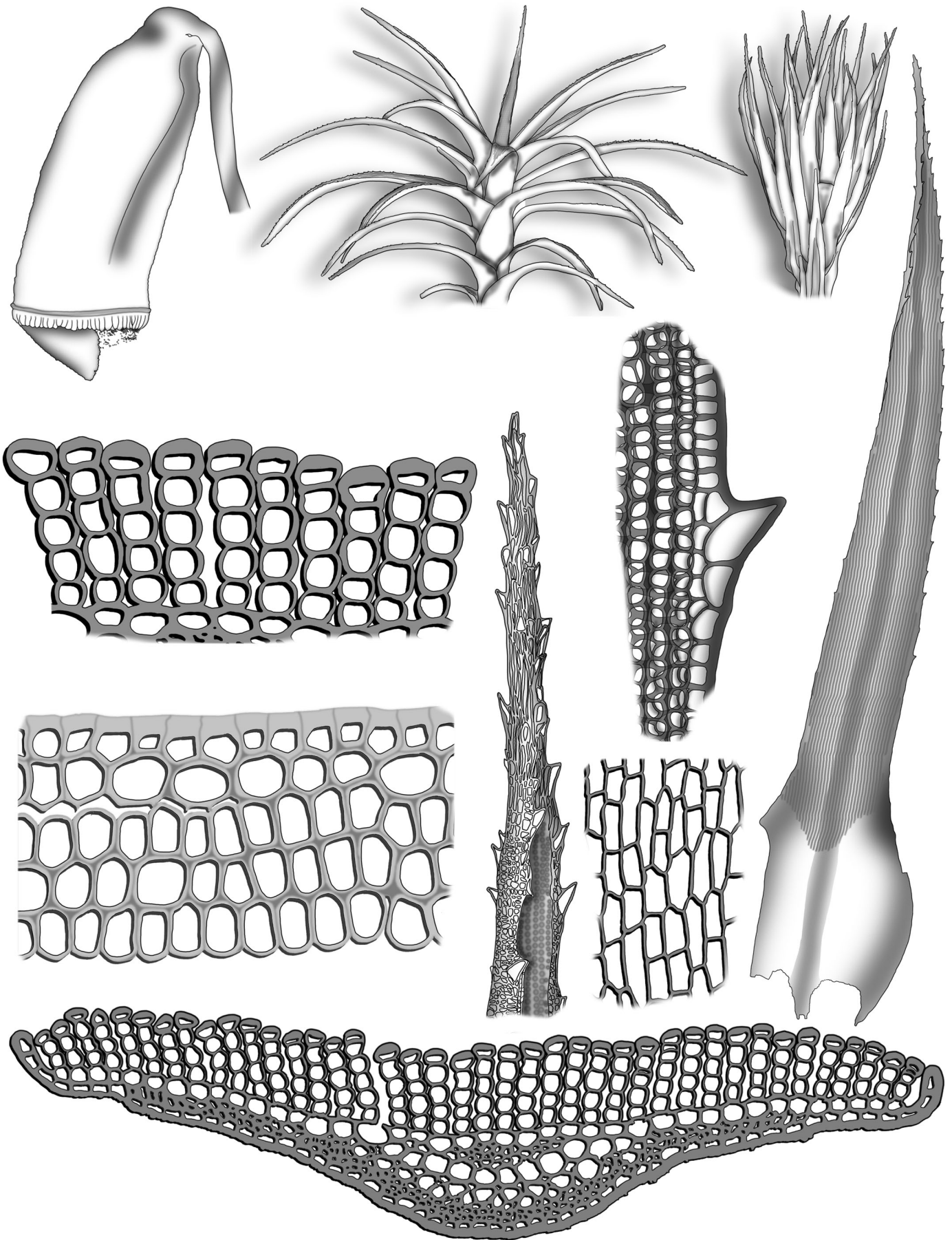


vouchers *Holzinger s.n., June 30, 1902 (MIN not cataloged);  
Linnaean Club U. of M. 109 (MIN 1156719):*

- a* **gametophore** (wet v. dry): recurved limbs when wet (left)
- b* **leaf**: differentiated shoulder hinge between limb and sheath; narrow lamina (contrast with *P. longisetum*)
- c* **leaf – apex**: sharply toothed (reddish) awn
- d* **leaf – lamina and marginal tooth**: narrowly exposed lamina (contrast with *P. longisetum*) and sharp marginal tooth
- e* **leaf tr.s.:** narrow erect lamina (contrast with *P. longisetum*) and constricted costal area (contrast with *Polytrichum* species)
- f* **leaf – lamella** (profile): straight outline, top cells with small lumen compared to others, thick-walled on top (and brown)
- g* **leaf – lamellae tr.s.:** enlarged thick-walled (brown) and non-papillose, flat-topped (not retuse) upper cells with narrow lumen
- h* **leaf – sheath, medial cells**: short-rectangular shape



*Polytrichastrum ohioense*

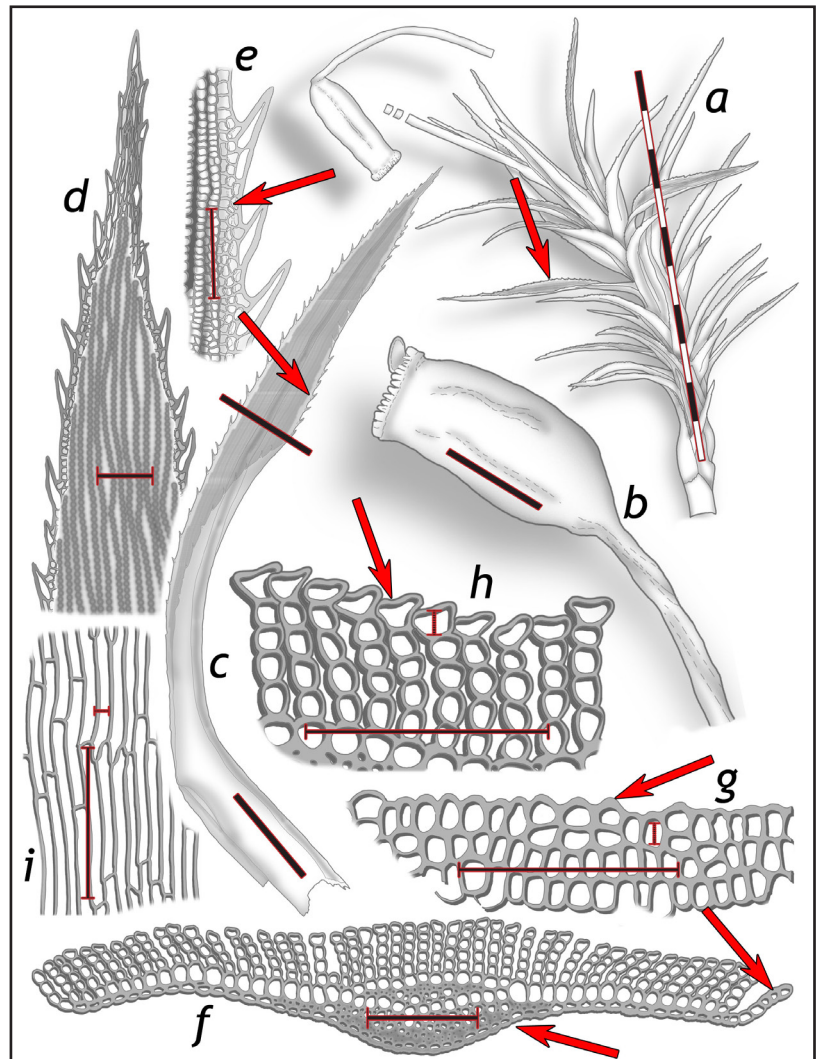


*Polytrichastrum ohioense*

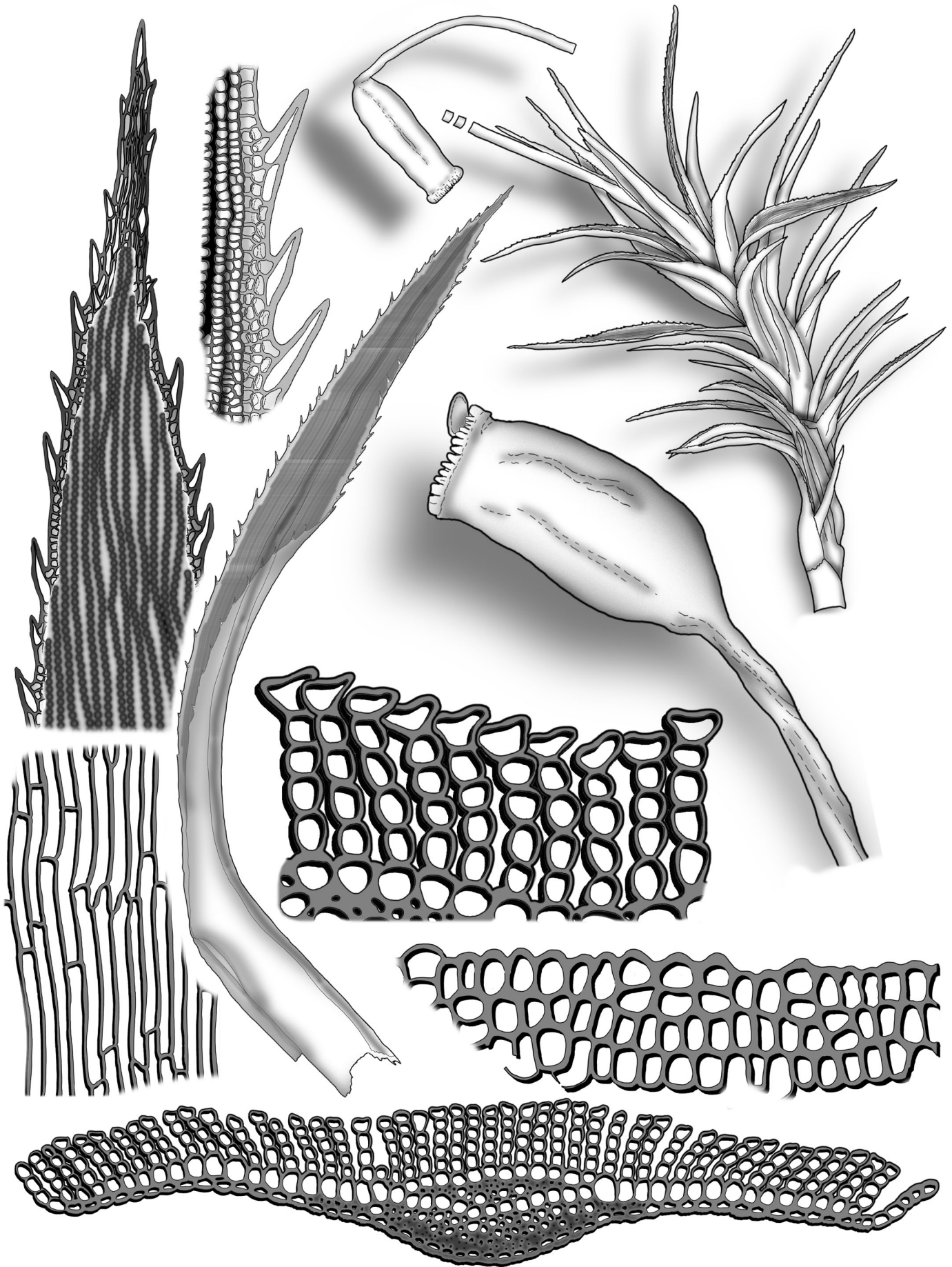


vouchers *Janssens 26287, 26849, 26865, 42284, 53895, 55465; Bowers 22627:*

- a* gametophore with sporophyte: long seta (interrupted to fit); recurved but not sharply reflexed leaves when wet (in contrast with *Polytrichum commune*)
- b* capsule: angular, box-like shape but tapering base with poorly delimited hypophysis
- c* leaf: lamina narrow (contrast with *P. longisetum*)
- d* leaf – apex: sharply toothed awn
- e* leaf – lamina and marginal teeth: narrowly exposed lamina (3-6 cells wide, contrast with *P. longisetum*) and sharp marginal teeth
- f* leaf tr.s.: narrow erect lamina (contrast with *P. longisetum*); constricted costa (contrast with *Polytrichum* species)
- g* leaf – lamella (profile): crenulate outline
- h* leaf – lamellae tr.s.: enlarged flat-topped, shallowly retuse or oblique top cells, thin-walled, and smooth
- i* leaf – basal sheath cells: narrow-elongate rectangular cells



*Polytrichastrum pallidisetum*



*Polytrichastrum pallidisetum*

***P. alpinum*: vouchers Janssens 28811, 29248, 29271**tr.s.: pentagonal lumen of top cells of lamellae and papillae covering upper, thickened surfaceprofile: greatly thickened and papillose top cellstop view: even rows of mostly narrow cells covered by papillae***P. longisetum*: vouchers Janssens 27919; Buck 307**tr.s.: top cells are only slightly enlarged and non-thickened walls are smoothprofile: smooth to slightly crenulate outline

top view: fairly even rows with wide, smooth top cells

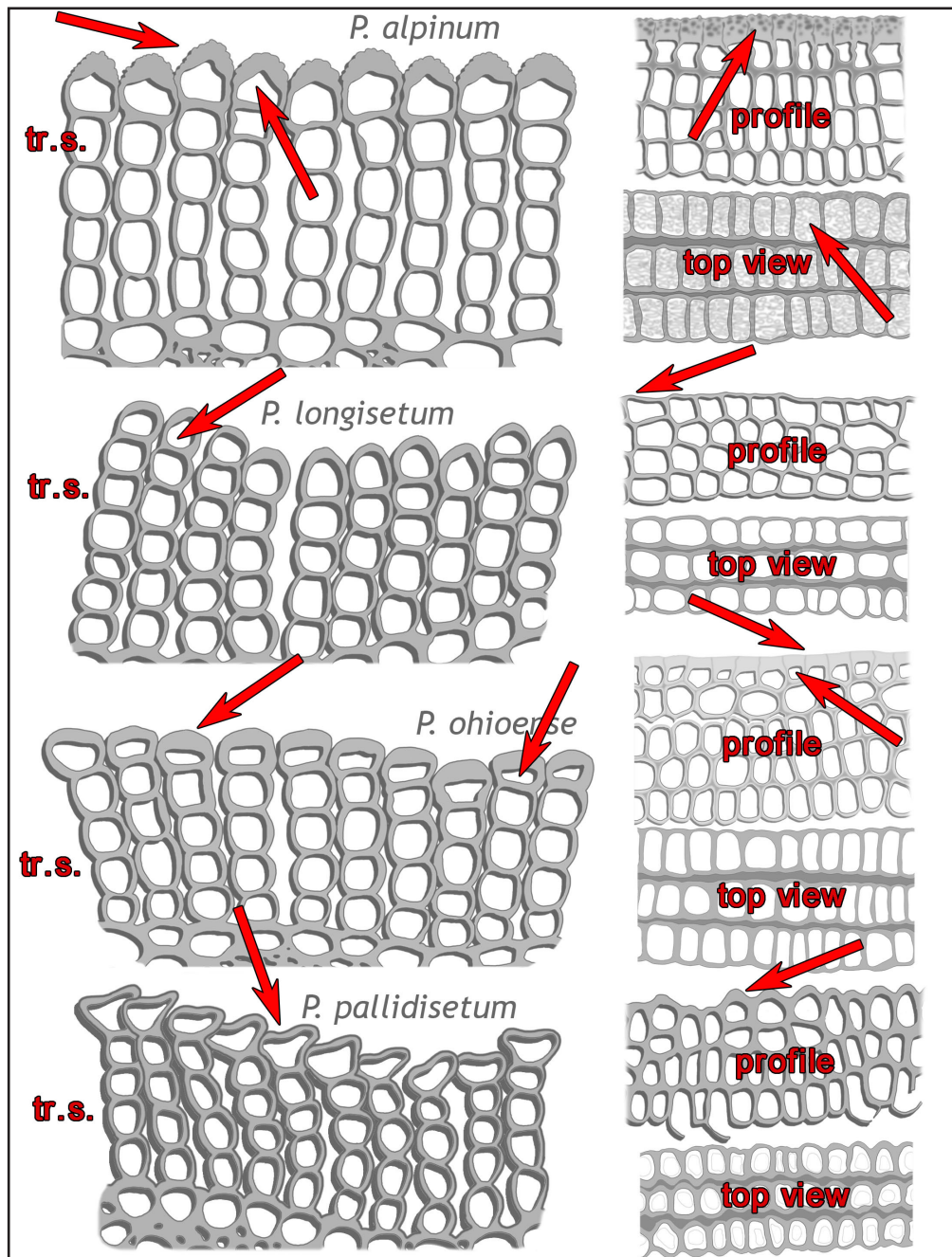
***P. ohioense*: voucher Linnaean Club U. of M. 109 (MIN 1156719)**tr.s.: enlarged thick-walled (brown) and flat-topped (not retuse), smooth upper cells with narrow lumen

profile: straight outline, top cells with small lumen compared to others, thick-walled on top (and brown)

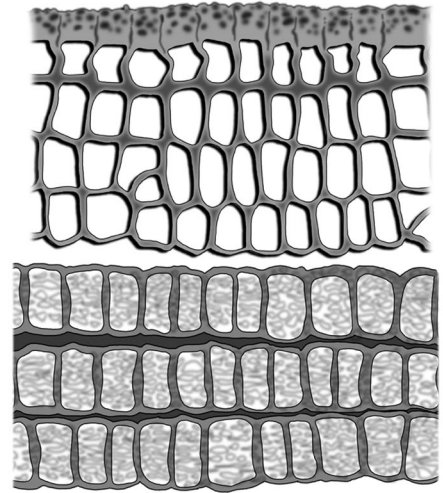
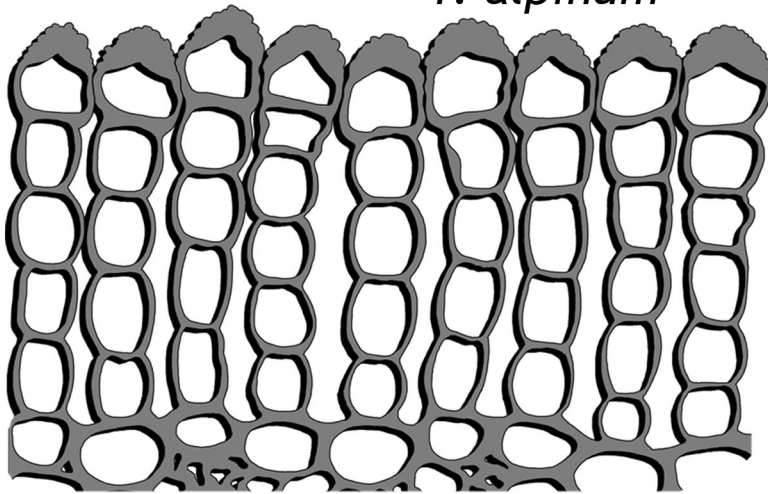
top view: even rows of dense, (colored) cells

***P. pallidisetum*: vouchers Janssens 26865, 42284**tr.s.: enlarged flat-topped, shallowly retuse or oblique top cells, thin-walled, and smoothprofile: crenulate outline

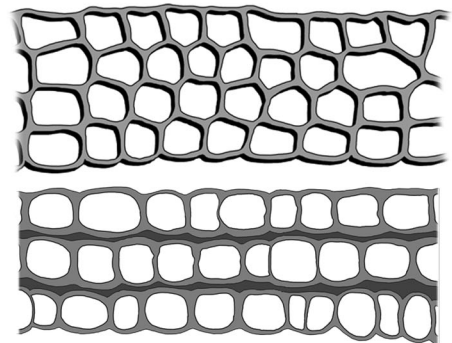
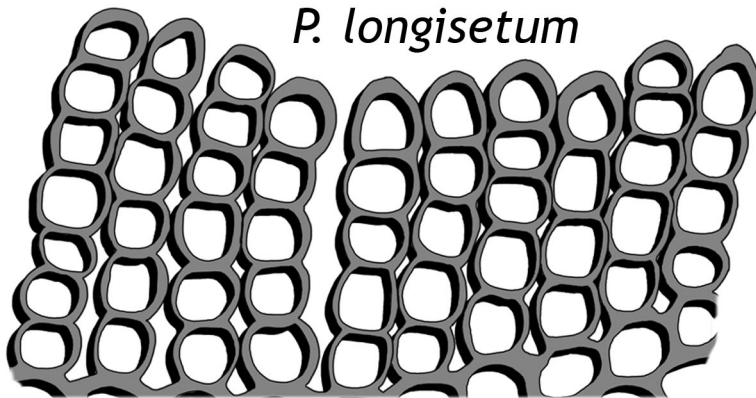
top view: highly uneven rows of irregularly shaped cells; narrow lumen of the cells below can be seen through

***Polytrichastrum* summary of diagnostic characters**

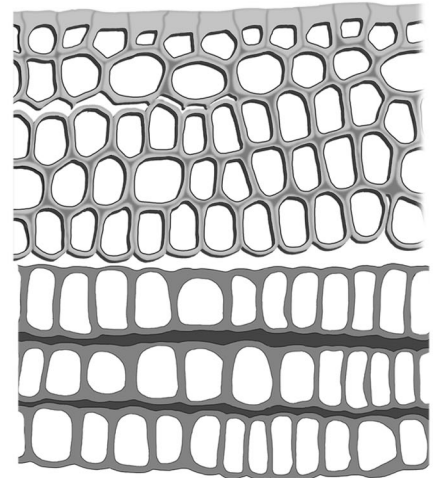
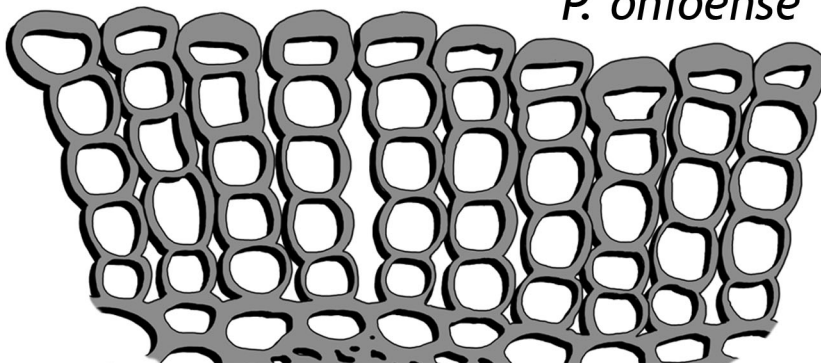
*P. alpinum*



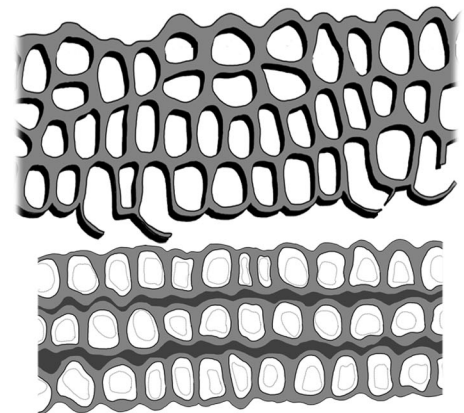
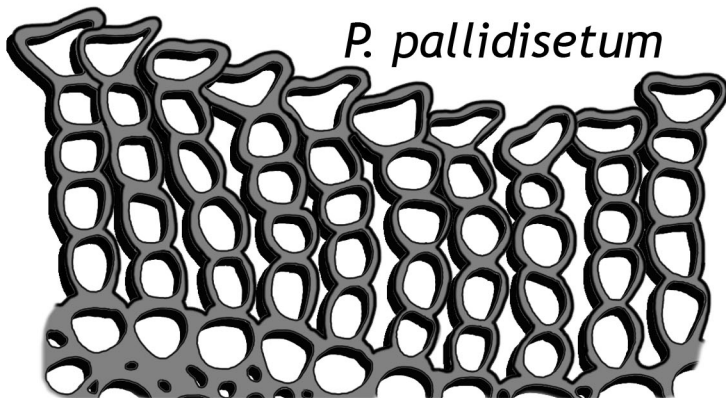
*P. longisetum*



*P. ohioense*



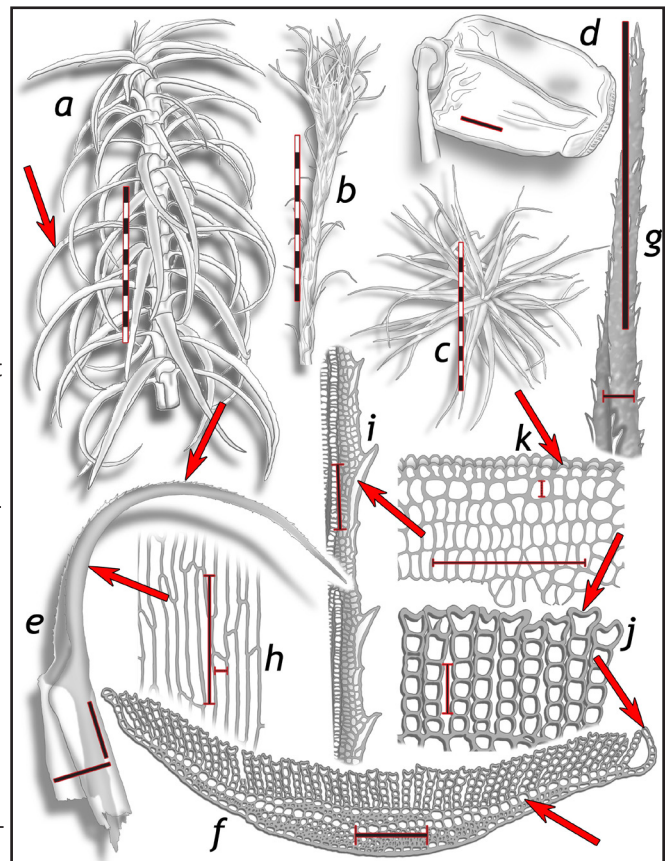
*P. pallidisetum*



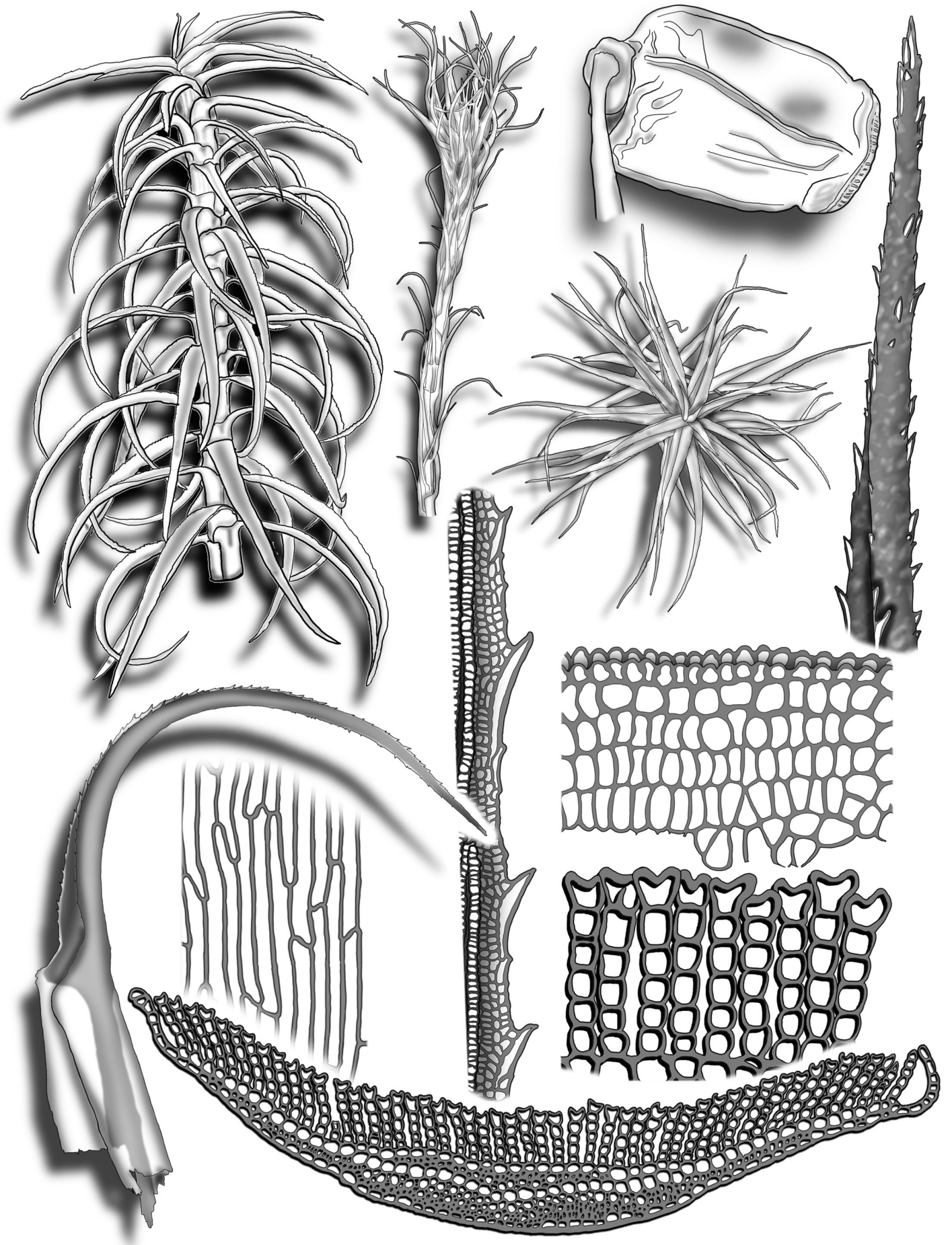


vouchers *Janssens 11721, 16810, 20663, 29668, 44085, 46579, 52234, 55849; Frelich & Reich 1842:*

- a* **gametophore** (wet, profile): strongly squarrose-recurved leaves with reflexed limbs (contrast with other *Polytrichum* and *Polytrichastrum* species) and tightly clasping base
- b* **gametophore** (dry, profile): tightly appressed leaves, highly hygroscopic, contrast with wet plant
- c* **gametophore** (wet, top view): radial star-shaped aspect because of long and narrow leaf limbs
- d* **capsule** (mature): square box-like shape with pronounced edges and highly pronounced hypophysis
- e* **leaf**: tightly clasping sheath and long reflexed limb (contrast with other *Polytrichum* and *Polytrichastrum* species) with narrow, erect sharply toothed margin (contrast with other *Polytrichum* species); costa not prominent abaxially (contrast with *Polytrichastrum* species, see also *f*)
- f* **leaf tr.s.:** narrow erect lamina region, leaving all lamellae exposed (contrast with other *Polytrichum* species); large number of costal guide cells along nearly the entire width of the leaf limb (contrast with *Polytrichastrum* species)
- g* **leaf – apex:** dark-colored rough awn
- h* **leaf – basal sheath cells:** narrow elongate-rectangular to linear shaped cells
- i* **leaf – margin:** sharp and embedded teeth in narrow lamina (contrast with other *Polytrichum* species)
- j* **leaf – lamellae tr.s.:** deeply notched top cells (contrast with other *Polytrichum* species but compare with *Polytrichastrum pallidisetum*)
- k* **leaf – lamella** (profile): crenulate profile and projecting pairs of knobs of top cells forming a deep groove between them



### *Polytrichum commune*

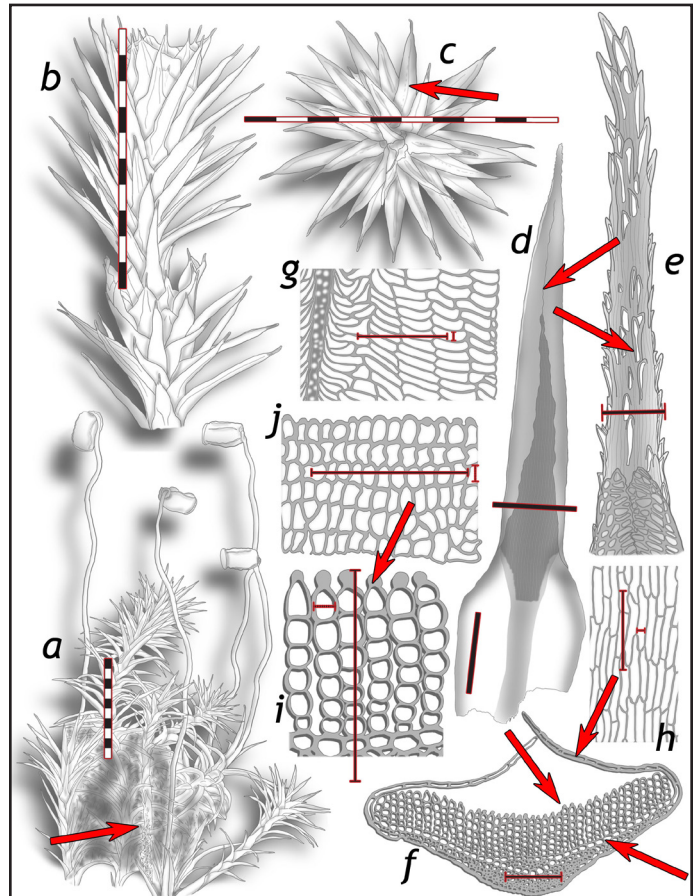


*Polytrichum commune*

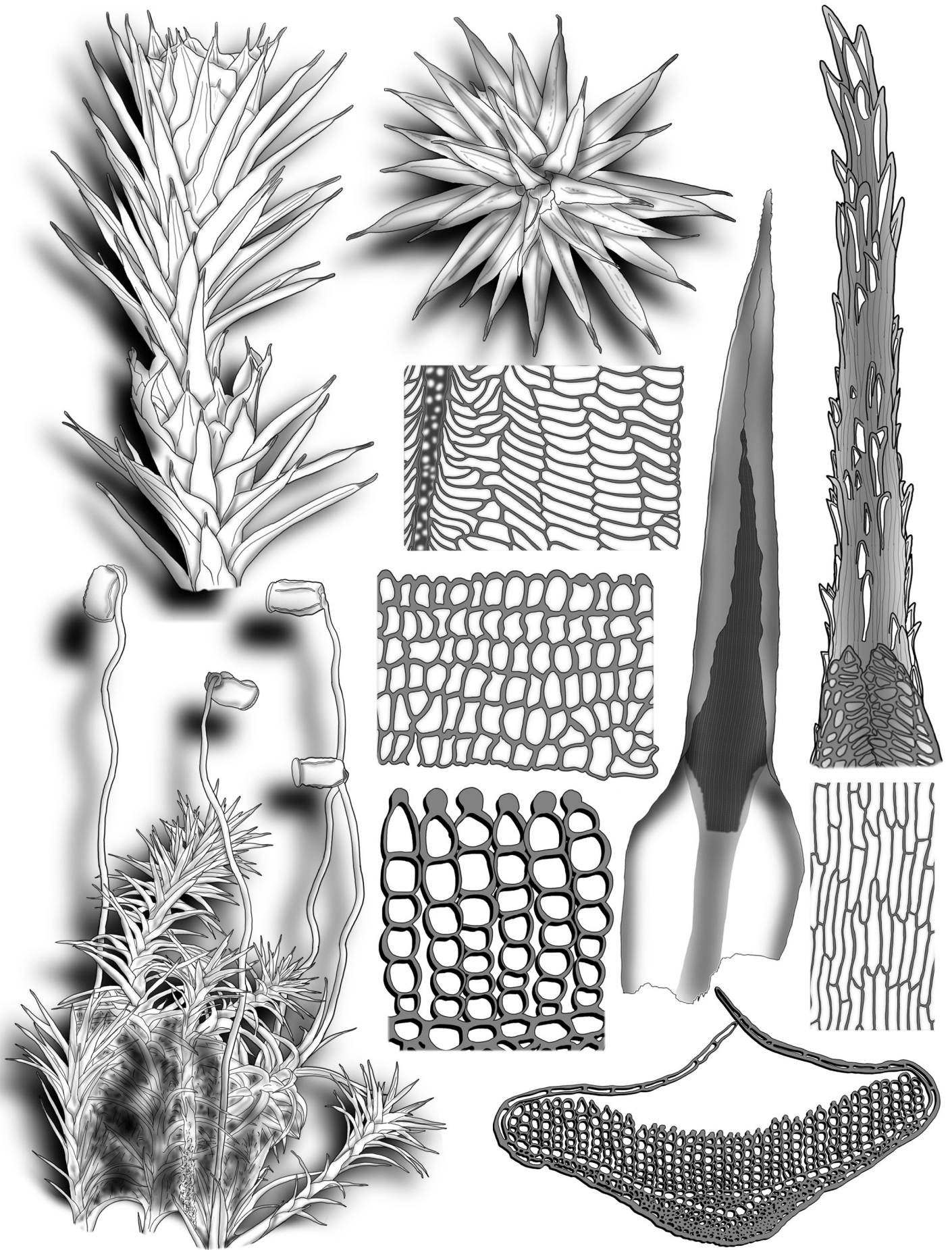


vouchers *Janssens 20622, 28823, 39149, 41302, 54032, 54890, 55970*:

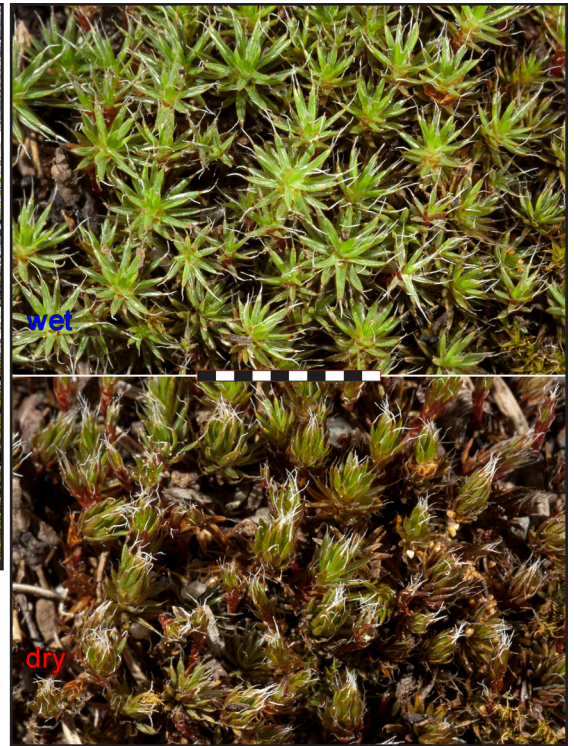
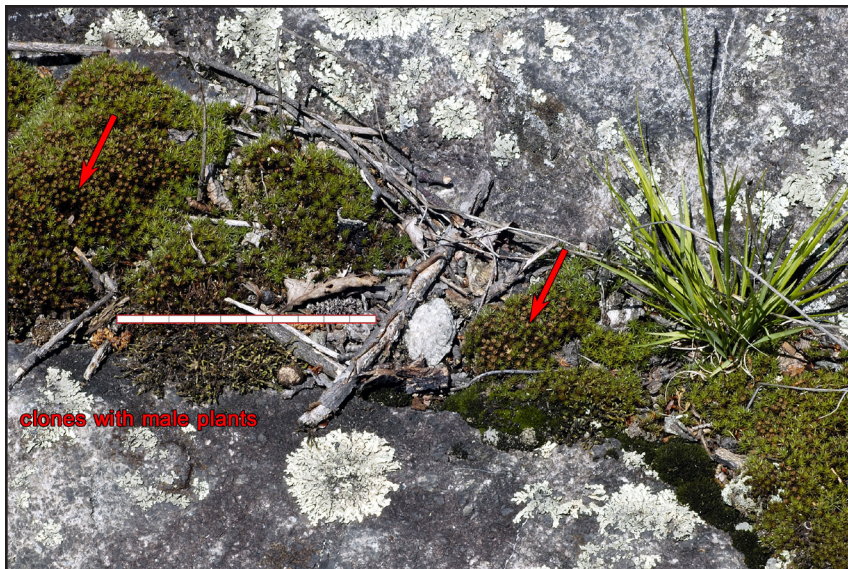
- a* **gametophores & sporophytes** (profile): limited tomentum (contrast with *P. strictum*) and rectangular, horizontal box-shaped capsule
- b* **gametophore** (profile with 2 androecia: previous year's below, present year's above): spreading to erect-spreading leaves with straight limbs
- c* **gametophore** (top view): longitudinal midlines reflecting overfolded laminae (contrast with *Polytrichastrum* species and *P. commune*)
- d* **leaf**: folded-over laminae, overlapping below leaf apex, separate below
- e* **leaf – awn**: short, colored (reddish-brown) hairpoint or awn (contrast with *P. piliferum*) with sharp spinose teeth and overfolded laminae at base
- f* **leaf tr.s.**, near upper part of leaf: overfolded laminae (contrast with *P. commune*) covering numerous lamellae; central lamellae with thick protruding knobs (contrast with *P. commune*), lateral ones with thinner-walled and rounded top cells; large number of costal guide cells along nearly the entire width of the leaf limb (contrast with *Polytrichastrum* species)
- g* **leaf – lamina**: thick-walled, obliquely oriented cells forming overlapping lamina; knob-like protrusions of lamellae's top cells protruding in space between laminae
- h* **leaf – medial part of basal sheath**: cells narrowly rectangular
- i* **leaf – lamellae tr.s.** (near leaf midline): thickened knob of top cells (contrast with *P. piliferum*, compare with *P. strictum*)
- j* **leaf – lamella** (lateral one, profile): crenulate top line (contrast with *Polytrichastrum* species)



### *Polytrichum juniperinum*

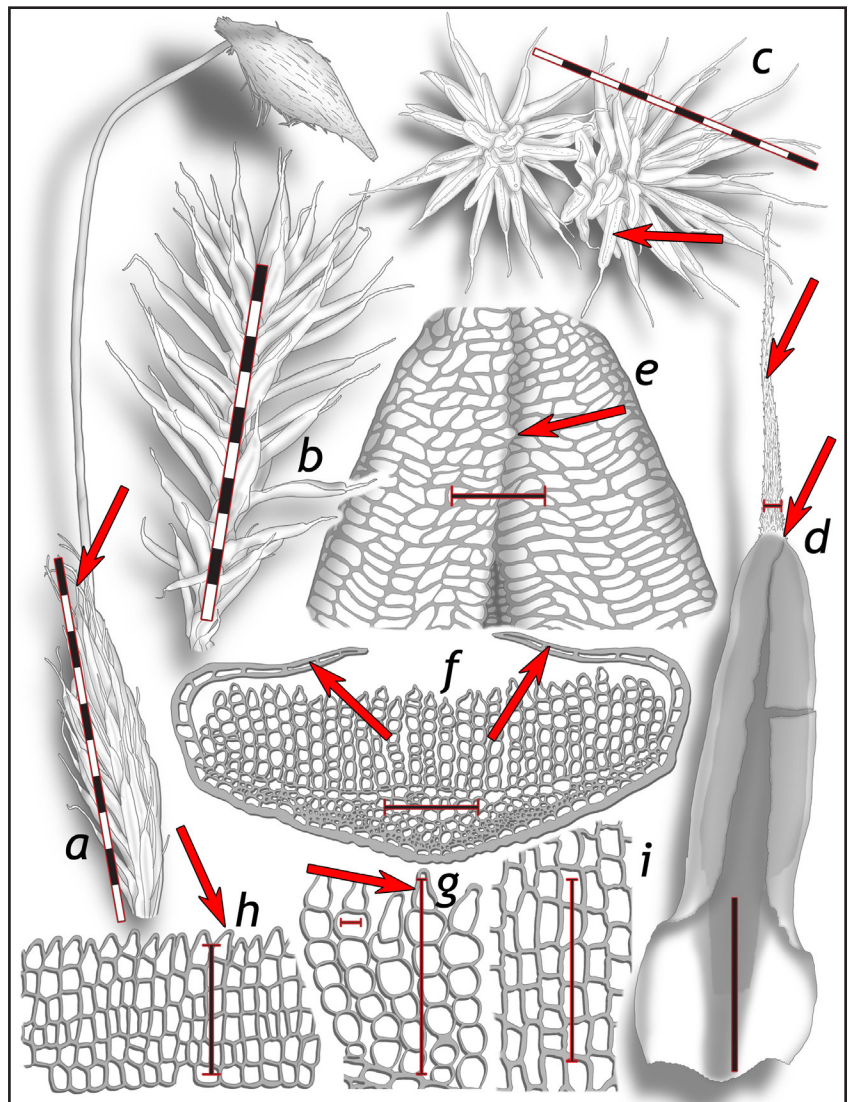


*Polytrichum juniperinum*

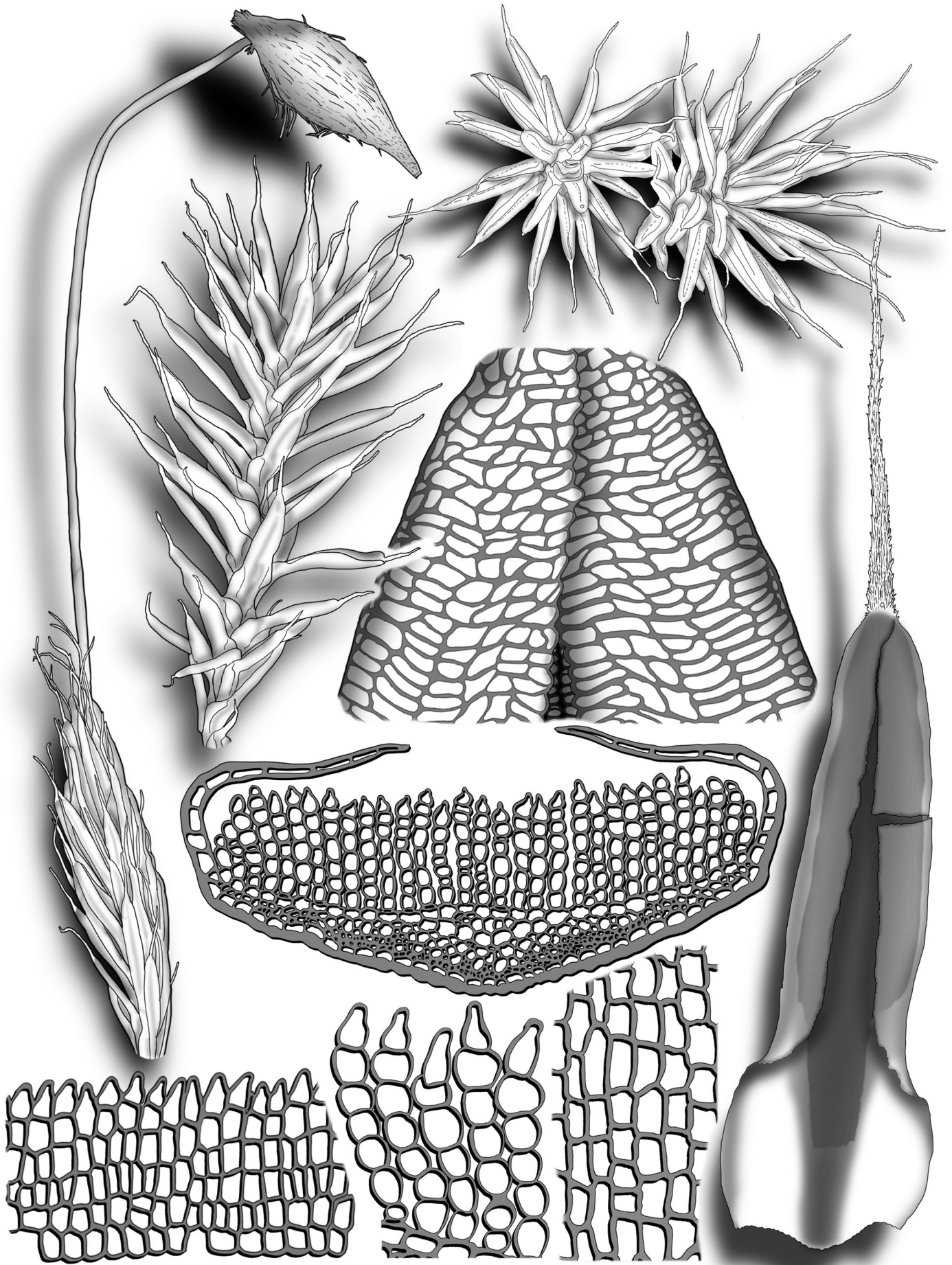


vouchers Janssens 28869, 39151, 44315, 54167, 54621, 54622, 55441:

- a* **gametophore and sporophyte** (dry, profile): incurved appressed leaves with intertwined hyaline hairpoints or awns (contrast with other *Polytrichum* and *Polytrichastrum* species); capsule, calyptra covering capsule completely, at right angle to seta
- b* **gametophore** (wet, profile): erect-spreading leaves, larger toward tip (comose, see also photos)
- c* **gametophores** (wet, top view): longitudinal midlines reflecting overfolded laminae (contrast with *P. commune* and *Polytrichastrum* species)
- d* **leaf**: folded-over laminae which meet and overlap only below sharply spinulose-toothed hyaline awn (contrast with other *P. commune* and *Polytrichastrum* species)
- e* **leaf – apex** (just below awn): overlapping laminae and its thick-walled, sinuose and oblique laminal cells
- f* **leaf tr.s.** (near mid-leaf): overfolded laminae covering many lamellae
- g* **leaf – lamellae tr.s.**: thin-walled cells and pyriform top cells (contrast with other *Polytrichum* and *Polytrichastrum* species)
- h* **leaf – lamella** (profile): deeply crenulate-dentate top line with its pyriform cells with pronounced but thin-walled knobs, oriented towards leaf apex (contrast with *P. juniperinum* and *P. strictum*)
- i* **leaf – basal sheath** (medial part): short-rectangular shape of its cells (contrast with other *Polytrichum* and *Polytrichastrum* species)



### *Polytrichum piliferum*

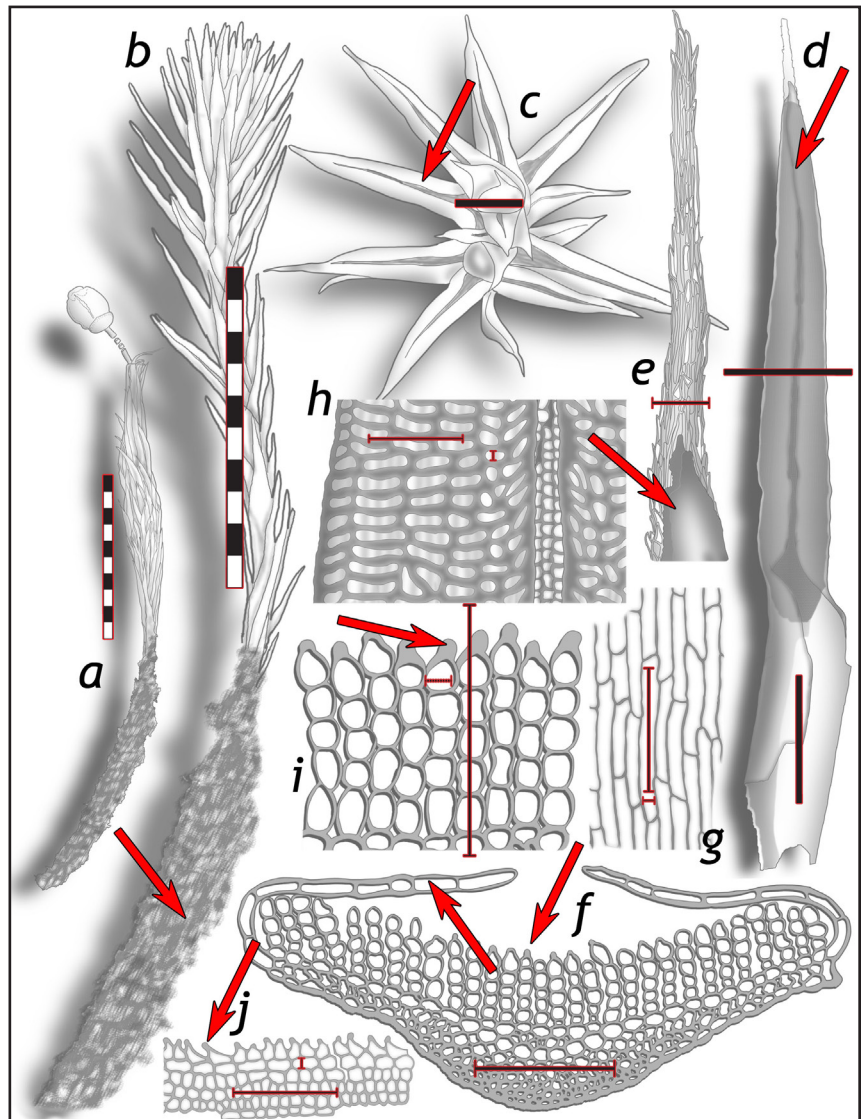


*Polytrichum piliferum*

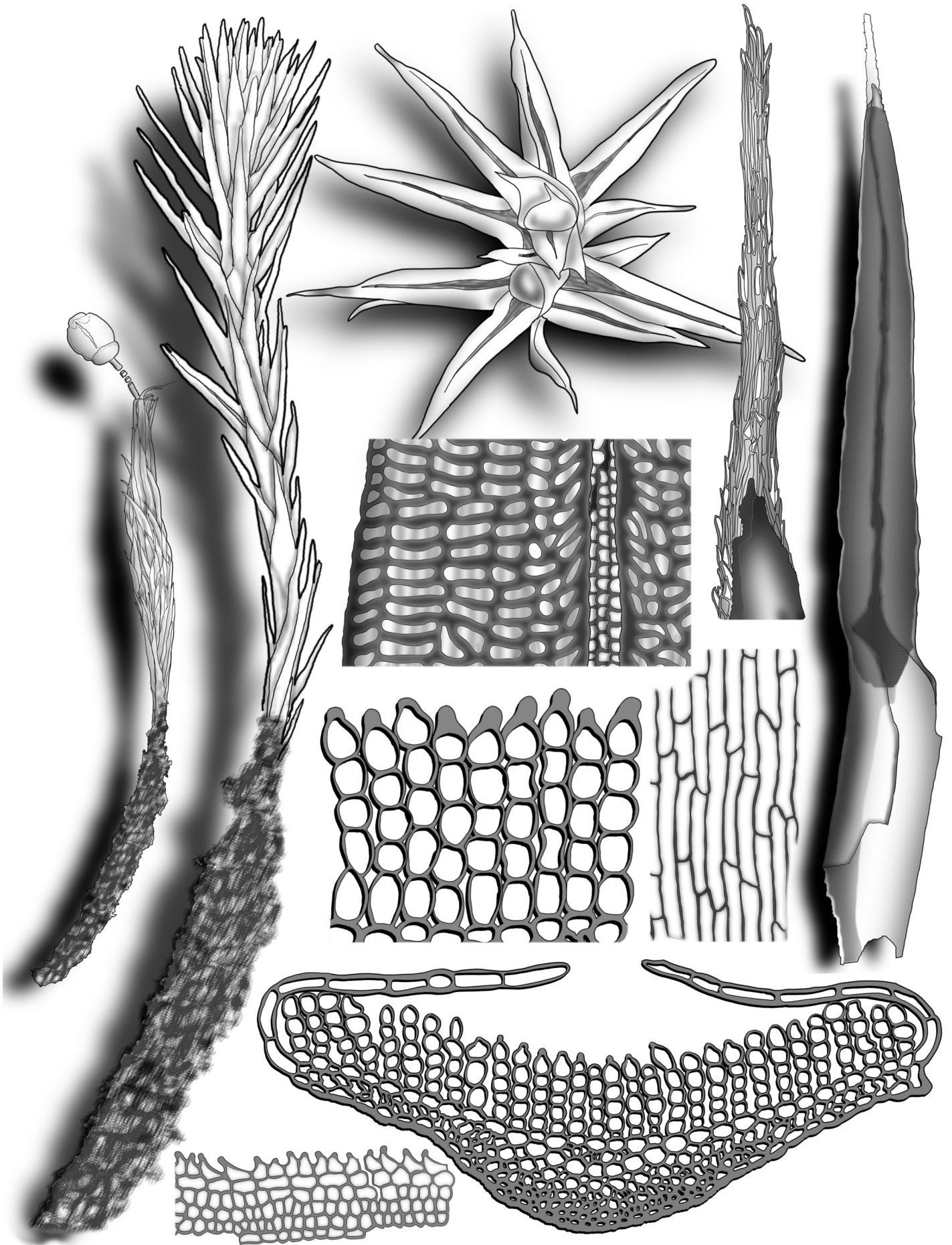


vouchers Janssens 22461, 24237, 42860, 52033, 52226, 55775:

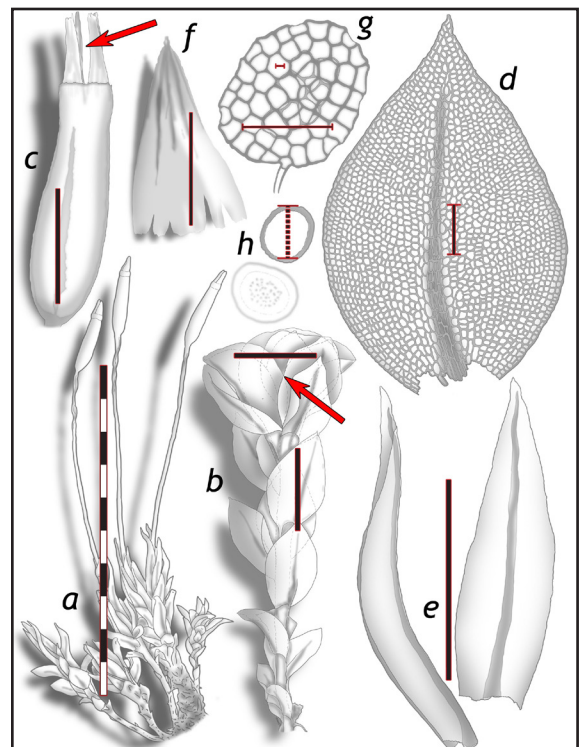
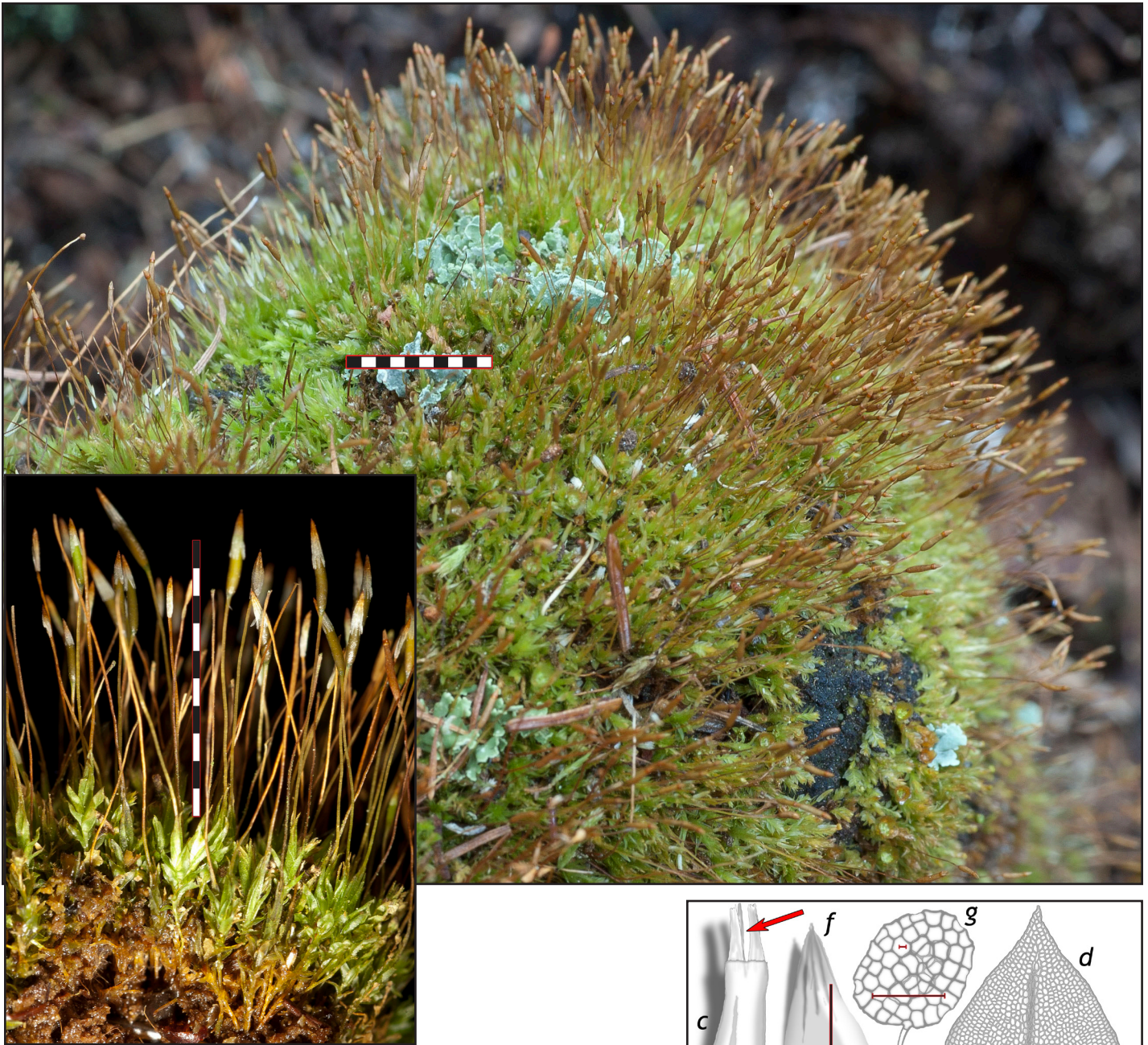
- a gametophore & sporophyte** (dry): strongly appressed leaves; apical perichaetial leaves with long awns (see also e); capsule horizontal, box-shaped, nearly cubic on > 2-cm long seta (here interrupted)
- b gametophore** (wet): tomentum covering a substantial part of stem (contrast with *P. juniperinum*); spreading to erect-spreading leaves with straight limbs (contrast with *P. commune*)
- c gametophore** (top view): longitudinal midlines reflecting overfolded laminae, joining near tip of leaves (contrast with *Polytrichastrum* species and *P. commune*)
- d leaf**: folded-over laminae overlapping partly below a short hairpoint or awn
- e leaf – awn**: teeth and completely overfolded laminae at base of awn
- f leaf tr.s.** (near median part of leaf): overfolded laminae covering numerous lamellae; central ones with thick protruding knobs (contrast with *P. commune*), lateral ones with thinner-walled and rounded top cells (compare with *P. juniperinum*)
- g leaf – basal sheath** (median part): cells narrowly rectangular
- h leaf – lamina**: thick-walled and obliquely oriented cells forming 5 to 7 cell-wide overfolded laminae (see also f)
- i leaf – lamellae tr.s.** (near leaf midline): top cells with thickened knob (contrast with *P. piliferum*, compare with *P. juniperinum*)
- j leaf – lamella** (medial, in profile): strongly crenulate outline formed by pyriform top cells



*Polytrichum strictum*



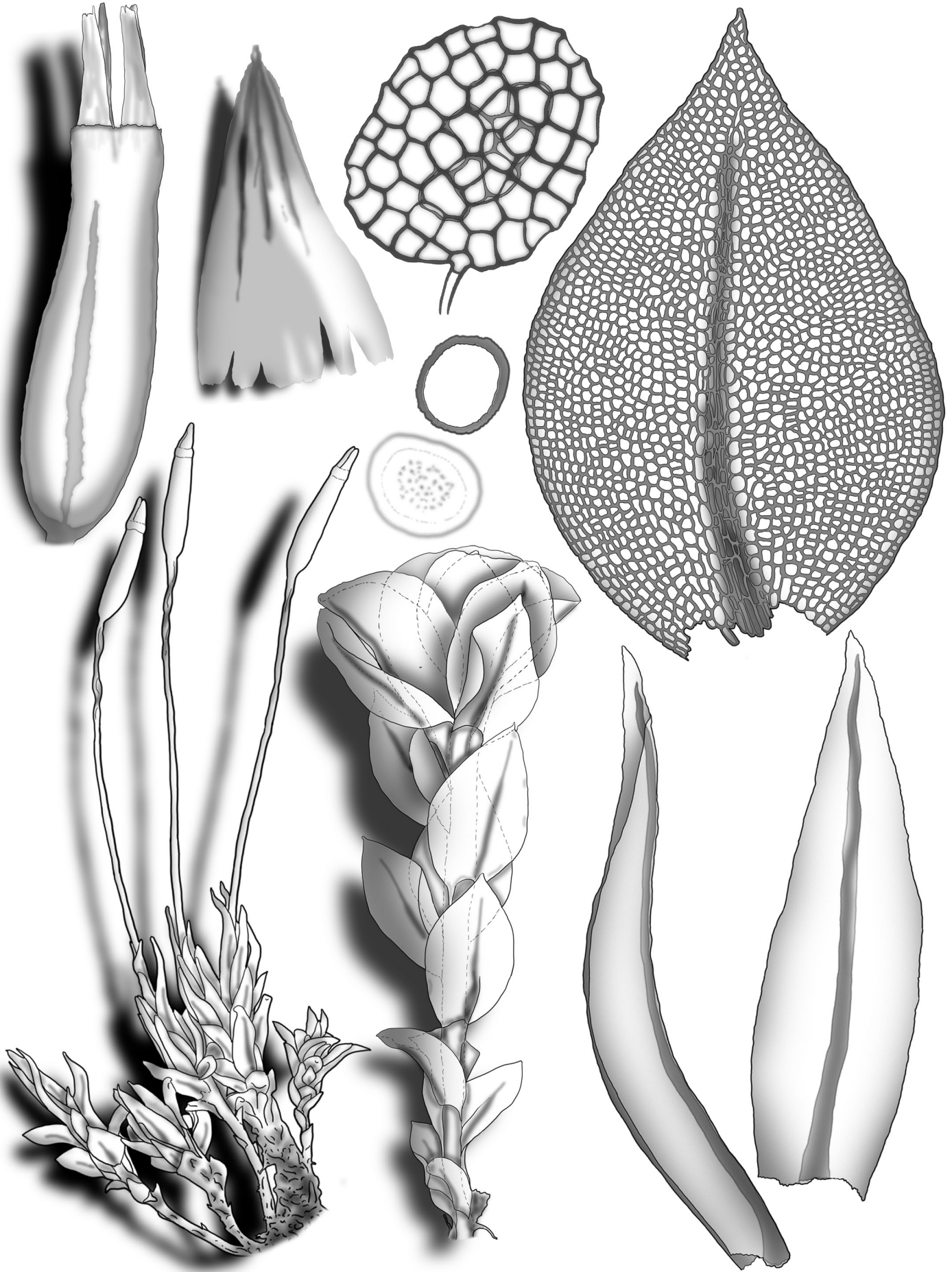
*Polytrichum strictum*



vouchers *Janssens, J.A. 11726, 11739, 22221, 42790, 52003, 52569, Frelich & Reich 3144 & 3578A2:*

- a* **gametophores and sporophytes:** elongated distal and perichaetial leaves (see also *e*); smooth seta; nearly erect straight or slightly curved capsules
- b* **gametophore with gemmae cup:** ovate proximal leaves; gemmae cup formed by large truncated distal leaves
- c* **capsule:** four large peristome teeth composed of entire cells
- d* **caudal leaf:** entire leaf margin; small oblong cells at proximal margin
- e* **distal and perichaetial leaves**
- f* **calyptra:** lower part transparent and hyaline (see also photo above)
- g* **gemma**
- h* **spores** (upper in optical tr.s., lower showing papillose outer surface)

*Tetraphis pellucida*



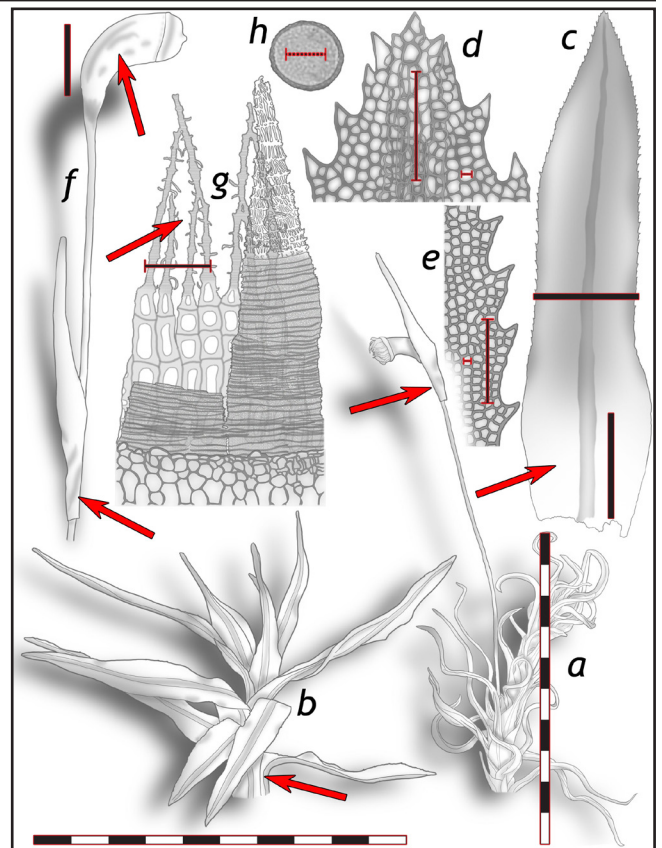
*Tetraphis pellucida*



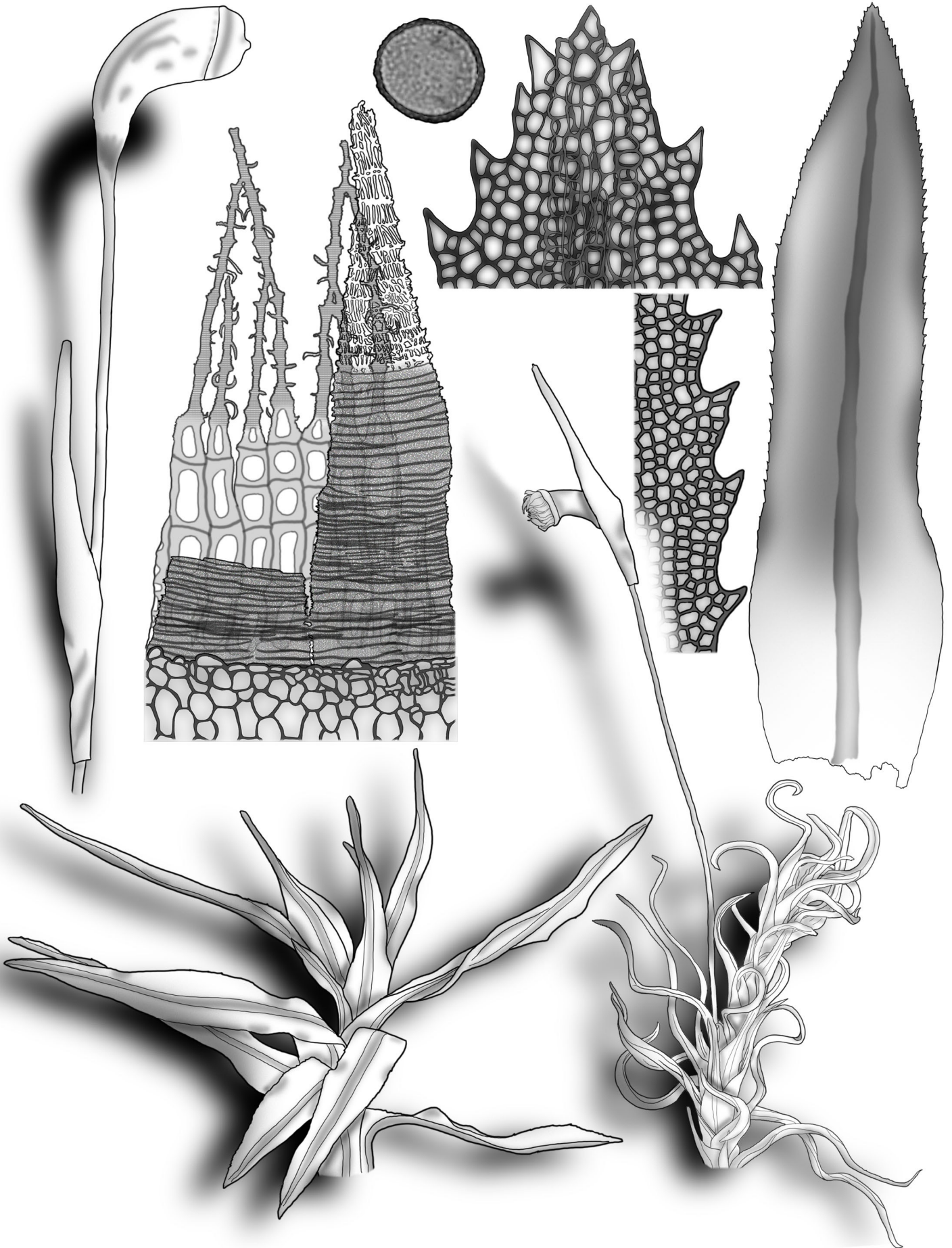
*Timmia megapolitana* subsp. *megapolitana*

vouchers *Janssens 15315C, 15318, 15359, 26184, 38968, 38970, 51628*:

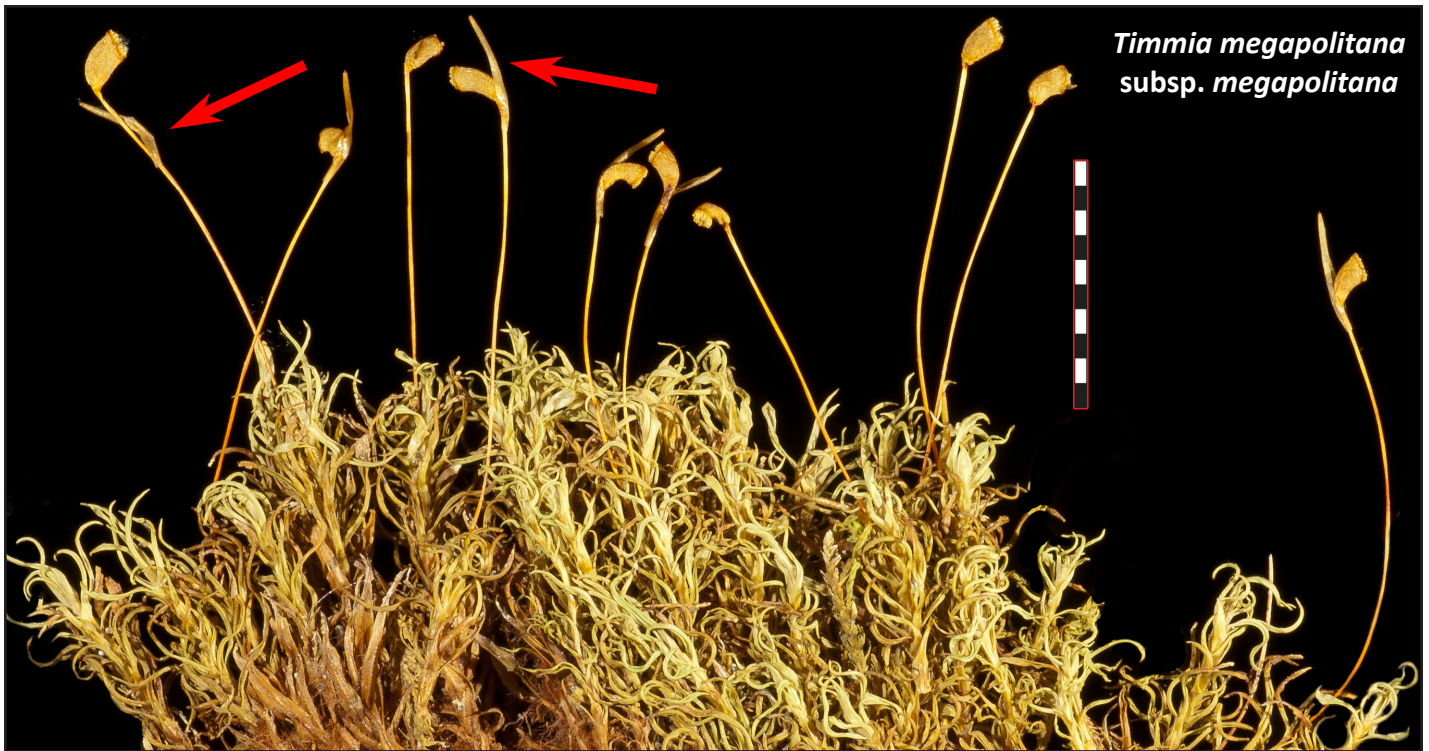
- a* **gametophore and sporophyte** (dry): crisped leaves; calyptra still attached to seta (see also *f* and photo on p. 66)
- b* **gametophore** (wet): strap-like limbs; clasping basal sheaths
- c* **leaf**: pale leaf sheath; sharply serrate margins without differentiated border; no adaxial lamellae (contrast with *Atrichum* species); see pp. 66-67 for cellular detail and contrast between subsp. *megapolitana* and subsp. *bavarica*)
- d* **leaf – apex**: percurrent costa
- e* **leaf – margin**: large, multicellular and sharp teeth; cell not differentiated into a border (contrast with *Atrichum* species)
- f* **sporophyte and calyptra**: calyptra attached but slid down along seta; capsule curved and inclined
- g* **peristome**: peristome double, with endostome with high perforated basal membrane (behind broken-off exostome tooth) and partly adhering, appendiculate cilia
- h* **spore**



*Timmia megapolitana* subsp. *megapolitana*



*Timmia megapolitana* subsp. *megapolitana*



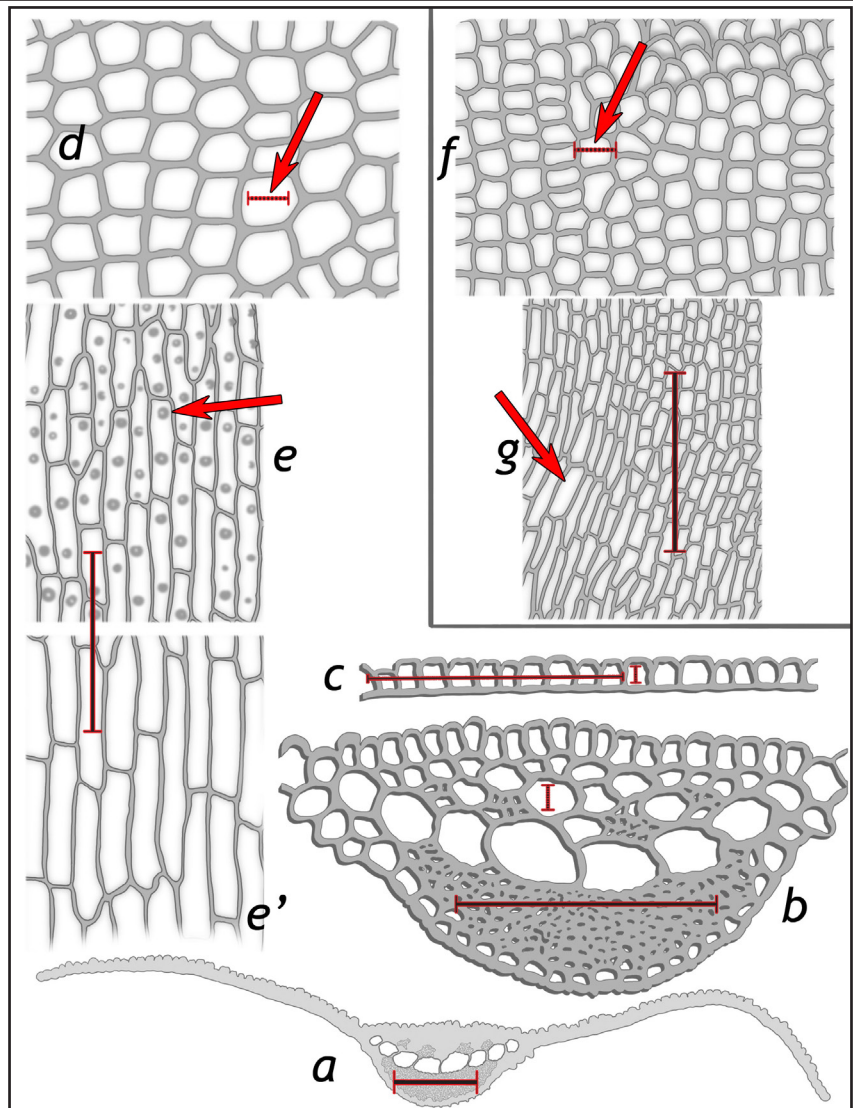
vouchers *Janssens 15359, 26184, 38970* (subsp. *megapolitana*), and *Holzinger s.n., June 23, 1897* (MIN 1170959, as subsp. *bavarica*):

(subsp. *megapolitana*)

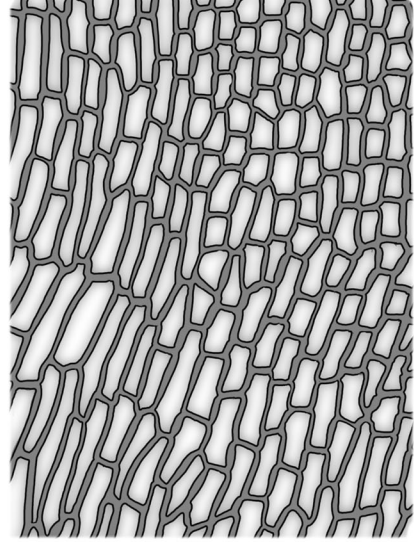
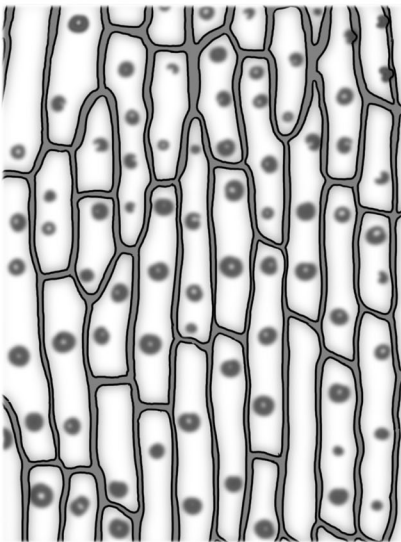
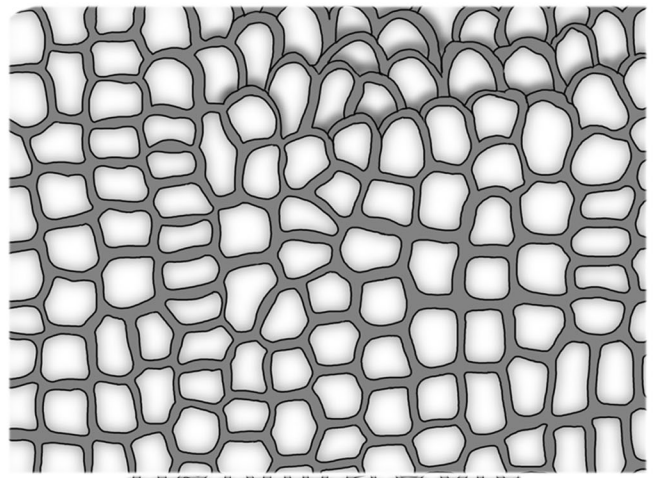
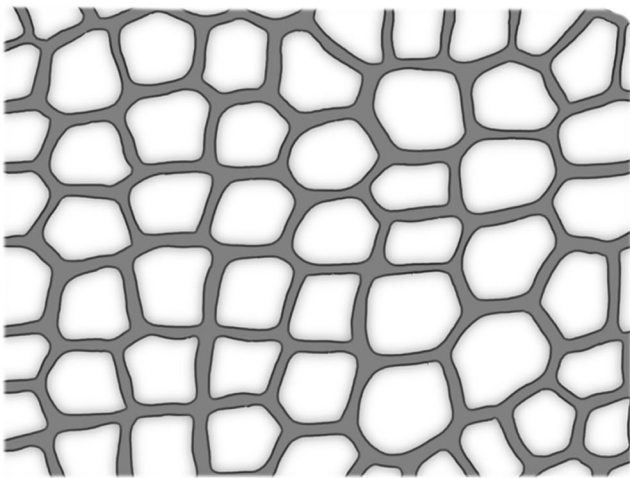
- a* leaf tr.s.: large guide cells in costa
- b* leaf – costa tr.s.: large abaxial stereid band below guide cells; several smaller adaxial stereid bands above guide cells
- c* leaf – lamina tr.s.: cell with flattened mamillae on adaxial surface; abaxial surface smooth
- d* leaf – medial cells: mostly >10 μm in diameter (contrast with subsp. *bavarica*, see *f*)
- e* leaf – distal sheath cells at shoulder: 2-4 papillae in longitudinal row over cell lumen (contrast with subsp. *bavarica*, see *g*)
- e'* leaf – proximal sheath cells: smooth surface

(subsp. *bavarica*)

- f* leaf – medial cells: mostly < 10 μm in diameter (contrast with subsp. *megapolitana*, see *d*)
- g* leaf – distal sheath cells at shoulder: smooth distal and proximal sheath cells (contrast with subsp. *megapolitana*, see *e*)

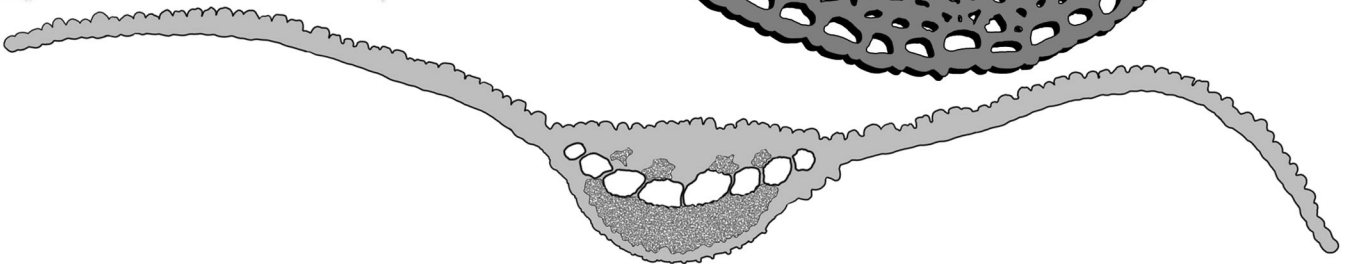
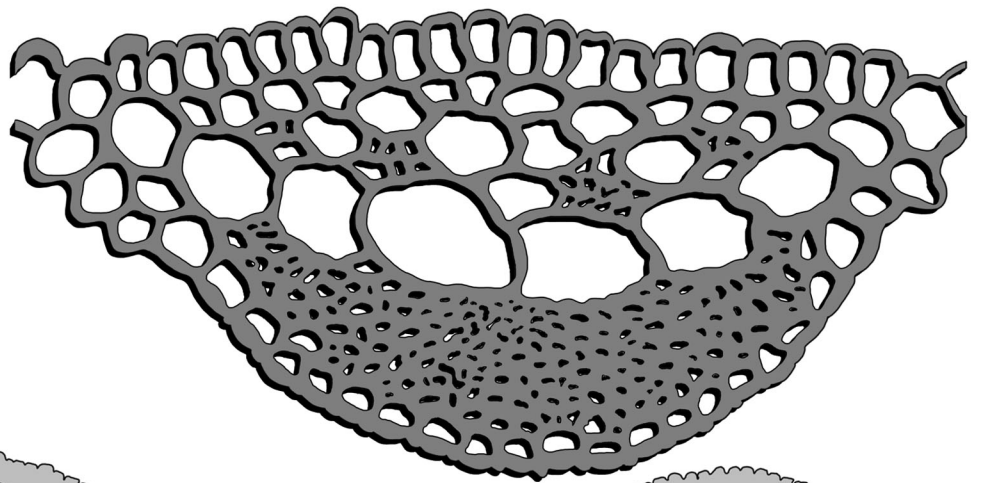
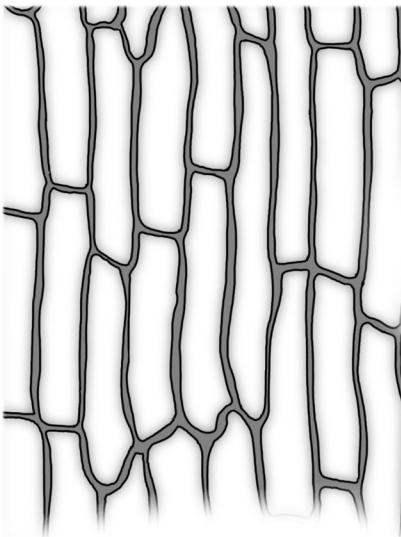


*Timmia megapolitana* subsp. *megapolitana* vs. subsp. *bavarica*

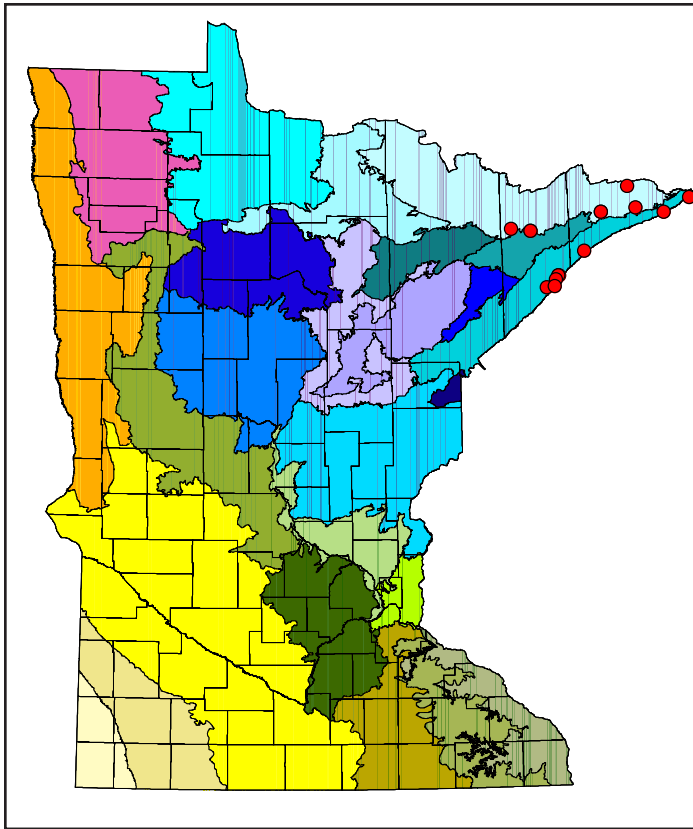


subsp.  
*megapolitana*

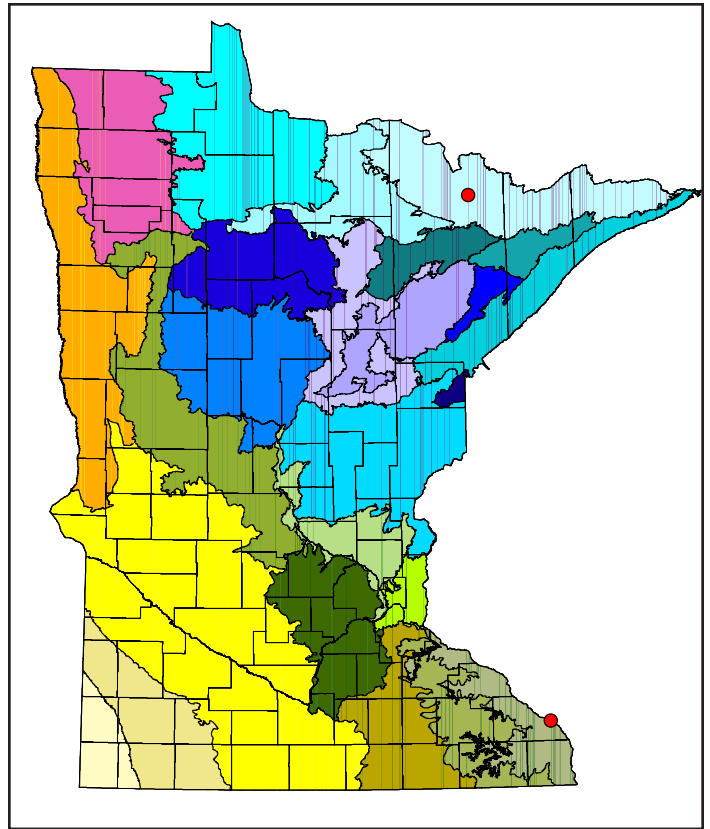
subsp.  
*bavarica*



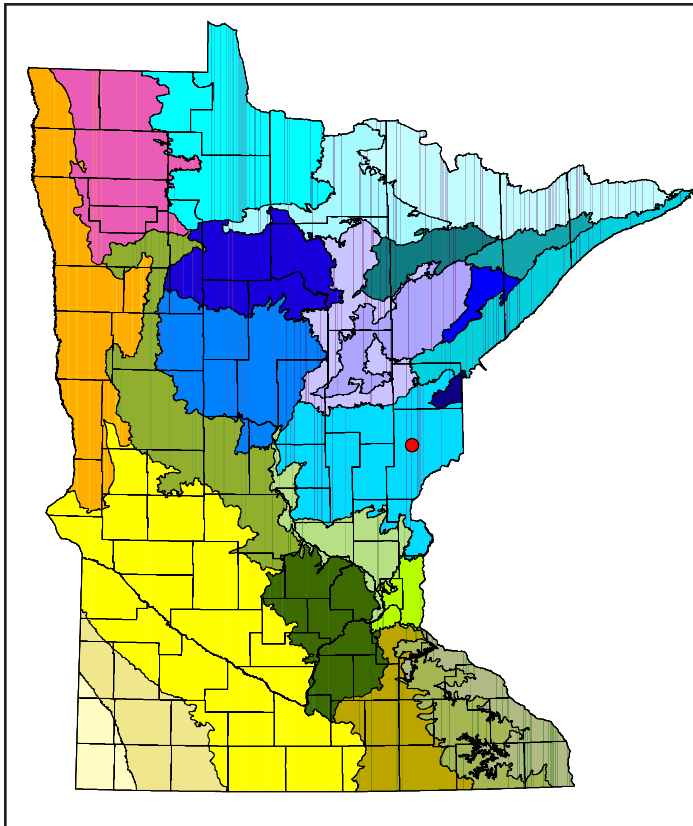
*Timmia megapolitana* subsp. *megapolitana* vs. subsp. *bavarica*



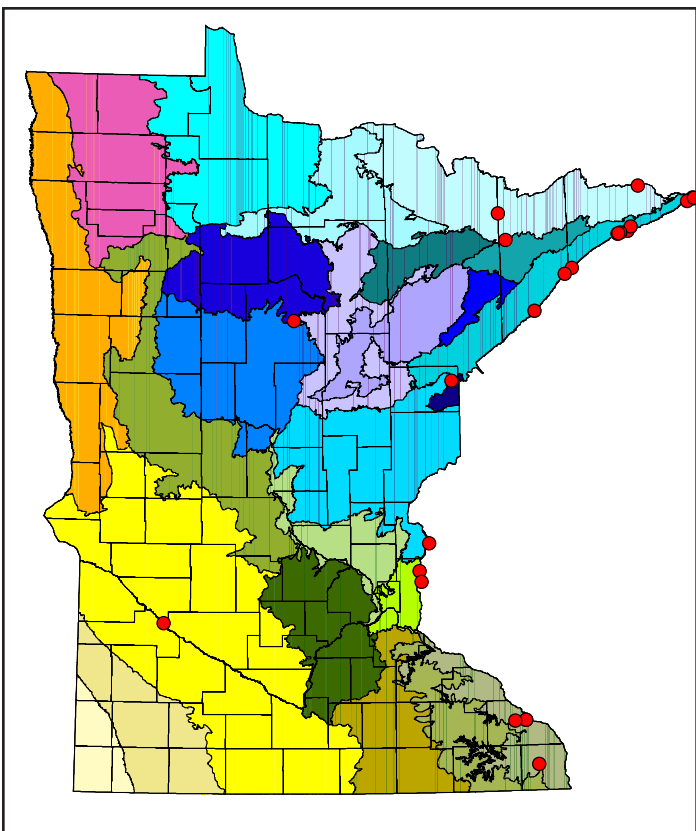
*Andraea rupestris* (n=22)



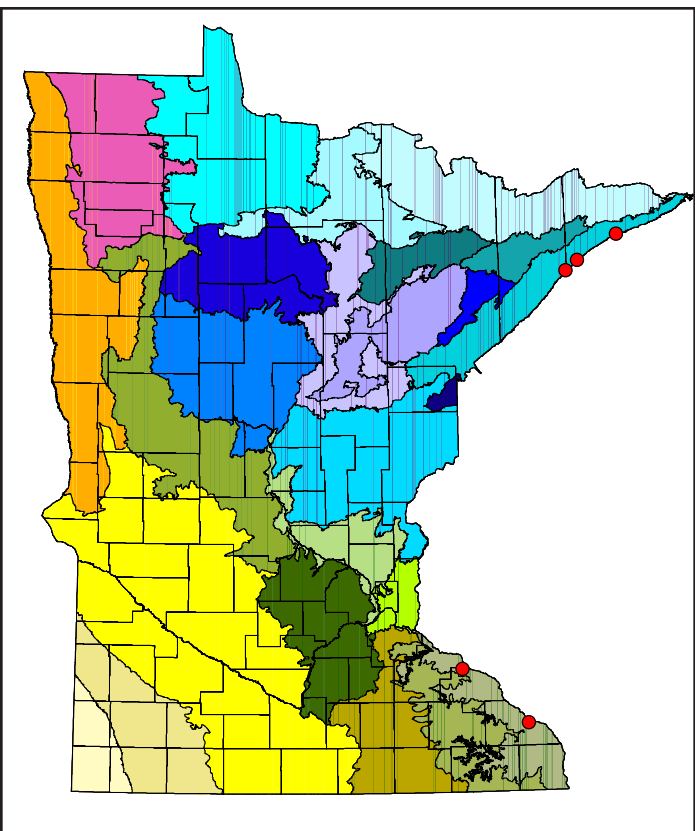
*Buxbaumia aphylla* (n=2)



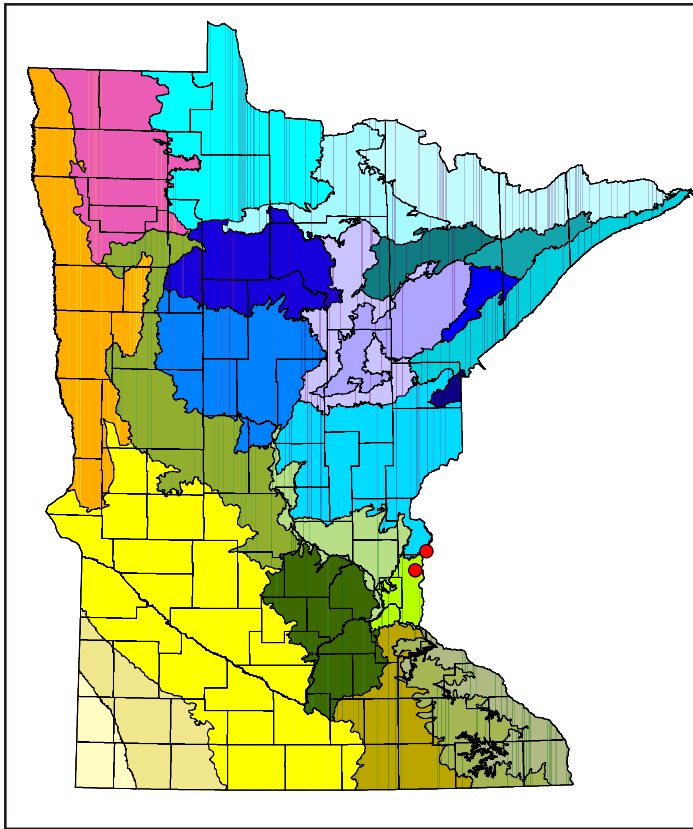
*Diphyscium foliosum* (n=1)



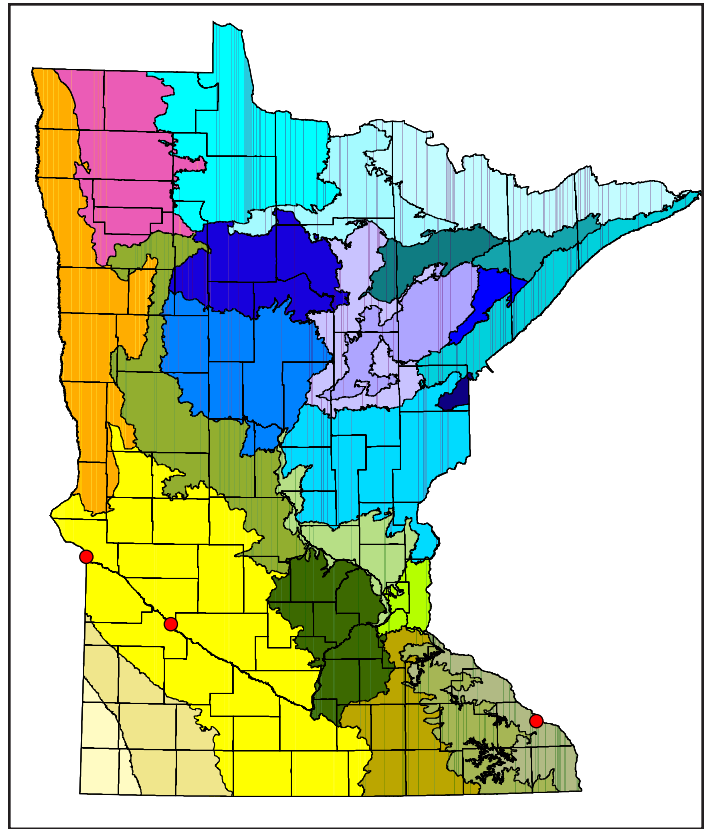
*Encalypta ciliata* (n=35)



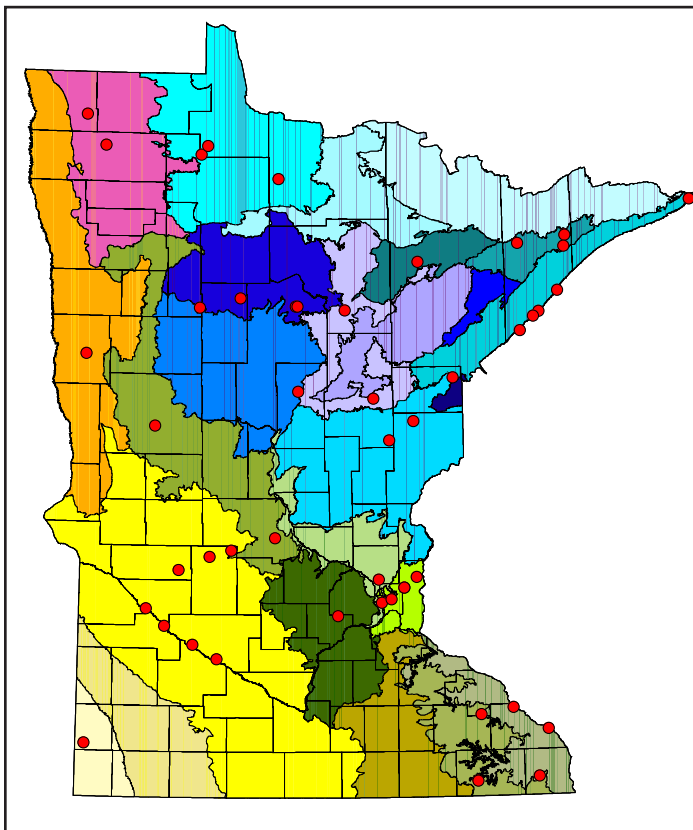
*Encalypta procera* (n=12)



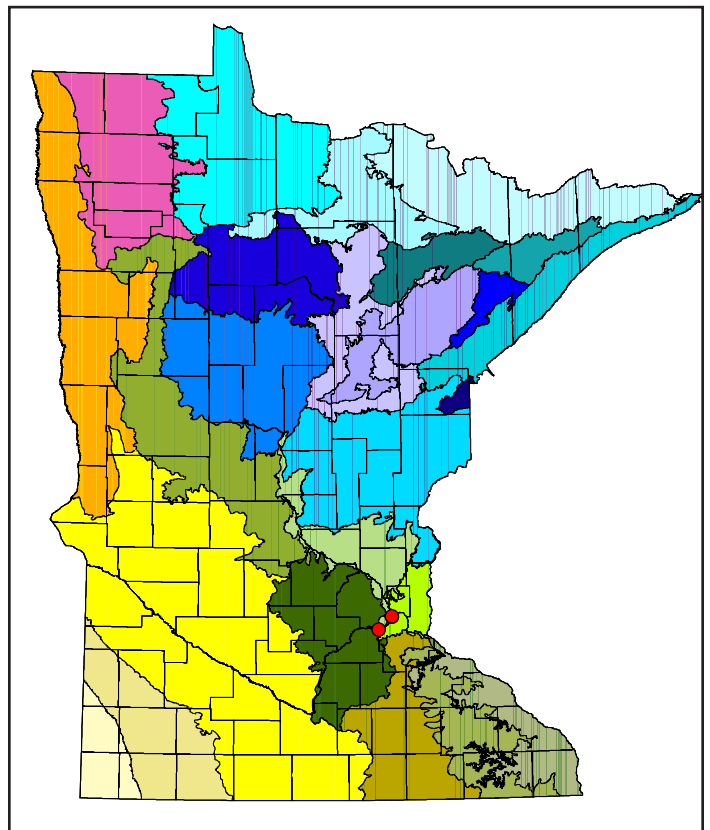
*Aphanorhegma serratum* (n=3)



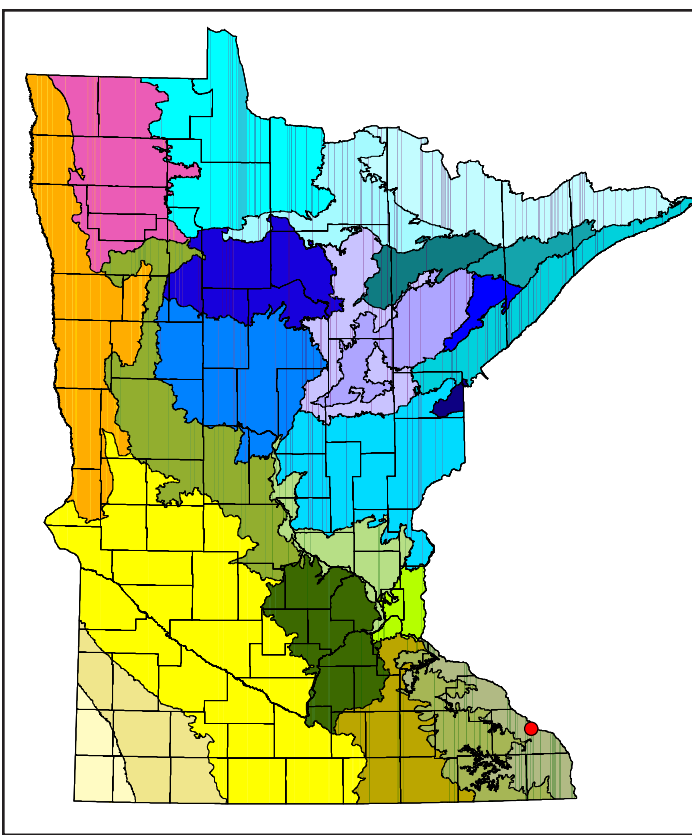
*Funaria americana* (n=4)



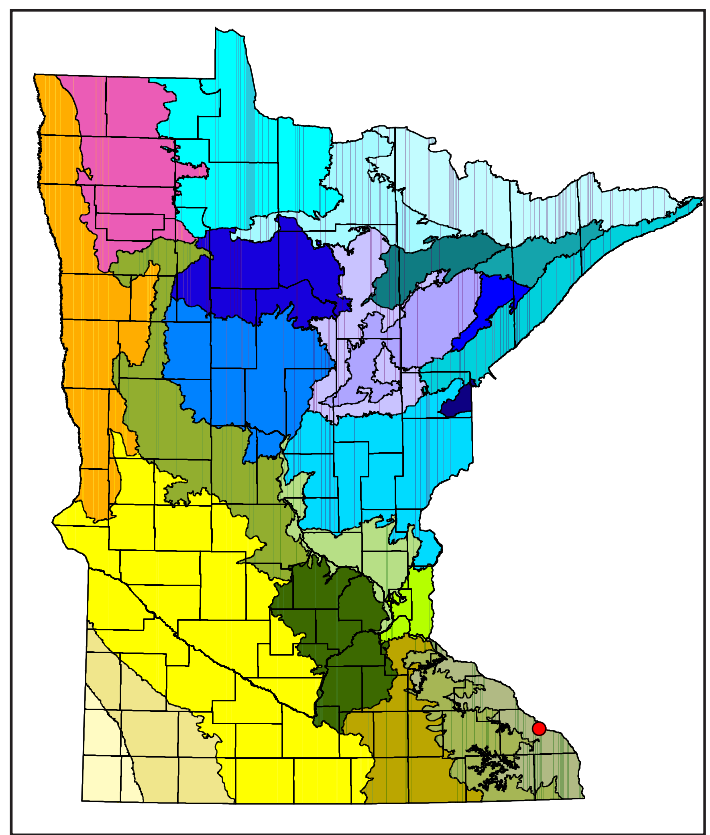
*Funaria hygrometrica* (n=57)



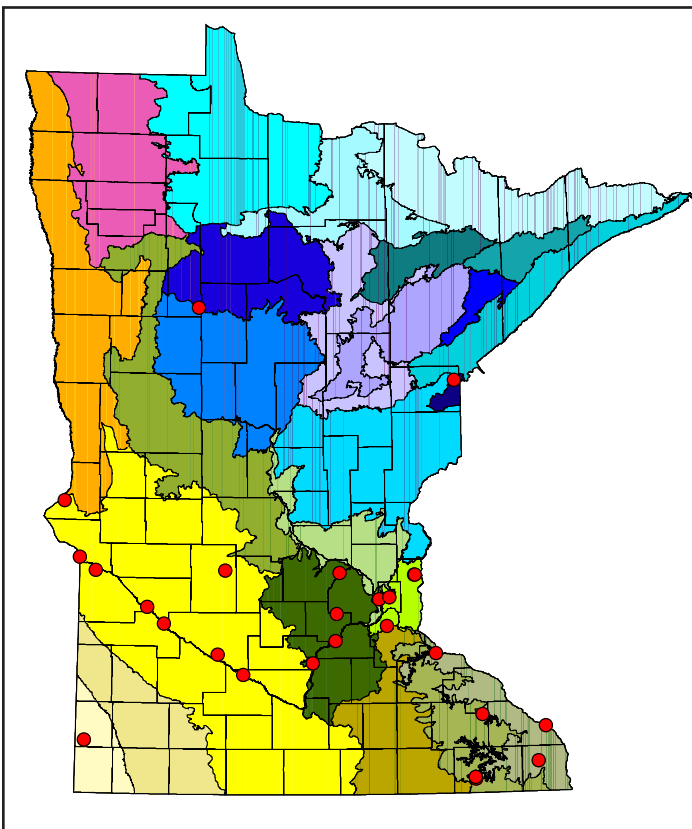
*Physcomitrella patens* (n=3)



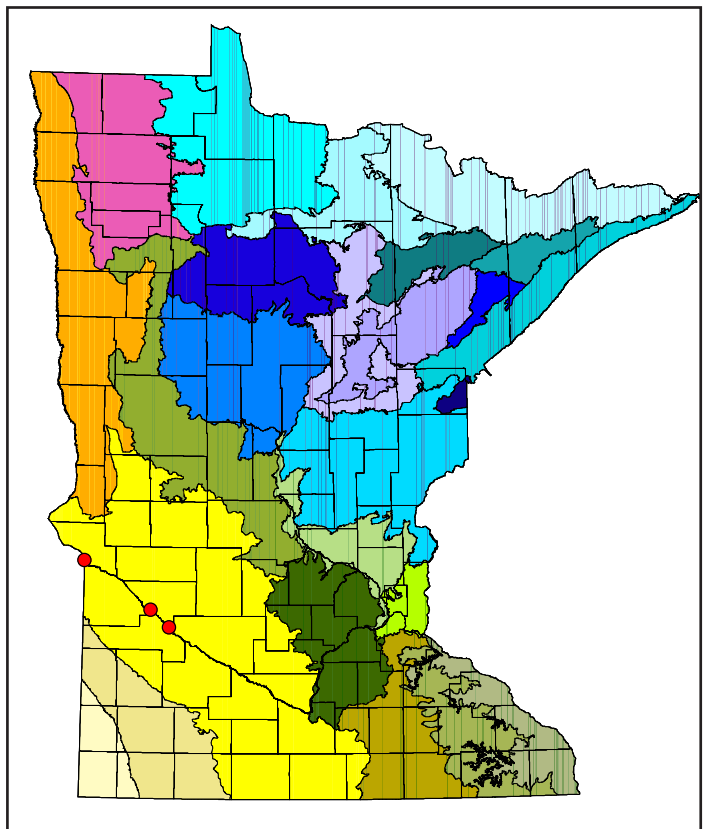
*Physcomitrium hookeri* (n=2)



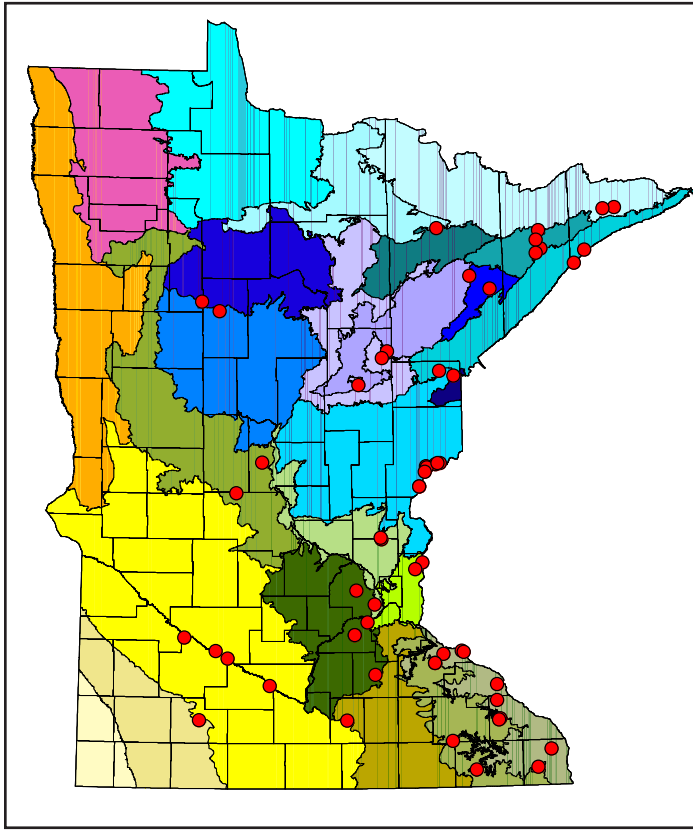
*Physcomitrium immersum* (n=2)



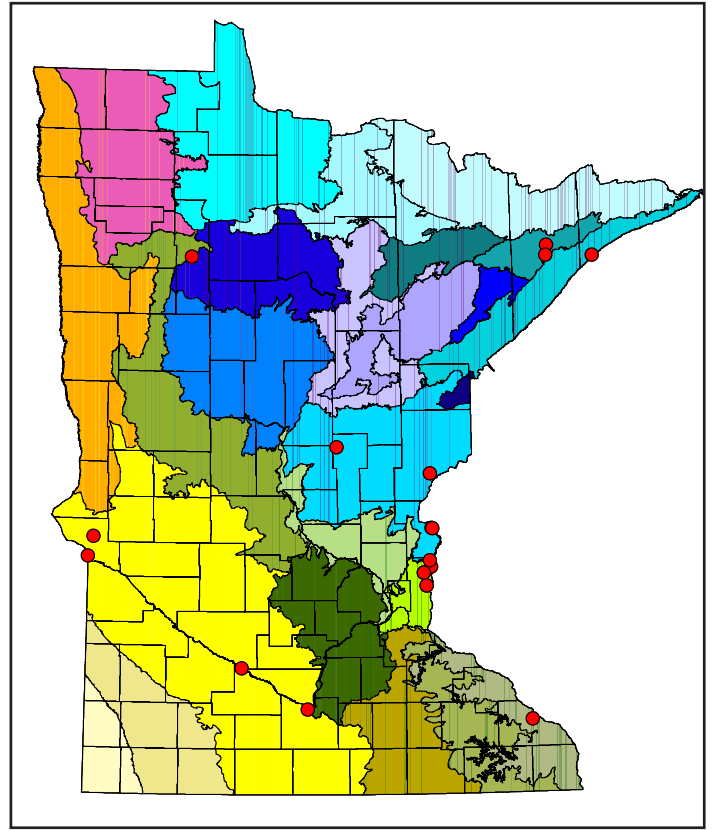
*Physcomitrium pyriforme* (n=34)



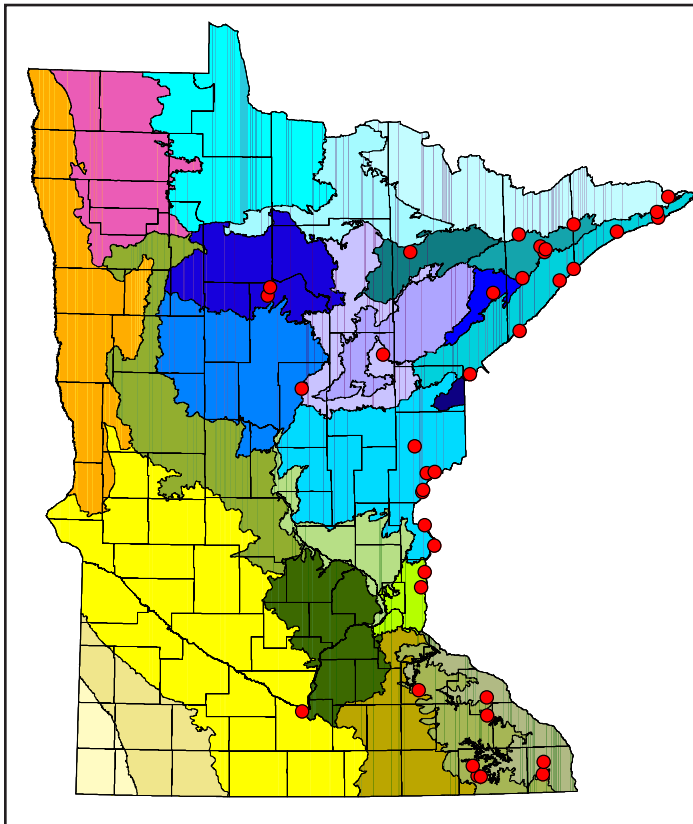
*Pyramidula tetragona* (n=4)



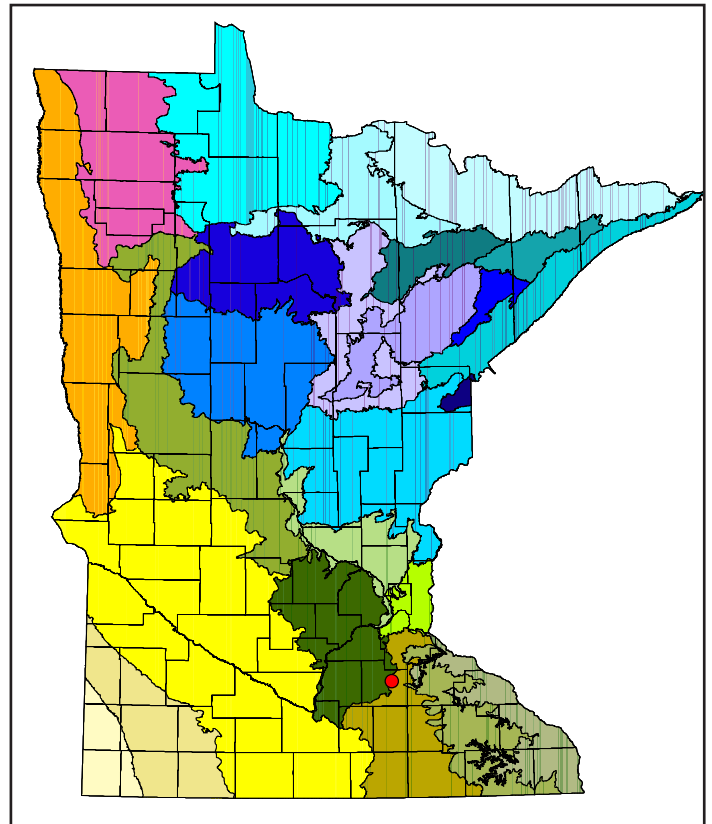
*Atrichum altecristatum* (n=91)  
(unconfirmed records from Chippewa, Itasca, Pipestone)



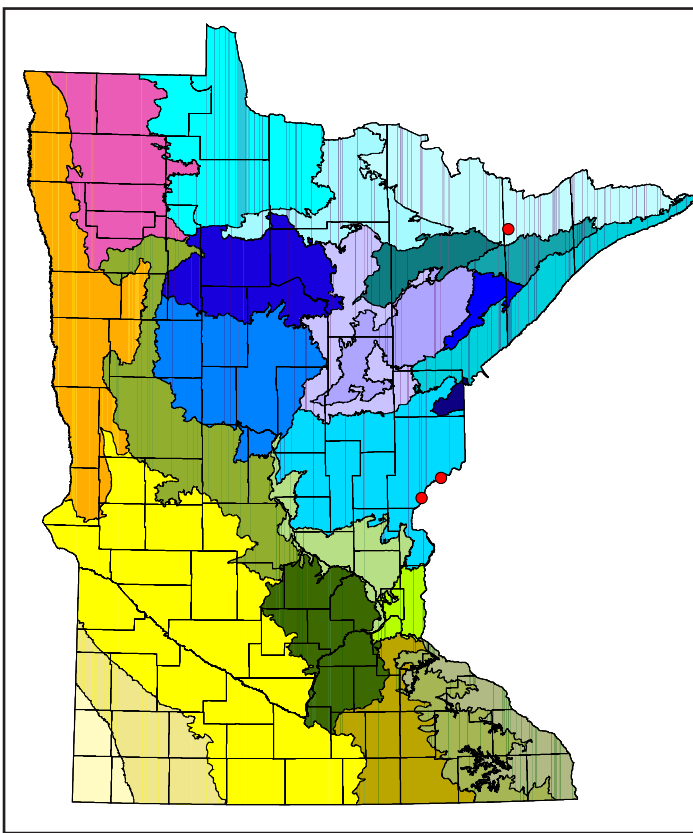
*Atrichum angustatum* (n=28)  
(unconfirmed records from Chippewa, Ramsey)



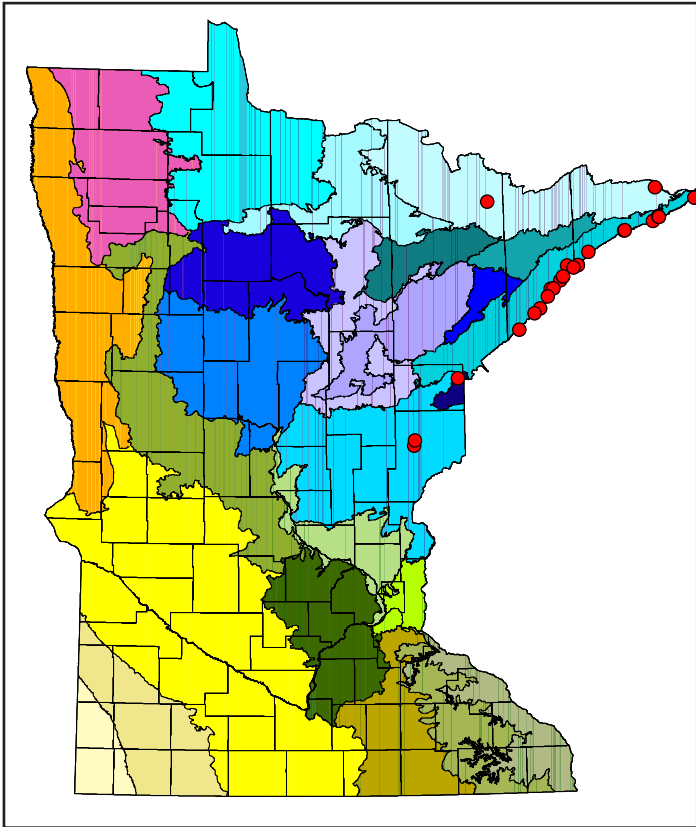
*Atrichum crispulum* (n=66)



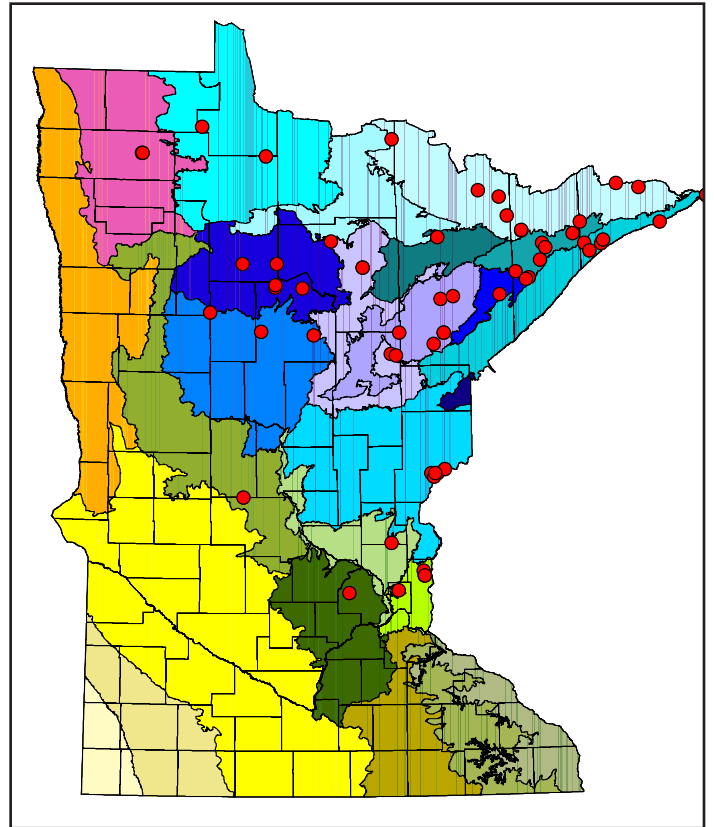
*Atrichum crispum* (n=1)



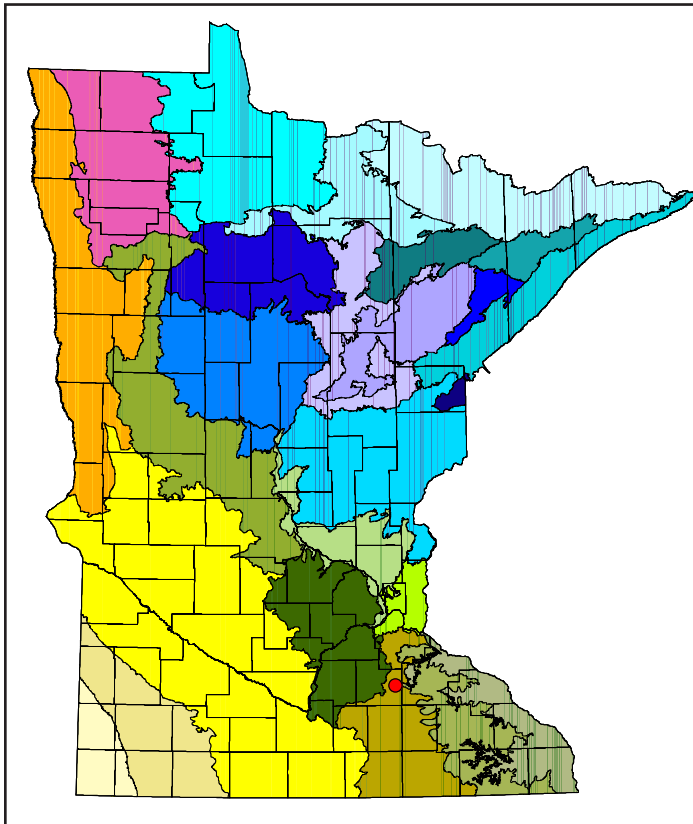
*Atrichum tenellum* (n=3)



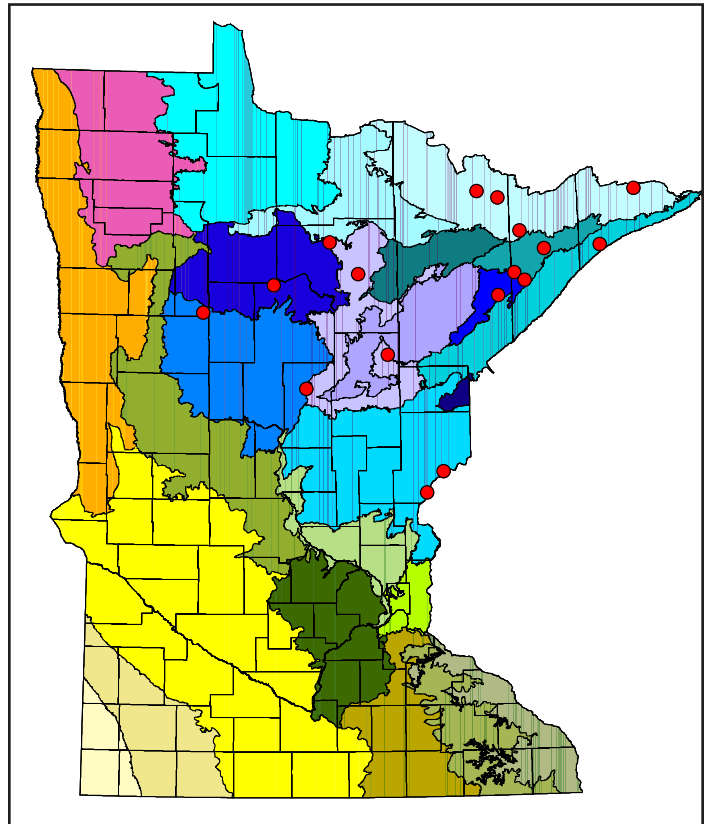
*Polytrichastrum alpinum* (n=75)



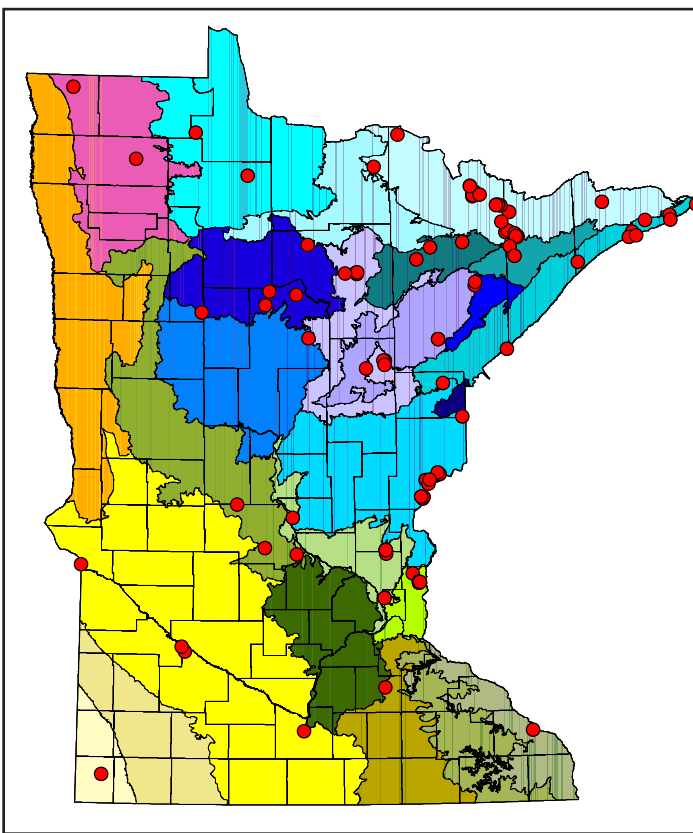
*Polytrichastrum longisetum* (n=115)  
(unconfirmed record from Chisago)



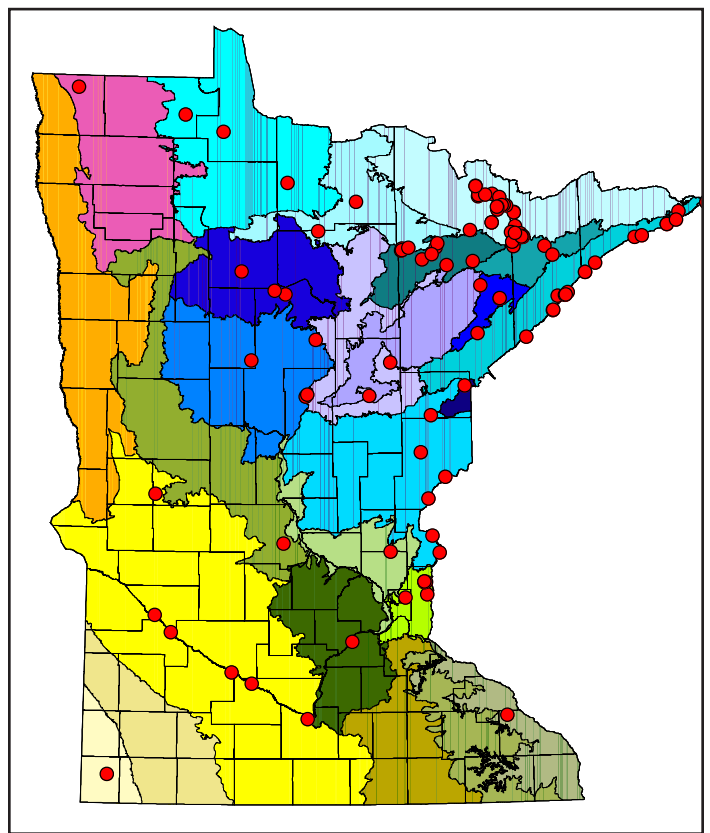
*Polytrichastrum ohioense* (n=1)  
(unconfirmed records from Clearwater, Cook, Winona)



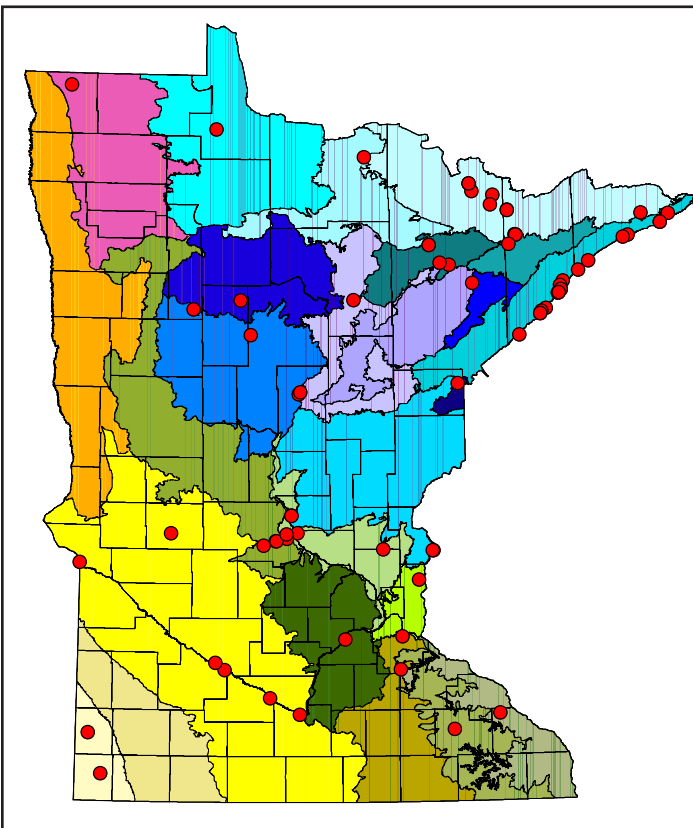
*Polytrichastrum pallidisetum* (n=35)  
(unconfirmed record from Winona)



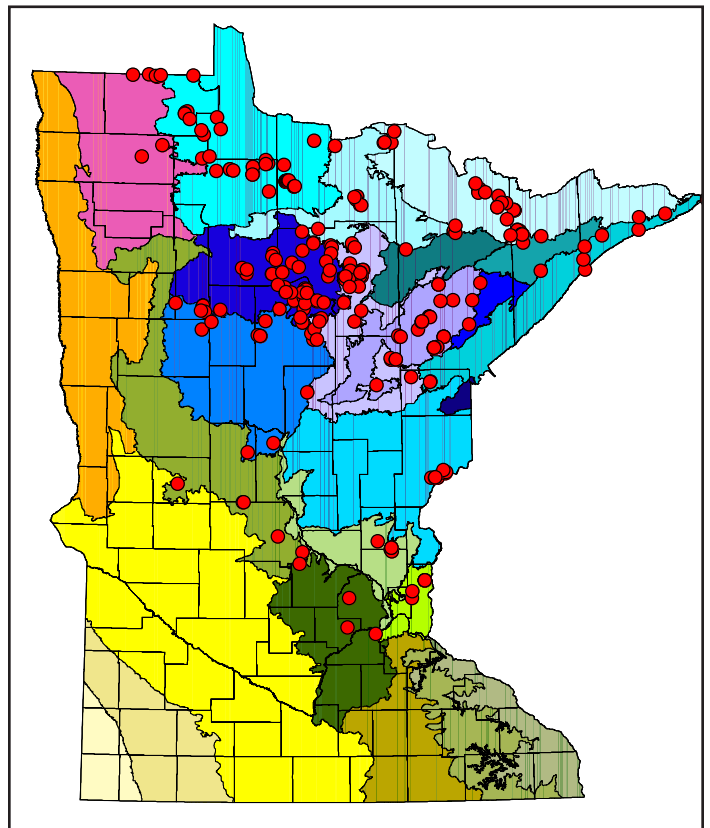
*Polytrichum commune* (n=214)  
(unconfirmed records from Chisago, Houston)



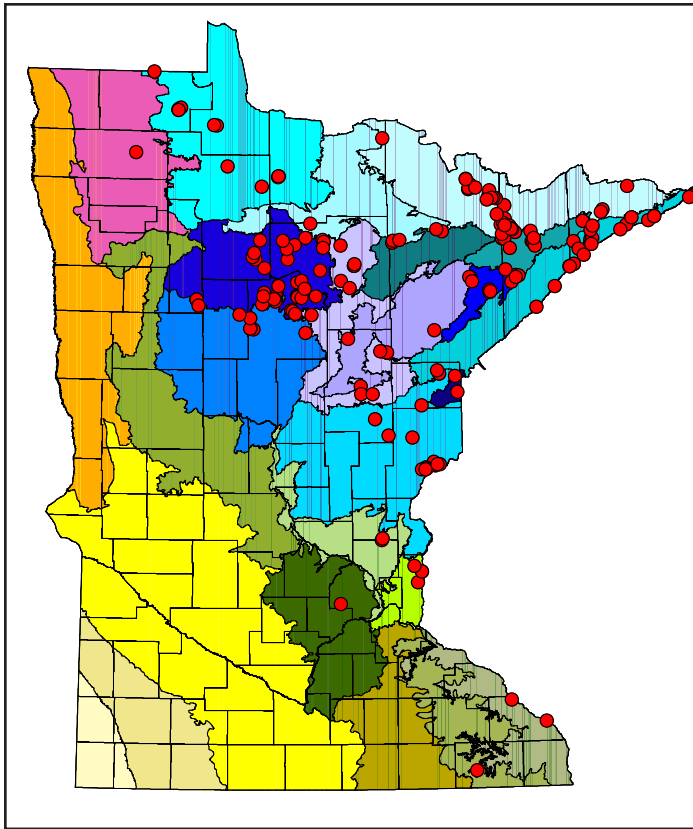
*Polytrichum juniperinum* (n=248)  
(unconfirmed records from Clearwater, Cottonwood, Dakota, Hennepin, Houston, Rice)



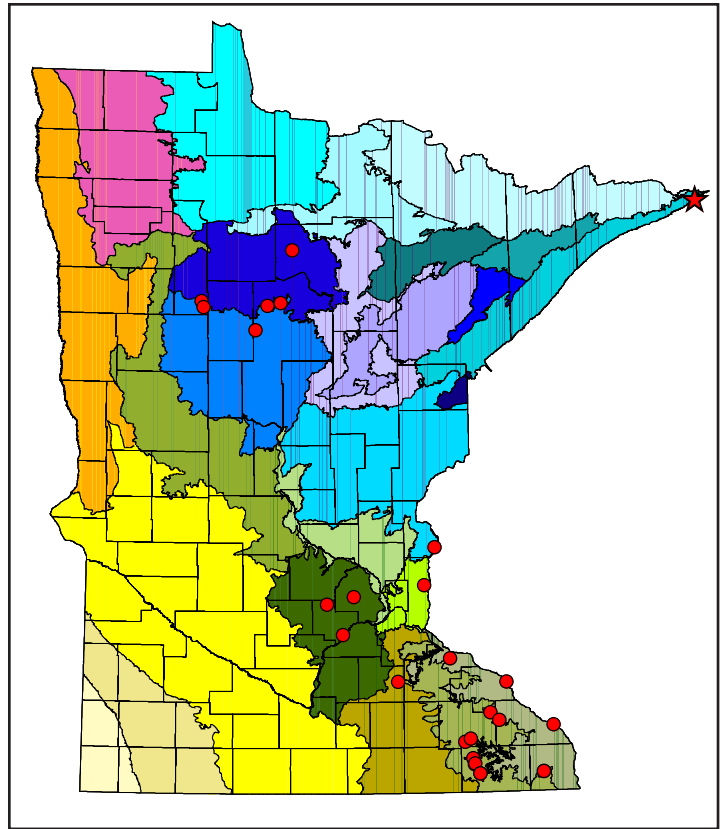
*Polytrichum piliferum* (n=114)  
(unconfirmed records from Cottonwood and Rice)



*Polytrichum strictum* (n=841)



*Tetraxis pellucida* (n=602)  
(unconfirmed CNABH record from Houston)



*Timmia megapolitana* (n=62)  
(dots = subsp. *megapolitana*; star = subsp. *bavarica*; unconfirmed CNABH records from Big Stone, Dakota, Kandiyohi, Redwood, St. Louis)