

[5. Shifted to left margin.—Ed.]

5. Endostome segments narrow, less than $\frac{1}{2}$ the length of the exostome teeth, or rudimentary.
7. Capsule symmetric or nearly so, seta strongly curved, axis of the capsule aligned with the seta 4. *Funaria polaris*
7. Capsule curved to nearly straight, horizontal to pendent from the seta.
8. Capsule nearly straight and cylindrical, mouth $\frac{2}{3}$ or more the diameter of the capsule, leaves tending to be broadly oblong-ovate 1. *Funaria flavicans*
8. Capsule curved and pyriform, mouth $\frac{1}{2}$ or less the diameter of the capsule, leaves tending to be oblong-lanceolate to oblanceolate 3. *Funaria microstoma*

1. *Funaria flavicans* Michaux, Fl. Bor.-Amer. 2: 303.
1803 [E]



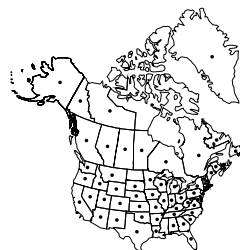
Plants 2–5 mm, with a basal antheridial branch, yellow-green. **Leaves** 2–3 mm, imbricate, concave, scarcely contorted when dry, broadly ovate to obovate, abruptly narrowed to an acuminate tip, margin entire or nearly so; laminal cells hexagonal to oblong-hexagonal distally, little

differentiated at the margins, becoming elongate toward the base. **Seta** 8–20 mm, straight to slightly flexuose, not or scarcely hygroscopic. **Capsule** 2–3 mm, ovoid-pyriform from a short neck, asymmetric by the weakly oblique mouth, inclined to horizontal, becoming striate and nearly cylindrical when dry and empty, annulus large and revoluble, operculum convex, exothecial cells narrowly oblong and transversely elongate in 3–5 rows below the mouth; peristome teeth yellowish, lanceolate, somewhat trabeculate proximally, becoming hyaline and appendiculate, fusing to form a latticed dome, papillose striate proximally, papillose at the tips; endostome segments about $\frac{1}{4}$ as long as the teeth, bluntly 2-lobed or emarginate, papillose. **Calyptra** cucullate, rostrate, smooth. **Spores** 18–30 μm , obscurely angled, finely papillose by low irregular ridges.

Sterile soil or gravel in disturbed areas such as burned over woods, around foundations, and roadsides; low to moderate elevations; Ont.; Ala., Ark., Conn., Fla., Ga., Ill., Ind., Iowa, Kans., Ky., La., Md., Miss., Mo., Nebr., N.Mex., N.C., Okla., S.C., Tenn., Tex.

Funaria flavicans is found throughout southeastern Canada and United States east of the Rockies. It differs from the weedy and variable *F. hygrometrica* in the barely hygroscopic seta, the slightly asymmetric capsule that becomes weakly plicate when dry, and the short segments of the endostome.

2. *Funaria hygrometrica* Hedwig, Sp. Musc. Frond.,
172. 1801



Plants 4–10 or more mm, with a basal antheridial branch, medium green to yellowish green; leafless proximally with leaves crowded and bulbiform distally, sometimes laxly foliate throughout. **Leaves** smaller proximally, distal leaves 2–4 mm, deeply concave, oblong-ovate to broadly obovate distally,

acute to apiculate or short-acuminate, entire or weakly serrulate distally; costa subpercurrent to short-excurrent; distal laminal cells thin-walled and inflated, hexagonal or oblong-hexagonal becoming much more oblong proximally. **Seta** usually (12–)20–45(–80) mm, slender and flexuose, usually hygroscopic. **Capsule** 2–3.5 mm, pyriform, asymmetric, curved to straight, horizontal to pendent or merely inclined or nearly erect, becoming sulcate when dry below the strongly oblique mouth; annulus revoluble, operculum slightly convex; peristome brown, papillose-striate proximally and papillose distally, strongly trabeculate, becoming appendiculate distally, forming a lattice by fusion of the tips; endostome segments lanceolate about $\frac{2}{3}$ as long as the teeth, yellowish, finely papillose-striate. **Calyptra** cucullate, smooth. **Spores** mostly 12–21 μm , finely papillose.

Varieties ca. 20 (2 in the flora): worldwide except Antarctica.

Funaria hygrometrica is one of the most common, weedy, and widely distributed mosses in the world; its distribution closely parallels that of *Bryum argenteum*. It is widely illustrated in textbooks to demonstrate the life cycle of a typical moss, possibly because of the abundant conspicuous sporophytes produced and its frequent presence in greenhouses. However, the peristome with opposite, instead of alternate, teeth in the two peristome rows is clearly atypical among the majority of mosses. Most of the varieties that have been described probably do not merit recognition because of the morphological plasticity of the species in response to environmental conditions.

1. Capsule 2–3.5 mm, horizontal to pendent, curved, capsule neck less tapered, mouth of capsule narrow 2a. *Funaria hygrometrica* var. *hygrometrica*
1. Capsule 2–3 mm, inclined to nearly erect, straight or weakly curved, capsule narrowly tapered to a long slender neck, mouth of capsule wide 2b. *Funaria hygrometrica* var. *calvescens*

2a. *Funaria hygrometrica* Hedwig var. *hygrometrica*



Funaria convoluta Hampe; *F. flaviseta* Warnstorff; *F. hygrometrica* var. *patula* Bruch & Schimper; *F. hygrometrica* var. *utahensis* Grout

Capsule 2–3.5 mm, horizontal to pendent, curved, neck only moderately tapered, mouth strongly oblique.

Bare mineral soil in disturbed habitats, greenhouses, campfire sites, and occasionally on wood or gravel; low to high elevations; Greenland; Alta., B.C., Man., N.B., Nfld. and Labr., N.W.T., N.S., Nunavut, Ont., P.E.I., Que., Sask., Yukon; Ala., Alaska, Ariz., Ark., Calif., Colo., Conn., Del., Fla., Ga., Idaho, Ill., Ind., Iowa, Kans., Ky., La., Maine, Md., Mass., Mich., Minn., Mo., Mont., Nebr., Nev., N.H., N.J., N.Mex., N.Y., N.C., Ohio, Okla., Oreg., Pa., R.I., S.C., S.Dak., Tenn., Tex., Utah, Vt., Va., Wash., W.Va., Wis., Wyo.; Mexico; Central America; South America; Europe; Asia (including Indonesia); Africa; Pacific Islands (New Zealand); Australia.

2b. *Funaria hygrometrica* var. *calvescens*

(Schwägrichen) Montagne, Ann. Sci. Nat., Bot., sér. 2, 12: 54. 1839



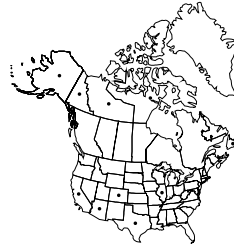
Funaria calvescens Schwägrichen, Sp. Musc. Frond. Suppl. 1(2): 77. 1816

Capsule 2–3 mm, inclined to nearly erect, straight or weakly curved, narrowly tapered to a long slender neck, mouth nearly parallel to the axis of the capsule.

Soil, disturbed habitats such as partially shaded building foundations; low elevations; Ariz., Fla., Ga., La., N.C., S.C., Tenn., Tex.; Mexico; West Indies; Central America; South America; Africa.

Variety *calvescens* seems to be a tropical expression of the species although it is known from a few southern states in the United States. H. A. Crum and L. E. Anderson (1981) suggested that the name has been misused to the extent that other North American records outside the southeastern United States should be ignored. This variety is apparently widely distributed in tropical latitudes.

3. *Funaria microstoma* Schimper, Flora 23: 850. 1840



Plants 4–6 mm, light green. **Leaves** 2–3 mm proximally on the stem, distal leaves 4–5 mm, somewhat crowded distally, oblong-lanceolate to oblanceolate, narrowly acuminate, entire; costa ending in the slender apex; distal laminal cells thin-walled, oblong-hexagonal to rhombic-hexagonal,

becoming longer proximally. **Seta** usually 20–25 mm, slender, hygroscopic, becoming twisted when dry. **Capsule** 1.5–2.5 mm, obovoid, strongly asymmetrical and curved, inclined to horizontal, becoming sulcate when dry; annulus revoluble; operculum low-conic, small, about 0.5 mm or less than half the diameter of the mature, undehisced capsule; peristome teeth brownish basally, slender, appendiculate in the distal hyaline portion; endostome a low, irregular membrane partially adherent to the teeth. **Calyptra** cucullate, rostrate, smooth. **Spores** 22–27 µm, papillose to finely baculate-insulate.

Moist, often gravelly, mineral soil; low to high elevations; Nfld. and Labr. (Nfld.), N.W.T., Nunavut, Yukon; Alaska, Ariz., Calif., Colo., Ill., R.I., Tex.; South America; Europe; Asia; Australia.

Funaria microstoma has not often been recognized by North American collectors. It may be overlooked because it is found in habitats where the similar *F. hygrometrica* might be expected. It can be distinguished in the field with a hand lens by the small capsule mouth and the narrow leaves near the stem tip.

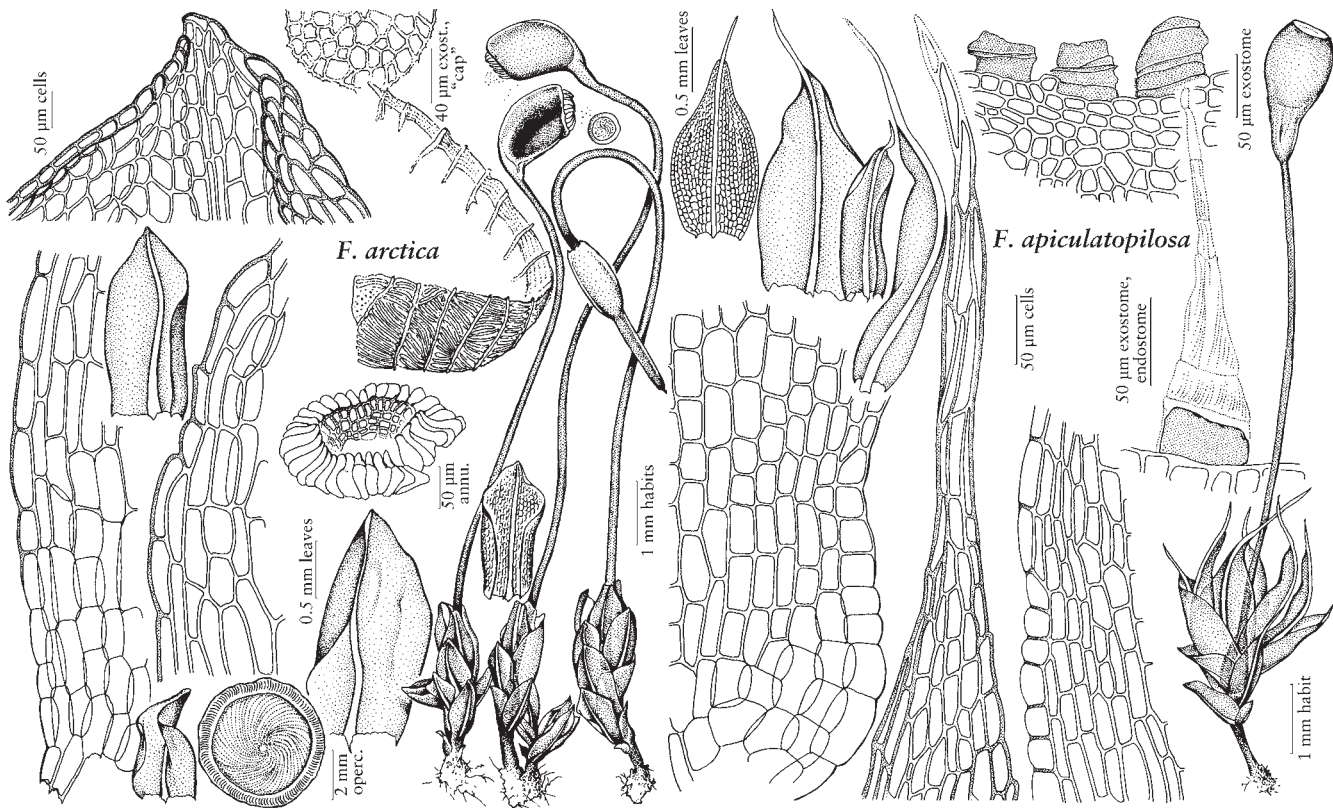
4. *Funaria polaris* Bryhn, Bryoph. Itin. Pol. Norv., 70.

1906 [E] [F]



Plants 2–5 mm, with a basal short antheridial branch, green. **Leaves** 1.7–2.5 mm, concave, clustered at the apex of the stem, ovate, oblong-ovate to obovate, abruptly narrowed to a short, acuminate tip, margin entire; costa ending in the acumen, sometimes as a minute reflexed apiculum; distal

laminal cells hexagonal to rhombic-hexagonal, becoming elongate proximally, little differentiated at the margins. **Seta** 8–15 mm, flexuose curved to cygneous or sigmoid, hygroscopic. **Capsule** 1.5–2 mm, pyriform from a short neck, generally pendent from the strongly curved seta, mouth oblique on the weakly curved capsule, somewhat sulcate when dry and empty, annulus revoluble, operculum scarcely convex; peristome inserted below the rim of the mouth, teeth lanceolate, golden brown basally and hyaline at the tips, trabeculate and scarcely striolate



FUNARIA

papillate basally, weakly appendiculate and nearly smooth in the hyaline portion; endostome segments smooth, short and blunt extending from a narrow basal membrane less than $\frac{1}{4}$ the length of the exostome. Calyptra cucullate, rostrate, smooth. Spores 18–23 μm , very finely papillose.

Mineral soil or sand, often at the entrance to lemming burrows; low to moderate elevations; Greenland; N.W.T., Nunavut, Yukon; Alaska.

Two small species of *Funaria* with variously contorted setae, *F. polaris* and *F. arctica*, occur at higher latitudes in North America. Both occur on mineral soil, sand, or gravelly sand in moist situations such as river banks but, so far, only the former is known from the entrance of lemming burrows although it has been collected elsewhere. As seen through a hand lens, the two species can be separated in the field by the attenuated leaf tip of *F. polaris* in sharp contrast to the broad and blunt leaves of *F. arctica*.

5. *Funaria arctica* (Berggren) Kindberg, Eur. N. Amer. Bryin. 2: 330. 1897 [E] [F]



Funaria hygrometrica var. *arctica*
Berggren, Kongl. Svenska Vetensk.
Acad. Handl., n. s. 13(7): 57. 1875;
F. groutiana Fife; *F. microstoma* var.
obtusifolia Grout

Plants 2–5 mm, green to yellow-green, stem with a few scale-like leaves proximally becoming crowded and bulbiform distally.

Leaves few and small proximally, distal leaves 1.5–2.5 mm, concave, broadly oblong-ovate to broadly obovate distally, some approaching a length-width ratio of 1.2:1, broadly acute to (mostly) obtuse with a few tiny teeth at the point, entire basally; costa percurrent; distal laminal cells thin-walled, elongate-hexagonal, soon becoming elongate oblong-rectangular proximally. Seta usually 7–12 mm, hygroscopic, sometimes cygneous when young and becoming variously contorted at maturity. Capsule 1.5–2 mm, obovate, weakly to moderately curved, inclined to horizontal, wrinkled when dry, mouth slightly oblique and nearly the diameter of the capsule, annulus revoluble, operculum convex; peristome inserted just

below the rim at the mouth of the capsule, teeth lanceolate, golden brown below and hyaline at the tips, trabeculate and papillate-striate basally becoming spiculate-papillate toward the hyaline tip that is appendiculate and papillate distally, endostome a low, transparent, almost smooth membrane 3–5 cells high with rounded segments of 1–3 cells. **Calyptra** cucullate, smooth. **Spores** 25–32 μm , finely papillose.

Sand or mineral soil along rivers but not yet reported from the mouth of lemming burrows, moderate to high latitudes; Greenland; N.W.T., Nunavut, Yukon; Alaska.

Two small species of *Funaria*, *F. polaris* and *F. arctica*, are found in somewhat similar habitats in higher latitudes on sand or other mineral soil. They grow in admixture with other pioneer species of mosses as well as with each other, on newly exposed sites. In order to be certain of the identity of a particular plant, the collection should be examined individually and the desired species selected and isolated. In practice, it can be done quickly and efficiently using a dissecting microscope at about 30 \times depending on the condition of the material. Blunt-leaved forms belong to *F. arctica* and those with acuminate tips are *F. polaris*. Additional features separating them include the curved versus straight capsule, spore size, and the appendiculae combined with surface of the hyaline portion of the peristome teeth.

6. *Funaria apiculatopilosa* Cardot, Rev. Bryol. 40: 37. 1913 [F]



Entosthodon apiculatopilosus (Cardot) Fife; *Funaria orcuttii* Bartram

Plants 3–5 mm, yellowish green, stem with leaves crowded at the tip forming a bulbiform spiral when dry and bearing a short antheridial branch at the base.

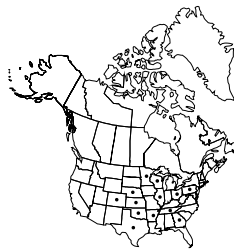
Leaves few and reduced proximally, distal leaves 1.7–2.3 mm, concave, the blade ovate to obovate, abruptly contracted to a flexuose, hyaline tipped awn, distal blade margins weakly crenulate to rounded serrate above, entire proximally; costa strong, excurrent with the distal end hyaline; distal laminal cells thin-walled, rhomboid to elongate-hexagonal, proximal cells short-rectangular to almost quadrate toward the margins becoming oblong-rectangular near the costa. **Seta** usually 3–6 mm, flaring into a slender neck, hygroscopic. **Capsule** 1.5–2 mm, inclined to arcuate, asymmetric, obovoid, mouth oblique; annulus none; operculum conic-convex; peristome inserted below the rim of the mouth; exostome transparent and papillose, of low, truncate segments about $\frac{1}{4}$ the length of the teeth, endostome teeth lanceolate, reddish with a hyaline tip, obliquely papillose-striate to the papillose hyaline tip, trabeculae weakly developed, appendiculae almost absent

in the tip. **Calyptra** cucullate, smooth. **Spores** 22–30 μm , nearly smooth to papillose.

Sand mixed with clay; moderate to high elevations; Tex.; Mexico (Puebla, Zacatecas)

Funaria apiculatopilosa is clearly distinct from other exannulate members of the genus in the very long-excurrent sinuose costa with a hyaline tip. The distal leaves spiral around the base of the seta when dry, and are spreading when moist. The trabeculae are thin, lightly pigmented and relatively few, and the spores are thin-walled. It is known from the Davis Mountains in Texas.

7. *Funaria americana* Lindberg, Öfvers. Kongl. Vetensk.-Akad. Förh. 20: 398. 1863



Entosthodon americanus (Lindberg) Fife

Plants 2–5 mm, pale olive green, stem with leaves crowded at the tip, and bearing a short antheridial branch at the base. **Leaves** larger distally and reduced proximally, distal leaves 2–3 mm, erect spreading, the blade elliptic to

oblong-lanceolate or obovate gradually narrowed to a slender acumen, distal blade margins entire to weakly serrulate distally and entire proximally; costa narrowing distally and ending in the acumen; distal laminal cells thin-walled, rhomboid to oblong-hexagonal, somewhat narrowed at the margins, proximal cells becoming rectangular toward the base. **Seta** 6–10 mm, nearly straight. **Capsule** 1.5–2 mm, inclined, asymmetric, elongate-pyriform from a neck nearly as long as the spore sac, shrunken below the mouth but not plicate when dry; annulus none, operculum short-conic; peristome teeth lanceolate-triangular, dark yellow-brown, papillose-striate throughout, trabeculae distinct but moderately thickened, weakly appendiculate and extending into the tip; endostome segments about $\frac{3}{4}$ the length of the teeth, triangular basally, narrowing midway to a slender tip, finely papillose. **Calyptra** cucullate, smooth. **Spores** 25–30 μm , somewhat angled, finely rugose-verrucate.

Exposed calcareous soils among loosely tufted grasses or in moist bright disturbed habitats in early spring; low to moderate elevations; Ark., Colo., Ga., Ill., Kans., Minn., Nebr., Ohio, Okla., Pa., Tenn., Tex., Wis.; Mexico.

Funaria americana has been reported mainly from the area between the Appalachians and the Rocky Mountain divides, and it is reputed to be most likely encountered in disturbed microhabitats along river bluffs. Confusion has existed between the application of the names *F. americana* and *F. muhlenbergii*, as explained by H. A. Crum and L. E. Anderson (1981). Generally, collections from North America east of the Rockies continental divide belong to *F. americana*, and those from the western states belong to *F. muhlenbergii*, a species originally

described from Europe. Such disjunctions are known for a number of genera and species of terrestrial plants. The costa extending nearly to the tip of the long leaf acumen is diagnostic. In *F. muhlenbergii*, the costa clearly ends before the short slender acumen.

8. *Funaria muhlenbergii* Turner, Ann. Bot. (Koenig & Sims) 2: 198. 1805



Funaria calcarea Wahlenberg;
F. mediterranea Lindberg

Plants 2–6 mm, green to yellow-green, leaves crowded at the tip. **Leaves** few and scale-like proximally, distal leaves 1.5–3 mm, oblong-lanceolate to ovate or occasionally oblong-ovate, narrowed to a slender acuminate tip

to about $\frac{1}{6}$ the leaf length, entire to serrulate distally and entire proximally, costa ending at the base of or before the acumen; distal laminal cells short-rhomboid to rhomboid-hexagonal, becoming oblong-rectangular proximally and narrowing at the basal margins. **Seta** 5–15 mm, reddish, nearly straight. **Capsule** 2–3 mm, inclined, asymmetric, pyriform with the neck as long as the spore sac, scarcely wrinkled and little contracted below the mouth when dry; annulus none; operculum conic-rounded; peristome teeth linear-lanceolate, reddish brown basally, hyaline at the tips, strongly trabeculate and appendiculate, papillose-striate throughout; endostome segments narrowly lanceolate and about $\frac{2}{3}$ the length of the teeth, papillose. **Calyptra** cucullate, long-rostrate. **Spores** 21–30 μm , baccate insulate.

Bare, apparently alkaline, soils; moderate elevations; B.C., Yukon; Alaska, Ariz., Calif., Colo., Mont., N.Mex., Tex., Utah, Wash.; Mexico; Central America; Europe; Asia (Israel); n Africa.

The apparent rarity of *Funaria muhlenbergii* in semi-arid portions of the West may be due to the maturation of the species in early spring when the weather is cool and wet, and moisture is available from winter rains and melting snow. S. Flowers (1973) provided a good illustration of American plants.

9. *Funaria serrata* Bridel, Musc. Recent., suppl. 3: 70. 1817 [E]



Plants small to medium-sized, gregarious or caespitose. **Stems** 2–6(–10) mm, erect, simple except for a basal antheridial branch. **Leaves** crispate to contorted when dry, erect to spreading when moist, oblong-ovate to broadly obovate, concave, 1.5–3(–10) mm; apices acute to acuminate; margins entire

to serrate distally; costa single, subpercurrent to excurrent; proximal laminal cells elongate-rectangular, distal cells rhombic-hexagonal to rectangular. **Sexual condition** autoicous; antheridial branches 1–2, basal, perigonal paraphyses clavate with an enlarged inflated cell. **Seta** erect to strongly curved or twisted, (3–)7–20 (–80) mm. **Capsule** stegocarpous, usually inclined to pendent, exserted, asymmetric and usually curved, pyriform, 1.5–3 mm, often sulcate or plicate when dry and empty; exothecial cells oblong-hexagonal to linear, walls incrassate especially so on inner tangential wall; stomata immersed; annulus large and revoluble or not differentiated; operculum convex to weakly conic, usually oblique to the axis of the capsule, cells in obliquely radial rows; peristome double, teeth well developed, oblique, lance-acuminate, papillose-striate, often strongly trabeculate, frequently appendiculate at the tips and fusing with a latticed disk, endostome segments opposite the teeth, $\frac{1}{6}$ or more the length of the teeth, papillose or weakly papillose-striate with a basal membrane, cilia absent. **Calyptra** cucullate, often long-rostrate, large, usually smooth. **Spores** spherical, smooth or papillose to baccate-insulate.

Soil in disturbed places, often near streams or ditches; low to moderate elevations; Ala., Ark., Del., Fla., Ga., La., Miss., N.C., Okla., S.C., Tenn., Tex.

Funaria serrata occurs along the coastal plain. The absence of an annulus on the strongly curved capsule and the leaves serrate nearly to the base are distinctive traits for this species.

4. PHYSCOMITRELLA Bruch & Schimper, Bryol. Europ. 1: 13. 1849 • [Genus *Physcomitrium* and Latin *-ella*, diminutive]

Bernard Goffinet

Plants small, scattered to gregarious. **Stems** 3–3.5 mm, erect, simple or forked. **Leaves** somewhat crisped when dry, erect-spreading when moist, lanceolate, ovate-lanceolate, or obovate, plane to weakly concave, 2–2.5 mm; margins entire to serrulate distally; apices acuminate; costa single, extending $\frac{1}{2}$ – $\frac{2}{3}$ of the leaf length, occasionally slightly forked at apex, or percurrent; proximal

laminal cells rectangular, distal cells short-rectangular to rhombic with narrow ends. **Sexual condition** paroicous. **Seta** erect, to 0.2 mm. **Capsule** cleistocarpous, erect, immersed, symmetric, globose and apiculate, to 0.8 mm, wrinkled upon aging; exothecial cells irregular in shape, usually thin-walled; stomata with single guard cell, restricted to base of capsule, superficial; annulus none; operculum not differentiated, dehiscence irregular; peristome absent. **Calyptra** conic-mitrate, not or slightly lobed, small, covering apiculus of capsule only, smooth. **Spores** spherical to slightly elliptical, densely papillose to slightly spinulose.

Species 2 (2 in the flora): North America, c, n Europe, Asia (China, Japan, w Siberia), Africa, Australia.

Physcomitrella is distinguished from other Funariaceae by the immersed capsule with irregular dehiscence, and the thin-walled, translucent exothecial cells. The generic name implies a resemblance to *Physcomitrium*, which is named, however, for its large calyptra, unlike that of *Physcomitrella*.

- 1. Costa extending to at most 2/3 the length of the leaf. 1. *Physcomitrella readeri*
- 1. Costa extending to leaf apex 2. *Physcomitrella patens*

1. *Physcomitrella readeri* (Müller Hal.) I. G. Stone & G. A. M. Scott, *J. Bryol.* 7: 604. 1974 [F]



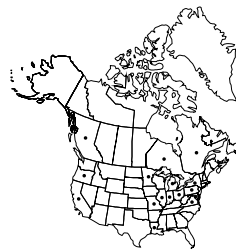
Ephemerella readeri Müller Hal., *Hedwigia* 41: 120. 1902;
Physcomitrella californica H. A. Crum & L. E. Anderson; *P. patens* subsp. *californica* (H. A. Crum & L. E. Anderson) B. C. Tan; *P. patens* subsp. *readeri* (Müller Hal.) B. C. Tan

Plants to 4.5 mm. **Stems** to 3 mm, branching near base. **Leaves** to 2 × 0.6 mm, ovate-lanceolate, acuminate, margins plane, serrulate in distal 1/3; costa extending 1/2–2/3 of the leaf length, occasionally slightly forked at apex; proximal cells 75–180 × 35–60 µm, distal cells 45–115 × 15–50 µm, marginal cells not differentiated. **Calyptra** entire at base, often with a single slit extending toward apex. **Spores** 27–42 µm.

Capsules mature Jan–Apr. Mineral soil (mudflats) in lake banks; low elevations; Calif.; Asia (China, Japan); Pacific Islands (New Zealand); Australia.

Physcomitrella readeri is distinguished from the sympatric *P. patens* mainly by its shorter costa. The size of the rostrum has also been given taxonomic significance, but capsules of *P. patens* may also bear an apiculum reaching 0.2 mm. Similarly, the forked costa has been considered diagnostic of *P. readeri*, but this feature is not constant. The status of *P. readeri* has been repeatedly debated, but the geographic restriction of plants with short costae to a circum-Pacific range may justify taxonomic recognition. *Physcomitrella readeri* grows with *P. patens* in two localities in California.

2. *Physcomitrella patens* (Hedwig) Bruch & Schimper, *Bryol. Europ.* 1: 13. 1849 [F]

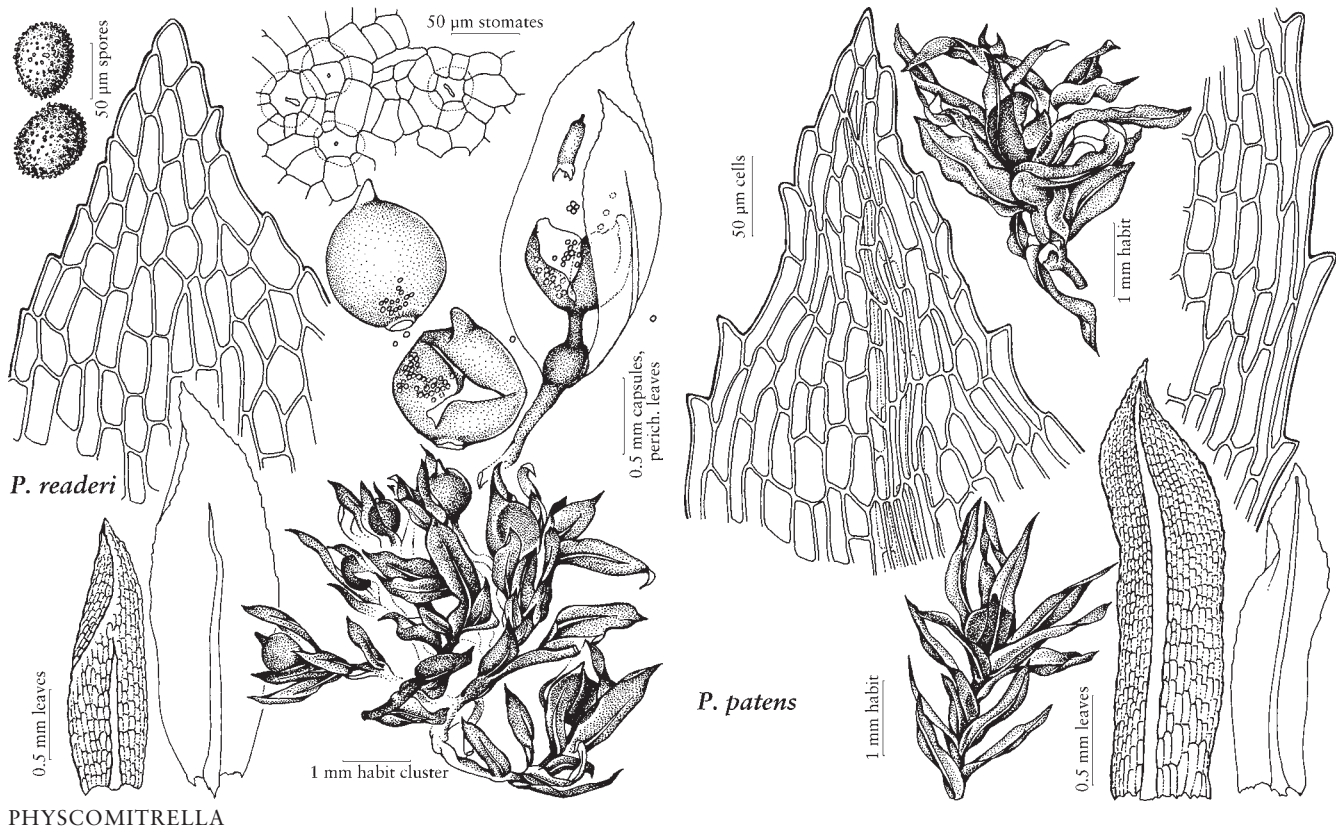


Phascum patens Hedwig, *Sp. Musc. Frond.*, 20. 1801; *Aphanorrhagma patens* (Hedwig) Lindberg

Plants to 5 mm. **Stems** to 3.5 mm. **Leaves** to 2.5 × 1 mm, lanceolate or ovate-lanceolate to obovate, acuminate, not or weakly concave, margin of lanceolate leaves somewhat reflexed when dry, serrulate in distal 1/3, rarely below leaf median; costa ending near apex; proximal cells 65–135 × 15–45 µm, distal cells 36–66 × 12–27 µm; marginal cells sometimes longer than medial laminal cells, reaching 150 µm. **Calyptra** entire at base. **Spores** 21–33 µm.

Capsules mature Aug–Jan. Early pioneer on wet mineral soil, river banks, fields; low to moderate elevations; B.C., Ont., Que.; Calif., Ill., Ind., La., Md., Mich., Minn., Mo., N.Y., Ohio, Oreg., Pa., Va; c, n Europe; Asia (w Siberia).

Physcomitrella patens is fairly variable in leaf shape and stature. The species is similar to *Aphanorrhagma*, with which it is broadly sympatric, but far less common. It differs from *A. serratum* by the thin-walled exothecial cells and the unlobed calyptra.



PHYSCOMITRELLA

5. **PHYSCOMITRIUM** (Bridel) Bridel, Bryol. Univ. 2: 815. 1827 • [Greek *physa*, bladder, and *mitrion*, little turban, alluding to often urn-like calyptra]

Terry T. McIntosh

Gymnostomum subg. *Physcomitrium* Bridel, Bryol. Univ. 1: 97. 1826

Plants small, scattered to gregarious. Stems 2–10(–25) mm, erect, simple or forked. Leaves crispate to contorted when dry, erect to spreading when moist, ovate-lanceolate, ovate, to obovate, sometimes concave and cucullate, 1.2–5 mm; margins entire to serrulate distally; apices somewhat blunt, or acute to acuminate; costa single, subpercurrent to short-excurrent; proximal laminal cells elongate-rectangular to rectangular, distal cells rectangular to hexagonal. **Sexual condition** autoicous, occasionally polygamous; perigonia at apices of short basal or lateral branches, usually with clavate paraphyses; perichaetia at stem apex, with a few filiform paraphyses. **Seta** erect, 0.5–13(–30) mm. **Capsule** stegocarpous, erect, immersed to exerted, symmetric, ovoid, globose, pyriform, or campanulate, often urceolate when dry, mouth sometimes flaring, 0.8–3 mm, smooth, neck usually wrinkled when dry; exothecial cells irregularly isodiametric, hexagonal, or oblong, sometimes collenchymatous; a few stomates usually present in neck, superficial; annulus narrow, consisting of 1–2 rows of small cells or revoluble as fragments of large cells; operculum convex to conic, apiculate to rostrate; peristome absent. **Calyptra** mitrate, deeply split into (2–)3(–4) spreading lobes, long-rostrate, sometimes inflated at the base, usually large, smooth. **Spores** spherical to sub-reniform, papillose to spinulose.

Physcomitrium is characterized by erect, symmetrical, and often urn-like capsules that lack peristomes. Infra-species variation of both the sporophyte and gametophyte of *Physcomitrium pyriforme* has led to many species being described over time in North America.

Species ca. 80 (4 in the flora): temperate North America, Mexico, Central America, South America, Europe, Asia, Africa, Australia.

Physcomitrium commonly occurs on exposed soil often associated with spring-wet sites, often on alluvial mud and river banks, from near sea level to ca. 2500 m, and the capsules mature over winter into spring.

- 1. Capsules immersed 3. *Physcomitrium immersum*
- 1. Capsules emergent to exserted.
 - 2. Leaves entire, rarely with somewhat uneven margins distally; annulus revoluble, composed of large, inflated, mostly deciduous cells 2. *Physcomitrium hookeri*
 - 2. Leaves often toothed distally; annulus of small, non-inflated, adherent cells.
 - 3. Plants 2–4(–5) mm; leaves to 2 mm long; seta 2–3 mm; capsules often shallow and wide-mouthed when dry; suboral cells weakly differentiated, usually consisting of 2–6 rows of irregularly isodiametric cells, spores less than 40 μm 1. *Physcomitrium collenchymatum*
 - 3. Plants commonly 3–10 mm; leaves usually to 2–5 mm; seta mostly 4–14 mm; capsules deeper, rarely wide-mouthed when dry; suboral cells strongly differentiated, consisting of 7–12 rows of transverse-elongate cells, spores typically greater than 40 μm 4. *Physcomitrium pyriforme*

1. *Physcomitrium collenchymatum* Gier, Trans. Kansas Acad. Sci. 58: 330, plate 1. 1955 [E] [F]



Plants light green or yellowish green. **Stems** 2–4(–5) mm. **Leaves** obovate to ovate-lanceolate, concave, distal leaves 1.2–2 mm; margins toothed distally; costa percurrent to subpercurrent. **Specialized asexual reproduction** as tubers occasionally present. **Seta** 2–3 mm. **Capsule** exserted,

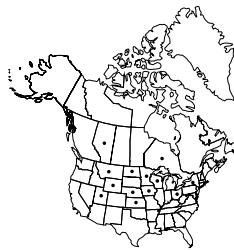
0.5–1.2 mm, ovoid to hemispheric when young, cupulate following dehiscence of operculum, and usually becoming shallow and wide-mouthed with age; neck short, indistinct; exothelial cells irregular rounded-hexagonal, often with curved walls, sometimes collenchymatous (apparently only on young capsules); suboral cells weakly differentiated, usually consisting of 2–6 rows of irregularly isodiametric cells. **Spores** 24–38 μm , spiculose or papillose.

Capsules mature late fall–spring. Wet soil in disturbed places; low to moderate elevations; N.S.; Fla., Kans., La., Miss., Tenn.

The small size combined with the wide-mouthed and shallow mature capsules distinguish this taxon from other species of *Physcomitrium*. The collenchymatous exothelial cells that are associated with the name of this species are most common in maturing capsules and rarely present in mature capsules (R. R. Ireland 1982; H. A. Crum and L. E. Anderson 1981).

SELECTED REFERENCE Crum, H. A. and L. E. Anderson. 1964. Notes on *Physcomitrium collenchymatum*. *Bryologist* 67: 350–355.

2. *Physcomitrium hookeri* Hampe, Icon. Musc., 30. 1844 [E]

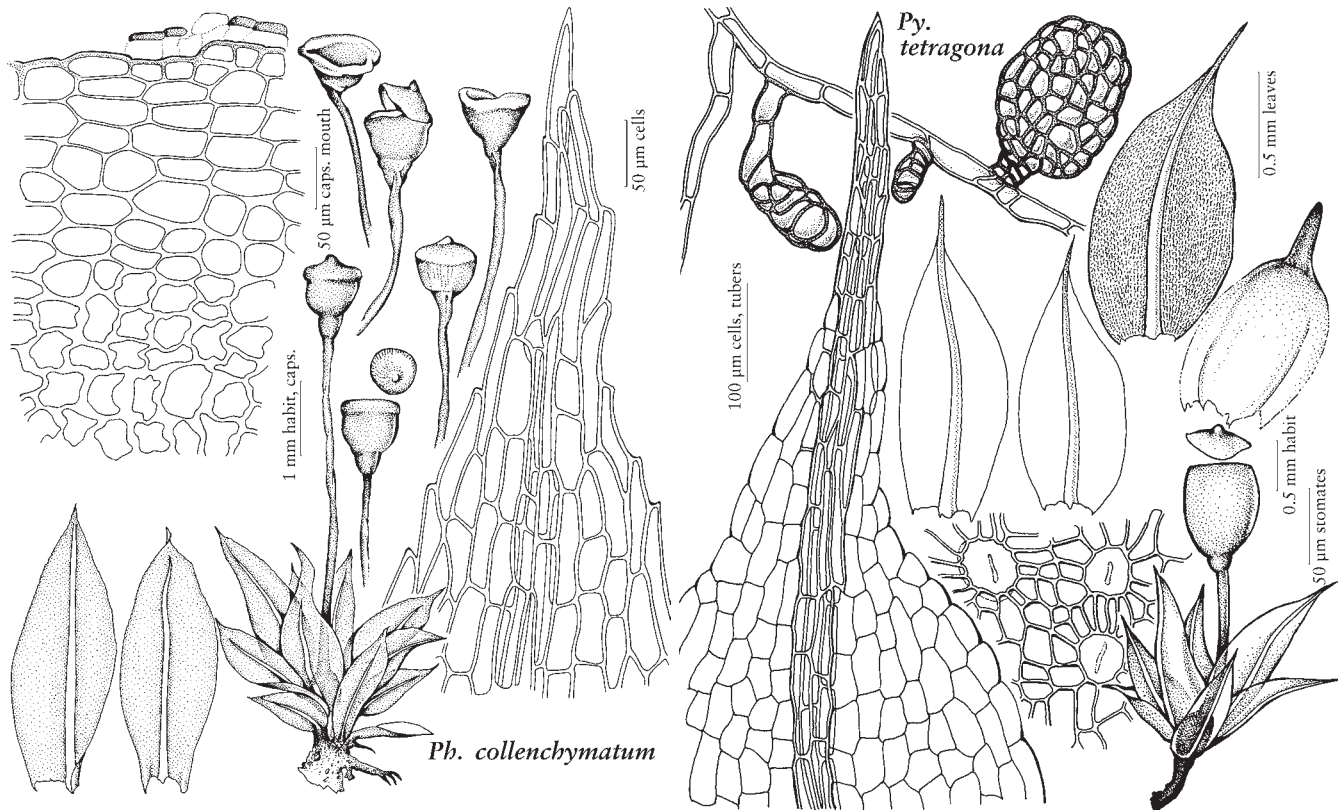


Gymnostomum latifolium Hooker in T. Drummond, Musci Amer., Brit. N. Amer., 16. 1828 not Bridel 1827; *Physcomitrium coloradense* E. Britton

Plants light green, sometimes brownish. **Stems** 1–3 mm. **Leaves** ovate, ovate-lanceolate, to oblong-ovate, flat or concave, sometimes cucullate, distal leaves 2–2.5(–3) mm; margins entire, occasionally uneven from slightly bulging cells distally; costa percurrent to subpercurrent. **Specialized asexual reproduction** absent. **Seta** (1)–2–4(–6) mm. **Capsule** emergent to exserted, 0.8–1.5 mm, ovoid to obovate when young, becoming pyriform or campanulate with age; neck short, usually distinct; exothelial cells irregular isodiametric, oblong, or hexagonal; suboral cells consisting of 3–7(–12) rows of short-rectangular cells; annulus revoluble, composed of large, inflated, mostly deciduous cells. **Spores** 20–34 μm , papillose.

Capsules mature spring. Wet soil in disturbed places; moderate to high elevations; Alta., Ont.; Iowa, Kans., Minn., Mont., Nebr., N.Y., N.Dak., Ohio, Utah, Wis., Wyo.

Physcomitrium hookeri lacks the toothed leaves and small annular cells that characterize other members of the genus. Although its distal leaf margins are often uneven from slightly bulging cells, they are never clearly toothed, and its revoluble annulus is composed of large, inflated cells.



PHYSCOMITRIUM • PYRAMIDULA

3. *Physcomitrium immersum* Sullivant in A. Gray,
Manual, 648. 1848



Plants light green. Stems 2–3(–4) mm. Leaves obovate to ovate-lanceolate, distal leaves 2–3 mm; margins toothed or occasionally smooth distally; costa subpercurrent to short-excurrent. Specialized asexual reproduction absent. Seta 0.5–1.2 mm. Capsule immersed, 1–1.2 mm, broadly cupulate; neck short, indistinct; exothelial cells irregular hexagonal or oblong, walls somewhat unevenly thickened; suboral cells consisting of 1–3 rows of short-rectangular cells. Spores 30–38 µm, papillose.

Capsules mature late fall–spring. Wet soil in disturbed places; moderate to high elevations; B.C., N.B., N.S., Ont., Que.; Colo., Iowa, Ky., La., Md., Minn., N.J., Oreg., Pa., Tex., Wash., Wis.; South America.

Physcomitrium immersum is easily recognizable by its immersed, broadly cupulate capsules that are usually clearly visible within the spreading leaves.

4. *Physcomitrium pyriforme* (Hedwig) Hampe, Linnaea
11: 80. 1837



Gymnostomum pyriforme Hedwig,
Sp. Musc. Frond., 38. 1801;
Physcomitrium californicum
E. Britton; *P. drummondii* E. Britton;
P. kellermanii E. Britton;
P. megalocarpum Kindberg;
P. pygmaeum James; *P. turbinatum*
(Michaux) E. Britton

Plants light green or yellowish green. Stems 0.2–15(–25) cm. Leaves obovate to ovate-lanceolate, distal leaves 2–5 mm; margins toothed, sometimes nearly smooth distally; percurrent to rarely short-excurrent. Specialized asexual reproduction absent. Seta (1)–6–15(–30) mm. Capsule exserted, 1–3 mm, globose-pyriform when young, highly variable in shape when old, urceolate to pyriform; neck short, distinct; exothelial cells irregular hexagonal; suboral cells consisting of 5–17 rows of rectangular cells. Spores (24)–46–60(–90) µm, papillose.

Capsules mature late fall–spring. Wet soil in disturbed places; low to high elevations; Alta., B.C., Man., N.B., N.S., Ont., Que., Sask.; Ala., Ark., Calif., Colo., Conn., Del., Fla., Ga., Idaho, Ill., Ind., Iowa, Kans., Ky., La.,

Maine, Md., Mass., Mich., Minn., Miss., Nebr., N.H., N.J., N.Y., N.C., N.Dak., Ohio, Oreg., Pa., S.C., S.Dak., Utah, Vt., Wash., W.Va., Wis., Wyo.; Mexico; Eurasia; Africa; Australia.

Physcomitrium pyriforme is morphologically variable and widespread across the continent. Plant size, leaf characters, and shape of the capsule vary from place to place and often within populations.

6. PYRAMIDULA Bridel, Muscol. Recent., suppl. 4: 20. 1818 • [Latin *pyramis*, pyramid, and *-ula*, diminutive, alluding to calyptra]

Bernard Goffinet

Plants very small, gregarious or loosely caespitose. **Stems** to 1 mm, erect, rarely branching, **Leaves** somewhat crisped when dry, erect-spreading when moist, ovate to oblong, concave, 1.5–2.5 mm; margins entire; apices acuminate; costa single, percurrent, filling most of acumen; proximal laminal cells rectangular, distal cells short-rectangular to hexagonal. **Specialized asexual reproduction** by occasionally stalked, spherical, dark purple rhizoidal tubers. **Sexual condition** autoicous. **Seta** erect, to 1.5 mm. **Capsule** stegocarpous, erect, mostly exserted, globose and mostly urceolate following dehiscence, sharply constricted to neck, to 1 mm, wrinkled when dry, neck short, abruptly narrowed to seta; exothecial cells thin-walled, irregular in shape except for narrowly rectangular suboral cells; stomata with single guard cell, restricted to neck, superficial to rarely somewhat immersed; annulus none; operculum plane; peristome absent. **Calyptra** long-persistent, large, enclosing entire capsule and seta, four-angled, beaked, opening by longitudinal slits for nearly entire length to the clasping base. **Spores** spherical to angular, smooth.

Species 1: c United States, Europe, Africa.

1. *Pyramidula tetragona* (Bridel) Bridel, Muscol. Recent., suppl. 4: 20. 1818 [F]



Gymnostomum tetragonum Bridel, Muscol. Recent., suppl. 1: 270. 1806

Plants scattered to gregarious; leaves with arcuate acumen when dry, capsules hidden in large angular calyptrae.

Capsules mature Jan–May. Mineral soil, grasslands, less often

forests, river banks, commonly among other mosses; mainly moderate elevations; Iowa, Kans., Minn., Mo., Nebr., N.Mex., Okla., Tex.; n, c Europe, n Africa.

Pyramidula tetragona is easily identified by the large, four-angled calyptra that encloses virtually the entire sporophyte. The capsule that sharply contracts to the neck, which itself is abruptly narrowed to the seta, also distinguishes the species. In addition, no other species of Funariaceae produces rhizoidal tubers.