3. Atrichum crispum (James) Sullivant in A. Gray, Manual ed. 2, 641. 1856 E

Catharinea crispa James, Proc. Acad. Nat. Sci. Philadelphia 7: 445. 1855

Plants small to moderately robust, yellowish green or rarely dark green, brown proximally with age. **Stems** 1–5 cm. **Leaves** 1–8.5 × 0.7–2 mm, ovate-lanceolate to ovate, sometimes lingulate to lanceolate near stem apex, plane to somewhat concave, not undulate, only rarely with scattered abaxial teeth, apex acute, border cells and teeth with minute, verrucose or striate papillae; costa percurrent to subpercurrent, with a few abaxial teeth near apex, rarely absent; lamellae 0–3(–4), often discontinuous, 1–4 cells high; median leaf cells 35–52 µm wide, hexagonal to irregularly angled, rarely rounded, thin-walled, not or weakly collenchymatous, without trigones, smooth. **Sexual condition** dioicous, male plants as large as female plants or larger; perigonial bracts ovate to suborbicular, forming antheridial buds, often more than one bud per plant. **Seta** 1–3 per perichaetium, 0.5–3 cm. **Capsule** 1–3.5 × 0.5–1 mm, cylindric to ovate, usually somewhat curved, erect or often inclined; operculum 1.5–3.5 mm. **Spores** 10–28 µm.

Capsules mature spring–summer (Apr–June). Sandy soil along streams, roadside ditches in shaded habitats, sometimes at margins of swamps and marshes, rarely on rotting logs in woods; low to moderate elevations; N.B., Nfld. and Labr. (Nfld.), N.S., Ont., P.E.I., Que.; Conn., Del., Fla., Ill., Ind., Iowa, Ky., Maine, Md., Mass., Mich., Mo., N.H., N.J., N.Y., N.C., Ohio, Pa., R.I., S.C., Tenn., Vt., Va., W.Va.; introduced in Europe.

Atrichum crispum is frequent in the Atlantic coastal plain but also occurs at higher elevations in the mountains. It is apparently introduced in Europe (Ireland, western England, Wales, and Spain) where only male plants are known. This is a dioicous species, the plants varying in size from small to large, often yellowish green, leaves with a few low and often interrupted lamellae, and large, thin-walled leaf cells without trigones, with few or no teeth on the abaxial surface of lamina. The most distinctive microscopic character is the minute, verrucose or striate papillae on the marginal cells and teeth of the leaves (R. R. Ireland 1991). The marginal cilia on the leaf sheath of *Bartramiopsis* are similarly papillose.

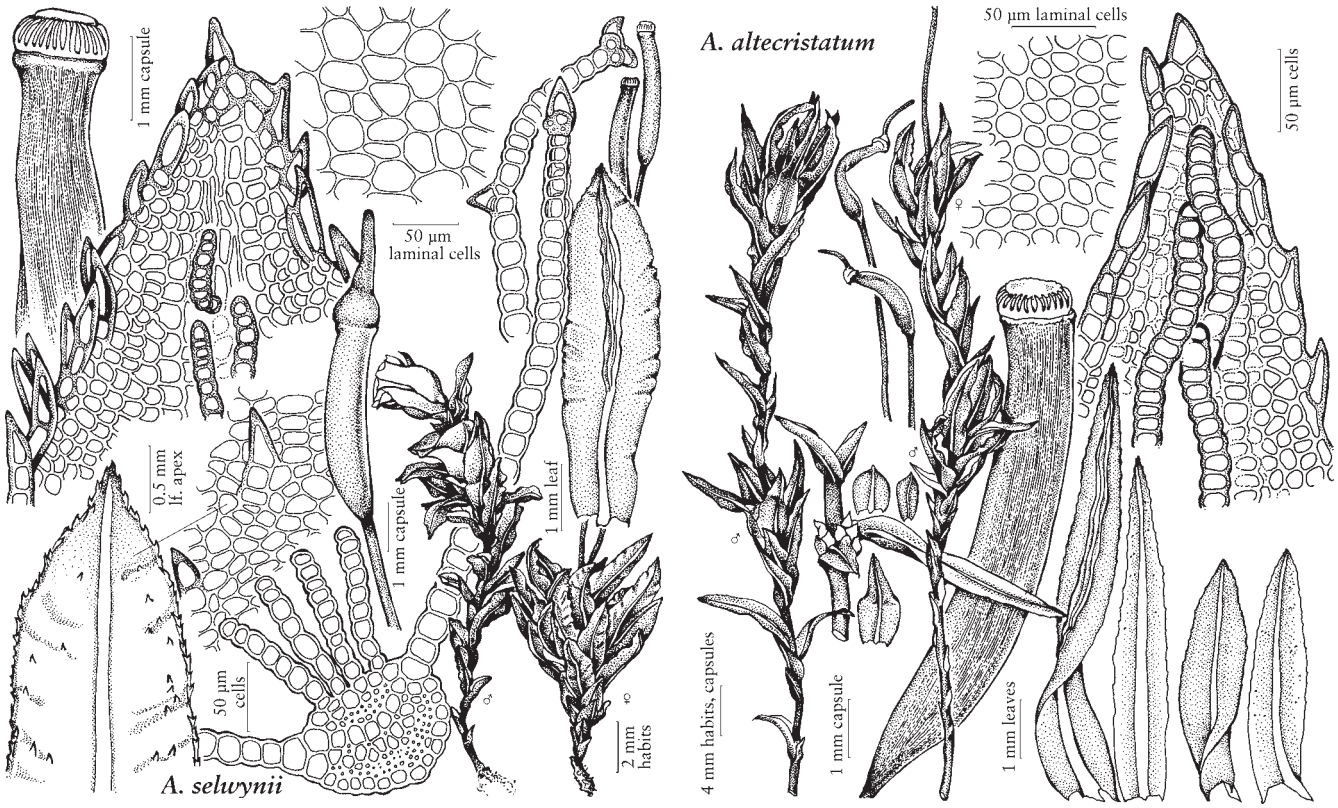
4. Atrichum selwynii Austin, Bot. Gaz. 2: 95. 1877 F

Atrichum rosulatum Müller Hal.

Plants small to medium-sized, often distinctly rosulate, light to dark green, brown proximally with age. **Stems** 1–4 cm. **Leaves** 2.5–8.5 × 1–2 mm, lingulate to lanceolate, ovate-lanceolate near base of stem, plane to somewhat keeled and concave, often with oblique rows of teeth on undulations on abaxial surface, the teeth often with bases united, the apex acute or sometimes obtuse, the leaf margins irregularly toothed, the teeth crowded, double or sometimes single, rarely triple-toothed; costa percurrent or ending a few cells below the apex, smooth or with teeth on abaxial surface near apex, seldom extending below leaf middle; lamellae 2–6, laxly spreading, 8–12(–14) cells high, or at times lower and inconspicuous, 2–5 cells high; median lamina cells 27–40(–48) µm wide, hexagonal, occasionally irregularly angled or rounded, rather thin-walled to firm, collenchymatous with small trigones. **Sexual condition** dioicous; male plants as large or larger than females, perigonial bracts small, ovate or suborbicular, often more than one bud per plant. **Seta** 1–3(–8) per perichaetium, to 5 cm, erect to slightly flexuose. **Capsule** 2–7.5 × 0.5–1 mm, cylindric, usually somewhat curved and inclined, sometimes straight and erect; operculum 2–3 mm. **Spores** 10–19 µm.

Capsules mature spring–late summer (Mar–Sept). Soil, open and shaded habitats, bare roadside banks, overturned tree roots; low to high elevations; Alta., B.C., Man., N.W.T., Sask.; Alaska, Ariz., Calif., Colo., Idaho, Mont., N.Mex., Oreg., S.Dak., Utah, Wash., Wyo.; Central America (Guatemala).

Atrichum selwynii is a common species largely restricted to western North America. It is easily recognized by the rosulate habit, the characteristic leaf border, with teeth irregular and crowded near the leaf apices, large, thin-walled leaf cells (to 48 µm wide), and numerous sporophytes per perichaetium. E. Nyholm (1971) treated *A. altecristatum* as a variety of *A. selwynii*, but *A. altecristatum* is monoicous and exclusively eastern. T. C. Frye (1937) combined *A. selwynii* and *A. altecristatum*, as *A. undulatum* var. *selwynii* (Austin) Frye. The easternmost outpost of *A. selwynii* is in the Black Hills of South Dakota, in company with other western mosses. Plants from the Pacific Coast Ranges with low and inconspicuous lamellae, 2–5 cells high, were referred by Frye (1910) to *A. undulatum*, part of his overly broad concept of this species, but were recognized by W. C. Steere et al. (1954) as clearly not that species. Plants of *A. selwynii* from Rocky Mountain populations typically have lamellae 8–12 cells high and higher.



ATRICHUM

5. Atrichum crispulum Bescherelle, Ann. Sci. Nat., Bot., sér. 7, 17: 351. 1893

Plants large, green to dark green, becoming brown to reddish brown with age. **Stems** to 6 cm, sometimes matted with whitish rhizoids. **Leaves** 5–9 × 0.8–1.6 mm, densely imbricate, lingulate to lanceolate, plane to slightly keeled and concave, obliquely transversely undulate, often with rows of teeth on undulations on abaxial surface, the apex attenuate; costa subpercurrent to percurrent, with abaxial teeth along the undulations in distal half; lamellae 4–6, laxly spreading, 2–4(–6) cells high; median leaf cells 24–27(–30) µm wide, rounded to irregularly angled, weakly convex on both surfaces, thick-walled, strongly collenchymatous with trigones, smooth or usually with minute, rounded or striate papillae on abaxial surface. **Sexual condition** dioicous; male plants as large as females, perigonial bracts small, imbricate, ovate or suborbicular, often more than one perigonial bud in sequence per shoot. **Seta** 1–3 per perichaetium, 1.5–4 cm, reddish brown. **Capsule** 4–7 × 0.5–1 mm, usually somewhat curved and inclined, rarely straight and erect; operculum 2–3.5 mm. **Spores** 12–19 µm.

Capsules mature summer (Jun–Aug). Soil, humus, mostly shaded habitats; often wet banks along streams or sometimes at margins of fens and swamps; low to high elevations; N.B., Nfld. and Labr. (Nfld.), N.S., Ont., P.E.I., Que.; Ark., Del., Ill, Ind., Iowa, Kans., Ky., La., Maine, Md., Mass., Mich. Miss., N.H., N.Y., N.C., Ohio, Pa., Tenn., Va., W.Va., Wis.; e Asia (China, Japan).

Atrichum crispulum is a large, handsome, dioicous species, distinguished by its broad leaves with few, low lamellae, long, narrow, curved capsules, and by its growth in shaded, wet environments on banks along streams and at margins of fens and swamps. *Atrichum undulatum,* on the other hand, prefers dry weedy habitats, and when sterile can be distinguished from *A. crispulum* by the reddish brown rhizoids more or less confined to the base of the plant, instead of matted whitish rhizoids often extending well up the stem in *A. crispulum.* As suggested by R. R. Ireland (1969), the "paraphyllia" in the type of *A. paraphyllium* Wareham are innovations probably caused by the plants being buried in sand. In recent North American literature this species has been called *A. oerstedianum* (Müller Hal.) Mitten, but comparisons with the type of *A. oerstedianum* indicate that the two are distinct. *Atrichum oerstedianum*, a species of Mexico and Central America, has leaves broadly elliptic-lanceolate with an obtuse apex, only sporadically toothed on the abaxial surface and not undulate, lamellae (2–)4–

5, 1–2 cells high, often interrupted, and a colored border. The cells of the lamina are irregular in size and shape, with a "disordered" arrangement as opposed to the more regular arrangement of cells in longitudinal rows in *A. crispulum*.

6. Atrichum altecristatum (Renauld & Cardot) B. B. Smyth & L. C. D. Smyth, Trans. Kansas Acad. Sci. 23/24: 284. 1911 E F

Atrichum undulatum var. *altecristatum* Renauld & Cardot, Bot. Gaz. 15: 58. 1890; *A. selwynii* var. *altecristatum* (Renauld & Cardot) Nyholm; *A. undulatum* var. *allegheniense* (Jennings) Jennings

Plants small to medium sized, light to dark green, brown proximally with age. **Stems** 1–3 cm. **Leaves** 2–8 × 0.7–1.5 mm, keeled and concave, rarely almost plane, rather narrowly lanceolate to lingulate, more or less undulate with rows of abaxial teeth on the undulations, the apex acute or sometimes proximal leaves obtuse; costa percurrent or subpercurrent with abaxial teeth near apex; lamellae 4–6(–8), laxly spreading, 4–6 (–9) cells high; median leaf cells 24-28 µm wide, rounded to ± regularly hexagonal, rather thick-walled, strongly collenchymatous with trigones, smooth or occasionally with minute, verrucose or striate papillae mainly on abaxial surface. **Sexual condition** polygamous, some shoots apparently unisexual males or females, others with both sexes; perigonia inconspicuous, the outer perigonial bracts resembling stem leaves but with a broader base, the inner small, ovate or suborbicular. **Seta** 1–3 per perichaetium, 1–3.5 cm, erect. **Capsule** 2–7 × 0.5–0.8 mm, cylindric, usually somewhat curved and inclined, sometimes straight and erect; operculum 2–3 mm. **Spores** 9–21 µm.

Capsules mature spring–fall (Mar–Oct). Soil banks along roads, trails, often on hummocks in clearings in woodlands, open or semishaded conditions; usually low elevations; Man., N.B., Nfld. and Labr. (Nfld.), N.S., Ont., P.E.I., Que.; Ark., Del., D.C., Ill., Ind., Iowa, Kans., Ky., Maine, Md., Mich., Minn., Mo., Nebr., N.H., N.Y., N.C., Ohio, Okla., Pa., S.D., Tenn., Va., W.Va., Wis.

Atrichum altecristatum is a common and widespread species, particularly in northcentral United States. It is distinguished from *A. angustatum* by the lamellae 4–6, and 4–6 cells high (against 6–9 lamellae, up to 15 cells high in *A. angustatum*), and leaf cells 24–28 µm in longest dimension, collenchymatous, with evident trigones (as opposed to cells smaller and subquadrate in *A. angustatum*, bulging mammillose on the adaxial surface). The difference in sexuality is more difficult to demonstrate, since most plants in a colony may appear female, with only a few shoots bearing a male inflorescence followed by a female inflorescence and sporophyte on the same stem about a centimeter above the male. As a result, the species is monoicous, but functionally dioicous. The taxon known as *A. crispum* var. *molle* (Holzinger) Frye evidently belongs here (R. R. Ireland 1969).

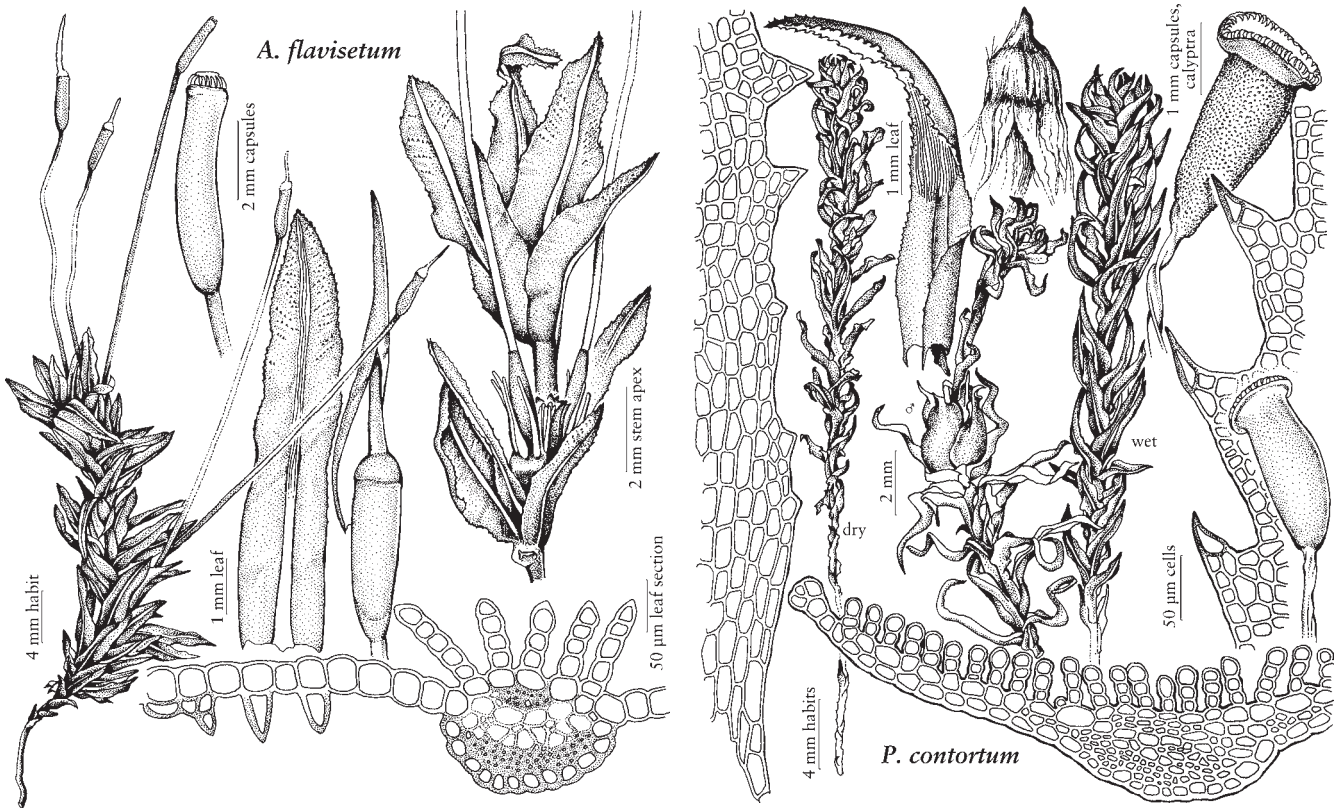
7. Atrichum cylindricum (F. Weber) G. L. Smith, Brittonia 29: 371. 1977 E

Polytrichum cylindricum F. Weber in F. Weber and D. M. H. Mohr, Beitr. Naturk. 2: 397. 1810; *Atrichum undulatum* var. *attenuatum* Bruch & Schimper

Plants dark green. **Stems** (2.5–)4–5 cm, densely leafy. **Leaves** 7–8 × 0.8–1 mm wide midway between base and tip, narrowly triangular-lanceolate to linear, subfalcate, plane, not undulate, with a few scattered abaxial teeth, or none, long-tapering to a narrowly acute apex, margin stoutly bordered, doubly toothed from proximal 1/8 of leaf, often colored; costa spinose abaxially towards leaf apex; lamellae (4–)5(–6), low and strictly parallel, (1–)3–4 cells high; median leaf cells 20–25 µm wide, rounded hexagonal, with their longest dimension at right angles to the costa, with distinct trigones, smooth or occasionally with striate papillae near base of leaf. **Sexual condition** polygamous, most shoots apparently unisexual and female; unisexual male shoots not reported, perigonial leaves similar to the others, but with broader bases, to broadly lanceolate and unbordered in proximal 1/2, the innermost bracts tiny, obovate. **Seta** reddish brown, 3–4(–5) cm, usually 1 per perichaetium, occasionally 2. **Capsule** 6–8(–10) × 0.8–1 mm, reddish brown, finely striate, narrowly cylindric, somewhat curved, erect to inclined. **Spores** 18–20 µm.

Moist soil, ravines, ditches, stream banks in mixed forest, low wet woods and bottomland (swamp forest); low elevations; Ala., Fla., Ill., Ky., La., Miss., Mo., N.C., S.C., Tenn., Tex., Va.

Atrichum cylindricum is distributed along the Atlantic and Gulf coastal plain from Virginia to Florida and eastern Texas, and in the Mississippi Embayment and Cumberland Plateau. In addition to the published distribution (Gary L. Smith 1977), the species has also been found on hummocks in a cypress swamp in southern Illinois. *Atrichum crispulum* is similar in size to *A. cylindricum*, but is dioicous, with broader, distinctly undulate leaves and well-developed teeth on the back of the lamina. *Atrichum altecristatum* is a more slender plant with taller lamellae, shorter, broader, undulate leaves, toothed on the back and less strongly bordered, and shorter capsules.



ATRICHUM ◦ POGONATUM

8. Atrichum undulatum (Hedwig) P. Beauvois, Prodr. Aethéogam., 42. 1805 [1]

Polytrichum undulatum Hedwig, Sp. Musc. Frond., 98. 1801

Plants small to fairly large, dark green. **Stems** 2–5 cm. **Leaves** sparse below, more crowded above, 4–9 × 0.8–1.5 mm, lingulate to lanceolate, undulate, keeled distally, concave to flat proximally, with oblique rows of abaxial teeth on undulations, the apex acute; costa percurrent, with teeth on abaxial surface in distal half; lamellae 2–6, 2–4(–7) cells high; median leaf cells 20–32 µm wide, irregularly angled to hexagonal, sometimes rounded, often transversely elongate, convex on both surfaces, smooth or with minute, verrucose or striate papillae on abaxial surface, walls firm, strongly collenchymatous with trigones. **Sexual condition** polygamous, some shoots bisexual, others apparently male or female; perigonial bracts broad, forming antheridial buds, often several buds per plant. **Seta** 1 (–3) per perichaetium, 1–3 cm, reddish brown. **Capsule** 2–4(–8) × 0.5–1 mm, curved to distinctly arcuate, almost horizontal; operculum 2–3 mm. **Spores** (12–)16–28 µm.

Capsules mature spring–summer (Apr– Jul). Soil, dry weedy habitats, especially roadside ditches; usually low elevations; introduced; B.C., N.B., Nfld. and Labr. (Nfld.), N.S., Ont., P.E.I.; Maine; Europe; w, c Asia; n Africa.

No *Atrichum* species occurring in North America has been as widely misunderstood as *A. undulatum*. Evidently introduced from Europe, its weedy habitat and strongly arcuate, almost horizontal capsules are the surest means of recognition. Variety *minus*, a fixture of European manuals, is a stunted form that is highly variable and possibly a hybrid. Its occurrence in North America has not been demonstrated. As used by American authors (e.g., O. E. Jennings 1951), it probably refers to *A. altecristatum*.

9. Atrichum flavisetum Mitten, J. Proc. Linn. Soc., Bot., suppl. 2: 150. 1859 [F]

Atrichum hausknechtii Juratzka & Milde; *A. undulatum* var. *gracilisetum* Bescherelle; *A. undulatum* var. *hausknechtii* (Juratzka & Milde) Frye

Plants medium-sized, green or light green when wet, dark green when dry. **Stems** to 2 cm, often branched by subfloral innovations. **Leaves** ca. 10, oblong-linear, acute to acuminate, transversely undulate distally, toothed along the margin

nearly to the base, with irregular abaxial teeth corresponding to the undulations; costa percurrent to weakly excurrent; lamellae 4–6, 2–4 cells high; median leaf cells 24–30 µm wide, moderately thick-walled, ± isodiametric, transversely elongate. **Sexual condition** synoicous; perichaetia terminal or on an innovation continuing growth of the shoot and forming new perichaetia, several successive inflorescences with maturing capsules persistent on one stem; perigonia inconspicuous, hidden amid the perichaetial leaves. **Seta** (1–)2–4 per inflorescence, to 3.5 cm, rather slender, straw-yellow. **Capsule** 8 × 1.3 mm, erect to inclined, short-cylindric, nearly straight. **Spores** (8–)15–16 µm.

Capsule maturity date not determined. Banks or stumps in woods, roots of fallen trees, ravines in crevices of rock outcrops; low to moderate elevations; B.C.; Wash.; e Europe; Asia.

Atrichum flavisetum appears to be rare in North America and its distribution is poorly known. In the Old World it is known from European Russia, the Ural Mountains, the Caucasus, the Russian Far East, central Asia (Altai), China and the Himalayas. It is almost inseparable from *A. undulatum* by leaf characters alone, but usually fruits freely. The species is synoicous, but the antheridia and archegonia are not intermingled. The antheridia are central in position, associated with minute perigonial bracts; the archegonia arise at the periphery of the common involucre (C. Warnstorf 1914). Besides the inflorescence, *A. flavisetum* differs by its ecology, and the slender, yellowish seta and smallish capsules, which are short-cylindric and nearly straight. Older sporophytes often persist from successive inflorescences, seemingly lateral in position.

Excluded Species:

Atrichum oerstedianum (Müller Hal.) Mitten

North American specimens named as this species are *Atrichum crispulum*.

7. POGONATUM P. Beauvois, Mag. Encycl. 5: 329. 1804 • [Greek *pogon*, beard, alluding to hairy calyptra]

Gary L. Smith Merrill

Plants medium to large, in loose pure tufts or growing among other bryophytes, or individual stems small and scattered over a persistent protonemal mat. **Stems** simple or branched by subfloral innovations. **Leaves** with a sheathing base merging gradually or ± abruptly contracted to the blade, the sheath entire (toothed in *P. contortum*), with or without incrassate hinge-cells at the shoulders, not hyaline-margined (except in *P. urnigerum*); margins serrate, toothed, or entire, without a differentiated border of elongated cells; adaxial lamellae numerous and compact, occupying the full width of the blade, or somewhat fewer with an evident marginal lamina, marginal cells not differentiated, or strongly differentiated, thick-walled and coarsely papillose. **Sexual condition** dioicous; male plants similar to females in appearance, or bud-like and inconspicuous. **Seta** smooth. **Capsule** ovoid to short-cylindric, ± regular to somewhat asymmetric, terete, sometimes with 4 or more indistinct angles or ridges; hypophysis not differentiated, tapering; stomata none; exothecium mammillose to scabrous, the exothecial cells mamillate or with a single papillate projection of the outer wall; operculum rostrate from a convex base; epiphragm persistent, attached to the peristome teeth; peristome deeply reddish pigmented (at least in the median line), the teeth 32, compound, with median sinus narrow or almost obliterated. **Calyptra** with a densely matted felt of hairs, covering most or all of the capsule. **Spores** finely papillose.

Species 52 (5 in the flora): North America, tropical America, Europe, Africa, Asia, Australasia, widespread in the tropics of both hemispheres, with only a few North temperate representatives.

North American species of *Pogonatum* vary greatly in size and habit from tall, laxly tufted plants to protonema mosses with individual plants scattered and only a few millimeters high. *Pogonatum contortum* of the Pacific Northwest, with leaves strongly crisped and contorted when dry, is the most "typical" of the genus as a whole. *Pogonatum brachyphyllum* and

P. pensilvanicum are protonema-mosses, the gametophyte consisting of a persistent felted mat of protonema and leafy plants small and scattered. The other two species are distinctly polytrichoid in habit, with the margins of the lamellae thick-walled and coarsely papillose. *Pogonatum dentatum* is an arctic-montane species, whereas *P. urnigerum* has a somewhat more southerly distribution and occurs as well in the Himalayas and New Guinea. The sporophytes of our species are more uniform, with a scabrous exothecium, deeply pigmented peristome with compound peristome teeth, and no stomata. The exothecial "papillae" are projections of the cell wall, unlike the wart-like cuticular papillae often seen on the leaf surfaces of many Polytrichaceae.

SELECTED REFERENCE Hyvönen, J. 1989. A synopsis of genus *Pogonatum* (Polytrichaceae, Musci). Acta Bot. Fenn. 138: 1–87.

1. Plants to 0.6 cm, scattered over a green, persistent protonema.
   2. Lamellae 25–40, compact, the leaf appearing thick and fleshy; leaf margins entire . . . . . 2. *Pogonatum brachyphyllum*
   2. Lamellae 11–16, the leaf membranous; leaf margins irregularly notched . . . . . 3. *Pogonatum pensilvanicum*
1. Plants 3–8(–12) cm, in loose pure tufts or growing among other bryophytes.
   3. Leaves toothed from the apex nearly to the base; marginal cells of lamellae not differentiated, smooth . . . . . 1. *Pogonatum contortum*
   3. Leaves toothed above the shoulders, the margins of the sheath entire; marginal cells of lamellae thick-walled and coarsely papillose.
      4. Leaf margins with multicellular, hooked teeth; leaf sheath not hyaline-margined; marginal cells of lamellae ± rectangular, flat-topped, the lumen quadrate; peristome divided nearly to the base . . . . . 4. *Pogonatum dentatum*
      4. Leaf margins with mostly 1-cellular teeth; leaf sheath hyaline-margined; marginal cells of lamellae rounded to transversely elliptical, the lumen pentagonal; peristome divided to ca. 0.6 . . . . . 5. *Pogonatum urnigerum*

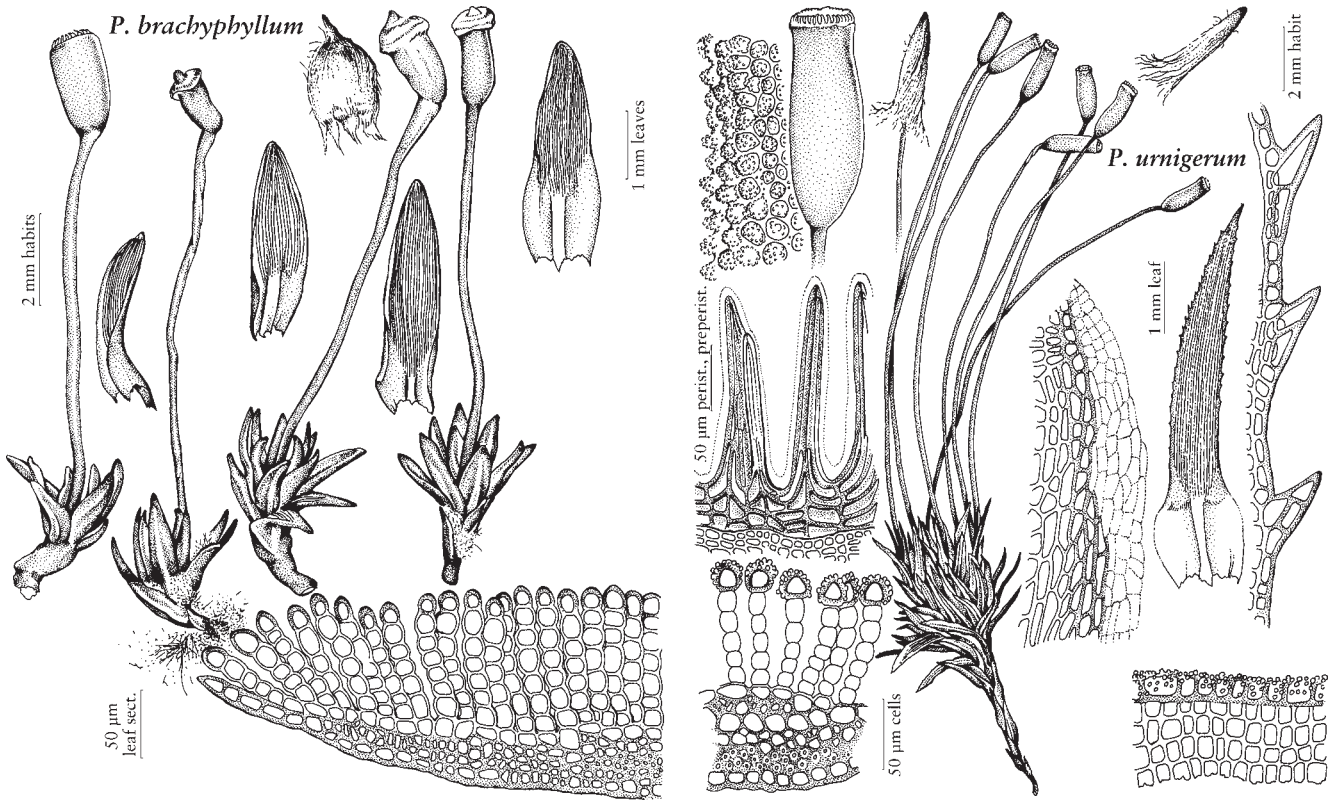
1. Pogonatum contortum (Bridel) Lesquereux, Mem. Calif. Acad. Sci. 1: 27. 1868 F

Polytrichum contortum Bridel, J. Bot. (Schrader) 1800(1): 287. 1801

Plants medium-sized to large, in loose tufts or scattered, olive green to dark green. **Stems** 3–12 cm, erect, mostly simple. **Leaves** 5–9 mm, strongly crisped and contorted when dry, plane and broadly spreading when moist, loosely sheathing at base, linear-lanceolate, ending in a short spine; sheath not strongly differentiated, with gradually sloping shoulders, toothed nearly to the base with small sharp teeth oriented at right angles to the margin, hinge-tissue not differentiated; margins of blade thickened, (1–)2-stratose, coarsely serrate, scalloped, the serrations ending in a sharp-pointed, narrowly conical, reddish orange tooth cell; marginal lamina 1-stratose, to 6 cells wide; costa smooth adaxially or sharply toothed at the extreme tip; lamellae 40–48, entire in profile, 2–5 cells high, the marginal cells in section slightly larger but otherwise undifferentiated, thin-walled, smooth; sheath cells short rectangular; cells of the abaxial surface of blade 24–27 µm wide, irregularly quadrate to hexagonal, transversely elongate, firm-walled, with distinct corner thickenings, and a narrow median strip of cells short-rectangular and longitudinally elongate. **Seta** 3–5 cm. **Capsule** 2–3.5 mm, reddish brown to blackish brown, sometimes with 4 or more indistinct angles or ridges, erect to slightly inclined and asymmetric; exothecium finely scabrous, the cells distinctly papillate; peristome 300–350 µm, divided to 0.6, dark reddish orange with hyaline margins. **Spores** 8–13 um.

Soil, usually on clay banks; mostly at lower elevations, rarely to 1000 m; B.C.; Alaska, Calif., Oreg., Wash.; e Asia (Japan).

Pogonatum contortum is a handsome plant, growing in deep olive green tufts, rather wiry in appearance, with leaves strongly crisped and contorted when dry, short-cylindric, small, slightly asymmetrical capsules and a reddish hairy calyptra covering the capsule. When sterile and in the dry condition, it resembles *Oligotrichum parallelum*, but when moistened the leaves of *P. contortum* are more firm-textured, broadly lamellate, and toothed to the base.



POGONATUM

2. Pogonatum brachyphyllum (Michaux) P. Beauvois, Prodr. Aethéogam., 84. 1805 E F

Polytrichum brachyphyllum Michaux, Fl. Bor.-Amer. 2: 295. 1803

Plants small, scattered on a deep-green, persistent protonema, dull green to red-brown with age. **Stems** 0.2–0.3 cm. **Leaves** 1.5–3 mm, incurved at the tips when dry, erect-spreading when moist, gradually tapering to the blade; sheath oblong, entire, not hyaline-margined, the zone of incrassate hinge-cells at the shoulders not sharply defined; blade lanceolate, broadly and bluntly pointed, appearing turgid and fleshy, entire; marginal lamina erect, narrow, 1-stratose; costa ending in the tip, smooth abaxially; lamellae 25–40, entire in profile, 7–12 cells high, the marginal cells in section rounded, often thicker-walled, smooth; sheath cells short-rectangular; cells on the abaxial surface of blade 14–17 µm wide, thick-walled, longitudinally elongate in the median portion, subquadrate to either side. **Seta** (0.5–)1.5–2.5 cm, reddish, often twisted below the capsule. **Capsule** 2–2.5 mm, ± asymmetric, suberect to inclined to almost horizontal; operculum with a convex base and a short, rather blunt beak; exothecium mammillose, the cells short-rectangular, thick-walled; peristome to 300 µm, deeply divided almost to the capsule rim, the teeth reddish with hyaline margins. **Spores** 13–18 µm.

Bare sandy or clayey soil on banks of ditches or streams, usually in open situations; low to moderate elevations; Ala., Ark., Fla., Ga., Ill., Ind., Kans., La., Md., Miss., Mo., N.J. N.Y., N.C., S.C., Tenn., Tex., Va.

Pogonatum brachyphyllum is endemic to eastern North America, and it has a more southerly distribution than *P. pensilvanicum*. The leaves of *P. brachyphyllum* are entire, short and broad, and appear succulent because of tall, closely packed lamellae. The calyptra is yellowish to reddish brown, contrasting with the rich, green protonemal mat.

3. Pogonatum pensilvanicum (Hedwig) P. Beauvois, Mém. Soc. Linn. Paris 1: 461. 1823

Polytrichum pensilvanicum Hedwig, Sp. Musc. Frond., 96, plate 21, figs. 1–6. 1801; *Pogonatum brevicaule* (Bridel) P. Beauvois; *P. tenue* Rau & Hervey

Plants small, dull and brownish, scattered on a bright green protonema. **Stems** 0.2–0.6 cm. **Leaves** 2–4 mm, when dry loosely sheathing at the base, the blade narrow, curved and often hooked at the tips, erect-spreading and almost straight

when moist; sheath oblong to oblong-ovate, in leaves near the base of the shoot abruptly contracted to the blade, in distal leaves more gradually tapering, not hyaline-margined, with a narrow strip of incrassate cells at the shoulders; blade narrowly lanceolate to linear, slenderly acuminate, ending in a short point; marginal lamina ± plane, variable in width, 1-stratose, irregularly notched-dentate or at times almost entire; costa smooth or weakly toothed abaxially near the tip; lamellae 11–16, entire in profile, 4–8 cells high, the marginal cells larger and rounded in section, single or in pairs, smooth; sheath cells short-rectangular; cells of lamina 10–12 µm, subquadrate to irregular. **Seta** 1–3.5 cm, reddish. **Capsule** 2.5–4 mm, erect or nearly so, sometimes indistinctly angled; exothecium scabrous, the cells short-rectangular, thick-walled; operculum obliquely rostrate; peristome 190–220 µm, divided to 0.8. **Spores** 9–12 µm.

Pioneer on steep banks of moist clay or silt; low to moderate elevations; N.B., Nfld. and Labr. (Nfld.), N.S., Ont., P.E.I., Que.; Ala., Ark., Conn., Del., Ill., Ind., Iowa, Fla., Kans., Ky., La., Maine, Mo., N.H., N.J., N.Y., Ohio, Okla., Pa., Tenn., Tex., Vt., Va., W.Va.; Mexico; West Indies.

Pogonatum pensilvanicum is widespread in eastern North America. It differs from *P. brachyphyllum* by the more slender, membranous leaves with irregularly dentate margins and fewer lamellae. The marginal cells of the lamellae are typically in pairs, and they may "bulge out and proliferate, giving rise to masses of what apparently are gemmae" (G. E. Nichols 1937). The calyptra is dirty white and stands out in contrast to the bright emerald-green protonema. When taken up, the texture of the protonemal mat is firm and often quite rubbery. Specimens with more regularly dentate leaf margins are sometimes distinguished as var. *torreyanum* (Bridel) Paris. *Pogonatum pensilvanicum* has been reported from South America.

4. Pogonatum dentatum (Bridel) Bridel, Bryol. Univ. 2: 122. 1827

Polytrichum dentatum Bridel, J. Bot. (Schrader) 1800(1): 287. 1801; *Pogonatum capillare* (Michaux) Bridel

Plants medium-sized, in loose tufts or scattered among other bryophytes, green to reddish brown with age. **Stems** to 3(–5) cm, comose from a wiry base, mostly unbranched. **Leaves** 2.5–6 mm, loosely imbricate, erect and somewhat incurved when dry, plane and erect-spreading when moist; sheath short-ovate, not hyaline-margined, abruptly contracted to the blade, the group of incrassate hinge-cells at the shoulders not much differentiated; blade rather broadly oblong-lanceolate to linear-lanceolate; marginal lamina erect, narrowly inflexed when dry, 1-stratose, 1–3 cells wide, toothed nearly to the shoulders with multicellular, uncinate teeth (rarely serrulate, but never entire), the teeth broadly triangular, (1–)3–7-celled, the terminal cell not much larger than the others; costa percurrent or slightly excurrent as a short, smooth to denticulate point, smooth or sparsely toothed near the tip; lamellae 20–30, entire or slightly crenulate in profile, 5–7 cells high, the marginal cells thick-walled and coarsely papillose, ± rectangular and flat-topped in section, broader than high, the lumen quadrate; median sheath cells short-rectangular, thin-walled; cells on abaxial surface of blade transversely elongate, 25–30 × 12–18 µm, with a median strip of cells shorter and ± isodiametric. **Seta** 1–3.5(–5) cm, brownish, straight to flexuose. **Capsule** 2–3 mm, erect to somewhat inclined, brownish; exothecium mammillose, the cells short-rectangular, incrassate, appearing distinctly pitted in surface view; peristome 350–450 µm, deeply divided from 0.8 to nearly to the base, the teeth slender, reddish brown with hyaline margins. **Spores** 18–24 µm.

Dry, sunny habitats, silt, sandy or gravelly soil, often in disturbed situations, among stones and boulders, over rock outcrops and on talus slopes; moderate to high elevations; Greenland; Alta., B.C., N.B, Nfld. and Labr., N.W.T., N.S., Nunavut, Que., Yukon; Alaska, Mich., N.H., N.Y., N.C., Oreg., Vt.; n Europe; n, e Asia; Atlantic Islands (Iceland).

Pogonatum dentatum is an arctic-montane species, widespread in the cooler regions of the Holarctic, southward at higher elevations to Oregon, and in eastern mountains to North Carolina. In arctic America, *P. dentatum* is more common and occurs at lower altitudes than *P. urnigerum* (D. G. Long 1985). *Pogonatum dentatum* is distinguished by the rectangular, flat-topped marginal cells of the lamellae in section, compared with the rounded marginal cells of *P. urnigerum*, with a broadly convex distal wall. The short, mostly unbranched stems, stout, hooked teeth of the leaf margins, and deeply dissected peristome will also serve to distinguish this species in the field. Caducous-leaved forms are frequent in the Arctic. In Nunavut, it is known from Ellesmere Island.

5. Pogonatum urnigerum (Hedwig) P. Beauvois, Prodr. Aethéogam., 84. 1805 F

Polytrichum urnigerum Hedwig, Sp. Musc. Frond., 100, plate 22, figs. 5–7. 1801

Plants medium to robust, in loose tufts or scattered among other mosses, green to glaucous green, brownish with age. **Stems** 2–5 cm, commonly branching by innovations, frequently dendroid. **Leaves** 2.5–6 mm, densely imbricate and crowded toward

the stem and branch tips, erect-appressed and somewhat incurved when dry, reflexed and widely spreading when moist, gradually to rather abruptly contracted to the blade, the hinge-cells sharply differentiated; sheath ovate to obovate, hyaline-margined on the flanks, with a wedge of incrassate hinge cells at the shoulders and extending a short distance up the blade margin; blade broadly oblong-lanceolate to narrowly linear-lanceolate, only slightly concave, toothed from apex almost to the shoulders, or sometimes subentire; costa percurrent or slightly excurrent as a subulate, serrate to smooth point, smooth abaxially or sparingly toothed towards the tip; lamellae 30–46, entire in profile, 4–7 cells high, the marginal cells enlarged, thick-walled and coarsely papillose, in section rounded to elliptical, broader than high, the distal wall broadly convex, the lumen rounded pentagonal; sheath cells short-rectangular to ± isodiametric approaching the blade; cells on abaxial surface of blade 24–27 µm, irregularly quadrate, ± isodiametric, thick-walled, the transverse walls often thicker. **Seta** 1–4 cm, typically one per perichaetium but several per plant at the tips of branches. **Capsule** 2–3 mm, short-cylindric to ovate-cylindric, erect to inclined, light brown to reddish brown to blackish with age; exothecium mammillose, densely areolate, the cells rounded quadrate, incrassate, with slit-like pits in the outer wall; peristome 300–350 µm, divided to 0.6, the teeth rather broad, reddish brown with hyaline margins. **Spores** 10–18 µm.

Disturbed sandy or gravelly soil on stream banks, roadsides, crevices of cliffs and boulders, and in late snow areas; moderate to high elevations; Greenland; Alta., B.C., N.B., Nfld. and Labr., N.W.T., N.S., Nunavut, Ont., P.E.I., Que., Sask., Yukon; Alaska, Colo., Idaho, Mont., N.H., N.Y., Oreg., Tenn., Vt., Wash., Wis.; Europe, Caucasus, Siberia, e Asia (Philippines, New Guinea.); Atlantic Islands (Iceland).

The most widely distributed species of the genus, *Pogonatum urnigerum* is notably absent from Middle America and south-temperate South America. In Nunavut, it is known from Baffin, Ellesmere, and Melville islands. The plants are usually more robust than are those of *P. dentatum*, often repeatedly branched, and the crowding of the leaves at the tips of the branches produces a distinctive tiered effect. The marginal cells of the lamellae are rounded in section, and the lumen is pentagonal, resembling the gable end of a house. Fruiting plants of the two species can be easily distinguished also by the peristome, which in *P. dentatum* is deeply divided almost to the base. *Polytrichastrum alpinum* also branches repeatedly, but the plants are generally larger and absent the bluish glaucous appearance characteristic of *P. urnigerum* in the field.

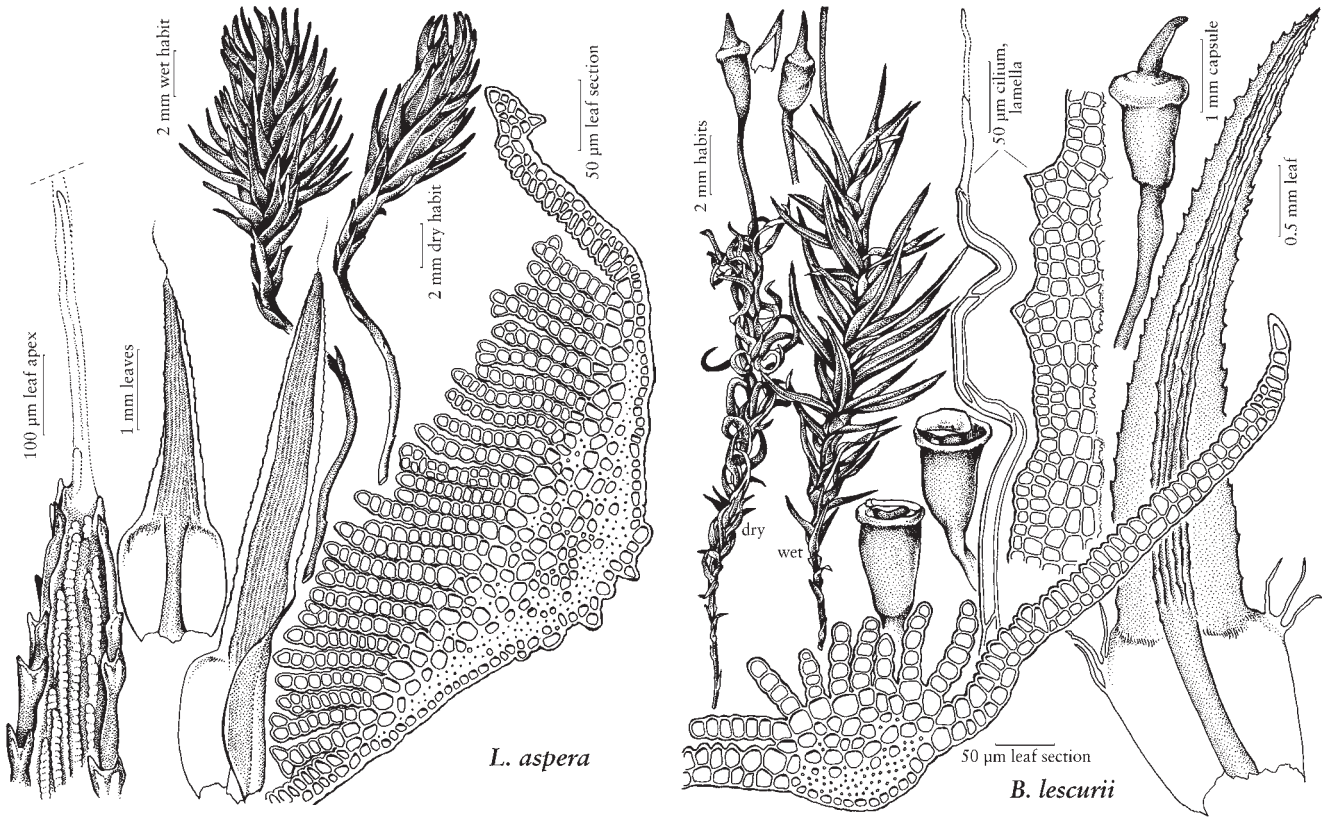
8. LYELLIA R. Brown, Trans. Linn. Soc. London 12: 561. 1819 • [For Sir Charles Lyell, 1767–1849]

Gary L. Smith Merrill

Plants robust, polytrichoid. **Stems** simple or rarely branched. **Leaves** with a sheathing base and divergent blade; sheath entire, hyaline-margined; limb firm, serrate-toothed in distal 1/3–1/2, with lamellae restricted to median portion of the limb, the lamina ± uniformly 2-stratose; lamellae entire, the marginal cells in section not differentiated, smooth. [**Capsule** ovoid, strongly dorsiventral, the upper surface flattened and concave with a narrow winged margin, lower surface rounded-convex, with hypophysis short, with conspicious stomata, guard cells surrounded by a circle of thin-walled, hyaline cells; operculum compressed-conic, with elongated oblique beak; peristome none; columella apex flattened and protruding from the central opening of a concave, thickened disc. **Calyptra** sparsely hairy to almost smooth. **Spores** echinulate.]

Species 4 (1 in the flora): North America, e Asia (including Siberia).

Lyellia is a small genus with a disjunctive distribution, with representatives occurring in the Himalayas and eastward, and a single species, *L. aspera,* at high latitudes in arctic America and eastern Asia. The capsules are strongly dorsiventral, resembling those of *Dawsonia* in shape, but without a peristome. The flattened columella apex projects from the center of the disc like a stopper in a wash basin (Gary L. Smith 1971, fig. 25); the epiphragm remains embedded in the operculum. The hypophysis has prominent stomata, the guard cells surrounded by a ring of thin-walled, hyaline subsidiary cells, which are sharply differentiated from the surrounding cells of the exothecium.



LYELLIA ◦ BARTRAMIOPSIS

1. Lyellia aspera (I. Hagen & C. E. O. Jensen) Frye in A. J. Grout, Moss Fl. N. Amer. 1: 111. 1937 F

Philocrya aspera I. Hagen & C. E. O. Jensen, Meddel. Grønland 15: 388, figs. 1–9. 1898

Plants bare and thread-like below, rather abruptly leafy above, dark green to chestnut-brown. **Leaves** with a narrower, lanceolate limb above the sheathing base, imbricate and crispate distally when dry, erect-spreading when moist, 7–8 mm, lamina 2-stratose, leaf tip truncate, with a single delicate, sinuous capillary hair (deciduous and often lost in older leaves); sheath pale to yellowish, not completely enclosing stem, oblong to subquadrate, entire, not hyaline-margined, with a wedge-shaped patch (hinge) of incrassate cells just above sheath; limb 0.7 mm wide at base, 4.5–5.5 mm; costa narrow, percurrent or excurrent with a few rows of teeth on abaxial surface near apex, forming discontinuous lamellae; lamina margins ± erect to broadly inflexed, entire below, 2-stratose and coarsely serrate in distal 1/3–1/2, teeth in pairs, terminal tooth cell not much larger than the others; lamina 2-stratose except for 1–2 rows of cells just inside the thickened margin, adaxial surface of lamina longitudinally grooved; lamina cells isodiametric, 7–12 µm wide, adaxial layer of cells in cross section higher than wide, turgid-mammillose, strongly bulging, moderately thick-walled; cells of abaxial layer isodiametric, ± plane, with thickened exterior walls; lamellae (18–)24–33 µm, restricted to 1/3–1/2 of leaf width, (5–)8–12(–15) cells high, in profile subentire to irregularly crenulate, marginal cells in cross-section undifferentiated or somewhat higher than wide and with a thickened apex, sporadically geminate. **Sporophytes** not reported within range of flora.

Soil; low to moderate elevations; typically admixed with other bryophytes; Greenland; Nunavut (Baffin Island), Yukon; Alaska; Asia (Russia in Siberia: Taimyr Peninsula, Yakutia, Chukotka, Anadyr Basin, Wrangel Island).

The delicate "whisker" at the leaf apex of *Lyellia aspera* (W. C. Steere 1956) is unique to this species and quite unlike the stout hair points of other Polytrichaceae. The hair is 2-seriate for much of its length, becoming 1-seriate near the tip, the longitudinal cell walls strongly thickened, and the transverse septa thin-walled. The hair is hygroscopic, twitching gently in response to changes in humidity. Sporophytes are not known for North America, for which place the species was first described. Capsules of *L. aspera* from Siberia (O. M. Afonina and E. N. Andrejeva 1993) are similar in essential features to those of *L. crispa*, the type of the genus, but smaller and more slender. In Nunavut, it is known from Baffin Island. The calyptra of *L. aspera* is still unknown.

9. BARTRAMIOPSIS Kindberg, Rev. Bryol. 21: 33. 1894 • [Genus *Bartramia* and Greek *-opsis*, resembling]

Gary L. Smith Merrill

Plants slender, not distinctly polytrichoid. **Stems** simple. **Leaves** with a sheathing base and divergent limb; sheath ciliate on the shoulders, not hyaline-margined; limb serrate-toothed to the sheath (or ciliate near the base), with lamellae restricted to the adaxial surface of the costa; lamina 2-stratose, with sporadic 1-stratose patches, the adaxial layer of cells bulging-mammillose; lamellae serrate in profile, the marginal cells in section not differentiated, smooth. **Capsule** short-cylindric, terete, flaring at the mouth when old and empty, weakly contracted at the base, the long-tapering neck merging with the seta; exothecial cells without thin spots or pits; stomata present, confined to the neck; operculum conic; peristome none; columella flaring at the tip, persisting and elevated above the rim of the capsule. **Calyptra** naked. **Spores** papillose.

Species 1: northern Pacific Radiant distribution, nw North America, e Asia (Japan, e Siberia).

Diagnostic features of *Bartramiopsis* include the serrate lamellae, the ciliate sheath, the terete capsule, which is flared at the mouth and tapers toward the base, the absence of a peristome, and the naked calyptra. The genus occupies an isolated position in the family, and the gametophyte has a curious un-polytrichoid appearance. The bistratose lamina and the absence of even a rudimentary peristome have led to its association with *Lyellia*, but the capsule in that genus is strongly dorsiventral with 2 sharp angles, with a bowl-shaped disc at the capsule mouth and the blunted columella apex forming a "stopper" in the small central opening. In *Bartramiopsis*, the exserted columella is broadly flared, extends to the capsule rim, and persists long after the operculum is shed.

1. Bartramiopsis lescurii (James) Kindberg, Rev. Bryol. 21: 35. 1894 F

Atrichum lescurii James, Bull. Torrey Bot. Club 6: 33. 1875; *Lyellia lescurii* (James) E. S. Salmon

Plants in loose to rather dense pure tufts, dull olive green, becoming dark reddish brown with age. **Stems** 3–10 cm, arising from a short, erect tuberous rhizome, slender and thread-like, distantly bracteate and appearing almost leafless proximally, ± abruptly leafy distally. **Leaves** loosely imbricate, 4–6 mm, linear-lanceolate from a sheathing base, the sheath yellowish and nitid, clasping stem; limb reflexed at the shoulders, subtubulose, twisted and contorted when dry, widely spreading and almost plane when moist; costa slender, percurrent, smooth abaxially, ending in a short spine; margins of sheath entire proximally, not hyaline-margined, at shoulders cilia 1-seriate, 0.4–0.6 mm, cells distinctly papillose; no hinge tissue; margins of limb plane, serrations ending in a conical tooth cell, sometimes with 1–2 short cilia near the shoulders; lamina 2-stratose except for a narrow strip just within the margin and locally 1-stratose streaks and patches, adaxial layer of cells strongly bulging mammillose in indistinct longitudinal rows; lamellae 4–5(–9), restricted to the costa, 4–8(–10) cells high, serrations ending in a small toothed cell; sheath cells linear at margin, the median short-rectangular, 23–28 × 6–9 µm; abaxial laminal cells irregularly arranged, subquadrate, 6–10(–12) µm, walls evenly thickened and firm; abaxial costal cells sharply differentiated, narrowly elongate to linear, 25–33(–55) × 5–6 µm. **Sexual condition** dioicous; male plants like the female, male inflorescence inconspicuous, several to a shoot, separated by sectors with normal vegetative leaves, perigonial bracts with a broader sheath, but otherwise like the leaves; perichaetial leaves scarcely differentiated. **Seta** rather stout, 7–12 mm. **Capsule** yellowish brown, erect, 2.5–4 mm, widest at the mouth; exothecial cells short-rectangular, 40–62 × 26–30 µm, smaller and ± isodiametric below mouth, smooth; stomata superficial, confined to the tapering neck; operculum almost as large as urn, beak about 1 mm; peristome none; columella broadly flaring, extending to capsule rim. **Calyptra** cucullate.

Soil banks or soil over rock, exposed tree roots; usually low to moderate elevations; B.C.; Alaska, Wash.; e Asia (Japan, Russia in Kamtschatka).