

of a shallow furrow on its abaxial side in the distal half. This is a unique feature, unknown in other species of the genus. Moreover, the leaf margin is wavy and lumpy in the distal portion, and the hyaline awn is terete and sharply spinulose-denticulate; this is a rather exceptional type of hair-point in this genus. *Bucklandiella heterosticha* has a flattened and very broad awn, 1-stratose leaf margins, broadly canaliculate leaves, and symmetric, not winged costae; it is unlikely to be mistaken for *B. occidentalis*. Likewise, *B. affinis* has an awn similar to that in *B. heterosticha* and, additionally, it differs from *B. occidentalis* in its broader leaves, 1-stratose leaf margins, and entirely different costal anatomy. *Bucklandiella lawtoniae* shares with *B. occidentalis* wavy and lumpy leaf margins and sharply denticulate awns that, however, are flattened, not terete, and distinctly erect-recurved to squarrose. Moreover, it has completely 1-stratose leaf margins and symmetric, reniform costa in the proximal portion, and lacks a basal marginal border. *Bucklandiella sudetica* is much less robust than *B. occidentalis* and has smooth leaf margins, flat and less denticulate awns, and symmetric costa.

12. *Bucklandiella sudetica* (Funck) Bednarek-Ochyra & Ochyra in R. Ochyra et al., Cens. Cat. Polish Mosses, 147. 2003



Trichostomum sudeticum Funck, Deutschl. Moose, 26. 1820;
Campylopus sudeticus (Funck) Fűrnröhr.; *Racomitrium heterostichum* var. *sudeticum* (Funck) Dixon; *R. jensenii* Kindberg; *R. sudeticum* (Funck) Bruch & Schimper; *R. sudeticum* [unranked] *papillosum* C. E. O. Jensen;

R. sudeticum var. *alaskanum* Cardot & Thériot

Plants small to medium-sized, rather slender but stiff, rarely robust, forming loose or dense cushions, tufts or mats, dull, variable in color, olive or yellowish green, yellowish or orange-brown to olivaceous distally, brown to blackish brown proximally. **Stems** (0.5–)1.5–4.5(–8) cm tall, erect to ascending, rarely prostrate, usually sparingly branched to almost unbranched. **Leaves** erect-appressed when dry, erect-patent to spreading when moist, lanceolate to narrowly ovate-lanceolate, broadly canaliculate to carinate, (1.2–)1.5–2.3(–2.8) × 0.4–0.8 mm; margins broadly recurved to $\frac{1}{2}$ – $\frac{3}{4}$ the leaf length on one side, narrowly and shortly recurved or plane on the other side, 2(–3)-stratose for 1(–4) cell rows and somewhat bulging to 1-stratose in the distal half; epilose or terminating in a hyaline awn, awns stout, denticulate to crenate, erect to erect-recurved, 0.15–0.4 mm; costa subpercurrent to percurrent, strongly convex on the

abaxial surface, in transverse-section semi-terete, (50–)60–85(–100) μm wide at the base, 40–55 μm wide near the apex, 3(–4)-stratose in the middle and at the base, with 3(–4) enlarged adaxial cells, 2(–3)-stratose with 2–3 adaxial cells distally; laminal cells 1-stratose with occasional 2-stratose strands near the apex, smooth to pseudopapillose; basal laminal cells elongate, (15–)25–50(–55) × 8–10 μm wide, with thickened, sinuose-nodulose lateral walls; alar cells not or only slightly differentiated, usually yellowish; basal marginal laminal cells quadrate to short-rectangular, pellucid, with moderately thickened and mostly sinuose walls, forming an indistinct border of (2–)5–10(–15) cells; medial and distal laminal cells quadrate to short-rectangular, mixed with oblate (5–)10–20(–25) × 5–10(–12) μm . **Inner perichaetial leaves** ovate-lanceolate, usually pilose. **Seta** yellow to brown, 2–3.5 mm. **Capsule** brown, dull to glistening, ovoid, obloid to obloid-cylindric, smooth, (0.7–)1.1–1.6 × 0.4–0.65 mm; operculum conic, with a straight or slanted beak; peristome teeth 280–410 μm , orange-yellow to reddish brown, papillose, usually variously cleft into 2–3 prongs in the distal half or only perforated to undivided, with a low basal membrane, 35–50 μm high. **Spores** (10–)12–16(–18) μm .

Dry, exposed or sheltered acidic rocks, boulders, cliff ledges, and rocky ground in fellfield habitats, less often in moist places, rock surfaces and in fissures, stony or gravelly ground among boulders and pebbles, well-drained talus slopes and hillsides, sometimes soil; low to high elevations (0–3600 m); Greenland; St. Pierre and Miquelon; Alta., B.C., N.B., Nfld. and Labr., N.S., Que., Sask., Yukon; Alaska, Calif., Colo., Idaho, Maine, Mont., N.H., N.Y., Oreg., Vt., Wash., Wis.; South America (Argentina, Chile); Europe; arctic and temperate Asia; Atlantic Islands (Falkland Islands, Iceland, South Georgia); Australia; Antarctica (South Sandwich Islands, South Orkney Islands, South Shetland Islands, Antarctic Peninsula).

Apart from *Bucklandiella microcarpa*, *B. sudetica* is the most common species of the genus in North America. It is highly variable, with a number of morphotypes to which, in the past, taxonomic status was given. Some morphological and anatomical structures exhibit consistency, making *B. sudetica* a fairly well-defined species, difficult to confuse with others of the genus. It is best characterized by its slender, sparsely branched stems; short and narrow leaves; muticous or short (to 0.4 mm) hyaline awns; leaf margins recurved and 2-stratose distally with frequent 1-stratose patches; relatively narrow costa that is distinctly convex on the abaxial surface and semi-terete in transverse section, 2–3-stratose near the apex, 3–4-layered in the proximal part, with 3–4 enlarged adaxial cells; distal leaf cells tending to be short or very

short, quadrate to short-rectangular; and basal laminal cells mostly sinuose-walled to the insertion.

One of the most distinctive phenotypes of *Bucklandiella sudetica* consists of robust plants with an always strong costa and prominently thickened leaf margins. They are sometimes designated as forma *kindbergii* (Frisvoll) Ochyra & Bednarek-Ochyra (A. A. Frisvoll 1988; H. Bednarek-Ochyra 1995) and are scattered throughout the southern distribution area of the species growing in the same habitats as typical plants of *B. sudetica*. They appear to be intermediate between the typical form of the species and *B. macounii*, and are characterized by being muticous or with short awns, to 0.15 mm; 2-stratose leaf margins for 1–3(–5) cell rows, with occasional 3–4-stratose spots for 1–2 cell rows; and

a robust costa, 70–90 µm wide basally, which is sometimes irregular in outline and 3(–4)-stratose in the base and 3(–4)-stratose in the middle. However, on account of the dark green or dark olivaceous color and slender habit of the plants, entirely hyaline awns, leaf margins recurved on both sides, predominantly 3-stratose costa, and strongly pseudopapillose laminal cells, these plants are considered as a variant of *B. sudetica*. The opposite phenotype of *B. sudetica* consists of epigeal and robust plants with 1-stratose leaf margins, and a narrow (55–85 µm in the base) and thin (2–3-stratose basally) costa. They may be mistaken for *B. microcarpa*, which, however, is a strongly branched plant with a flexuose awn, prominent pellucid basal marginal borders, and less sinuose cells towards the base of the leaf.

7. NIPHOTRICHUM (Bednarek-Ochyra) Bednarek-Ochyra & Ochyra in R. Ochyra et al., Cens. Cat. Polish Mosses, 137. 2003 • [Greek *nipha*, snow, and *trichos*, hair, alluding to hoary appearance owing to hyaline hair-pointed leaves]

Ryszard Ochyra

Halina Bednarek-Ochyra

Racomitrium subg. *Niphotrichum* Bednarek-Ochyra, Fragm. Florist. Geobot., Ser. Polon. 2: 70. 1995

Plants small, moderately sized to large, loosely to densely caespitose or forming extensive mats or patches, green, yellow- to grayish green or yellow-brown, sometimes olive with rusty-red tinge, often hoary when dry. **Stems** creeping, procumbent to ± erect, irregularly to pinnately, sparingly to copiously branched, often with numerous, short tuft-like branches. **Leaves** erect-appressed when dry, erect-spreading to squarrose when moist, ovate, elliptical, ovate-lanceolate, triangular, to lanceolate, obtusely to sharply keeled or broadly canaliculate distally; margins 1-stratose throughout, recurved on both sides to mid leaf or to apex; apices long- to broadly short-acuminate, sometimes muticous, usually awned, awn stout to capillaceous, straight, flexuose, or reflexed, not or decurrent, smooth or denticulate, papillose or epapillose; costa single, ending in mid leaf to percurrent, entire or branched distally, strongly flattened abaxially, 2-stratose throughout or 3-stratose in the base; basal laminal cells elongate to linear, sinuose-nodulose; alar cells mostly enlarged, thin-walled, hyaline to yellowish, forming somewhat inflated and decurrent auricles; supra-alar cells hyaline or yellowish, quadrate to rectangular, not sinuose or sinuose, epapillose, thin- or thick-walled, often forming a distinct or indistinct pellucid border; medial and distal laminal cells 1-stratose, subquadrate, to short-rectangular, sinuose, with tall, stout, conical papillae over lumina on both surfaces. **Perichaetial leaves** differentiated, hyaline or yellowish, obtuse to acute, sometimes piliferous. **Seta** yellowish to blackish red, erect, sinistrorse when dry, smooth. **Capsule** narrowly ellipsoid, obloid to cylindrical, smooth to somewhat sulcate when dry; annulus tardily deciduous, 2–3-seriate; operculum very long-subulate, straight; peristome teeth nearly as long as the urn or longer, red-brown, divided almost to the base into 2 or rarely 3 linear-subulate, densely papillose branches. **Calyptra** verrucose distally. **Spores** globose, finely papillose.

Species 8 (6 in the flora): North America, Europe, arctic and temperate Asia, Atlantic Islands (Azores, Iceland, Madeira).

Niphotrichum comprises species from the traditionally conceived genus *Racomitrium* centered around *R. canescens*. It is characterized by strongly papillose laminal cells with tall conical papillae that are situated over the lumina. This type of papillosity is common, for example, in the Pottiaceae but is unique in the Grimmiaceae. This exceptional diagnostic character is coupled with very long peristome teeth that are regularly cleft to the base into 2–3 filiform segments, and hyaline or yellowish hyaline and thin-walled alar cells that form convex and often decurrent auricles. Moreover, species of this genus possess massive, papillose, and denticulate awns; costae forked or branched at the tip, ending at mid leaf or extending to the leaf apex; triangular, elliptic, or broadly ovate-lanceolate leaves; innermost perichaetial leaves hyaline, sheathing, and sometimes pilose; setae smooth, sinistrorse on drying; operculum with a subulate beak as long as the urn or longer; and capsules often plicate when dry.

1. Leaves obtusely keeled to broadly canaliculate in the distal part, elliptical to broadly ovate-lanceolate; costa mostly distinctly branched, extending $1/2$ – $3/4$ of the way up the leaf; papillae tending to be relatively large and conspicuous in the distal part of the leaf lamina 7a. *Niphotrichum* sect. *Niphotrichum*, p. 286
1. Leaves sharply keeled to narrowly canaliculate in the distal part, ovate-lanceolate to triangular; costa mostly unbranched, extending $3/4$ of the way up the leaf to percurrent; papillae tending to be relatively small and inconspicuous in the distal part of the leaf lamina 7b. *Niphotrichum* sect. *Elongata*, p. 289

7a. NIPHOTRICHUM (Bednarek-Ochyra) Bednarek-Ochyra & Ochyra sect. NIPHOTRICHUM

Racomitrium [unranked] *Canescentia* Kindberg; *Racomitrium* sect. *Canescentia* (Kindberg) Bednarek-Ochyra

Plants medium-sized to robust, green, olive or grayish green distally, brown to blackish proximally. **Leaves** elliptical, ovate to ovate-lanceolate, broadly canaliculate to obtusely keeled in the distal part; costa distinctly branched or forked in most leaves, extending to mid leaf or three quarters of the leaf length; leaf cell papillae comparatively large and conspicuous in the distal part of the lamina.

Species 2 (2 in the flora): North America, Europe, arctic and temperate Asia, Atlantic Islands (Iceland).

Section *Niphotrichum* is best characterized by fairly short costae that usually extend to $1/2$ – $3/4$ of the way up the leaf and often imperceptibly merge with the laminal cells. This results in the shape of the distal parts of the leaves, which are broadly canaliculate to obtusely carinate in profile as clearly seen in transverse sections. In addition, the costae are distinctly branched or forked at the apex in most leaves.

SELECTED REFERENCE Frisvoll, A. A. 1983. A taxonomic revision of the *Racomitrium canescens* group (Bryophyta, Grimmiiales). *Gunneria* 41: 1–181.

1. Basal leaf cells distinctly papillose; awns not or weakly denticulate or serrulate at tips, distinctly papillose throughout 1. *Niphotrichum canescens*
1. Basal leaf cells not or faintly papillose; awns spinulose and serrulate, not or faintly papillose at tips 2. *Niphotrichum panschii*

1. *Niphotrichum canescens* (Hedwig) Bednarek-Ochyra & Ochyra in R. Ochyra et al., Cens. Cat. Polish Mosses, 137. 2003 [F]



Trichostomum canescens Hedwig, Sp. Musc. Frond., 111. 1801; *Bryum canescens* (Hedwig) Withering; *Grimmia canescens* (Hedwig) Müller Hal.; *Racomitrium canescens* (Hedwig) Bridel

Plants medium-sized and fairly slender to large, in loose or dense patches or tufts, dull green, yellow-

green or yellow-brown, often hoary when dry. **Stems** (1-)3-10(-12) cm, sparingly or profusely irregularly branched or often regularly pinnately branched with short, tuft-like branchlets. **Leaves** straight to distinctly falcate, imbricate when dry, patent to recurved when moist, ovate to broadly ovate-lanceolate, (1.5-)2-2.8 (-3.3) × 0.8-1.3 mm; margins broadly recurved to revolute throughout; apices rather abruptly narrowed, hyaline or not, sometimes muticous, usually awned, awns broad and stout to subulate, not reflexed, not or distinctly decurrent, mostly serrulate and spinulose, papillose distally and strongly so basally; costa weak, extending 1/2-3/4 way up the leaf, flattened and weakly convex abaxially, 90-120 µm wide near the base; basal cells rectangular, 30-50 × 4-7 µm strongly papillose with large papillae, often epapillose in 1-3 rows at the insertion; alar cells usually rounded and inflated in 3-5 rows, thin-walled, hyaline to yellowish hyaline, forming prominent, decurrent, somewhat inflated auricles; supra-alar cells elongate, thin- and straight-walled, producing a pellucid marginal border of 20-30 cells; medial and distal laminal cells rectangular, 10-30 × 5-10 µm, strongly papillose. **Inner perichaetial leaves** membranous, hyaline, acute, usually with hyaline awns. **Seta** dark red to reddish brown, 5-25 mm. **Capsule** brown, narrowly ellipsoid to cylindrical, 1.5-2.5 mm, smooth to somewhat furrowed when dry; peristome teeth 600-800 µm, reddish brown, densely papillose. **Spores** 8-11 µm.

Subspecies 2 (2 in the flora): North America, Eurasia.

Niphotrichum canescens is separated from all other congeners by its leaves broadly canaliculate to obtusely keeled in the distal portion, stout awns that are strongly papillose throughout and weakly serrulate, and short and forked costae ending well before the apex, usually in mid leaf or at three quarters of the leaf length.

1. Plants mostly robust; leaves ovate to broadly ovate-lanceolate, hyaline at the apex, strongly obtusely keeled and cucullate distally; awns non-decurrent 1a. *Niphotrichum canescens* subsp. *canescens*

1. Plants fairly gracile; leaves ovate-lanceolate to broadly ovate-lanceolate, chlorophyllose at the apex, less obtusely keeled in the upper part; awns decurrent 1b. *Niphotrichum canescens* subsp. *latifolium*

1a. *Niphotrichum canescens* (Hedwig) Bednarek-Ochyra & Ochyra subsp. *canescens* [F]



Plants mostly large. **Leaves** broadly ovate-lanceolate to ovate, often distinctly curved throughout the shoots, very broadly canaliculate distally, hyaline in the uppermost part and merging with the awn, making it very broad; awns not or weakly decurrent, distinctly denticulate and spinulose towards the apex.

Sandy or gravelly soils and fine rock-debris, acidic or calcareous substrates in rather dry situations, soil or humus over rock ledges along roadsides, gritty soil at lake shores, grassland and heaths, exposed boulders along streams and creeks and on dunes; low to high elevations (0-4200 m); Alta., B.C., Man., N.B., Nfld. and Labr., N.W.T., Ont., Que., Sask., Yukon; Alaska, Colo., Idaho, Maine, Mich., Mont., N.H., N.Y., Oreg., Utah, Vt., Wash., Wyo.; Europe; Asia (Siberia).

Subspecies *canescens* occurs across the continent from British Columbia, Washington, and Oregon to Newfoundland, with the southernmost extensions to the Rocky Mountains of Colorado and the northernmost station at Lake Iliamna in southern Alaska. It is highly variable; doubtless the differing phenotypes are reactions to varying environmental conditions. The most common phenotype comprises robust plants with broad and typically concave leaves that are falcate along the whole stem and are long-pilose with awns that merge with large hyaline apical parts of the leaves. The opposite extreme is plants with thin shoots and almost elliptical, non-falcate, spoon-shaped, and cucullate leaves that have a short and strait awn or are muticous.

1b. *Niphotrichum canescens* subsp. *latifolium*(C. E. O. Jensen) Frisvoll, *Gunneria* 41: 123. 1983

Racomitrium canescens var. *latifolium* C. E. O. Jensen, Meddel. Grønland 3(2): 345. 1887

Plants fairly gracile. **Leaves** ovate-lanceolate, straight or occasionally weakly falcate, often less obtusely keeled distally, chlorophyllous at the apex; awns mostly subulate and flexuose, distinctly decurrent,

moderately denticulate and spinulose towards the extreme apex.

Dry to moist, exposed habitats, acidic or less often calciferous substrates, soil, humus, rock-debris and rocky ground, between boulders, talus slopes, cliffs and ledges various communities of polar tundra and tundra-like alpine heaths and barrens; low to high elevations (0–2000 m); Greenland; Alta., B.C., N.W.T., Nunavut, Que., Yukon; Alaska, Wash.; Europe (Jan Mayen, Spitsbergen, Fennoscandia); arctic and temperate Asia (Japan, Sikkim); Atlantic Islands (Iceland).

Subspecies *latifolium* is widely distributed from Alaska to Greenland. The ranges of both subspecies overlap in the Rocky Mountains of British Columbia and Washington, and there the differences between the taxa seem to be less pronounced. There are some problematic plants with narrower awns and more lanceolate leaves, but because they are robust and have falcate leaves, they are referred to subsp. *canescens*. The plants from the more northerly regions are easy to determine. They are slender and the leaves are ovate-lanceolate, less concave, mostly straight, and chlorophyllose at the apex. Consequently, the awns embrace only the small uppermost part of the leaf lamina and are long-decurrent. In the Arctic, subsp. *latifolium* is likely to be mistaken for *N. panschii*. The differences between these taxa are discussed under the next species.

2. *Niphotrichum panschii* (Müller Hal.) Bednarek-Ochyra & Ochyra in R. Ochyra et al., *Cens. Cat. Polish Mosses*, 138. 2003



Grimmia panschii Müller Hal. in K. Koldewey et al., *Zweite Deutsche Nordpolarfahrt* 2(1): 72. 1873

Plants medium-sized and gracile to fairly large, olivaceous to green in the distal part, brown to blackish brown proximally. **Stems** (2–)4–6(–11) cm, ascending to erect, mostly unbranched, rarely

irregularly sparingly or pinnately branched. **Leaves** imbricate and closely appressed on drying, erect-spreading on wetting, straight, ovate-lanceolate to

elliptical, 1.9–2.8 × 0.9–1.3 mm; margins broadly recurved from base to apex; gradually tapering towards the apex, mostly terminated with a hyaline awn, awn mostly short and broad, less often long and narrow, slightly flexuose, irregularly denticulate and spinulose, papillose proximally, with narrow but fairly tall and irregularly arranged papillae on the abaxial side, epapillose or nearly so in the distal part; basal laminal cells elongate, 40–70 × 5–7 µm, epapillose or nearly so in 2–4 cell rows at the insertion, with thick and nodulose longitudinal walls; alar cells hyaline, forming small to medium-sized, rounded and somewhat inflated group of 2–4 cell rows; supra-alar cells not sinuose, thick-walled, forming a pellucid marginal border, consisting of to 10 (–20) cells; medial and distal laminal cells rectangular, 15–25 × 7–12 µm, distinctly papillose. Sterile.

Dry and exposed or moist to wet sites, acidic or seldom calciferous soil and rocky ground, between boulders, on scree, talus and rocky seepage slopes, cliffs and ledges, late snow beds and various communities of polar tundra; low to moderate elevations (0–1600 m); Greenland; Nfld. and Labr. (Labr.); Nunavut, Que., Yukon; Alaska; Europe (Spitsbergen); Arctic and temperate Asia.

Niphotrichum panschii is fairly frequent in the high Arctic of Alaska, the Yukon Territory, and Nunavut, as well as in Greenland (except for the southernmost part), only occasionally southwards to latitude ca. 55° N in Labrador. It is closely related to *N. canescens*, but the possibility of confusion with the typical subspecies of the latter is rather minimal since that is a temperate taxon and its range does not overlap that of *N. panschii*. The taxa have a similar leaf shape, although *N. panschii* always has straight leaves that are not hyaline in the distal part and it is less robust than subsp. *canescens*. *Niphotrichum panschii* is externally more similar to *N. canescens* subsp. *latifolium*, and they are more likely to be confused, especially because they often grow together. However, they can be recognized by their awns, which in *N. panschii* are less papillose but more strongly spinulose and serrate at the apex, relatively short, less flexuose, and directed upwards. In contrast, the awns of subsp. *latifolium* are strongly papillose throughout and only faintly serrulate, long, distinctly flexuose, and consequently spreading from the shoot. The stems of *N. panschii* are sparingly branched to almost unbranched, and the branches are usually erect and fragile, whereas those of subsp. *latifolium* are more profusely branched, and the branches are non-fragile.

7b. NIPHOTRICHUM sect. ELONGATA (Bednarek-Ochyra) Bednarek-Ochyra & Ochyra in R. Ochyra et al., Cens. Cat. Polish Mosses, 138. 2003

Racomitrium sect. *Elongata* Bednarek-Ochyra, Fragm. Florist. Geobot., Ser. Polon. 2: 94. 1995

Plants small, medium-sized to robust, green, olive or grayish green distally, brown. **Leaves** ovate-lanceolate, lanceolate to triangular, sharply keeled to narrowly canaliculate in the distal part; costa in most leaves unbranched or only occasionally forked in some leaves, extending to three quarters of the leaf length to percurrent; leaf cell papillae tending to be relatively small and inconspicuous in the distal lamina.

Species 6 (4 in the flora): North America; Europe; temperate Asia, Atlantic Islands.

Section *Elongata* is fairly homogeneous. Its members are readily recognized by their leaves, which are sharply keeled to narrowly canaliculate or canaliculate-keeled in the distal part, and their costae, which cease mostly at three quarters of the leaf length or are subpercurrent to percurrent and are generally undivided at the tip.

1. Leaf margins recurved to $\frac{1}{2}$ – $\frac{3}{4}$ of the way up the leaf 3. *Niphotrichum muticum*
1. Leaf margins recurved to the apex.
 2. Plants small; leaves 1.5–1.8 mm long; costa not grooved; laminal cells opaque, coarsely papillose, yellowish; alar cells forming a small and weakly inflated group; awns absent papillae or only faintly papillose at the base 4. *Niphotrichum pygmaeum*
 2. Plants medium-sized to large; leaves 2–3 mm long; costa lying in a shallow or deeper furrow; laminal cells coarsely to slightly papillose, mostly transparent, not yellowish (except the base); alar cells forming a conspicuous and distinctly inflated group; awns mostly coarsely papillose.
 3. Supra-alar cells elongate, thin-walled and not sinuose, forming a transparent marginal border; awns erect-flexuose when dry, not or indistinctly decurrent, faintly papillose to epapillose in the distal part 5. *Niphotrichum ericoides*
 3. Supra-alar cells short, thick- and sinuose-walled, not forming a translucent border; awns recurved when dry, conspicuously decurrent, coarsely papillose throughout 6. *Niphotrichum elongatum*

3. *Niphotrichum muticum* (Kindberg in Macoun) (Bednarek-Ochyra) Bednarek-Ochyra & Ochyra in R. Ochyra et al., Cens. Cat. Polish Mosses, 138. 2003 [F]

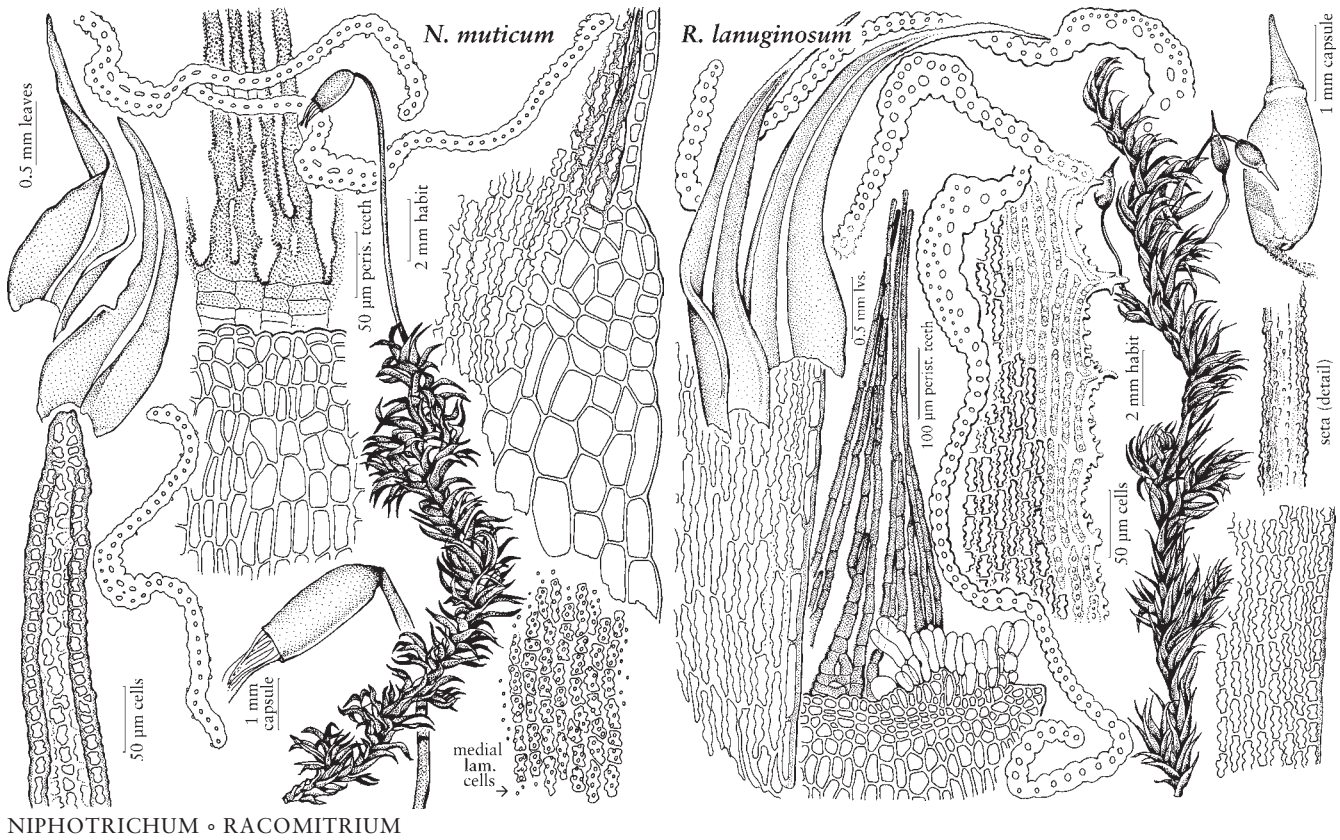


Racomitrium brevipes var. *muticum* Kindberg, Bull. Torrey Bot. Club 17: 272. 1890; *R. canescens* [unranked] *muticum* (Kindberg) Kindberg; *R. canescens* var. *muticum* (Kindberg) Macoun & Kindberg

Plants medium-sized, rarely small or fairly large, mostly slender, in fairly loose or dense mats or tufts,

light olivaceous, often with a rufous hue in the upper part, brownish to blackish brown proximally. **Stems** (1)–2–5(–9) cm, creeping, ascending to suberect, pinnately or sometimes irregularly branched to almost unbranched. **Leaves** imbricate and usually twisted and crispate when dry, erect-spreading to recurved when moist, narrowly ovate-lanceolate to triangular, sharply carinate and often distinctly plicate, 1.8–2.5 × 0.4–0.7 mm; margins

narrowly recurved from the base to $\frac{3}{4}$ way up the leaf, plane near the apex; muticous or sometimes with a short, to 200 μm , yellowish hyaline, weakly denticulate and sparsely papillose awn; costa yellowish, subpercurrent to percurrent, papillose and distinctly convex on the abaxial side, situated at the bottom of a fairly deep furrow, 40–60 μm wide at the base; basal laminal cells elongate 20–50 × 3–5 μm , with strongly incrassate, nodulose longitudinal walls, except for 3–5 epapillose cell rows at the insertion forming a bright yellow strip; alar cells yellowish hyaline, thin-walled cells in 4–6 rows, forming distinct convex auricles; supra-alar cells quadrate to short-rectangular, firm-walled forming \pm pellucid, often indistinct or absent, marginal border of 10–15 not sinuose cells; medial and distal laminal cells subquadrate to short-rectangular, (7–)10–20 × 4–6 μm , with low and narrow, sometimes indistinct papillae. **Inner perichaetial leaves** membranous, crenulate-dentate at the apex. **Seta** brown, 6–10 mm. **Capsule** brown, cylindric, 1.2–1.5 mm, sulcate when dry; peristome teeth lanceolate, 650–850 μm ,



brown, densely low-papillose, 2-fid to the base. Spores 9–11 µm.

Rocks, boulders, rocky ground, pockets of soil and humus over rock faces in dry or intermittently moist subalpine and alpine tundra-like heaths and barrens, cliffs and ledges, sometimes wet margins of melt pools; moderate to high elevations (900–2000 m); B.C.; Alaska, Wash.; temperate Asia.

Niphotrichum muticum is a circum-North-Pacific species having a discontinuous range extending from Honshu in Japan across the Aleutian arc and southern Alaska southwards to the Cascade Mountains of Washington, where it was once found with fully mature sporophytes. Otherwise, it is consistently sterile. The species is stenotypic. It is readily recognized by its leaf margins that are narrowly recurved to mid leaf or three quarters of the leaf length and by its leaves consistently muticous or with only a short, yellowish, hyaline, almost entire and faintly papillose awn, reaching only to 200 µm. Additionally, the costa is strongly convex abaxially and is distinctly papillose on the abaxial side. These features will easily separate *N. muticum* from epilose ecads of *N. ericoides*.

4. *Niphotrichum pygmaeum* (Frisvold) (Bednarek-Ochyra) Bednarek-Ochyra & Ochyra in R. Ochyra et al., Cens. Cat. Polish Mosses, 139. 2003 [C] [E]



Racomitrium pygmaeum Frisvold, *Gunneria* 41: 83, figs. 14a, 16g, 18b, 27–29. 1983

Plants small and fairly slender, olivaceous to greenish yellow. **Stems** 0.5–1.8(–2.5) cm, ascending, subpinnately or occasionally pinnately branched to almost unbranched, usually

radiculose throughout. **Leaves** imbricate, not or slightly altered when dry, erect-spreading to weakly recurved when moist, ovate-lanceolate, 1.5–1.8 × 0.5–0.6 mm; margins recurved throughout or often not or only weakly recurved distally the base; piliferous or rarely muticous, awn erect-flexuose, fairly long on the uppermost leaves, subulate, non-decurrent, slightly denticulate, epapillose throughout or faintly papillose in the proximal part; costa percurrent, sharply delimited from the laminal cells, superficial and not situated in a groove; 35–55 µm wide at the base; basal laminal cells rectangular, 15–45 × 4–6 µm, with moderately thickened, porose and nodulose longitudinal walls, epapillose in 2–3 cell rows at the insertion; alar cells mostly subquadrate to short-

rectangular, pellucid in 3–5(–6) rows, forming a small, not or weakly convex group; supra-alar cells quadrate to subquadrate, thin- and straight-walled, forming a marginal border consisting of up to 15 cells; medial and distal laminal cells short-rectangular to subquadrate, 6–25 × 6–10 μm, opaque due to relatively dense and coarse papillae. **Sporophytes** unknown.

Dry and open acidic ground in alpine heaths; moderate to high elevations (1900–2500 m); of conservation concern; B.C.; Wash.

Niphotrichum pygmaeum is known only from a few collections in British Columbia and Washington. It is the rarest and smallest species of the genus, readily known by its awn, which is epapillose or only slightly papillose at the base, percurrent costa, which is not situated in a channel, small and flat auricles, and opaque distal laminal cells that are yellow and fairly densely and conspicuously papillose.

5. *Niphotrichum ericoides* (Bridel) Bednarek-Ochyra & Ochyra in R. Ochyra et al., Cens. Cat. Polish Mosses, 138. 2003



Trichostomum ericoides Bridel, J. Bot. (Schrader) 1800(2): 290. 1801; *Bryum ericoides* (Bridel) Dickson; *Grimmia canescens* (Hedwig) Müller Hal. var. *ericoides* (Bridel) Müller Hal.; *Racomitrium brevipes* Kindberg var. *ericoides* (Bridel) Kindberg; *R. canescens* var. *ericoides* (Bridel) Hampe; *R. ericoides* (Bridel)

Bridel; *Trichostomum canescens* Hedwig [unranked] *ericoides* (Bridel) Hartman

Plants moderately sized to fairly large, occasionally small, loosely or densely caespitose or forming extensive mats, yellow- or olive green, rarely dark green in the uppermost part, brown to blackish brown proximally. **Stems** (1–)3–8(–12) cm, prostrate to ascending, mostly pinnately branched, occasionally almost unbranched. **Leaves** appressed and slightly twisted when dry, erect-spreading to somewhat recurved when moist, ovate-lanceolate to subtriangular, 2–3 × 0.9–1.2 mm; margins broadly recurved to revolute throughout; apices gradually long-acuminate, sharply keeled, plicate, piliferous or not infrequently muticous, awns erect or sometimes reflexed-flexuose, capillaceous, slightly decurrent, weakly denticulate, slightly papillose to epapillose distally, slightly to strongly papillose in the basal part with low or

sometimes high and narrow papillae; costa percurrent, lying at the bottom of a shallow and wide-angled furrow and strongly flattened in the basal part, (65–)75–100 μm wide; basal laminal cells elongate, 40–50 × 4–6 μm, with moderately thickened, nodulose and porose longitudinal walls, papillose with relatively low and narrow papillae, except for 1–4 epapillose cells at the insertion; alar cells rounded, thin-walled and hyaline in 3–5 rows, forming rounded and convex auricles; supra-alar cells elongate, with thin, straight or weakly sinuose walls, forming a transparent marginal border consisting of 10–15 cells; medial and distal laminal cells rectangular, 10–20 × 6–10 μm, papillose with relatively low and narrow papillae. **Inner perichaetial leaves** membranous, hyaline to yellowish hyaline, piliferous. **Seta** dark to reddish brown, lustrous, 12–15 mm. **Capsule** brown, long-cylindric, 1.5–2 mm, sulcate when dry; peristome teeth 600–800 μm, reddish brown to red, split to the base into 2 filiform branches, finely densely papillose. **Spores** 9–12 μm.

Dry or intermittently moist sites that are generally shaded, less often open and insolated, sandy, gravelly or gritty soil, humus and soil over rocks, boulders and rock ledges, grassland, stony ground and roadside banks, floor in mesic to dry woodlands and forests, stabilized dunes and disturbed places, various tundra communities, predominantly non-calcareous substrates; low to moderate elevations (0–1600 m); Greenland; B.C., N.B., Nfld. and Labr., N.S., Nunavut, N.W.T., Ont., Que., Yukon; Alaska, Calif., Idaho, Mich., Mont., N.Y., Oreg., Pa., Wash., Wyo.; Europe; Arctic and temperate Asia; Atlantic Island (Azores, Iceland).

Niphotrichum ericoides is a fairly frequent species, with a bicentric distribution in North America. It is most common in the western part of the continent, from Alaska to northern California and in the Rocky Mountains of Idaho and Wyoming. In eastern North America it is less frequent, and scattered from northern Labrador south to Pennsylvania. Apart from *N. panschii*, it is the only species of the genus that penetrates into the high Arctic in Nunavut, the Yukon Territory, and Alaska. The global range of *N. ericoides* also includes arctic, boreal, and temperate Europe, southwards to the Azores; in Asia, it is very rare in the Arctic, Siberia, and Japan. The material reported from Santiago, Chile, as *Racomitrium canescens* (He S. 1998; *Mahu 10543*, MO) also represents *N. ericoides*, but that attribution is fairly suspicious and possibly a result of a confusion of herbarium labels.

Niphotrichum ericoides has been considered to be very close to *N. canescens* and is usually recognized under the latter. However, the two taxa are not likely to be mistaken. The sharply keeled leaves in the distal portion, a percurrent costa, and the epapillose awns will safely discriminate *N. ericoides*. This species is more likely to be confused with *N. elongatum*, with which it often grows in mixed stands and shares the regularly pinnately branched habit with short, tuft-like lateral branchlets, which gives them both a nodose appearance. However, in *N. ericoides* the branchlets are erect-spreading when dry, whereas in *N. elongatum* they are recurved to squarrose at their apex. The awn in *N. ericoides* is erect-flexuose when dry, not or indistinctly decurrent, and often faintly denticulate to smooth. In contrast, the awns in *N. elongatum* are distinctly recurved, long-decurrent, and often sharply denticulate. Microscopically these species are easily separated by the shape of their supra-alar cells. In *N. ericoides* they are elongate and thin- and straight-walled, and form a distinct, transparent basal marginal border; in *N. elongatum* they are short, thick- and sinuose-walled, and opaque and not markedly different from the adjacent laminal cells.

6. *Niphotrichum elongatum* (Frisvoll) Bednarek-Ochyra & Ochyra in R. Ochyra et al., Cens. Cat. Polish Mosses, 138. 2003



Racomitrium elongatum Frisvoll, *Gunneria* 41: 74, figs. 1983

Plants medium-sized to large, in large, dense or loose tufts or mats, grayish olive or olivaceous in the distal part, brown or grayish proximally. **Stems** (1–)3–10(–13) cm, creeping, decumbent to ± erect, mostly pinnately branched

with short, tuft-like branchlets, usually distinctly recurved at the apex. **Leaves** imbricate, not altered on drying, recurved when moist, ovate-lanceolate to subtriangular, indistinctly plicate, 2–3.2 × 0.8–1.2 mm; margins broadly recurved throughout; apices sharply carinate, most often

piliferous, awns recurved to reflexed, subulate, strongly denticulate, mostly long-decurrent, slightly to distinctly papillose distally, strongly papillose basally with high and narrow papillae; costa percurrent, situated at the base of a moderately deep, wide-angled channel and strongly flattened basally, 75–100 µm wide; basal laminal cells long-rectangular, 20–50 × 4–6 µm, moderately thick-walled, nodulose, papillose with large papillae, except for 1–4 rows of epapillose cells at the insertion; alar cells hyaline, thin-walled in 3–5 rows, forming a sharply delimited, convex group; supra-alar cells short, thick- and sinuose-walled, forming non-transparent border of 6–10 cells; medial and distal laminal cells subquadrate to rectangular, 6–20 × 5–8 µm, distinctly papillose. **Inner perichaetial leaves** hyaline, piliferous. **Seta** brown, glistening, 10–15 mm. **Capsule** brown, long-cylindric, 1.4–1.8 mm, sulcate when dry; peristome teeth 650–800 µm long, reddish brown to red, split to the base into 2 filiform prongs, densely papillose. **Spores** 9–11 µm.

Dry sandy and gravelly soil, outcrops, tracks and in quarries, dry subalpine meadows, non-calcareous substrates, occasionally limestone grasslands or on thin soil over limestone; low to moderate elevations (0–1500 m); Greenland; Alta., B.C.; Nfld. and Labr. (Nfld.), Ont.; Alaska, Calif., Idaho, Mich., Mont., N.Y., Oreg., Wash., Wyo.; Europe; Atlantic Islands (Iceland, Madeira).

Niphotrichum elongatum has only recently been formally described as a distinct species. Although it was distinguished at that level by several bryologists of the early eighteenth century, it subsequently fell into oblivion and was merged with *N. canescens*. It is very distinct, though closely related to *N. ericoides*. In contrast to the latter, it is a more southern taxon, and in North America does not extend to the Arctic, reaching its northernmost locality on Gilbert Island in southeastern Alaska. Apart from a few collections from the southernmost tip of Greenland, it has been found only once at lat. 70° N in East Greenland. It grows in habitats similar to those of *N. ericoides*, with which it often occurs in mixed stands, but the latter generally favours drier, warmer, and more exposed microhabitats than the former.

8. RACOMITRIUM Bridel, Muscol. Recent., suppl. 4: 78. 1818 • [Greek *rhakos*, rag or remnant, and *mitra*, turban, alluding to calyptra frazzled or lobed at base]

Ryszard Ochyra

Halina Bednarek-Ochyra

Grimmia sect. *Racomitrium* (Bridel) Müller Hal.; *Racomitrium* Bridel sect. *Lanuginosa* (Kindberg) Noguchi; *Rhacomitrium* Lorentz, orthographic variant; *Trichostomum* sect. *Racomitrium* (Bridel) Duby

Plants medium-sized to large, coarse and rigid, usually hoary, grayish, brownish or yellowish green, yellow or yellow- to blackish brown. **Stems** mostly pinnately branched, with many short, lateral branchlets. **Leaves** erect to slightly secund when dry, loosely erect to erect-spreading or spreading-recurved when wet, narrowly ovate- to linear-lanceolate; margins 1-stratose, recurved to revolute, entire proximally, coarsely dentate along the hyaline border; apices gradually tapering to a long, slender, hyaline acumen; awns densely papillose, erose-dentate, long-decurrent, with the decurrencies flat or ruffled; costa percurrent, in transverse section 2-stratose, becoming 3-stratose in the proximal portion; laminal cells 1-stratose, sinuose, dull and opaque, distinctly papillose with large, flat papillae covering the longitudinal walls and almost the whole of the lumina except for a narrow central groove; basal marginal laminal cells long-rectangular, forming 1(–2)-seriate band, consisting of to 30 rectangular, translucent, not sinuose cells; alar cells not differentiated; medial cells long-rectangular; distal cells short-rectangular. **Inner perichaetial leaves** hyaline, oblong, oblong-lanceolate to elliptical, abruptly constricted into a short, smooth or weakly papillose awn. **Seta** single or often 2–3 per perichaetium, sinistrorse when dry, strongly papillose. **Capsule** straight, ovoid to ovoid-cylindric, somewhat ventricose in the base; annulus revoluble, 2–4-seriate; operculum long-rostrate; peristome teeth, long, reddish brown, split nearly to the base into 2 filiform, strongly papillose branches. **Calyptra** conic-mitrate to cucullate, naked. **Spores** spherical, pale yellow, finely roughened.

Species 3 (1 in the flora): North America, Central America, South America, Europe, Asia, South Africa, Atlantic Islands, Indian Ocean Islands, Pacific Islands, Australia, Antarctica.

Traditionally, *Racomitrium* has been considered as a homogeneous genus characterized by its laminal cells having thick and strongly sinuose to nodulose longitudinal cell walls. This characteristic leaf areolation was typically coupled with a peristome of linear teeth arising from a low or high basal membrane and divided nearly to the base into two filiform, somewhat paired segments that are equally thickened and less prominently trabeculate on both external and internal sides. In addition, the genus was characterized by the consistent lack of a central strand, usual presence of the prostome, sinuose-walled epidermal cells of the vaginula, and cladocarpous sexual condition. This combination of characters made *Racomitrium* readily recognizable. Revisionary studies of the genus showed that in its traditional circumscription it was an artificial, heterogeneous taxon and, as a result, it has been recently split into four genera, *Racomitrium* in the narrow sense, *Codriophorus*, *Niphotrichum*, and *Bucklandiella*. *Racomitrium* in the narrow sense is characterized by: distinctly papillose setae twisted to the left; long, hyaline, strongly papillose awns that are long-decurrent and erose-dentate; large, flat papillae with small secondary papillae densely covering the longitudinal cell walls and almost the whole lumina except for a narrow groove in the middle; peristome teeth divided to the base into 2(–3) filiform branches; and capsules slightly ventricose at the base. The papillosity of the setae is a unique feature of this genus, and is unknown in other acrocarpous mosses. That character, the unusual