

BRYOPHYTES OF ALTAI MOUNTAINS. VI.
THE FAMILY POLYTRICHACEAE (MUSCI)

МОХООБРАЗНЫЕ АЛТАЯ. VI.
СЕМЕЙСТВО POLYTRICHACEAE (MUSCI)

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Abstract.

The family Polytrichaceae in the flora of Altai Mountains, southern Siberia, includes 16 species of 5 genera, *Polytrichum*, *Polytrichastrum*, *Pogonatum*, *Atrichum* and *Psilopilum*. *Polytrichastrum altaicum* Ignatov & Merr. sp. nov., is described; *Polytrichastrum longisetum* var. *anomalum* (Milde) Ignatov & Merr. is a new combination. Keys and descriptions are provided for all species.

Резюме

На Алтае семейство Polytrichaceae представлено 16 видами из 5 родов, *Polytrichum*, *Polytrichastrum*, *Pogonatum*, *Atrichum* и *Psilopilum*. Описан один новый вид, *Polytrichastrum altaicum* Ignatov & Merr. sp. nov., и предложена одна новая комбинация *Polytrichastrum longisetum* var. *anomalum* (Milde) Ignatov & Merr. Для всех видов приведены описания и иллюстрации, а также даны ключи для определения.

INTRODUCTION

This paper is one of a series of treatments on the bryophyte flora of the Altai Mountains, beginning in the third volume of *Arctoa*. When completed, this series will provide descriptions, illustrations and comments on all the bryophyte groups known to occur in the Altai region. General information about the study area and its ecology is provided in Ignatov (1994).

The Polytrichaceae are a widely distributed group, and include many relatively large, common, and conspicuous mosses. Earlier publications on Altaian mosses, although based primarily on collections of non-bryologists, reported 11 species of Polytrichaceae (Keller, 1914; Krylov, 1925). Bardunov (1974) listed 4 additional species from the region. The present revision is based on critical studies of these previous collections, as well as extensive new material, collected chiefly by the first author.

Polytrichaceae Schwaegr. in Willd., Sp. Pl. ed. 4, 5(2): 1. 1830.

Small, medium to large terrestrial mosses, densely to loosely caespitose, on soil or humus, or on soil-covered rock. Shoots erect, acrocarpous, arising from an underground rhizome, typically unbranched, densely leafy above, bracteate below, the transition to mature leaves gradual or \pm abrupt; stems in cross-section with a distinct central conducting strand composed of hydrome and leptome, and traces extending into the leaves. Leaves differentiated into a membranous, sheathing base and a divergent, firm-textured blade (in *Atrichum* and *Psilopilum* the sheath not or scarcely differentiated, the leaves membranous, in *Atrichum* the leaves transversely undulate, crisped and twisted when dry); margins of lamina 1(3)-stratose, entire, serrate, or toothed, (in *Atrichum* with a 2-3-stratose border of linear, thick-walled cells); costa well-developed, narrow in sheathing portion, greatly broadened above and occupying most of the blade width, bearing numerous, closely-spaced photosynthetic lamellae on the adaxial surface (in *Atrichum* and *Psilopilum* the costa narrow, flanked by a broad, unistratose lami-

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na, the lamellae few and confined to the costa); costa in cross-section with a prominent arc of large diam. guide cells, and a broad abaxial stereid band. Lamellae (in profile) entire, finely serrulate, or crenulate, the marginal row of cells in cross-section undifferentiated or differing in size and shape, smooth, finely striolate, or coarsely papillose; abaxial lamellae sometimes present. Cells of sheath short- to elongate-rectangular to linear; cells at the leaf shoulders in a wedge-shaped group of incrassate, transversely elongate cells, forming a "hinge-tissue", one to several cells thick (not present in *Atrichum* and *Psilopilum*); cells of back of costa (or cells of the membranous lamina) \pm isodiametric, quadrate to transversely elongate-hexagonal. No specialized vegetative reproduction.

Diocious (less commonly monoicous). Perigonia indeterminate, typically proliferating and continuing the growth of the stem, often with several successive perigonia per shoot. Perichaetia terminal, the perichaetial leaves long-sheathing, or not much differentiated. Seta elongate, usually solitary, less often several from the same perichaetium. Capsules erect, inclined, or horizontal, sharply 4-alate (with knife-edge angles), acutely to rather bluntly 4- to 6-angled, or terete; apophysis indistinct or delimited by a deep basal constriction; exothecium smooth, bulging-mamillose, or papillose; stomata present (absent in *Atrichum* and *Pogonatum*). Peristome nematodontous, consisting of a single series of 32 to 64 unjointed, rigid teeth composed of fiber-like, sinuate cells, the teeth pale or strongly pigmented, simple (with a single median line, cf. Smith, 1971, fig. 23) or compound (the outlines of two teeth and the sinus between these are visible on the outer face of each tooth, l.c., figs. 24, 28); outer surface of teeth smooth to papillose, apparently varying with age (Figs. 10-12); teeth attached by their tips to a membranous or \pm fleshy epiphragm, an expansion of the distal end of the columella, which covers the capsule opening like the head of a drum. Spores (6)10-15(25) μ m in diam., echinulate, but appearing smooth under the light microscope (*Polytrichum*), or somewhat larger and evidently papillose. Calyptra cucullate, hidden by a loosely or densely interwoven, matted felt of hairs, arising from the tip of the calyptra and covering part or all of the capsule, or (in *Atrichum* and *Psilopilum*) the calyptra sparsely ciliate to naked.

The Polytrichaceae include 20 genera and about 400 species, distributed in all climatic zones of both hemispheres. The greatest diversity occurs in the middle elevations of mountains in temperate zones. In all zones there are both widely distributed and endemic species. About half of the species occurring in Altai

have a wide distribution in both the Northern and Southern hemispheres. Others are more limited in overall distribution, and some are common elsewhere but rare locally. Savicz-Lyubitskaya (1954) revised the family Polytrichaceae of the Soviet Union providing very useful dot maps for all species.

The generic classification used in this paper follows that of Smith (1971). As a consequence, several species which were formerly placed in the genus *Polytrichum* are assigned to *Polytrichastrum*. The distinctions between these two genera are reviewed by Smith (1971, 1974a) and by Merrill (1992), and in the keys and descriptions which follow.

Polytrichum s. str. is a genus characterized by "a unique set of tightly correlated sporophytic characters" (Merrill, 1992), which are not shared by the other species. Synapomorphies (shared derived characters) of the genus include differences in capsule shape, apophysis, peristome, epiphragm, exothecium, and spores. These can be summarized as follow:

Capsule: in *Polytrichum* sharply 4-alate, prismatic, with knife-edge angles, typically horizontal and often somewhat dorsiventral due to the upward orientation of the lateral angles; in *Polytrichastrum* acutely to obtusely 4-6 angled or terete, straight to inclined but not dorsiventral.

Apophysis: in *Polytrichum* sharply delimited by a deep basal constriction; in *Polytrichastrum* rather shallowly delimited.

Peristome: in *Polytrichum* of 64 usually uniform teeth, the teeth with a thin sharp keel on the inner face, often with one to several slender spur-like projections; in *Polytrichastrum* teeth less uniform, some smaller, often united, resulting in fewer than 64 teeth, without a keel.

Epiphragm: in *Polytrichum* thin, membranaceous except the edge; firmly attached to the peristome after capsule opening; on ventral (lower) surface with a row of pendent mamilliform projections which alternate with the peristome teeth (Figs. 13-16); in *Polytrichastrum* the epiphragm fleshy, easily detaching from the peristome, (but sometimes remaining attached to columella), lobed and fringed along the margin, the lobes turned upward (Fig. 17), opposite the peristome teeth and attached to the

inner surface, the ventral (lower) surface of epiphragm with a discernible ring of "annulus" (see Figs. 25-28).

Exothecium: in *Polytrichum* distinctly roughened, the exothecial cells bulging-mamillose, with prominent, sharply defined "pits", the pits appearing like holes or perforations in the center of the cell (in facts, they are an optical effect caused by the abrupt thinning of the cell wall from the inside); in *Polytrichastrum* the exothecium is smooth (not mamillose) and the exothecial cell walls are not pitted, or (in *P. sexangulare* and some exotic species of the genus), the outer wall has an indistinct, lighter colored thin spot. The surface of the exothecium under big SEM magnification in both *Polytrichum* and *Polytrichastrum* is covered by a layer of small spicules (Fig. 19) probably of some wax compound; this gives capsule surface a glaucous appearance, especially in *Polytrichum*.

Spores: in *Polytrichum* small (6-13 μm diam.), appearing smooth under the light microscope, but under the SEM echinulate, with small, sharply pointed, conical 'Christmas tree'-like projections (Fig. 1-3); in *Polytrichastrum* larger (13-25 μm), and appearing finely papillose under the light microscope, under the SEM with crowded finger-like projections of varying length which are often themselves papillose at the apex (Figs. 4-8).

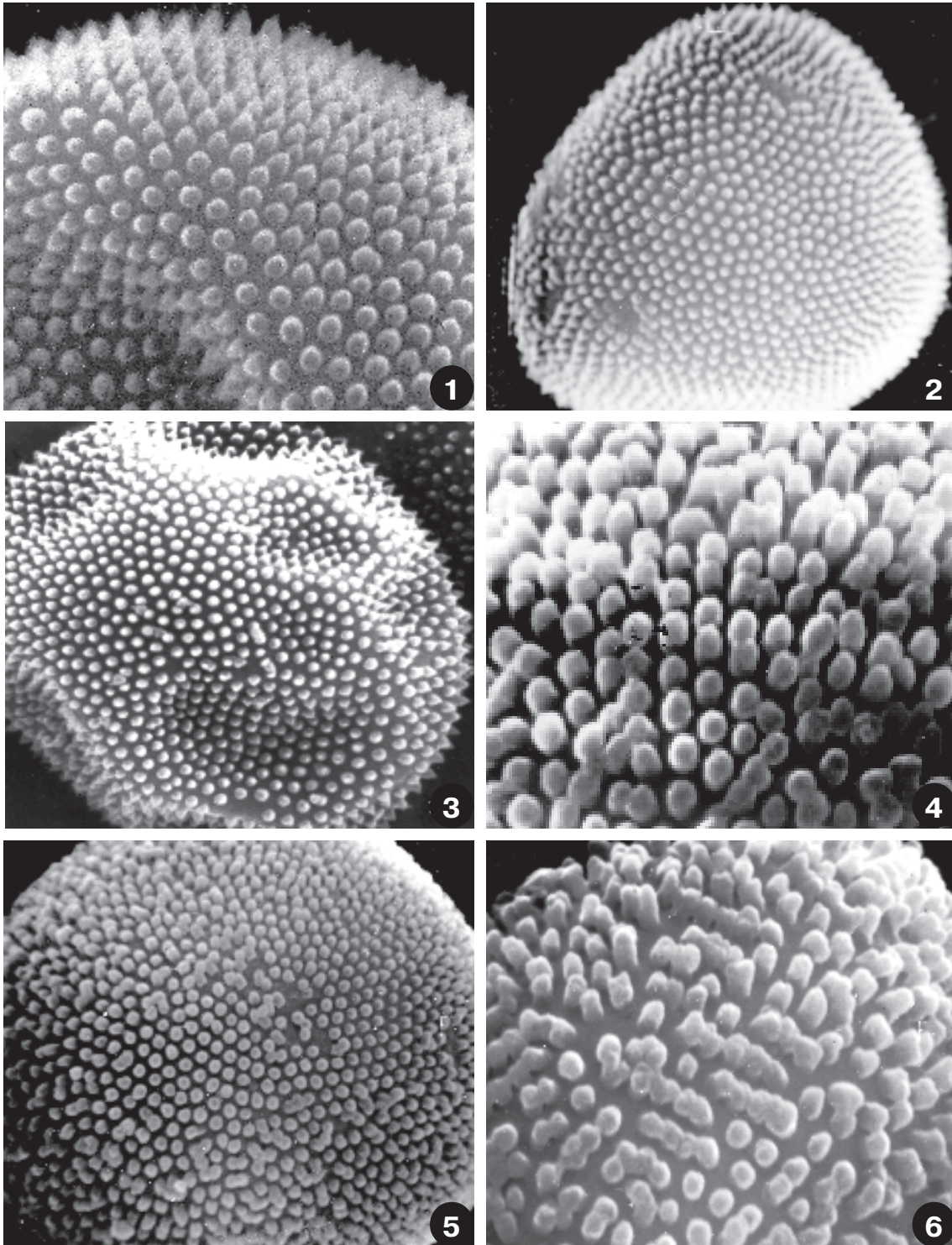
KEY TO THE GENERA OF
POLYTRICHACEAE IN ALTAI

1. Leaves with a ± broadened, membranous, sheathing base and a narrow, firm, divergent blade; costa occupying most of the width of blade, broadly lamellate, the unistratose lamina on either side narrow, 2-10 cells wide (to 20 cells wide in *Polytrichastrum longisetum* var. *anomalum*); calyptra densely hairy (see also supplementary key below)2
1. Leaves not or only weakly differentiated into sheath and blade; costa at mid-leaf 1/5 of the leaf width or less, flanked by a broad unistratose lamina; calyptra sparsely ciliate to naked.....4
 2. Exothecium smooth or the cells bulging-mamillose; stomata present; peristome teeth not strongly pigmented, simple (or when sporadically compound, then the

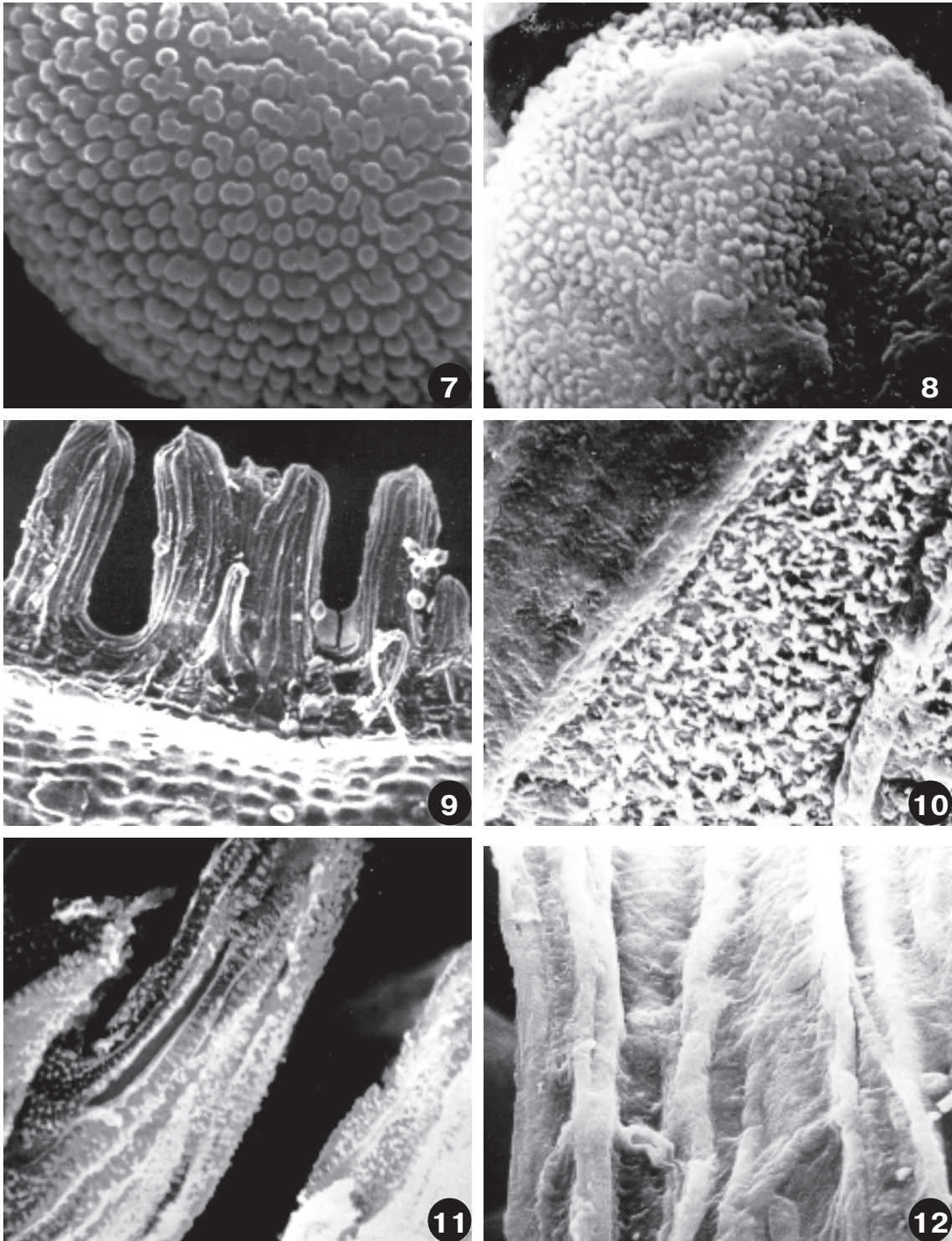
- median sinus broad); leaves green 3
2. Exothecium papillose, with a single papilla per cell; stomata absent; peristome teeth strongly pigmented, compound, the median sinus narrow, almost obscured; leaves bluish- to glaucous-green
.....*Pogonatum*
3. Capsules acutely to obtusely 4-6 angled or terete; apophysis rather shallowly delimited, or capsule tapering to the base, without a distinct apophysis; exothecium smooth, dull, the cells not pitted (with a diffuse thin-spot in *P. sexangulare*); peristome teeth not keeled; spores finely, but evidently papillose, 15-26 μm diam. *Polytrichastrum*
3. Capsules sharply 4-alate, prismatic, with knife-edge angles; apophysis sharply delimited by a deep basal constriction; exothecium mamillose, glaucous, the cells bulging, with a sharply-defined pit; peristome teeth keeled at back; spores echinulate, but appearing almost smooth under the light microscope, 6-10(12) μm diam. *Polytrichum*
4. Leaf margins unbordered (in ours), the margins unistratose, denticulate; small mosses with leaves ovate, 1-3 mm long; costa about 1/5 leaf of width above; capsules with stomata *Psilopilum*
4. Leaf margins strongly toothed and bordered by thick-walled, linear cells, the border 2(3)-stratose, the teeth in pairs; medium-sized mosses with leaves elongate, 5-10 mm long; costa about 1/10 of leaf width; capsules without stomata
.....*Atrichum*

SUPPLEMENTARY KEY TO ALTAIAN SPECIES OF
POLYTRICHUM, *POLYTRICHASTRUM* AND *POGONATUM* BASED ON GAMETOPHYTIC CHARACTERS

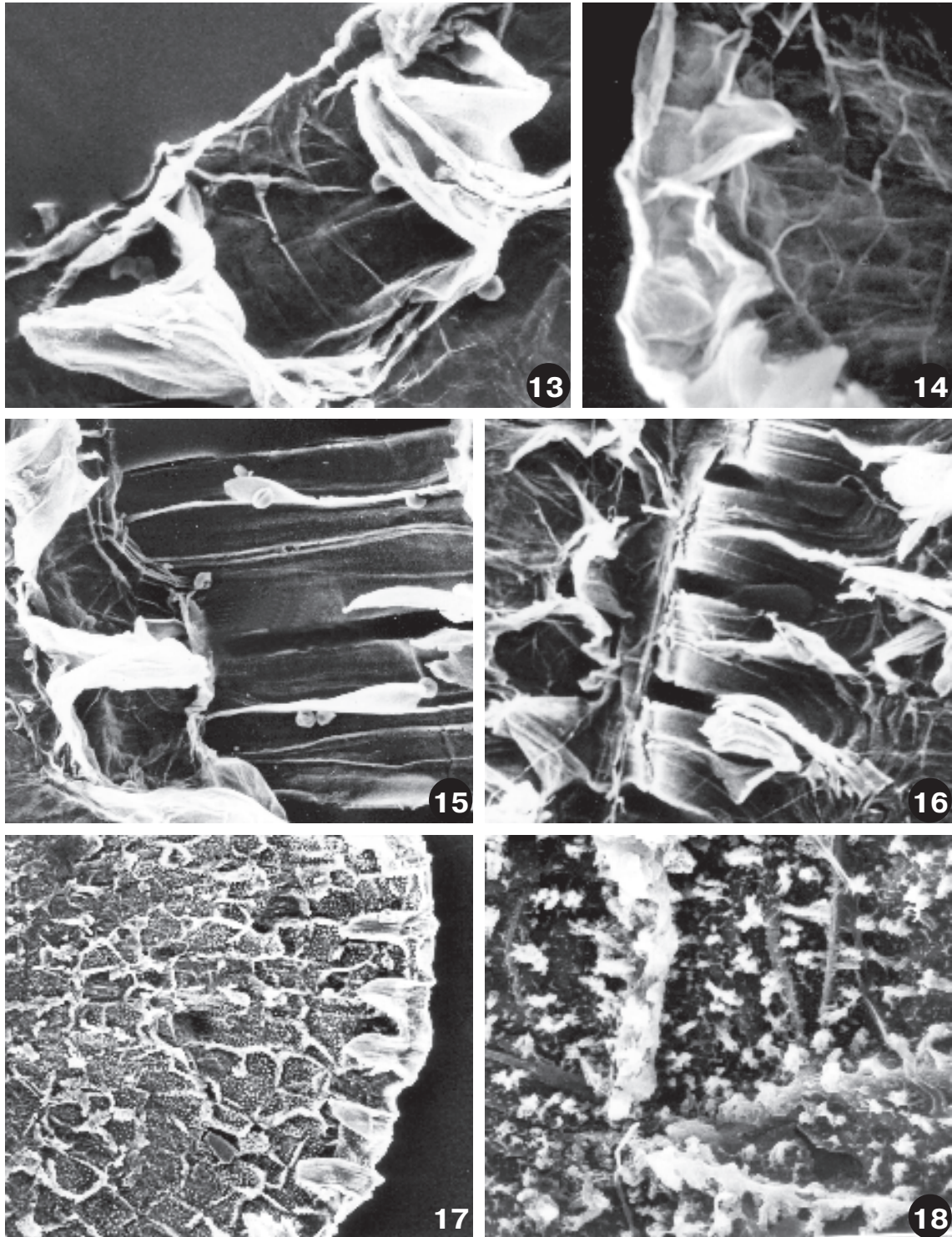
1. Lamella margins papillose 2
1. Lamella margins smooth 4
 2. Lamellar marginal cells ovate to pyriform, the outer wall strongly thickened
.....*Polytrichastrum alpinum*
 2. Lamellar marginal cells rounded to ± rectangular, the walls evenly thick-walled
..... 3
3. Lamellar marginal cells broadly rounded, with a broadly convex outer wall, the lumen rounded; plants often branched
.....*Pogonatum urnigerum*



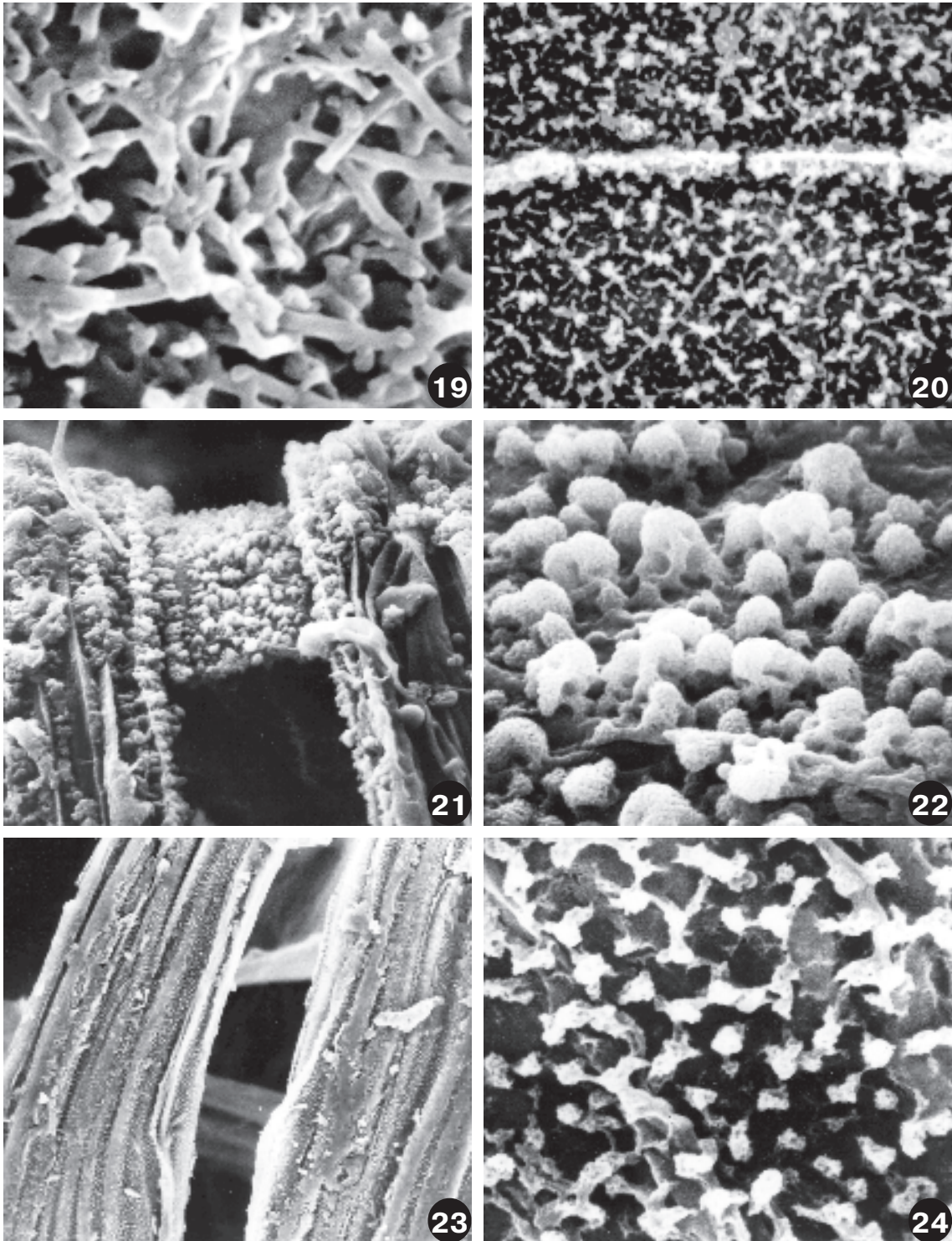
Figs. 1-6. Spores of: 1 - *Polytrichum juniperinum* Hedw. (Karatash 440 m Zolotukhin 20.V.1977); 2 - *Polytrichum commune* Hedw. (Kuderi Lake 1650 m Zolotukhin 11.VI.1987); 3 - *Polytrichum piliferum* Hedw. (Tamanel Peak 1800 m Ignatov 34/92); 4 - *Polytrichastrum longisetum* (Sw. ex Brid.) G. L. Sm. (Kayakkatuyarykskij Creek 2200 m Ignatov 6/4); 5,6 - *Polytrichastrum alpinum* (Hedw.) G. L. Sm. (Bayas Creek 460 m Ignatov 0/1349). Magnifications: 1 - 22000 \times ; 2 - 11000 \times ; 3 - 14000 \times ; 4 - 16000 \times ; 5 - 8000 \times ; 6 - 16000 \times .



Figs. 7 – *Polytrichastrum pallidisetum* (Funkc.) G. L. Sm. (*Bolshoye Istyube Creek* 470 m Ignatov 0/1355); 8 – *Polytrichastrum altaicum* Ignatov et Merr., sp. nov. (the holotype, *Dvukhkarovaya Creek* 2600 m 36/361); 9 – *Polytrichastrum longisetum* (Sw. ex Brid.) G. L. Sm. (*Kayakkatuyarykskiy Creek* 2200 m Ignatov 6/4); 10 – *Polytrichum commune* Hedw. (*Kuderi Lake* 1650 m Zolotukhin 11.VI.1987); 11, 12 – *Polytrichastrum alpinum* (Hedw.) G. L. Sm. (*Bayas Creek* 460 m Ignatov 0/1349). 7, 8 – spores; 9-12 – peristome teeth (11 and 12 – from the same collection). Magnifications: 7 – 16000 \times ; 8 – 8000 \times ; 9 – 300 \times ; 10 – 4700 \times ; 11 – 1000 \times ; 12 – 3700 \times .



Figs. 13, 15 – *Polytrichum commune* Hedw. (Kuderi Lake 1650 m Zolotukhin 11.VI.1987); 14 – *Polytrichum piliferum* Hedw. (Tamanel Peak 1800 m Ignatov 34/92); 16 – *Polytrichum juniperinum* Hedw. (Karataş 440 m Zolotukhin 20.V.1977); 17, 18 – *Polytrichastrum alpinum* (Hedw.) G. L. Sm. (Bayas Creek 460 m Ignatov 0/1349). 13, 14 – lobes on ventral side of epiphragm; 15, 16 – peristome teeth attached to epiphragm, ventral view; 17 – involute lobes of epiphragm margin, dorsal view; 18 – ventral surface of epiphragm. Magnifications: 13 – 800 \times ; 14 – 300 \times ; 15 – 550 \times ; 16 – 350 \times ; 17 – 250 \times ; 18 – 2700 \times .



Figs. 19 – *Polytrichastrum longisetum* (Sw. ex Brid.) G. L. Sm. (*Kayakkatuyarykskij* Creek 2200 m Ignatov 6/4); 20 – *Polytrichum commune* Hedw. (*Kuderi Lake* 1650 m Zolotukhin 11.VI.1987); 21-22 – *Atrichum flavisetum* Wils. ex Mitt. (*Tura Creek* 1300 m Ignatov 28/21); 23-24 – *Pogonatum dentatum* (Brid.) Brid. (*Bolshoye Istyube Creek* 470 m Ignatov 0/1391): 19 – spicalate projections (probably of wax compounds) on capsule surface; 20 – upper surface of epi-phragm; 21 – teeth and epi-phragm margin; 22 – upper surface of epi-phragm; 23 – outer surface of teeth; 24 – upper surface of epi-phragm. Magnifications: 19 – 2000 \times ; 20 – 6000 \times ; 21 – 2000 \times ; 22 – 15000 \times ; 23 – 1000 \times ; 24 – 15000 \times .

3. Lamellar marginal cells rectangular in cross-section, flat-topped, the lumen quadrate; plants unbranched *Pogonatum dentatum*
4. Margins of blade entire (or finely serrulate above) 5
4. Margins of blade serrate or toothed 9
5. Lamina broad, inflexed lamina, the margins overlapping and enclosing the lamellae 6
5. Marginal lamina narrow, erect, not covering the upper surface of the blade 8
6. Leaves ending in a long, hyaline hair-point *Polytrichum piliferum*
6. Leaves ending in a shorter, reddish toothed awn 7
7. Stems densely tomentose; leaves short, appressed when dry *Polytrichum strictum*
7. Stems not tomentose (or only radiculose at base); leaves longer, loosely spreading when dry *Polytrichum juniperinum*
8. Leaf apex cucullate; lamellar marginal cells ovate *Polytrichastrum sexangulare*
8. Leaf apex apiculate; lamellar marginal cells slenderly acuminate, ending in a knob *Polytrichastrum altaicum*
9. Lamellar marginal cells \pm undifferentiated, rounded in cross-section or slightly taller than those beneath 10
9. Lamellar marginal cells strongly differentiated, broader than high, notched or shallowly retuse 11
10. Sheath cells rectangular (5-9:1); marginal lamina 2-4 cells wide *Polytrichastrum formosum*
10. Sheath cells short-rectangular (3-4:1); marginal lamina 4-9(20) cells wide *Polytrichastrum longisetum*
11. Lamellar marginal cells notched to bilobed (rarely divided); lamellae bi-denticulate to almost entire in profile, the margin grooved and \pm straight-sided as seen from above; costa flat on back. Generally robust plants (to 30 cm tall) *Polytrichum commune*
11. Lamellar marginal cells cuneate, flat-topped to shallowly retuse; lamellae crenulate in profile and seen from above; costa forming a ridge on the back of the leaf. More slender, medium-sized plants, to 8 cm high *Polytrichastrum pallidisetum*

Polytrichastrum G. L. Sm., Mem. New York Bot. Gard. 21(3): 35. 1971. Holotype: *Polytrichum alpinum* Hedw.

Plants medium-sized to robust, in loose tufts. Leaves with differentiated sheath and blade, the blade erect to somewhat spreading when dry, widely spreading when wet; sheath hyaline-margined, entire, often highly nitid (polished and glossy), a well-developed hinge tissue present; margins of the blade sharply toothed to entire; costa typically short-excurrent, scabrous, or (especially in perichaetial leaves) prolonged into a toothed awn, or rarely (*P. sexangulare*) the apex cucullate. Lamellae numerous, closely-spaced, occupying most of the blade width, their margins smooth, finely striolate, or coarsely papillose, \pm entire to regularly crenulate in profile, the marginal cells undifferentiated or sharply distinct in size and/or shape. Dioicous (or monoicous, but appearing unisexual). Male plants with inconspicuous rosettes. Seta solitary. Capsules terete or acutely 4- to 6-angled, the apophysis not or shallowly delimited from the urn. Exothecium smooth (neither bulging-mammillose nor papillose), the cells sometimes (*P. sexangulare*) with an indistinct thin spot in the outer wall, irregularly polygonal, but in general arranged in longitudinal rows. Peristome teeth 64, but often somewhat fewer, leiodont, not keeled at back, usually with some teeth compound, not deeply pigmented. Epiphragm readily detached, with erect tooth-like processes opposite the peristome teeth and attached to their inner face. Spores 13-26 μ m diam., finely papillose. Calyptra with a rather loosely interwoven felt of hairs, covering only the upper portion of capsule.

KEY TO THE ALTAIAN SPECIES OF
POLYTRICHASTRUM

1. Marginal cells of the lamellae in cross-section narrowly ovate to pyriform, the upper (free) wall strongly thickened, the lumen pentagonal or narrowly triangular. Sect. *Polytrichastrum* 2
1. Marginal cells of the lamellae \pm undifferentiated or shallowly retuse, the cell walls evenly thickened, the upper wall not strongly thickened. Sect. *Aporotheca* 4
2. Lamellar margins coarsely papillose; leaf margins serrate-toothed; capsule terete *P. alpinum*
2. Margins of lamellae smooth; leaves entire; capsule angled or terete 3
3. Costa percurrent, the leaf apex blunt and sub-cucullate; capsule obtusely (4)6-angled; marginal cells of lamellae ovate to pyriform;

- exothecial cells each with a diffuse thin spot on the outer wall *P. sexangulare*
3. Costa short-excurrent, the leaf apex with an apiculate tip; marginal cells of lamellae slenderly tapering to a knob-like tip; capsule terete; exothecial cells lacking thin-spots *P. altaicum*
4. Lamellae in profile regularly crenulate; lamella marginal cells in cross-section broader than the cells beneath, the apex flattened to shallowly retuse *P. pallidisetum*
4. Lamellae in profile entire (to finely serrulate); marginal cells in cross-section undifferentiated, taller than wide, rounded to elliptical 5
5. Sheath cells short-rectangular (3-4:1); marginal lamina 4-9 cells wide (10-20 cells wide in var. *anomalum*); spores 18-26 diam. *P. longisetum*
5. Sheath cells elongate-rectangular (5-7:1); marginal lamina 2-4 cells wide; spores 13-16 μ m diam. *P. formosum*

Sect. **Aporotheca** (Limpr.) G. L. S. Merr., Bryologist 95: 271. 1992.

Polytrichum sect. *Aporotheca* Limpr., Laubm. Deutschl. 2: 615. 1893.

Lectotype (Smith, 1971): *Polytrichum formosum* Hedw.

Polytrichastrum longisetum (Sw. ex Brid.) G. L. Smith, Mem. New York Bot. Gard. 21(3): 35. 1971. Fig. 25

Polytrichum longisetum Sw. ex Brid., J. Bot. (Schrader) 1800(1): 286. 1801.

Plants medium to large, mostly unbranched, in loose tufts, to 3-5(10) cm high. Leaves widely spreading when moist, erect and somewhat twisted when dry, 1.5 mm wide, 5-6 mm long; sheath rather short, oblong, yellowish, often not as distinctly delimited as in other species of the genus (almost lacking in var. *anomalum*), the hinge-tissue not strongly developed; marginal lamina plane to erect, 4-9 cells wide (to 20 cells wide in var. *anomalum*), sharply toothed (less often bluntly toothed to merely denticulate); costa excurrent, ending in a short yellowish awn. Lamellae (15)20-45, in profile entire or finely serrulate, (2)4-7 cells high, the lamellar marginal cells almost undifferentiated in shape and size, ovate to elliptic in cross-section, taller than wide, sometimes slightly thicker-walled. Median cells of sheath short-rectangular, (12)14-18(23) μ m wide x

(30)42-62(80) μ m long (ca. 3-4:1); cells along the margins of the lamina \pm isodiametric, hexagonal, 15-18 μ m wide (in var. *anomalum* the cells of the broad lamina larger, to 22-24 μ m). Seta to 4(7) cm tall, often exceeding the leafy shoots in length. Capsules inclined, acutely 4-angled, yellowish brown, 1.5-2 mm wide x 2-3 mm long, with a \pm rounded apophysis more than 1/2 the capsule diam., differentiated by a shallow groove. Exothecium smooth, the cells irregularly rectangular, lacking thin-spots. Operculum rostrate, the beak about 0.5 mm long. Peristome 0.4-0.6 mm high, divided to 0.8, the teeth ca. 50, pale to somewhat colored along the median line, narrow (ca. 80 μ m wide), the space between the teeth appearing wider than width of the teeth. Epiphragm with well-developed tooth-like processes. Spores 18-26 μ m diam. Calyptra hairy, yellowish to golden brown to fuscous, covering the upper portion of the capsule.

Polytrichastrum longisetum is similar in habit and habitat preferences to both *P. formosum* and *P. pallidisetum*. Differences include the rather short, less strongly delimited sheath and short-rectangular sheath cells, and the broader lamina margins. Both *P. formosum* and *P. longisetum* have \pm undifferentiated lamella marginal cells, and lamellar margins entire to finely serrulate in profile due to the weakly projecting leading angles of the marginal cells; in *P. pallidisetum* the lamellae are crenulate in profile, and the marginal cells in cross-section broadened, flat-topped to shallowly retuse.

Distribution. *Polytrichastrum longisetum* is a widespread species, occurring mostly in cool climates. It is known in the mountains of central and northern Europe, including Iceland; in Asia, it is common in arctic and boreal zones and in mountains of Mongolia, Northern China and Japan. In North America it occurs from Labrador to Minnesota, south to Pennsylvania and Illinois, Alaska, and Colorado. Reported also for southernmost South America, South Africa, and New Zealand. In Altai, this is a rather frequent species, found in two rather different types of habitats: 1) on rich humus soil at bases of fallen trees in mesic coniferous forests at lower and middle elevations, and 2) on bare peat in bogs at upper elevations. This dualism in habitat preferences has also been observed in the lowlands of European and Asian Russia.

Specimens examined: *Airykoel Lake* 1655 m (Zolotukhin & al. 9.VII.1984); *Ayulyuyuzuyuk Creek* 2500 m (0/1359); *Bogoyash Creek, in middle course* 2200 m (Zolotukhin 24.VI.1986); *Bogoyash Lake* 2350 m (Koroleva 15.VI.1986); *Karakol Lakes* 1800 m (26/103); *Kayakkatuyarykiskij Creek* 2200 m (6/4); *Kobiguayuk Creek* 2100 m (0/405); *Kukol* 1850 m (0/1357); *Malyi Shaltan*

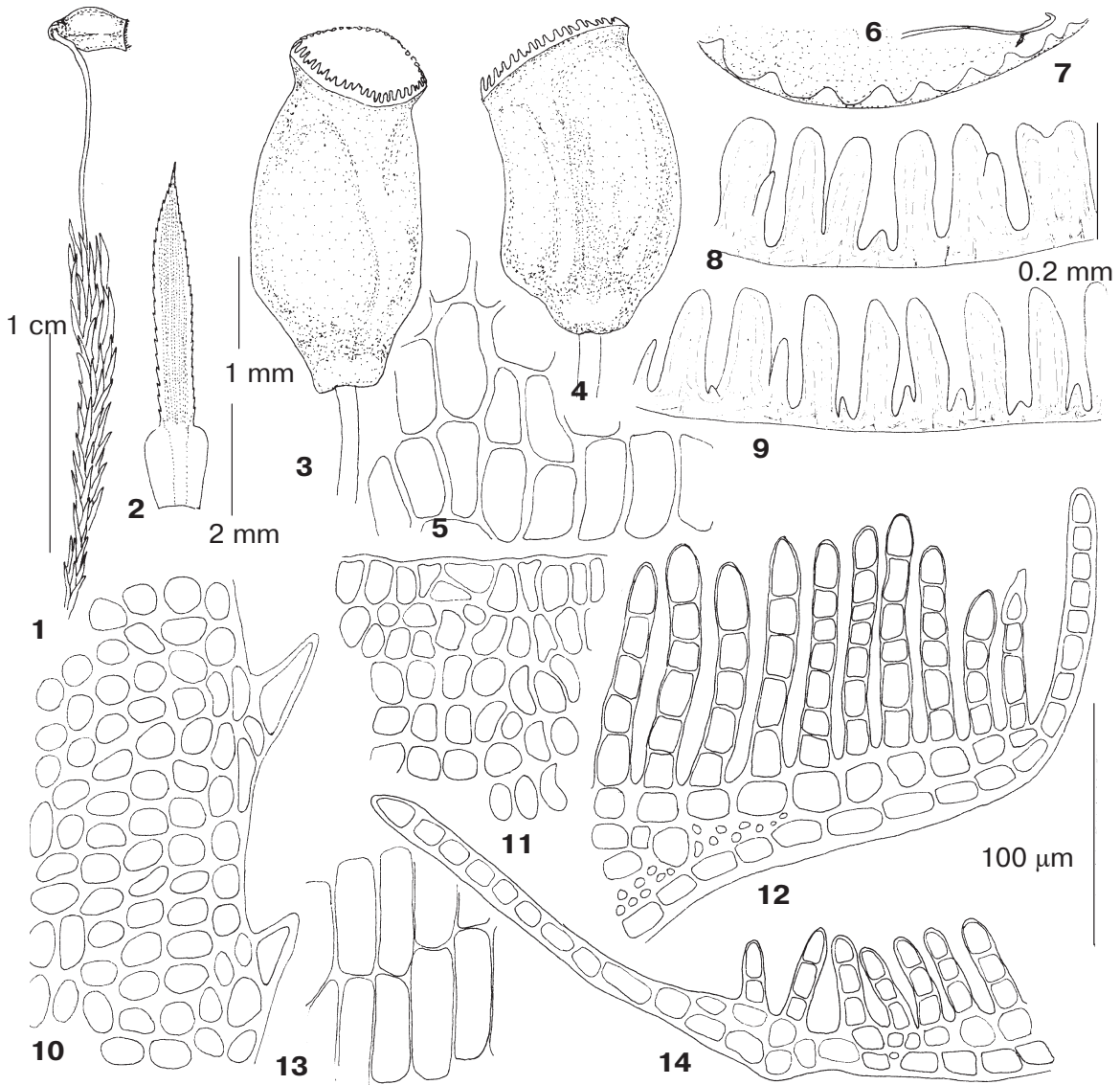


Fig. 25. 1-13: *Polytrichastrum longisetum* (Sw. ex Brid.) G. L. Sm. (from *Kayakkatuyarykskij Creek* 2200 m Ignatov 6/4) and 14: *P. longisetum* var. *anomalum* (Milde) Ignatov et Merr., comb. nov. (from *Ayukol* 1450 m Ignatov 0/1358): 1 - habit; 2 - leaf; 3, 4 - capsules; 5 - exothecium cells; 6 - cross section of epiphragm margin; 7 - dorsal view of epiphragm margin; 8, 9 - portions of peristome; 10 - cells of leaf margin; 11 - side view of lamella; 12, 14 - leaf cross sections; 13 - cells of leaf base. Scale bars: 1 cm - for 1; 2 mm - for 2; 1 mm - for 3, 4; 0.2 mm - for 6-9; 100 μ m - for 5, 10-14.

Creek, upper course 1200 m (Zolotukhin & al. 18.VII.1984); *Uedinennoye Lake* 880 m (0/1356); *Uzunoyuk Creek, in middle course* 2150 m (Zolotukhin 10.VII.1990).

In Altai, the expression known as *P. longisetum* var. *anomalum* occurs at lower elevations, typically on soil walls at upturned roots of fallen trees. It is distinctive in appearance, looking more like an *Atrichum* or *Timmia* than a *Polytrichum* or a *Polytrichastrum*. No sporo-

phytes were observed in such forms. Leaf cell size and shape are the same as in more typical *P. longisetum*, as is the more weakly developed sheath, here almost lacking. Only a few collections from Altai represent intermediates between these two forms, although in other regions (for example, in Central Russia and Ural Mts.), transitions are more numerous. In North America, similar forms of *P. longisetum*

occur; the same tendencies are expressed in *P. pallidisetum* and *P. formosum*, but not to the same degree. In one of the collections (Ayukol, Ignatov 0/1358), the marginal teeth are distinctly striolate. This feature has not been observed previously in this species. The varieties can be distinguished as follows:

- lamellae 20-45, occupying most of blade width, (2)4-7 cells high; marginal lamina narrow, 4-9 cells wide; sheath oblong-ovate, rather short var. *longisetum*
- lamellae 15-20, occupying ca. 1/2 of the width of the blade, 1-3 cells high, flanked by a broad, unistratose lamina up to 20 cells wide; sheath weakly developed, almost obsolete var. *anomalum*

Polytrichastrum longisetum var. **anomalum** (Milde) Ignatov & G. L. Merr., comb. nov.
Atrichum anomalum Milde, Hedwigia 8: 161. 1869.

Polytrichum gracile var. *anomalum* (Milde) I. Hagen, Tromsø Mus. Aarsh. 21-23(3): 265. 1905.

Polytrichastrum longisetum fo. *anomalum* (Milde) Schljakov, Novosti Sist. Niz. Rast. 19: 209. 1982.

Pogonatum manchuricum Horik., J. Jap. Bot. 12: 24. 1936.

Oligotrichum sibiricum Bardunov, Novosti Sist. Niz. Rast. 1968: 303. 1968.

Lamina broad, unistratose, up to 20 cells wide; leaf base not or only slightly broader than the blade; lamellae 12-20, confined to the median portion of the leaf, 1-3 cells high.

Specimens examined: *Adylda Creek* 1100 m (34/16); *Ayukol* 1450 m (0/1358); *Bolshoye Istyube Creek* 470 m (0/1360) 15.VI.1986).

Polytrichastrum formosum (Hedw.) G. L. Smith, Mem. New York Bot. Gard. 21(3): 37. 1971. Fig. 26

Polytrichum formosum Hedw., Sp. Musc. Frond. 92. pl. 19: f. 1a. 1801.

Plants medium to large, robust, mostly unbranched, to 10 cm high. Leaves erect or erect-spreading and tubular when dry, laxly spreading-recurved when moist, 5-6(10) mm long; sheath erect, elliptic, yellowish-brown, clasping the stem; marginal lamina erect, 3-5 cells wide, sharply toothed nearly to the base of blade; costa short excurrent, ending in a brownish to reddish brown toothed point, toothed at back near tip. Lamellae 24-60, in profile entire or

finely serrulate, 4-6 cells high, the lamella marginal cells almost undifferentiated in shape and size, in cross-section narrowly conic to elliptic, somewhat taller than broad, sometimes pale brownish, 12-16 μm high. Median cells of sheath elongate, ca. 9-10 μm wide x 50-60(85) μm long (5-7:1); cells of the lamina near margin \pm isodiametric, 10-13 μm wide. Seta stout, to 4 cm tall. Capsules acutely 4-angled, inclined to horizontal, yellowish brown to brownish, 1.5 mm wide x 5 mm long, with rather small round apophysis 1/4 the capsule diam., differentiated by a shallow groove. Exothecium smooth, the cells not bulging, lacking thin-spots. Peristome 0.6 mm high, divided to 0.6, usually very regular in appearance, the teeth ca. 60, pale to brownish. Epiphragm with indentations in the broad edge at site of attachment of the teeth, lacking erect, tooth-like processes. Spores 13-16 μm diam., finely papillose. Calyptra hairy, covering the upper portion of the capsule.

Differences between *Polytrichastrum formosum* and *P. longisetum* are discussed under the latter species.

Distribution: This species is widely distributed throughout the temperate regions of Eurasia. In Europe, it is the most common *Polytrichastrum* species, known in practically all countries, as well as from most provinces of the European part of the former USSR, Ural and Caucasus. In Asian Russia it is scattered throughout South Siberia and southern Far East. In North America, *P. formosum* has a similar distribution: absent from the Arctic, but widespread from Newfoundland to southern Alaska, southward to Pennsylvania and Minnesota, and in the West to Colorado and California. It is also reported from Mexico, Southwest Asia, Nepal, Mongolia (Khangai Mts.), China, and Japan, as well as from New Guinea, Africa (Macaronesia, North Africa and mountains of East Africa), and New Zealand. In Asian Russia, *P. formosum* is known only in southern Siberia, where there are few localities in Altai and the Western Sayan Mts. In Altai, *P. formosum* has principally the same distribution and ecology as *P. pallidisetum*, occurring in the milder areas of Northern Altai, mostly at upturned roots of fallen trees in mesic coniferous forests.

Specimens examined: *Kamga Creek, 10 km upstream* 520 m (0/90); *Kamga Creek, 4 km upstream* 450 m (0/1364); *Kamga Creek, 8 km upstream* 510 m (0/1361); *Kamga Creek, 9 km upstream* 500 m (0/1363); *Maloye Istyube Creek, 1.5 km upstream* 650 m (Zolotukhin 19.V.1977); *Uedinennoye Lake* 880 m (0/1362).

Polytrichastrum pallidisetum (Funck) G. L. Smith, Mem. New York Bot. Gard. 21(3): 35. 1971. Fig. 27

Polytrichum pallidisetum Funck, Krypt.

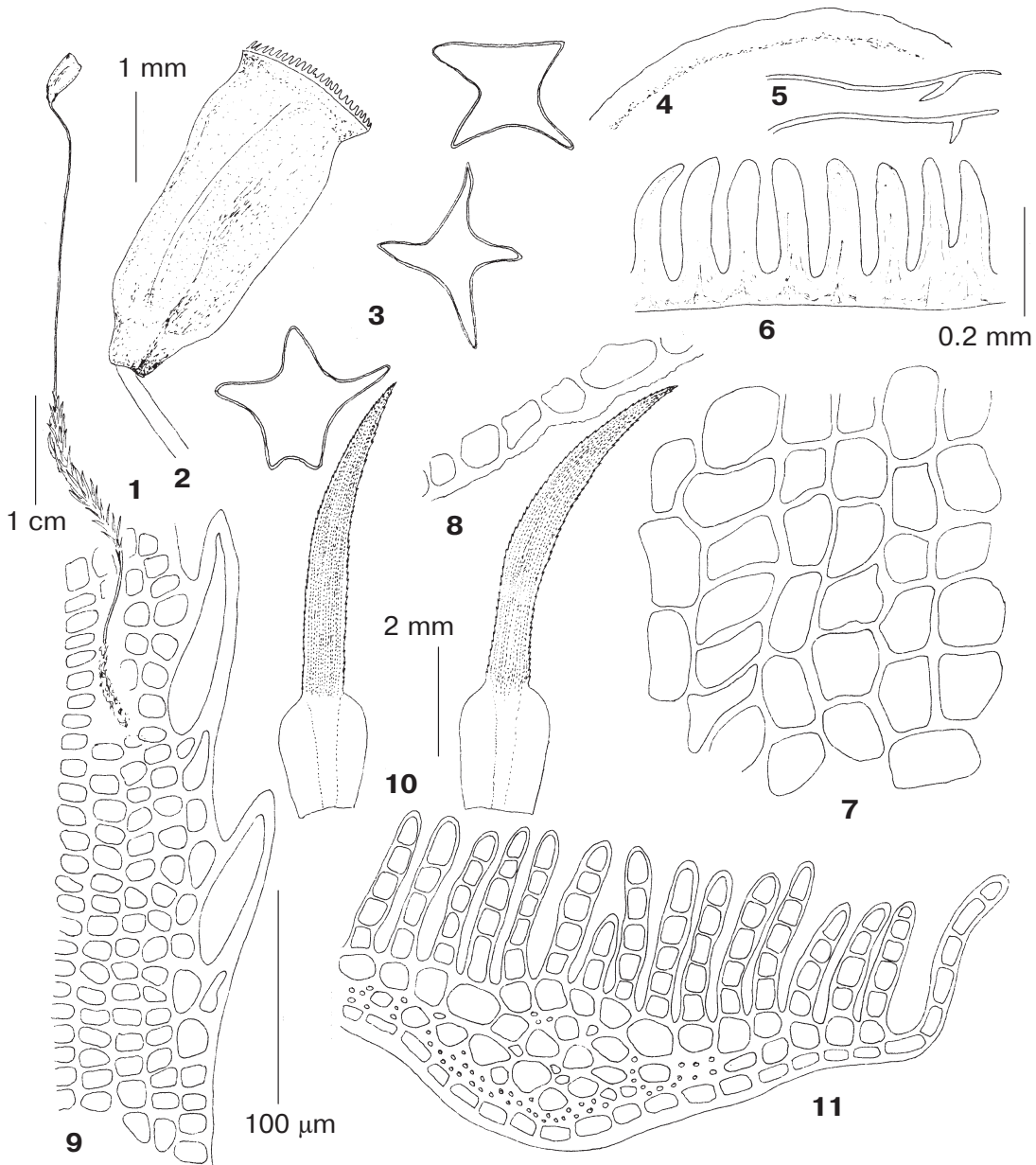


Fig. 26. *Polytrichastrum formosum* (Hedw.) G. L. Sm. (from *Kamga Creek* 510 m 0/1363): 1 - habit; 2 - capsule; 3 - cross sections of capsules; 4 - dorsal epiphragm margin; 5 - cross section of epiphragm margin; 6 - portion of peristome; 7 - exothecium cells; 8 - cross section of exothecium; 9 - cells of leaf margin; 10 - leaves; 11 - leaf cross section. Scale bars: 1 cm - for 1; 2 mm - for 10; 1 mm - for 2, 3; 0.2 mm - for 4-6; 100 µm - for 7-9, 11.

Gew. Fichtelgeb. 3: 55. 1802.

Polytrichum decipiens Limpr., Rabenhorst
Krypt-Fl. 4(2): 618. 1893.

Plants medium, dark green, in loose tufts, the stems not or sparingly branched, to 8 cm high. Leaves erect spreading when dry, the blade widely spreading but not sharply reflexed when moist, 6-10 mm long; sheath with tapering shoulders, hyaline or

yellowish in color; marginal lamina plane, 3-9 cells wide, sharply toothed from the apex almost to base of blade; costa excurrent, ending in short, reddish, toothed awn. Lamellae 20-40, crenulate in profile, 4-6 cells high, the lamellar marginal cells in cross-section broader than the cells beneath, cuneate (obtrapezoidal), flat-topped to shallowly retuse, typically somewhat variable in shape in the same leaf cross-section, frequently tinged with brown, 5-8×10-

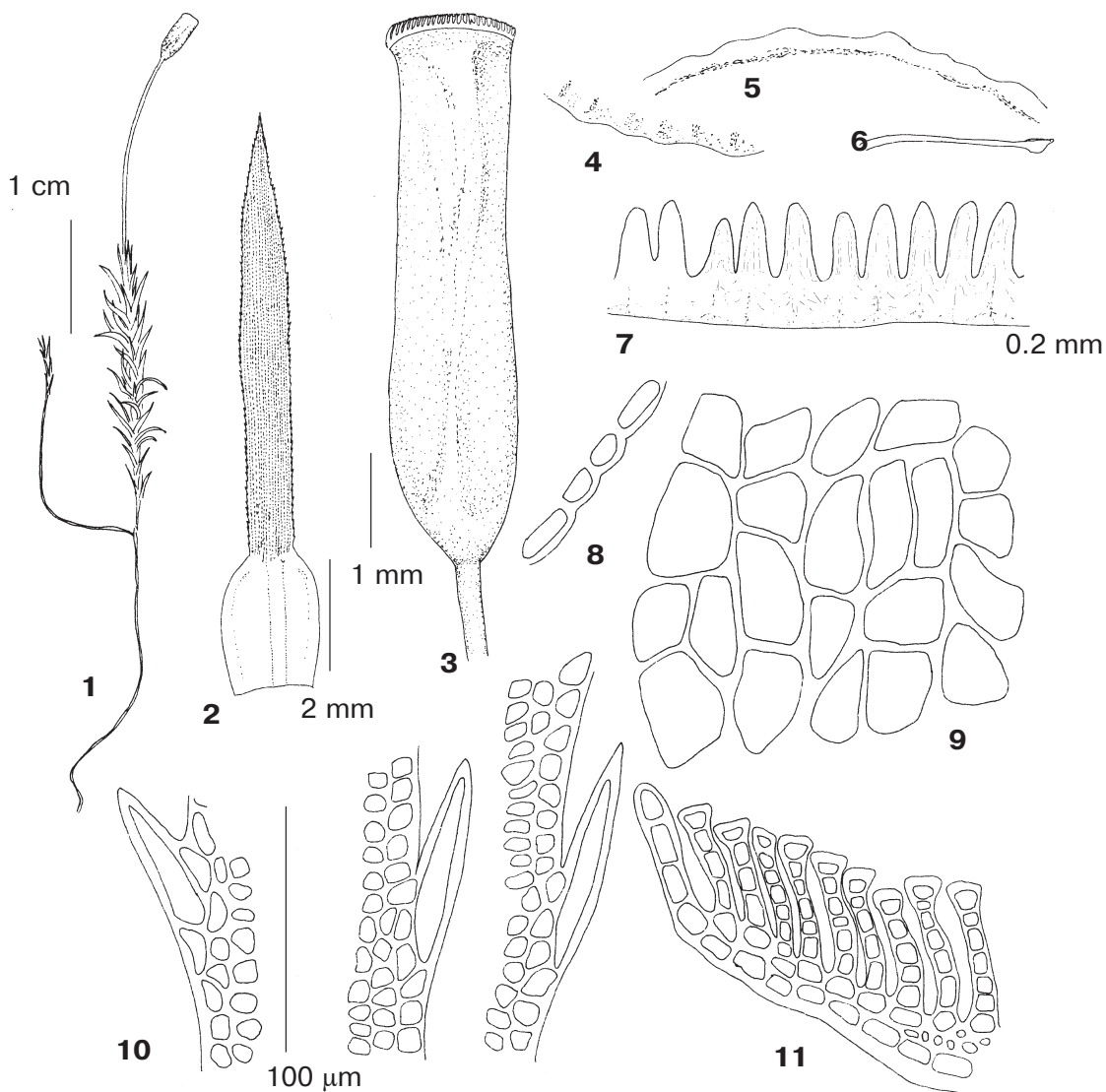


Fig. 27. *Polytrichastrum pallidisetum* (Funck) G. L. Sm. (from *Bolshoye Istyube Creek* 470 m Ignatov 0/1355): 1 – habit; 2 – leaf; 3 – capsule; 4 – dorsal epiphragm margin; 5 – ventral epiphragm margin; 6 – cross section of epiphragm margin; 7 – portion of peristome; 8 – cross section of exothecium; 9 – exothecium cells; 10 – cells of leaf margin; 11 – leaf cross section. Scale bars: 1 cm – for 1; 2 mm – for 2; 1 mm – for 3; 0.2 mm – for 4-7; 100 µm – for 8-11.

angular, about 9-12 µm wide, (60)70-80(100) µm long (ca. 5-7:1); marginal lamina cells ± isodiametric, 12-16 µm. Seta yellowish, to 5 cm tall. Capsules acutely 4-angled, suberect to inclined, pale yellowish brown, slender and somewhat curved, 1.0-1.5 mm wide x 3-5 mm long, tapering to the base (particularly when old and empty), the apophysis not or only weakly differentiated; exothecial cells smooth, lacking thin spots. Peristome 0.24 mm high, divided to 0.6, the teeth ca. 50, pale. Epiphragm without well-developed tooth-like processes. Spores ca. 12-16 µm diam., finely papillose. Calyptra hairy, covering the upper portion of the capsule.

In the field, *Polytrichastrum pallidisetum* most closely resembles *P. formosum*, and in Altai they occur in much the same habitats and at similar elevations. The species is best characterized by the lamella marginal cells, which are broadened and truncate to shallowly retuse in cross-section; in profile, the lamellae are distinctly crenulate. When viewed from above, the marginal cells are convex, so that the edge of the lamella resembles a string of beads, as compared with *P. formosum* and *P. longisetum*, in which the lamellae are narrow, ± sharp-

of the lamella resembles a string of beads, as compared with *P. formosum* and *P. longisetum*, in which the lamellae are narrow, \pm sharp-edged, and straight-sided when viewed from above.

In the absence of sporophytes, *P. pallidisetum* can be confused with *Polytrichum commune*, since both species have retuse lamellar marginal cells. In *P. commune*, the arc of guide cells (seen in section below mid-point of blade) is 18-24 cells wide, vs. 8-12 cells wide in *P. pallidisetum*; the median sheath cells in *P. commune* are elongate-rectangular to linear, as much as 20:1, vs. short-rectangular, about 5-7:1, in *P. pallidisetum*. Typically, the lamellae of *P. commune* are taller, as many as 10-12 cells high, vs. 4-6 cells high in *P. pallidisetum*. The lamellar marginal cells of *P. pallidisetum* in a given cross-section are far from uniform, varying from retuse to flat-topped to slightly convex; they are, however, never deeply notched, nor are they divided as sometimes occurs in *P. commune*. When capsules are present, the two species can be separated without difficulty.

Distribution: *Polytrichastrum pallidisetum* has principally a Holarctic distribution, being rather scattered in most regions. In Western Europe it is known from the mountains of central Europe and Scandinavia, a few records in European Russia, Belorussia and Ukraine, Urals, and Caucasus, mountain areas of South Siberia and the Russian Far East (Ussuri region). Also known from Western China (*E. H. Wilson 5416*, 1903-1904, BM!), Szechuan, and Japan. Its main distribution is in eastern North America, where it is a species of coniferous or northern hardwood forests, from Labrador and Newfoundland to northern Michigan and Minnesota, Wisconsin, Ohio, and Pennsylvania, southward in the mountains to North Carolina and Tennessee. In North America, it has been confused with *P. ohioense* (Ren. & Card.) G. L. Smith, a closely-related species which has lamellae entire in profile, straight-sided when viewed from above, with marginal cells transversely elliptical (oblate) in cross-section, and the distal wall strongly thickened. In Altai, *P. pallidisetum* is rather rare, occurring in areas with an especially mild climate, in the vicinity of Teletzkoye Lake. It grows on soil rich in humus at roots of fallen trunks and on soil-covered rocks in *Pinus sibirica* forests.

Specimens examined: *Atkichu Creek, at mouth* 440 m (Zolotukhin 21.X.1989); *Bolshoye Istyube Creek* 470 m (0/1355, 0/1360a, 18/43); *Djankovskiy pereval, in silva* (Verestschagin 11.VI.1905, H-BR Brotherus!); *Kam-*

ga Creek, 13 km upstream 630 m (0/1377); *Maloye Istyube Creek, 1 km upstream* 600 m (Zolotukhin 19.V.1977); *Uedinennoye Lake* 880 m (0/1354).

Sect. **Polytrichastrum**

Species of sect. *Polytrichastrum* differ in leaf dentition, capsule shape, and exothecial pitting, but they all have essentially the same type of lamellar marginal cell: ovate, narrowly ovate to pyriform in cross-section, with the free wall thickened and the cell lumen pentagonal to narrowly triangular. The wall thickenings extend down the lateral walls, so that the marginal cells in profile appear to be even more strongly thick-walled than is actually the case. The lamellar margins are papillose in *P. alpinum*, but in other species they are smooth. There is a tendency in species of sect. *Polytrichastrum* toward small, stunted forms with subentire leaves and short, globose capsules (e.g. *P. alpinum* var. *septentrionale*). Peristome teeth tend to be rather narrow and longer in proportion to their width; distributions typically extend to higher latitudes and altitudes than members of sect. *Aporothea*.

Polytrichastrum alpinum (Hedw.) G. L. Smith, Mem. New York Bot. Gard. 21(3): 37. 1971. Fig. 28

Polytrichum alpinum Hedw., Sp. Musc. Frond. 92. pl. 19: f. 2b. 1801.

Plants robust, medium to large, in loose tufts, often branched, the stems varying from very short (in exposed alpine habitats) to 10 cm high. Leaves erect-spreading and inrolled when dry, spreading when moist, 5-7 mm long; sheath obovate to elliptic, with tapering shoulders, \pm nitid, broadly hyaline-margined; marginal lamina erect, 3-4 cells wide, coarsely serrate with multicellular teeth (rarely subentire); costa excurrent, ending in a short, toothed awn. Lamellae in profile \pm entire, 5-6(7) cells high, the marginal cells coarsely papillose, in cross-section ovate to narrowly ovate, the outer wall strongly thickened, the lumen pentagonal, the walls often yellowish to dark-brown. Median cells of sheath elongate-rectangular, 6-10 x 40-65(80) μ m; cells of the marginal lamina \pm isodiametric, 15-20 μ m. Seta to 4 cm tall. Capsules terete, ovate-cylindric, suberect to inclined, 1.0-1.5 mm wide, 2-4 mm long, the stomata numerous in a broad basal band, the apophysis somewhat rugose, but otherwise not differentiated. Exothecial cells smooth, irregularly rectangular, lacking thin spots in the outer wall. Operculum rostrate. Peristome 0.6 mm high, divided to 0.3-0.25, the teeth ca. 50, pale to somewhat colored

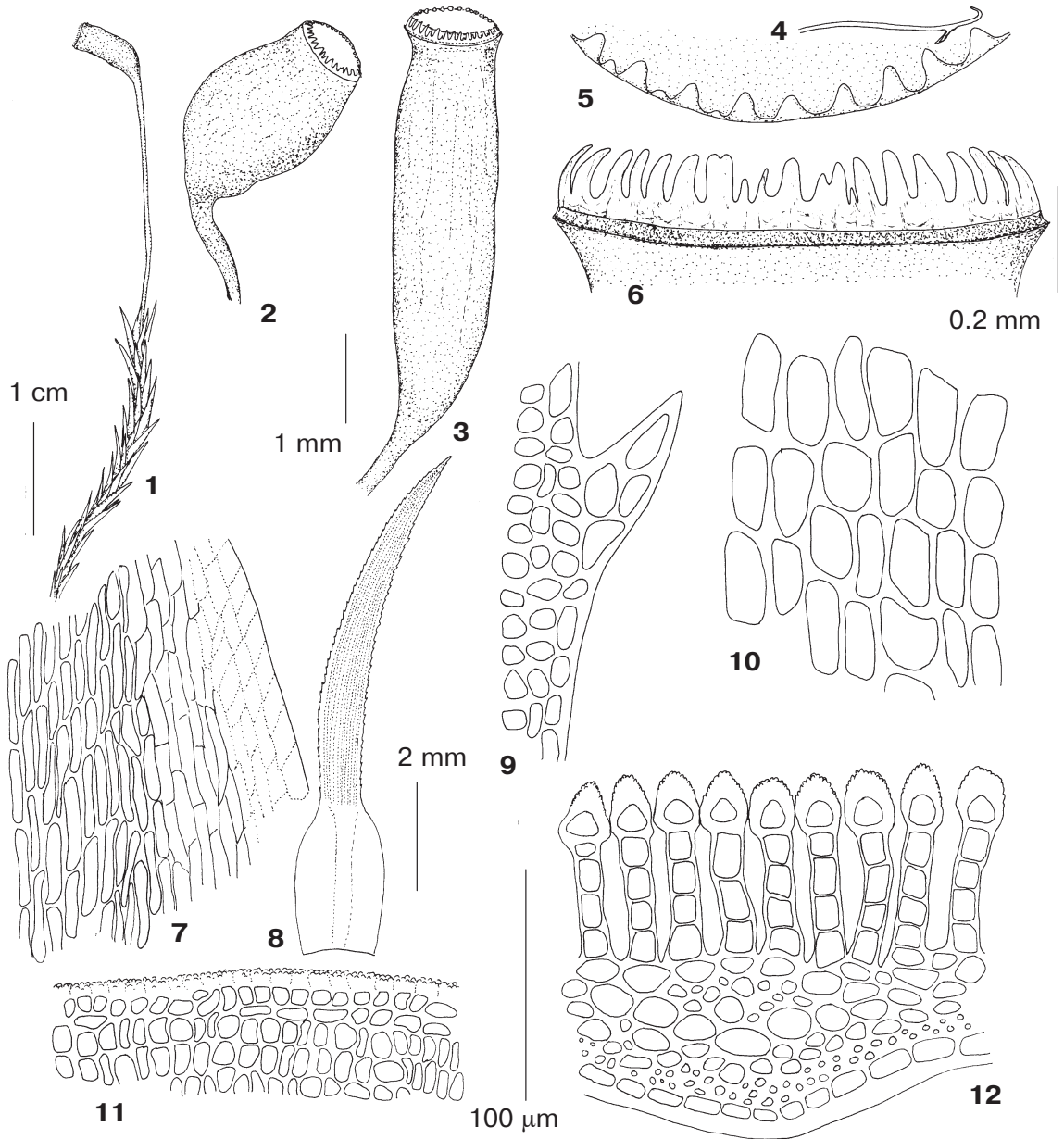


Fig. 28. *Polytrichastrum alpinum* (Hedw.) G. L. Sm. (1, 3-12, from *Derbogach* 450 m Ignatov 0/5) and *P. alpinum* var. *septentrionale* (Sw.) G. L. Sm. (2 - from *Tabozhok* 2350 m Ignatov 31/152): 1 - habit; 2, 3 - capsules; 4 - cross section of epiphragm margin; 5 - dorsal epiphragm margin; 6 - portion of peristome; 7 - cells of upper basal part of leaf; 8 - leaf; 9 - cells of leaf margin; 10 - exothecium cells; 11 - side view of lamella; 12 - leaf cross section. Scale bars: 1 cm - for 1; 2 mm - for 8; 1 mm - for 2, 3; 0.2 mm - for 4-6; 100 μ m - for 7, 9-12.

in the median part, at least some teeth compound. Epiphragm with well-developed tooth-like processes. Spores ca. 20 μ m, finely papillose. Calyptra hairy, covering the upper portion of the capsule.

Polytrichastrum alpinum is easily known by the typically tall, branching plants in green tufts, terete capsule, leaf margins with multi-

cellular teeth, and the lamellar marginal cells with a strongly thickened, papillose outer wall, apparent both in cross-section and in profile.

Distribution: *Polytrichastrum alpinum* is widespread in all cool and alpine Holarctic regions, southward to Caucasus, mountains of Central Asia, Himalayas, Japan, and is reported from South Africa, southern South America, Antarctica, Australia and

New Zealand, and New Guinea. In North America, *P. alpinum* occurs from Greenland to Alaska, southward in the mountains to North Carolina, Colorado and California, and also in Mexico. In tropical America, from Mexico south to Bolivia, *P. alpinum* is replaced by a related species, *P. tenellum* (C. Muell.) G. L. Smith (see Merrill, 1992).

As a rule, *P. alpinum* is rather rare in lowlands, though some records from regions with oceanic climate are from near sea level. In Altai (as well as other Siberian mountains, also in Urals) this species grows not only in high mountains, but is relatively common also on rock outcrops (especially in deep canyons, near waterfalls, etc.) at lower altitudes. In the alpine belt it is very common in shrubby tundra and among rocks, in places with enough snow in winter, although sometimes also on exposed lichen tundras.

Specimens examined: *Ayulyuyuzuyuk Creek* 2450 m (0/1373); *Bayas Creek, at mouth* 460 m (0/1349); 500 m (0/1348); *Bayas Lake* 1550 m (0/1376); 2000 m (0/1346); *Bolshoye Istyube Creek* 470 m (Zolotukhin 5.VI.1986); *Buguzun Creek, at mouth of Sailyugem Cr.* 2100 m (Pavlov V.N. 19.VIII.1993); *Derbogach* 450 m (0/5); *Kairu Creek, 8 km upstream* 1000 m (15/63, 15/75); *Kamga Bay* 450 m (Zolotukhin 20.X.1988); *Karagai* 440 m (0/262); 500 m (Zolotukhin 10.VIII.1988); *Karakol Lakes* 1900 m (28/118); *Kayakkatuyarykskij Creek* 1920 m (3/161); 2800 m (7/69); *Kishite* 440 m (Zolotukhin 11.VII.1988); *Kobiguayuk Creek* 2880 m (0/1372); 2900 m (0/1375); 2908 m (0/1374); *Krasivoje Lake* 2530 m (36/310a); *Kukol* 1800 m (0/1347, 0/1350) 1900 m (0/1370); *Srednij Shaltan Creek* 600 m (0/81); *Tabozhok Peak* 2350 m (31/152); 2750 m (31/153); *Uzunoyuk Creek, upper course* 2400 m (Zolotukhin 9.VII.1990); *Yailyu* 450 m (0/1371).

Polytrichastrum alpinum* var. *septentrionale (Brid.) G. L. Smith, Mem. New York Bot. Gard. 21(3): 37. 1971.

Polytrichum septentrionale Brid., J. Bot. (Schrader) 1800 (1): 285. 1801.

In the Arctic and high mountains some plants have stunted stems, shorter subentire leaves and short subglobose capsule with reduced peristome. These are segregated in a separate variety, *P. alpinum* var. *septentrionale*. This taxon was reported for Altai by Krylov (1925), but we have not seen the cited specimen. In our collection there is a single specimen from high mountains of South-East Altai, which differs from the other specimens by almost subentire leaves and short subglobose capsule (Fig. 28, 3). We refer it to this variety despite of some disagreements (plants are ca. 5 cm tall).

There is a long-standing confusion and misapplication of the names *Polytrichum septentrionale* Sw., *P. norwegicum* Hedw., and *P.*

sexangulare, dating from the earliest days of bryology, which is still reflected in many older collections in herbaria. The type of *P. norwegicum* is a form of *P. alpinum* (see Smith, 1971, p. 37), not identical with *P. alpinum* var. *septentrionale*.

Specimen examined: *Malaya Kokorya Creek* 2300 m (36/53);

Polytrichastrum altaicum Ignatov & Merr., sp. nov. Fig. 29

P. alpini primo adspectu simile, sed foliis margine integris, cellulis lamellarum margine laevibus in sectione transversali anguste pyriformibus acuminatisque recedit.

Holotype: Altai, Dvukhkarovaya Creek, 25. VII. 1993, *Ignatov 36/361* (MHA); isotype: (F).

Plants medium-sized for the genus, in loose tufts, unbranched, densely leafy above, slender and leafless below, to 5 cm tall. Leaves spreading when moist, erect-spreading to somewhat curved when dry; sheath broadly elliptic, 1.5 mm wide, 2 mm long, hyaline-margined, the blade narrowly triangular, straight to subfalcate, 0.5 mm wide, 3-4 mm long; marginal lamina (2)4-5(6) cells wide, entire (or in some leaves with a few irregular teeth above); costa ending in a shortly apiculate tip. Lamellae 30-34, in profile ± entire or a little wavy, 8-9 cells high, the lamellar marginal cells smooth, in cross-section narrowly pyriform, slenderly tapering and ending in a thickened knob, the free wall thickened, the cells 11-12 µm wide x 18-24 µm tall, scarcely wider than those beneath. Median sheath cells rectangular, 10-13 µm wide x 32-40 µm. Seta rather stout, 1.5-2 cm long. Capsules ovoid-cylindric to short elliptic, erect to inclined, 1.5-2 mm wide, 2-2.5 mm long; exothelial cells smooth, irregularly rectangular, lacking thin spots. Operculum rostrate, the beak about 0.5 mm long. Peristome 0.2 mm tall, divided to 0.6, the teeth ca. 50, reddish brown except for the margins. Spores 16-18 µm diam., finely papillose. Calyptra hairy, covering the upper portion of the capsule.

In overall appearance, *Polytrichastrum altaicum* does not differ greatly from *P. alpinum*, and the relatively short, terete capsule and entire leaf margins are seen in several named varieties of that species, such as var. *septentrionale*. The combination of the last-named characters with smooth lamellar marginal cells, however, makes this plant difficult to assign to *P. alpinum*. Smooth lamellar margins occur in *P. sexangulare*, another high mountain species, which also has entire leaves. However, *P. sexangulare* has (4)6-angled capsules, and

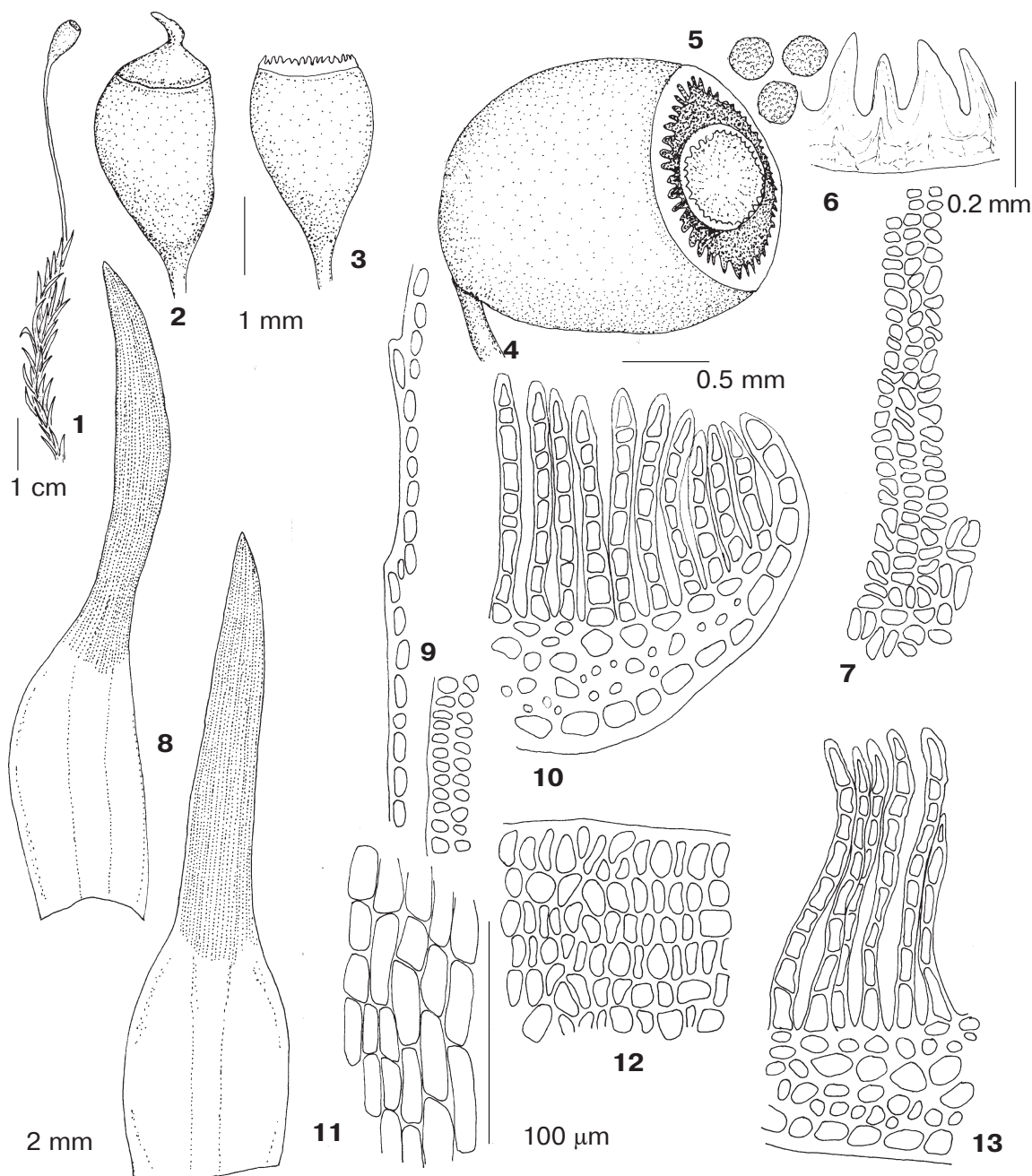


Fig. 29. *Polytrichastrum altaicum* Ignatov et Merr., sp. nov. (from the holotype, *Dvukhkarovaya* Creek 2600 m 36/361): 1 - habit; 2, 3, 4 - capsules; 5 - spores; 6 - portion of peristome; 7 - exothecium cells; 8 - leaves; 9 - cells of leaf margin; 10, 13 - leaf cross section; 11 - basal leaf cells; 12 - side view of lamella. Scale bars: 1 cm - for 1; 2 mm - for 8; 1 mm - for 2, 3; 0.5 mm - for 4; 0.2 mm - for 6; 100 μ m - for 5, 7, 9-12.

leaves bluntly cucullate at the apex.

Polytrichastrum emodi G. L. Sm., described from the Himalayas (Smith, 1974b), is another species which in certain respects is intermediate between *P. alpinum* and *P. sexangulare*. It has toothed leaves and a cylindrical capsule as

in *P. alpinum*, but the lamellae are smooth, as in *P. altaicum* and *P. sexangulare*. The slender-necked lamellar marginal cells in *P. emodi* (i.e., fig. 6,7) are much the same as those of *P. altaicum*, but the leaf margins of *P. emodi* are serrate.

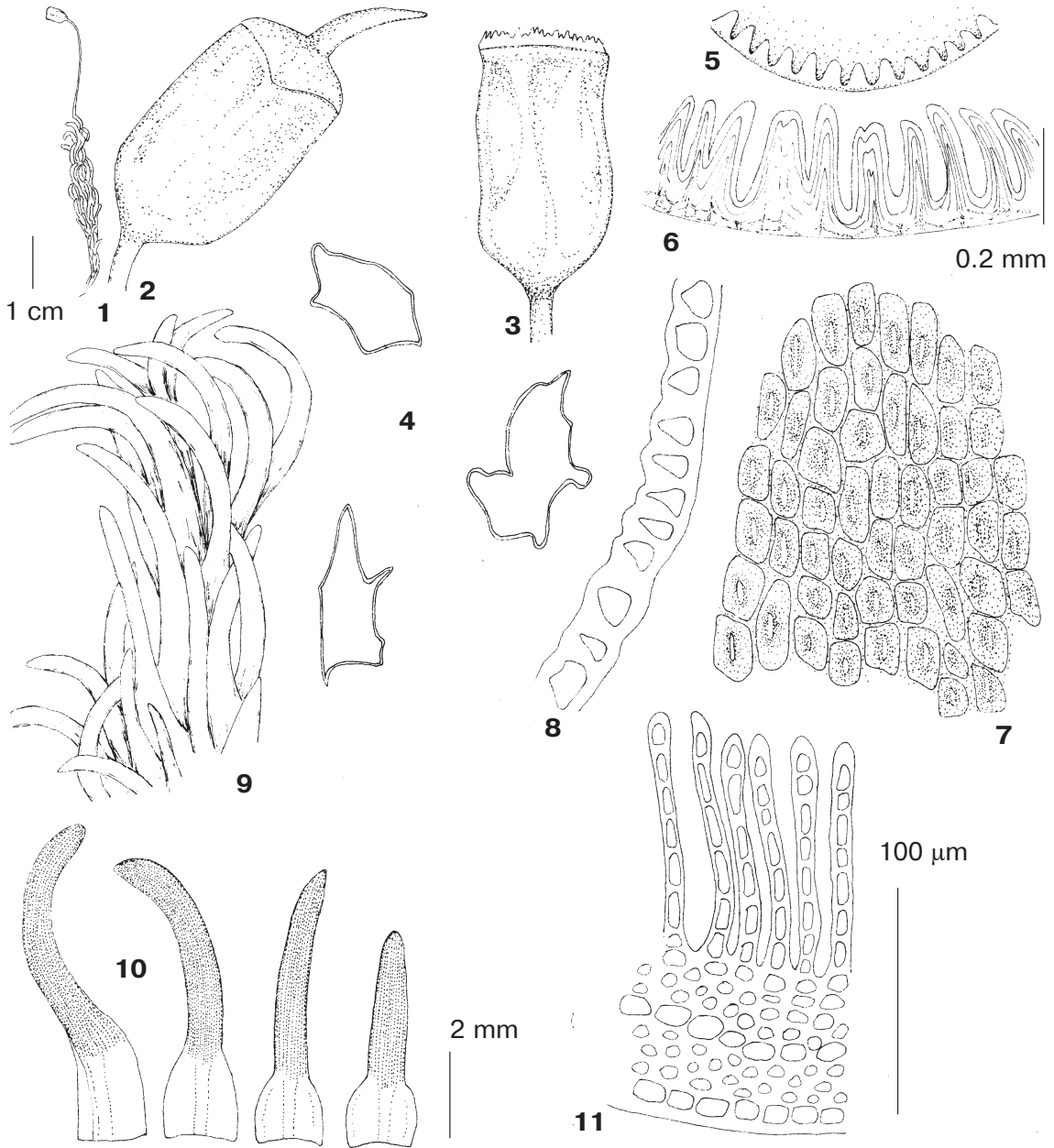


Fig. 30. *Polytrichastrum sexangulare* (Floerke ex Brid.) G. L. Sm. (from *Kobiguayuk Creek* 2800 m Ignatov 0/193): 1 - habit; 2, 3 - capsules; 4 - cross sections of capsules; 5 - dorsal epiphragm margin; 6 - portion of peristome; 7 - exothecium cells; 8 - cross section of exothecium (outer surface on the left); 9 - leafy shoot; 10 - leaves; 11 - leaf cross section. Scale bars: 1 cm - for 1; 2 mm - for 9, 10; 1 mm - for 2-4; 0.2 mm - for 5, 6; 100 μ m - for 7, 8, 10, 11.

The largest concentration of endemic (or near-endemic) species of *Polytrichastrum* is in the Himalayas (Smith, 1974b): *P. emodi*, *P. papillatum* G. L. Smith, *P. torquatum* Osada & G. L. Smith, and *P. xanthopilum* (Mitt.) G. L. Smith. Of these, *P. papillatum* has been report-

ed from Alaska, and *P. xanthopilum* is very similar to the endemic *P. appalachianum* (Anders.) Merr. of the southern Appalachian mountains (see Merrill, 1992).

Distribution: Known only from the type, growing on cliffs beside a snow field, at 2600 m.

Polytrichastrum sexangulare (Floerke ex Brid.) G. L. Smith, Mem. New York Bot. Gard. 21(3): 35. 1971. Fig. 30

Polytrichum sexangulare Floerke ex Brid., J. Bot. (Schrader) 1800(1): 285. 1801.

Plants rather small and wiry, green to reddish brown with age, densely leafy, to 3(6) cm high. Leaves erect and broadly incurved when dry, erect-spreading when moist, 3-6 mm long; sheath broadly elliptic, hyaline-margined, strongly contracted to the blade; marginal lamina entire to remotely denticulate, erect to narrowly inflexed in the distal half of blade, 2-6 cells wide; costa percurrent, the apex blunt and \pm cucullate. Lamellae 6-7(8) cells high, in profile weakly crenulate, the lamellar marginal cells in cross-section narrowly ovoid to slightly pyriform, smooth, with a thickened outer wall, only slightly wider than the cells beneath. Median sheath cells rectangular, 14-18 μ m wide x 24-37 μ m long; cells of the marginal lamina quadrate to hexagonal, rather thick-walled, 11-14 μ m wide and long. Seta stout, yellowish brown, to 4 cm long. Capsules obtusely (4)6-angled (rarely almost terete and subglobose), erect to somewhat inclined, 1.5 mm wide, 3 mm long, with a small apophysis delimited by a shallow groove. Exothecial cells smooth, irregularly rectangular, with an elongated lighter area in the cell centre due to the pit in the inner cell wall. Operculum rostrate. Peristome 0.3 mm high, divided to 0.3-0.5, the teeth ca. 50, simple, rather slender, at times somewhat colored in the median portion. Epiphragm with well-developed tooth-like processes. Spores 16-18 μ m, finely papillose. Calyptra hairy, covering the upper portion of the capsule.

Polytrichastrum sexangulare can usually be distinguished even with a hand-lens because of the cucullate apex and entire leaves. Unlike *Polytrichum juniperinum*, *P. strictum*, and *P. piliferum*, the marginal lamina is narrow and erect, or narrowly inflexed, scarcely exceeding the lamellae in height, and the cells of the lamina are thick-walled and quadrate, not enlarged, and strongly transversely elongated.

This species is at times difficult to distinguish from *P. alpinum* var. *septentionale* (Sw. ex Brid.) G. L. Sm., which also has subentire leaves. In some cases, it may be necessary to examine the lamellar margins to be certain of the determination: the lamellae of *P. sexangulare* are perfectly smooth. The sporophytes of *P. sexangulare*, which are highly diagnostic, are rather rarely produced.

Distribution: This species has a rather scattered distribution in cool and especially montane regions

of the Holarctic. It is known from Northern Europe (including Svalbard and Iceland), Central Europe, Caucasus, Turkey, Northern Ural, mountains of South Siberia, basin of Ochotsk Sea (Kamchatka and Northern Kuril Islands), Chukotka Peninsula, Japan, Pacific and Arctic North America. In many regions *P. sexangulare* is not a common species. In Altai it is known from rather few localities in subalpine to upper alpine zone. Typically it grows in open tundra, often close to late snow beds.

Specimens examined: *Balaktykol Lake* (Krylov 2.VIII.1915, LE!); *Bystraya Creek* 1800 m (Krylov & Rechan 20.VII.1968, LE!); *Karatumysh* 2110 m (Zolotukhin & al. 14.VIII.1978); *Kobiguayuk Creek* 2800 m (0/193); *Perevalnaya Creek* 1900 m (Zolotukhin & al. 11.VII.1984); *Sumultinskij Belok* (anonymous 14.VIII.1923, LE!); *Talizkiye Belki* (Pobedimova 672, LE!).

Polytrichum Hedw., Sp. Musc. Frond. 88. 1801. Type: *Polytrichum commune* Hedw.

Plants medium to tall and robust, in loose tufts, densely leafy above, bracteate below, rhizoidous at base (stems densely tomentose in *P. strictum*), to 30 cm tall. Leaves with differentiated sheath and blade, with a well-developed hinge tissue, the blade spreading to squarrose-reflexed at the hinge between sheath and blade, erect to erect-spreading when dry; sheath entire, hyaline-margined, often highly nitid, with a well-developed hinge-tissue at the junction between sheath and blade; marginal lamina narrow, plane or erect, sharply toothed with stout, unicellular teeth (*P. commune*), or entire-margined, broadly expanded and inflexed, the margins overlapping, enclosing the lamellae; costa excurrent, forming a short, reddish, toothed awn, or a long, hyaline, spinulose hair-point almost equalling the blade in length. Lamellae numerous, closely-spaced, crenulate to bluntly dentate in profile, smooth, the marginal cells distinctly differentiated. Dioicous. Male plants with conspicuous rosettes formed by the broadly overlapping perigonal bracts, innovating and producing several successive perigonia per shoot. Perichaetial leaves typically long-sheathing, the sheath broadly hyaline-margined, with a weakly-developed and greatly shortened blade. Seta solitary. Capsules suberect to horizontal, 4-alate, prismatic, with knife-edge angles, glaucous in fresh capsules; apophysis thickened and discoid, sharply delimited from the urn by a deep basal constriction, with stomata confined to the groove; exothecial cells bulging-mammillose, often transversely elongate, each with a sharply defined, circular to slit-like pit in the outer wall. Operculum umbonate, with a short beak. Peristome teeth 64, pale, single, pterygodont, with a vertical keel at back (at least at base of tooth), with spur-like projections; epiphragm remaining attached to the peristome teeth, rather thin and delicate except at the edge, its lower margin dissected into

pendent lobes alternating with the peristome teeth. Spores small, ca. 10 µm diam., echinulate, but often appearing quite smooth. Calyptra with a densely interwoven, matted felt of hairs, enclosing the whole capsule.

KEY TO THE ALTAIAN SPECIES OF *POLYTRICHUM*

1. Unistratose lamina broad, ± entire, sharply infolded, enclosing the lamellae; marginal cells of lamellae narrowly ovoid to pyriform in cross-section. Sect. *Juniperifolia* 2
1. Unistratose marginal lamina narrow, plane or erect, sharply toothed; marginal cells of lamellae retuse to bilobed in cross-section. Sect. *Polytrichum* *P. commune*
 2. Leaves with a long, hyaline, spinulose hair-point *P. piliferum*
 2. Leaves with a short, reddish, toothed awn 3
3. Stems densely clothed with tomentum; leaves short, appressed when dry, 3-5 mm long; capsule cubic *P. strictum*
3. Stems not to only moderately tomentose; leaves longer, erect-spreading when dry, 5-8 mm long; capsule short oblong *P. juniperinum*

Sect. **Polytrichum**

Polytrichum commune Hedw., Sp. Musc. Frond. 88. 1801. Fig. 31

Plants medium-sized to robust, in loose or rather dense tufts, mostly unbranched, dark green to brownish with age, very variable in size, 3-5 (to as much as 30) cm tall. Leaves erect-spreading when dry, with recurved tips, spreading when moist, the blade square-rose-reflexed from the hinge between sheath and blade, to 12 mm long; sheath oblong to elliptic, clasping the stem, whitish to yellowish brown, highly nitid, hyaline-margined; marginal lamina plane or erect, narrow, 6-7 cells wide, sharply toothed with unicellular teeth from the tip to near the base of the blade, the base of the teeth embedded in the margin; costa excurrent, ending in short, reddish, rough point, the leaves toothed at back near the tip. Lamellae 25-50, distinctly crenulate to subentire in profile, 6-12 cells high, the margins grooved as seen from above, or with 2 rows of projecting knobs; lamellar marginal cells in cross section wider than those beneath, 16-22 µm wide, smooth, deeply notched, bilobed, or the apex merely depressed, rarely divided into two cells by a vertical partition, the walls ± evenly thickened, brownish. Sheath cells elongate-rectangular to linear, 10-15 µm wide, 60-90 µm long (as much as 20:1). Peri-

gonial leaves broad, forming a conspicuous rosette. Perichaetial leaves long-sheathing, with hyaline, scarious margins, the blade greatly reduced. Seta stout, yellowish brown, to 7 cm high. Capsules inclined to horizontal, reddish brown, glaucous when fresh, 4-angled, 4 mm wide x 6 mm long, the apophysis discoid, sharply delimited. Peristome 0.25 mm high, divided to 0.6, the teeth 64. Spores 5-8(12) µm diam., greenish, appearing smooth under light microscope. Calyptra golden yellow to brownish, completely enveloping the capsule.

When optimally developed, in forests and in bogs, *Polytrichum commune* is easily recognizable by its size, which exceeds that of any other local species of Polytrichaceae. Alpine plants, however, will often require examination of leaf cross-sections. For differences between this species and *Polytrichastrum pallidisetum*, which also has retuse lamellar marginal cells, see the discussion under that species.

Distribution: This species is very aptly named. It occurs throughout temperate and boreal latitudes in the Northern Hemisphere, and extends into the tropics, but is unaccountably absent from some areas, e.g., the Himalayas. The species is widespread but scattered in the Southern Hemisphere, and reported from Brazil, New Zealand and Australia. The African continent is host to a multitude of species belonging to sect. *Polytrichum*, but this group is very poorly represented in tropical America.

In the boreal zone, *P. commune* often dominates in forest and peatland communities. Avoiding xeric lowlands, *P. commune* is not rare in rather dry territories in high mountains, like that in Mongolia, where it is common throughout the country. In Altai, it occurs everywhere at elevations ranging from 350 m to 2650 m. It grows in conifer forests on litter or among moss carpets at middle elevations, forming pure mats in relatively wet places, and is also common on the edges of bogs among *Sphagnum*. On grazing meadows it occurs on ant hummocks. It occasionally grows on rock outcrops (on humus in crevices), and on rotten stumps and logs, and in the high mountains, it grows among dwarf *Betula* shrubs, and among big rocks in rock fields.

Specimens examined. *Bardaky Lake* 1950 m (12/11); *Bayas Lake* 1950 m (0/1351); *Bolshoye Istyube Creek* 470 m (0/2089a); *Booshkon Creek, upper course* 1900 m (Zolotukhin & al. 31.VIII.1979); *Kayakkatuyarykskij Creek* 1760 m (8/5, 8/75, 8/91); 1920 m (3/185); (3/239); 2050 m (7/140); *Kobiguayuk Creek* 2220 m (0/359); 2450 m (0/124); 2650 m (0/1352); *Kolyushta Peak* 2030 m (Zolotukhin & al. 27.VII.1982); *Korbulu Peak* 1800 m (Filatova 19.VII.1981); *Kuderi Lake* 1650 m (Zolotukhin 11.VI.1987); *Kumyi, Altaian State Reserve* 1600 m (Zolotukhin 24.VII.1978); *Ozernaya Creek* 2150 m

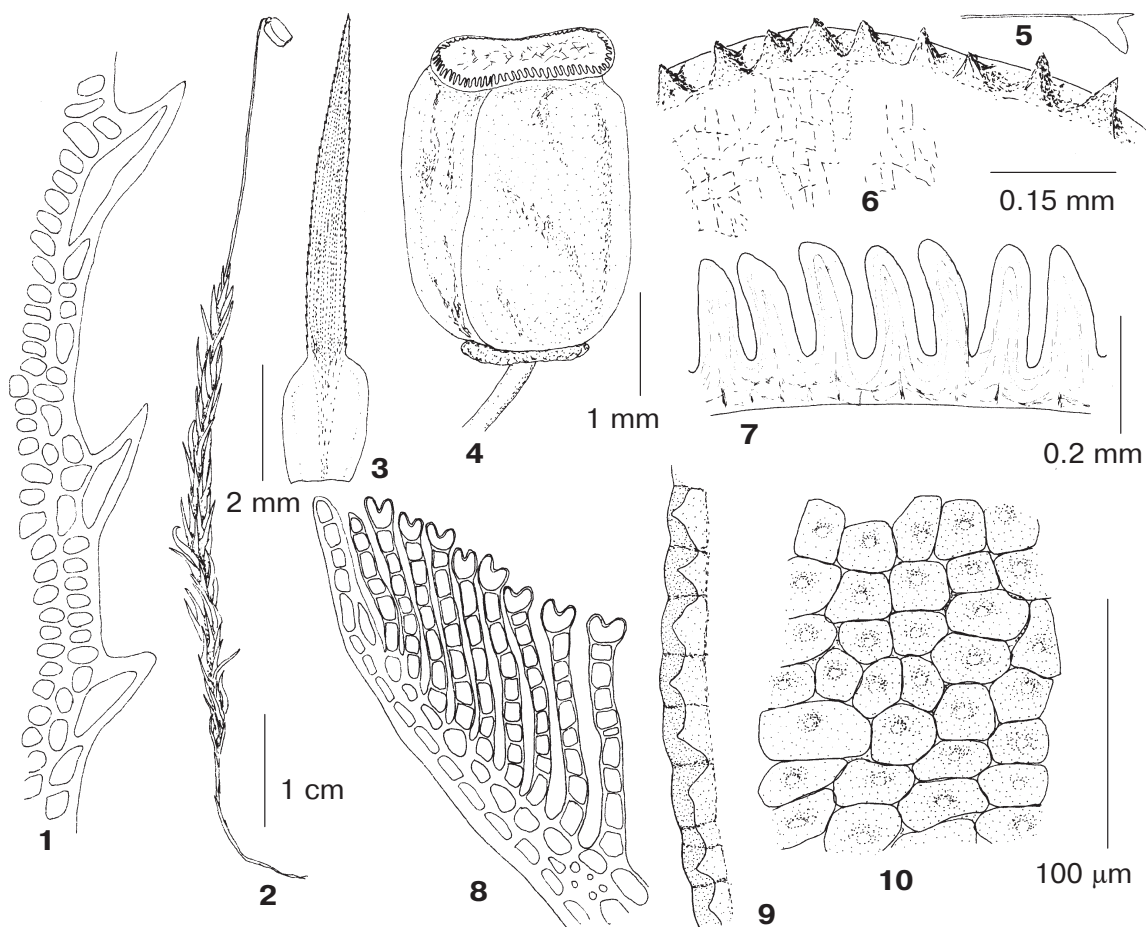


Fig. 31. *Polytrichum commune* Hedw. (from *Kuderi Lake* 1650 m Zolotukhin 11.VI.1987): 1 – cells of leaf margin; 2 – habit; 3 – leaf; 4 – capsule; 5 – ventral epiphragm margin; 6 – cross section of epiphragm margin; 7 – portion of peristome; 8 – leaf cross section; 9 – cross section of exothecium cells (outer surface on the left); 10 – exothecium cells. Scale bars: 1 cm – for 2; 2 mm – for 3; 1 mm – for 4; 0.2 mm – for 7; 0.15 mm – for 5, 6; 100 μ m – for 1, 8-10.

(Zolotukhin & al. 9.VIII.1978); *Seminskij Pass* 1800 m (25a/16); *Uzunkel Lake* 2100 m (Zolotukhin & al. 9.VIII.1978); *Yailyu* 450 m (0/1353)

Sect. *Juniperifolia* Brid.

Polytrichum sect. *Juniperifolia* Brid., Musc.

Recent. Suppl. 1: 47. 1806.

Lectotype (Smith, 1971): *Polytrichum juniperinum* Hedw.

***Polytrichum juniperinum* Hedw., Sp. Musc.**

Frond. 89. 1801. Fig. 32

Plants small to medium-sized, in loose tufts, usually unbranched, green to whitish green, reddish brown with age, 2-5(10) cm tall. Leaves loosely erect and somewhat incurved when dry, erect- to widely spreading when moist, to 6 mm long; sheath oblong, yellowish, hyaline-margined, with sloping shoulders, the blade slender, pale whitish green and nitid on the upper surface; blade margins entire to

finely serrulate above, the lamina broadly inflexed from the leaf shoulders to the base of the awn, membranaceous, colorless and transparent, the margins overlapping and enclosing the lamellae; costa excurrent, forming a reddish awn, toothed on the back above or almost smooth. Lamellae 24-46, bluntly crenate in profile, 6-8 cells high, the marginal cells in cross-section ovate to pyriform, ending in a distinct knob. Sheath cells elongate-rectangular, 7-10 μ m wide, 70-100 μ m long (4-6:1); lamina cells at margins small, incrassate, and irregular in shape; cells of the broadened lamina transversely elongated, 10-15 μ m wide, 45-60 μ m in longest dimension. Perigonal leaves broadly overlapping and forming conspicuous rosettes, often with several consecutive perigonia per shoot. Perichaetial leaves long-sheathing, the blade almost obsolete, yellowish to hyaline, with slender awns. Seta stout, yellowish to reddish brown, 1-3(5) cm high. Capsules suberect

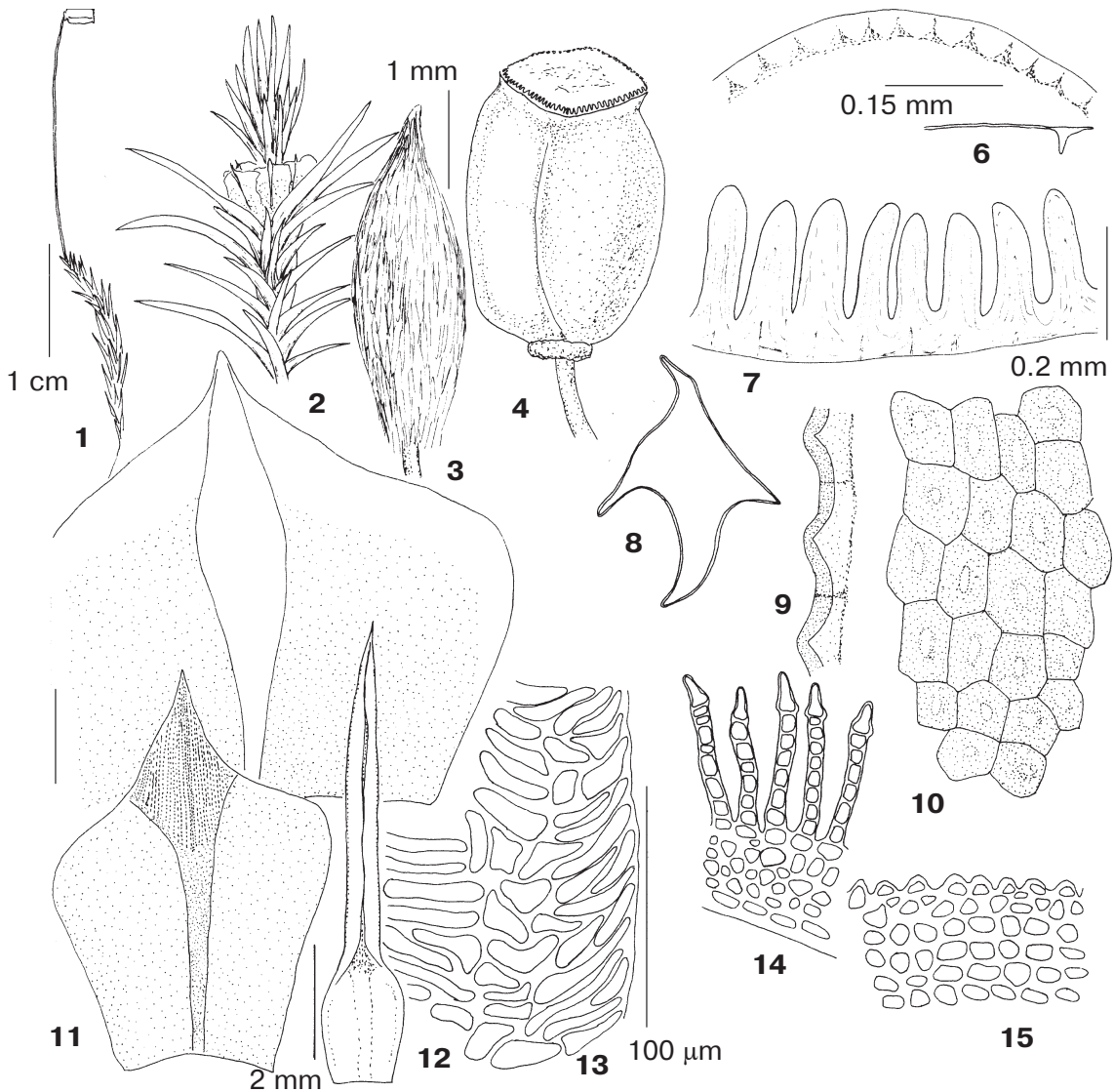


Fig. 32. *Polytrichum juniperinum* Hedw. (from Karatash 440 m Zolotukhin 20.V.1977): 1 - habit; 2 - upper portion of male shoot; 3 - calyptra; 4 - capsule; 5 - ventral epiphragm margin; 6 - cross section of epiphragm margin; 7 - portion of peristome; 8 - cross section of capsule; 9 - cross section of exothecium cells (outer surface on the left); 10 - exothecium cells; 11 - perigonial leaves; 12 - stem leaf; 13 - cells at leaf margin; 14 - leaf cross section; 15 - side view of lamella. Scale bars: 1 cm - for 1; 2 mm - for 12; 1 mm - for 2-4, 8; 0.5 mm - for 11; 0.2 mm - for 7; 0.15 mm - for 5, 6; 100 μ m - for 9, 10, 13-15.

to horizontal, reddish brown with a bluish, glaucous cast when fresh, oblong, longer than wide, 4-angled, prismatic, 1.5-2.0 mm wide, 2.5-5 mm long, the apophysis discoid, sharply delimited. Peristome 0.24 mm high, divided to 0.8, teeth 64, single, keeled at back. Spores 6-10(12) μ m, smooth, greenish. Calyptra whitish to light brown, covering the capsule.

Distribution: *Polytrichum juniperinum* is nearly ubiquitous, being a frequent species throughout the Holarctic, in cool-temperate and temperate re-

gions of the South Hemisphere, and at higher elevations in the tropics. It occurs throughout the Americas from Alaska to Patagonia, including many tropical countries, and in Antarctica, as well as in Australia and New Zealand. In Altai, *P. juniperinum* is very common at all elevations, on mineral soil or soil rich in humus, on peat in bogs, decaying logs and stumps, upper surfaces of inclined trunks, and on soil-covered rocks. Typically, it occurs in open to moderately shaded places in a wide range of humidity, avoiding only the most xeric and the most

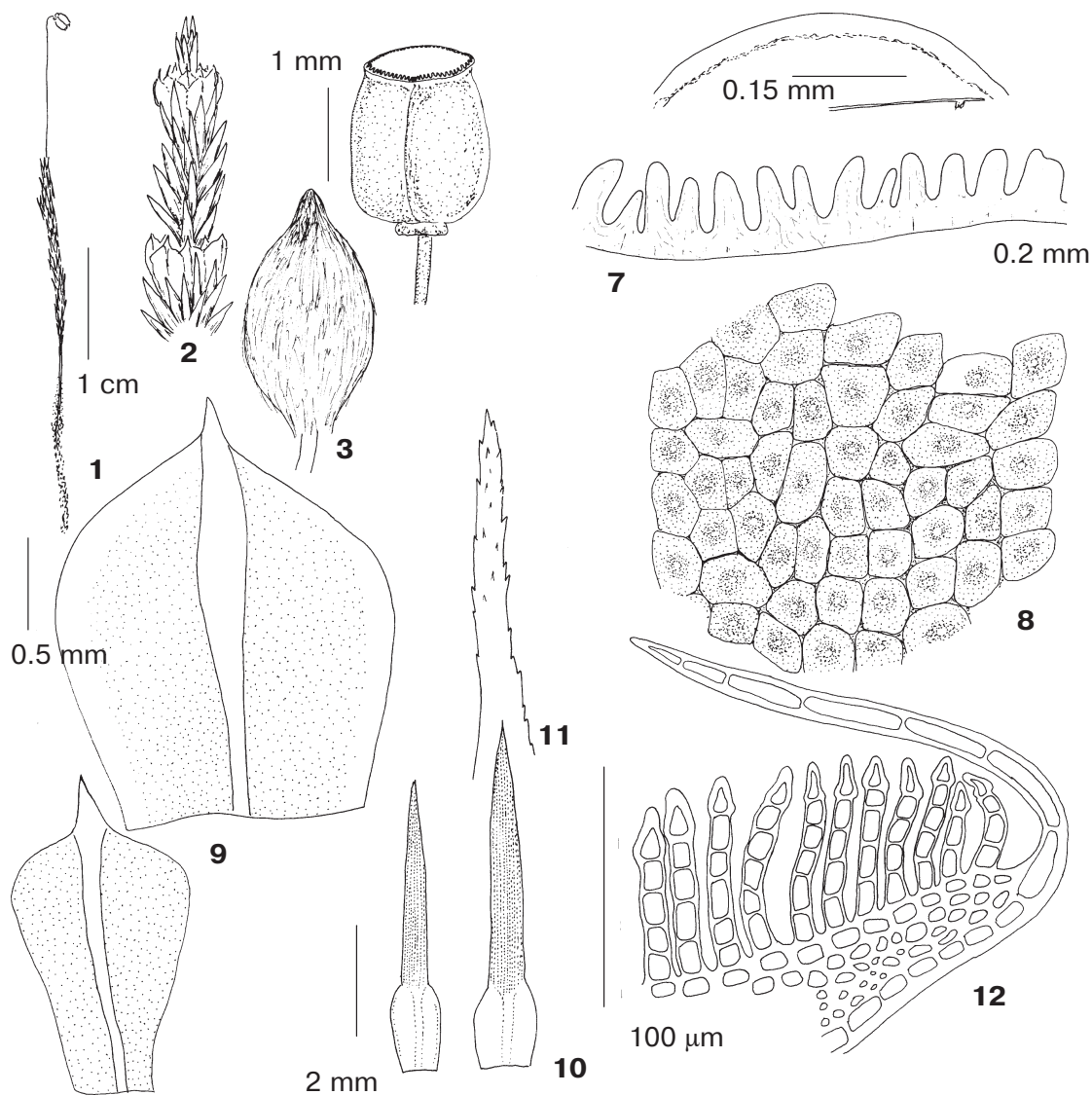


Fig. 33. *Polytrichum strictum* Brid. (from *Seminskij Pass* 1800 m Ignatov 25a/15): 1 – habit; 2 – upper portion of male shoot; 3 – calyptra; 4 – capsule; 5 – ventral epiphragm margin; 6 – cross section of epiphragm margin; 7 – portion of peristome; 8 – exothecium cells; 9 – perigonal leaves; 10 – stem leaf; 11 – leaf awn; 12 – leaf cross section. Scale bars: 1 cm – for 1; 2 mm – for 10; 1 mm – for 2-4, 8; 0.5 mm – for 9; 0.2 mm – for 7; 0.15 – for 5, 6; 100 µm – for 8, 11, 12.

moist habitats.

Specimens examined: *Adylda Creek* 1100 m (34/86); *Ayulyuyuzuk Creek* 2250 m (0/1366); *Baigazan* 440 m (Zolotukhin 28.VII.1982); *Bardaky Lake* 1950 m (12/42); *Karagai* 440 m (Zolotukhin 12.VIII.1988) (0/268); *Karatash* 440 m (Zolotukhin 20.V.1977); *Klyk Pass* 700 m (0/1367); *Kobiguayuk Creek* 2070 m (Zolotukhin 17.VI.1989); 2250 m (0/163); 2600 m (0/1365); 2650 m (0/173, 0/332); 2908 m (0/184); *Kos-Bazhi Peak* 2511 m (Zolotukhin 14.VII.1982); *Krasivoje Lake* 2530 m (36/310); *Oimok* 1100 m (Zolotukhin 20.V.1977); *Ok-Porok Creek, at mouth* 440 m (Zolotukhin 14.X.1988); *Sai-Khonash* 2400 m (Zolotukhin 8.VII.1990); *Seminskij Pass* 1800 m (25a/16a); *Tabozhok Peak* 2350 m (31/151); *Tamanel Peak* 2150 m (34/19); *Uzunoyuk Creek, in mid-*

dle course 2150 m (Zolotukhin 10.VII.1990); *Yailyu* 550 m (Zolotukhin 15.V.1977); *Yakhansoru Lake* 1950 m (Zolotukhin 26.VI.1990).

***Polytrichum strictum* Brid., J. Bot. (Schrad-er) 1800(2): 286. 1801.** Fig. 33

Polytrichum juniperinum var. *strictum* (Brid.) Roehl., *Deutschl. Fl.* (ed. 2), *Kryptog. Gew.* 3: 58. 1813.

Stems slender, sparingly branched, in compact tufts, green to somewhat whitish green, dark brownish with age, the stems densely matted with wooly whitish to brownish tomentum, 4-20 cm tall. Leaves

rather short, stiffly erect to loosely appressed when dry, erect-spreading when moist, 3-5(7) mm long; sheath brownish, hyaline margined, with sloping shoulders; blade margins entire to finely serrulate above, the lamina broadly inflexed, membranaceous, the margins overlapping and enclosing the lamellae; costa short excurrent as a reddish, roughened awn, toothed on the back in upper part of leaf. Lamellae 25-40, bluntly crenate in profile, 6-7 cells high, the marginal cells in cross-section pyriform, ending in a distinct knob. Sheath cells elongate-rectangular, 5-7:1; lamina cells at margins small, \pm irregular in shape, often obliquely oriented towards the leaf apex, the cells of the broadened portion of lamina transversely elongated and colorless. Perigonal leaves forming conspicuous rosettes, with several consecutive perigonia per shoot. Perichaetial leaves a little longer than the stem leaves. Seta yellowish brown, to 3 cm high. Capsules inclined to horizontal, reddish brown, short oblong to almost cubic, 1.5 mm wide, 2-3 mm long. Peristome 0.2 mm high, divided to 0.8. Spores 7-9 μm , smooth. Calyptra dirty white to light brown, enclosing the capsule.

Polytrichum strictum has often been treated as a variety or subspecies of *P. juniperinum*. However, the woolly, tomentose stems, the short, stiffly erect leaves, the almost cubical capsule, and its characteristic habitat on bog mats or at the margins of bogs, forming deep, compact hummocks in association with *Sphagnum*, make this an easily recognizable species. The general appearance of the plant remains its most diagnostic character. Abolin (1985) concluded, based on statistical analysis of multi-year studies on permanent plots, that the "syndrome of *P. strictum*" is a response of *P. juniperinum* to conditions of moisture. In Altai, however, this species sometimes grows in non-boggy conditions, but remains small-leaved and tomentose. This relative genetic stability supports recognition of these forms as separate species.

Distribution: *Polytrichum strictum* is widespread in the arctic and boreal regions of the Holarctic and also from southern South America and Antarctica. In Russia it occurs in all regions, being however rare in xeric areas. In North America, it occurs from Greenland to Alaska, southward to Illinois, Colorado and Washington. In Altai, it grows in subalpine and alpine zones, where bogs are widespread. Typically, it is associated with *Sphagnum*, but also occurs nearby on mineral outcrops, on rotten stumps, in shrubby tundra.

Specimens examined: *Bogoyash Creek, upper course* 2500 m (Revushkina & al. 17.VIII.1977); *Karatumysh* 2000 m (Zolotukhin & al. 30.VII.1978); *Kayakkatuyarykskij Creek* 1760 m (8/74) 1920 m (3/2112); *Seminskij Pass* 1800 m (Makarov & al. 18.VI.1972, 25a/15); *Tokpak Creek, in middle course* 1950 m (36/203); *Uzunkul Lake* 2100 m (Zolotukhin & al. 9.VIII.1978).

***Polytrichum piliferum* Hedw., Sp. Musc.**

Frond. 90. 1801.

Fig. 34

Stems small for the genus, unbranched, comose at the tips, green to somewhat whitish green, reddish brown with age, 0.5-3(5) cm tall. Leaves erect and somewhat incurved when dry, erect-spreading when moist, to 6 mm long; sheath hyaline-margined, with sloping shoulders; blade margins entire to finely serrulate above, the lamina broadly inflexed from the leaf shoulders to the base of the awn, membranaceous, the margins overlapping and enclosing the lamellae; costa long excurrent, forming a hyaline, spinulose hair-point, the leaf apex \pm contracted to the base of the awn. Lamellae crenate-dentate in profile, 6-8 cells high, the marginal cells in cross-section pyriform, terminating in a distinct knob, except for those lamellae in the "shade" of the inflexed lamina. Sheath cells elongate-rectangular, 10-15 μm wide, 60-90 μm long (4-6:1); lamina cells at margins small, incrassate, and irregular in shape, or obliquely oriented toward the leaf apex; cells of the broadened lamina transversely elongated and sinuate. Perigonal leaves shorter and broader than stem leaves, broadly overlapping and forming a conspicuous rosette. Perichaetial leaves a little longer than stem leaves. Seta yellow-brown, 1-3 cm high. Capsules inclined to horizontal, reddish brown, glaucous when fresh, short oblong to almost cubic, 1.5-2.5 mm wide, 2.5-4 mm long. Peristome 0.24 mm high, divided to 0.6. Spores 9-12 μm , smooth under the light microscope. Calyptra dirty white to light brown, enclosing the capsule.

Polytrichum piliferum, because of the hyaline hair-points on the leaves, is not likely to be confused with any other (see however a note on muticous form below). The leafy shoots are often very small, forming loose reddish brown tufts, crowned by a whitish tuft of hyaline hair-points. *Polytrichum hyperboreum* R. Br., which has been treated as a variety under *P. piliferum*, is a larger plant, growing in loose, glossy tufts, and is more likely to be confused with *P. juniperinum*. The hair-point is shorter, reddish in the lower half, and hyaline in the distal portion.

A single collection from Kobiguayuk Creek basin, near the top of a peak of 2908 m alt., in melting water near snow-bed (Ignatov 0/1369), is a very unusual form of *P. piliferum*

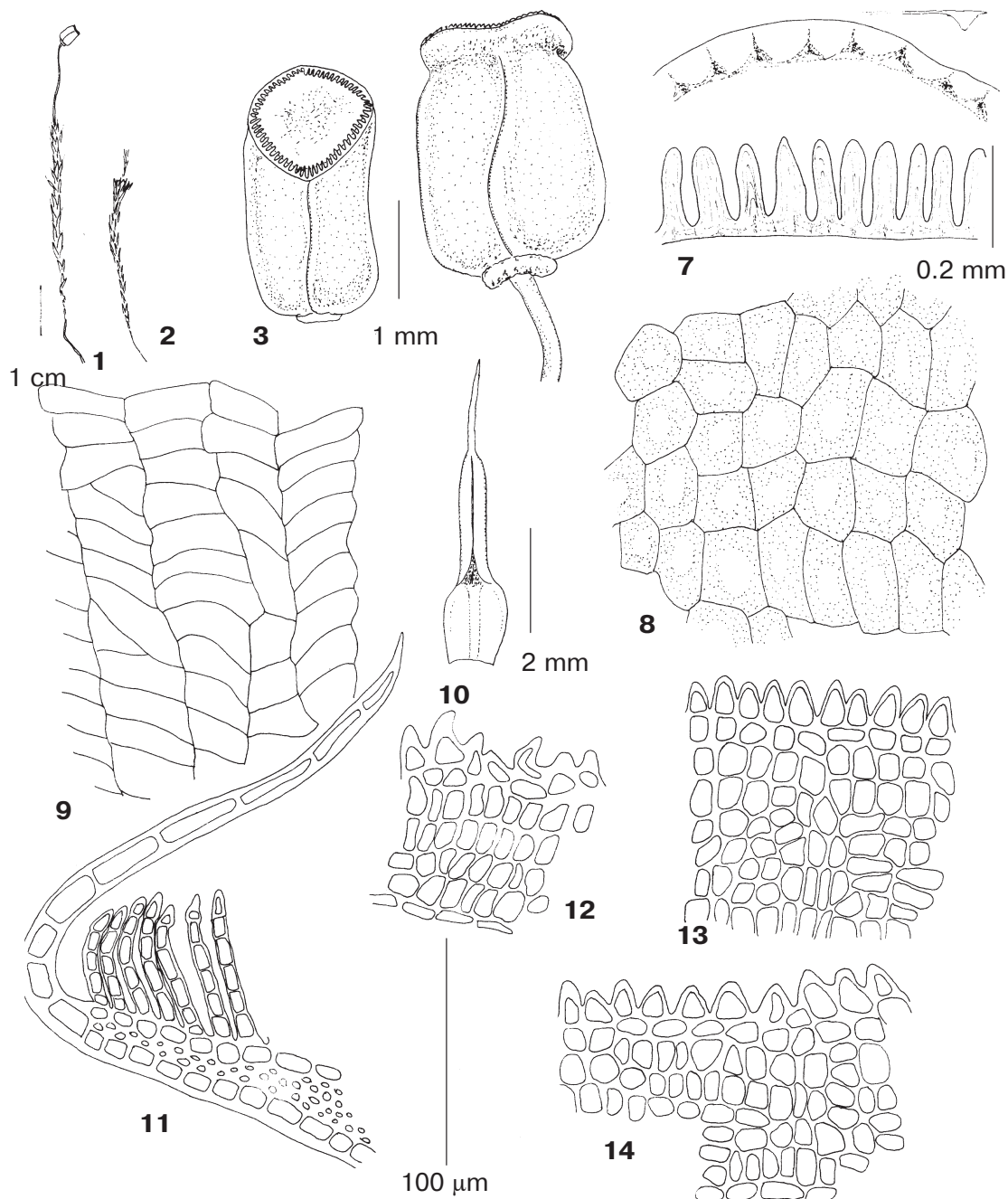


Fig. 34. *Polytrichum piliferum* Hedw. (from Tamanel Peak 1800 m Ignatov 34/92): 1 - female plant; 2 - male plant; 3, 4 - capsules; 5 - ventral epiphragm margin; 6 - cross section of epiphragm margin; 7 - portion of peristome; 8 - exothecium cells; 9 - lamina cells at margin; 10 - leaf; 11 - leaf cross section; 12-14 - side views of lamellae. Scale bars: 1 cm - for 1, 2; 2 mm - for 10; 1 mm - for 3, 4, 8; 0.2 mm - for 5-7; 100 μ m - for 8, 9, 11-14.

with apparently caducous awns. In this large collection we found only four leaves at the extreme stem apex, which had slender, bristle-like hyaline awns. The truncate or bluntly-tipped leaves resemble those of *Polytrichas-*

trum sexangulare, but differ in the broadly involute margins of the transversely elongated lamina cells. The lamellae are bluntly-dentate to entire, the marginal cells in section thin-walled and \pm undifferentiated.

Distribution: *Polytrichum piliferum* is a widespread species in most Holarctic regions, and is also known from southernmost South America, East Africa, Hawaii, Australia, and Antarctica. In Altai, it is very abundant at high elevations in more humid areas, where it is one of the most common species in exposed lichen and low-grass tundras, and also in *Kobresia*-dominated communities on the upper courses of Chulyshman and Bashkaus Rivers. At lower elevations in forest regions this species is uncommon, occurring on xeric slopes, sometimes on dry fallen logs, etc. It is absent in steppe regions and surprisingly also in tundra of high-mountains of the South-East Altai.

Specimens examined: *Bashkaus River, upper course* 2250 m (36/105); *Bogoyash Creek, upper course* 2965 m (Zolotukhin 18.VI.1986); *Bolshoye Kurkure Creek, upper course* 2300 m (Galanin 9.VIII.1976); *Gorno-Altaysk* 400 m (35/14); *Khabarovka* 2000 m (Makarov & al. 25.VI.1972); *Kobiguayuk Creek* 2908 m (0/419); *Kolyushta Peak* 2050 m (Zolotukhin & al. 27.VII.1982); *Korbulu Peak* 1800 m (Fulatova 19.VII.1978); *Kumyi Creek* 1800 m (Zolotukhin 22.VI.1990); *Tamanel Peak* 1800 m (34/92); *Yabolu Creek, at mouth* 1800 m (Zolotukhin 21.VIII.1979).

DOUBTFUL RECORDS

Polytrichum jensenii I. Hag., Meddel. Groenland 15(7): 444. 1897.

Polytrichum commune var. *jensenii* (I. Hag.) Moenk. in Warnst., Krypt. Fl. Brandenburg 2: 1105. 1906.

This is a northern plant, with weakly toothed to sub-entire leaf margins, often treated as a variety of *P. commune*. It is confirmed in Europe by Duell (1984) only from Sweden and the Faeroes, although it is also reported from Svalbard, Norway and northern Russia. Savicz-Lyubitskaya (1954) maps it in Siberia north of 62° with exceptions only for the very continental territory of Yakutia. Bardunov (1974) cited this species for several localities in Altai; several his collections studied by us appeared in fact a *P. commune*.

Polytrichum swartzii C. J. Hartm., Handb. Skand. Fl. (ed. 5) 5: 361. 1849.

Polytrichum commune var. *swartzii* (C. J. Hartm.) Nyholm, Ill. Moss Fl. Fennoscand. II. Musci 681. 1969.

Reported from Altai by Khomutova & al. (1938), but specimens have not been seen in her collection in MW. This is also principally a northern species, similar to *P. commune*, but differing in the flattened (not retuse) marginal cells of the lamellae. We have seen this species in Asian Russia only from the North. Savicz-Lyubitskaya (1954) also maps it in Western Siberia only in lowlands in middle and lower courses of Ob River and Yenisey River.

Psilopilum Brid., Bryol. Univ. 2: 95. 1827.

Holotype: *Psilopilum arcticum* Brid.

Small plants, usually 1 cm or less in height. Leaves not or only weakly differentiated into sheath and blade, broadly ovate, concave, strongly channelled, with a ± cucullate apex; leaf base often differentiated only by the absence of lamellae or by areolation, sometimes hyaline-margined; lamina broad, unistratose, the margins unbordered or bordered by short, rhomboidal cells, entire or denticulate to bluntly and irregularly toothed by projecting angles of marginal cells; costa narrow, about 1/5 the leaf width, smooth or with low abaxial lamellae confined to the costa. Lamellae 5-15, restricted to the costa, straight or transversely undulate, to 12 cells high, ± entire or the margins incised, the segments irregularly dentate; lamellar marginal cells undifferentiated. Dioicous. Perigonia proliferating, perichaetia terminal. Seta short, rather stout, straight to somewhat curved. Capsules broadly and asymmetrically ovate, inclined to horizontal, or roughly cylindrical, curved to arcuate, gibbous or misshapen; apophysis not differentiated; exothecium smooth, the exothecial cells often with radial longitudinal walls somewhat thicker-walled; stomata present, at base of the capsule. Peristome of 32 blunt, linear, crowded teeth (Smith, 1971, fig. 78), but the teeth often poorly formed and highly irregular in shape. Spores of medium-size, 12-18 μm diam., finely papillose. Calyptra cucullate, smooth.

Psilopilum laevigatum (Wahlenb.) Lindb., Oefvers. Forh. Kongl. Svenska Vetensk.-Akad. 18(4): 190. 1861. Fig. 35

Polytrichum laevigatum Wahlenb., Fl. Lapp. 349. 22. 1812.

Plants small, yellowish to brownish green, in loose tufts, or as individual stems growing among other bryophytes, somewhat arcuate above, 7-10 mm high. Leaves erect-incurved to weakly spreading both wet and dry, strongly concave and channelled in the lamellate portion, becoming abruptly cucullate approaching the apex, ovate to oblong-ovate (when flattened), straight or weakly falcate, 0.8-0.9 mm wide, 1.4-1.8 mm long; lamina margins not bordered, denticulate with projecting angles of marginal cells; costa not greatly broadened above, about 1/5 the width of leaf, percurrent, smooth on the back above. Lamellae 8-12, extending from near the base to the apex, 8-10(12) cells high in distal third of leaf, strongly transversely undulate, the margins deeply incised-divided into broad panels, subentire to bluntly and irregularly serrate-

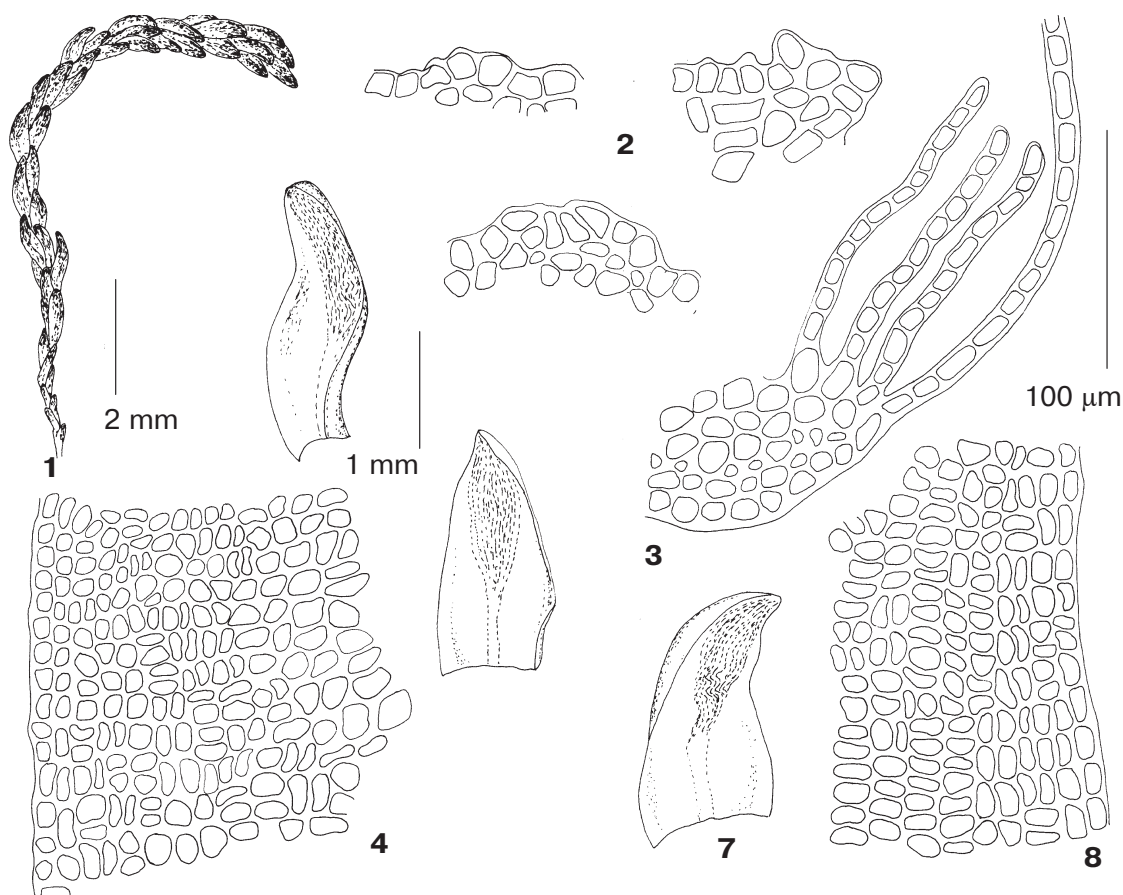


Fig. 35. *Psilopilum laevigatum* (Wahlenb.) Lindb. (from *Kayakkatuyarykskij Creek* 1950 m Ignatov 4/14): 1 – habit; 2 – side views of lamellae; 3 – leaf cross section; 4, 8 – lamina cells at margin; 5-7 – leaves. Scale bars: 2 mm – for 1; 1 mm – for 5-7; 100 µm – for 2-4, 8.

dentate in profile, the marginal cells undifferentiated. Cells near base of leaf short-rectangular, 10.5-12.5 µm wide x 14-18(22) µm long; cells of upper portion of lamina ± isodiametric, quadrate, 12-15 µm wide and long. Altaian specimen sterile.

The Altaian plants of *Psilopilum laevigatum* are sterile and suboptimal, but we are reasonably certain that this collection belongs to this species. *Psilopilum laevigatum* has no close relatives in South Siberia and therefore poses no problems in identification locally. A similar species, *Oligotrichum falcatum* Steere, occurs to the eastward in Siberia (Yakutia) and also southward in Tibet (Xizang), and recent studies have revealed a rather widespread distribution of this species in Asia. Superficially, *O. falcatum* and *P. laevigatum* are quite similar. The strongly falcate-secund leaves of *O. falca-*

tum are its most diagnostic character, but the degree of falcateness is quite variable. This species also has low lamellae on the abaxial surface of the lamina, whereas *P. laevigatum*, has only adaxial lamellae restricted to the costa. The abaxial costa in leaves of the Altaian collection is smooth. Another falcate-leaved species, *Oligotrichum nepalense* G. L. Sm. (Smith, 1976, figs. 1-9), differs by the deeply fimbriate-dissected margins of the lamellae. The Altaian plants show no trace of the border of short, rhomboidal cells said to be characteristic of this species.

Formerly considered to be a genus with a “bipolar” distribution, *Psilopilum* is now limited to two species, *P. laevigatum* and *P. cavifolium* (Wils.) I. Hag., occurring at high latitudes in the Northern Hemisphere. The Southern Hemisphere species formerly included in

Psilopilum now constitute the genus *Notoligotrichum* G. L. Sm. (Smith, 1971, p. 50). These have bilaterally compressed capsules, cryptopore stomata, and distant, tapering, acuminate peristome teeth (l.c., figs. 78,79); in addition, most have papillose lamellae.

Distribution: *Psilopilum laevigatum* is widespread in the Arctic and Subarctic regions of both Eurasia and North America (Yukon, Alaska, Northwest Territories, Greenland). In Europe, it is known from Scandinavia, Svalbard, Iceland, Kola Peninsula, Polar Ural and northern parts of Komi Republic and Archangelsk Province. In the Urals, it extends southward to 61°N. In the Asian Arctic this species is common and even weedy on disturbed areas. In the mountainous region of South Siberia, *P. laevigatum* is locally common (for example in Eastern Siberia at 1700-2700 m), but is absent in other areas, such as the Western Sayan Mts. The species is known further westward in Mongolian Altai and Russian Altai, although rare in both. In North America *P. laevigatum* grows only in Arctic Canada and in the mountains of Labrador, and is reported from Yukon and Greenland. Only a single collection was made in Altai, in the subalpine zone at 1950 m alt., associated with *Marsupella emarginata*, hanging down on a wet dripping cliff.

Specimen examined: *Kayakkatuyarykskij Creek* 1950 m (4/14).

Atrichum P. Beauv., Mag. Encyc. 9 Ann. 5: 329. 1804, *nom. cons.*

Type: *Polytrichum undulatum* Hedw. *typ. cons.*

Plants medium-sized, in loose tufts, bright green when wet, dark green when dry, brownish with age. Stems usually simple, bracteate below, loosely to densely leafy above. Leaves not differentiated into sheath and blade, erect to widely spreading when wet, crisped and twisted when dry, oblong lanceolate to linear, bordered by 1-2 rows of linear, thick-walled cells, spinose-toothed, the teeth often in pairs; costa narrow, terete in cross-section, percurrent or ending near the apex, toothed on the back above; lamina broad, unistratose except for the thickened border, typically transversely undulate, toothed on the back above, the teeth arranged in oblique rows corresponding to the undulations. Lamellae few, confined to the adaxial surface of the costa, entire in profile, the marginal cells not differentiated. Median leaf cells subquadrate, rounded-hexagonal to transversely elongate-hexagonal, becoming short-rectan-

gular below, evenly thin-walled to firm and collenchymatous (with distinct trigones), usually papillose with rounded to striate papillae. Dioicous or polyioicous (some shoots autoicous, others apparently unisexual male or female), or synautoicous (perigonia on a tiny male branch amid the perichaetial leaves). Perigonial bracts broad, forming cup-like inflorescence, or (*A. flavisetum*) small and obovoid, scarcely longer than the antheridia. Perichaetial leaves similar to stem leaves but longer and broader-based. Setae 1 to several from the same perichaetium; capsules cylindric, lacking a basal constriction and stomata; exothecium smooth, the cells elongate rectangular, their radial longitudinal walls strongly thickened, lending the capsule a finely striate appearance. Peristome teeth 32, simple, linear, crowded, not strongly colored. Operculum rostrate with a long beak. Spores papillose. Calyptra cucullate, naked or hispid at the tip.

KEY TO THE ALTAIAN SPECIES OF *ATRICHUM*

1. Lamellae 5-7 cells high; median leaf cells rather thin-walled, without trigones; teeth on back of leaf few or lacking; dioicous *A. tenellum*
1. Lamellae 2-4 cells high; median leaf cells firm, collenchymatous (with distinct trigones); lamina strongly toothed at back in oblique rows; monoicous 2
2. Sporophytes terminal, arising from a pure female flower; some plants bisexual, others apparently unisexual female; shoots with terminal perigonia proliferating, the new shoot ending in a perichaetium; sporophytes usually 1 per stem; seta reddish, rather stout; capsules curved to strongly arcuate, horizontal *A. undulatum*
2. Sporophytes apparently lateral due to innovation, arising from a paroicous inflorescence; perigonia and perichaetia developing ± simultaneously in the same receptacle, the perigonium on a minute branch; sporogones 2-6 on a stem; seta yellowish, slender; capsules slightly curved to nearly straight *A. flavisetum*

Atrichum flavisetum Wils. ex Mitt., J. Linn. Soc., Bot. Suppl. 1: 150. 1859. Fig. 36

Atrichum haussknechtii Jur. & Milde, Verh. K. K. Zool.-Bot. Ges. Wien 20: 598. 1870.

Atrichum fertile Nawasch., Hedwigia 28: 359. 1889.

Plants medium-sized, green or light green when wet, dark green when dry. Stems simple, to 2 cm high. Leaves spreading when wet, crisped and contorted when dry, oblong-linear, acute to acuminate, 1.5 mm wide, ca. 10 mm long, transversely undulate above, toothed along the margin nearly to the base, and also toothed on abaxial lamina, where along the undulate plicae a few irregular teeth are arranged; costa 0.3 mm wide, percurrent to weakly excurrent. Lamellae 4-6, 2-4 cells high. Median leaf cells moderately thick-walled, \pm isodiametric, transversely elongate, in \pm regular longitudinal rows, ca. 24-30 μ m wide, towards the base becoming elongate rectangular, to 100 μ m long. Paroicous or synautoicous, the inflorescence various: inflorescence inconspicuous, on a short branch amid the perichaetial leaves; inflorescence terminal, but commonly an innovation (from the inflorescence) continuing growth of the shoot and forming new perichaetia, up to 3 perichaetia with open and maturing capsules present on one stem. Setae (1)2-4 per perichaetium, rather slender, yellowish, 0.3 mm thick, to 3.5 cm long. Capsules erect to inclined, cylindrical, nearly straight, 1.3 mm wide x 8 mm long. Peristome 0.3-0.6 mm high, divided to 0.6, with 32 teeth. Spores (8)15-16 μ m diam., smooth. Operculum conic and long rostrate. Calyptra cucullate, naked or hispid at the tip.

Differences between *Atrichum flavisetum* and *A. undulatum* include the multiple sporophytes per plant which appear lateral in position, the more slender, yellowish seta, the nearly straight, suberect capsules, and synoicous inflorescence. In *A. undulatum* the sporophytes are usually borne singly, the seta is rather stout and reddish, and the capsules strongly curved and horizontal. Typically, in *A. undulatum*, many plants will be autoicous, producing a terminal perigonium which soon proliferates, the new shoot forming a perichaetium inflorescence; also present will be numerous, apparently unisexual female (and rarely unisexual male) shoots. As a result, the species is monoicous, but functionally dioicous. In addition to the differences in sporophytes, these two species have definite geographical and ecological differences (see below).

Atrichum flavisetum has a long history in the Russian bryological literature, the name *A. flavisetum* having replaced the more familiar *A. haussknechtii* Jur. & Milde (Smith, 1976). It has often been treated as a variety of *A. undulatum* var. *gracilisetum* Besch. (e.g., Nyholm, 1971; Lou & Koponen, 1986).

Excellent illustrations of the inflorescence of this species were published by Nawaschin (1889, figs. 1-9, as *A. fertile*). For a further discussion of the sexuality in this species, and the differences between it and *A. undulatum*, based on Russian material, see Warnstorf (1914).

Distribution: In central European Russia, *A. flavisetum* is rare and known only from a few localities. For example, in Moscow Prov. it grows in ravines with limestone outcrops, mostly in the same localities with *Polystichum braunii* (Spenn.) Fée, a rare fern species (Ignatov & Ignatova, 1990). *Atrichum undulatum*, on the other hand, is a very common and weedy species. Further to the east, in the Middle Ural Mts., *A. flavisetum* is found in closed forest communities (at upturned roots of fallen trees), whereas *A. undulatum* occurs only as a weedy species along roadsides. In Altai, *A. flavisetum* is a more or less widespread species in a variety of habitats, whereas *A. undulatum* is known only from only few places on the shore of Teletzkoye Lake (an area especially rich in relicts).

Still further to the east, in Siberia, *A. flavisetum* is locally common in the mountains of South Siberia and the Baikal area, whereas *A. undulatum* has not been found (Bardunov, 1969; 1974). True *A. undulatum* is also absent from China, with the possible exception of a single specimen from Sechuan (Lou & Koponen, 1986). At the same time, *A. flavisetum* is widespread in China and the Himalayas. Both taxa are reported for Indochina (Tan & Iwatsuki, 1993) and the Russian Far East (Savicz-Lyubitskaya, 1954; Bardunov & Czerdantseva, 1982, and herbarium specimens in MHA). Both are present in the Caucasus and Western Asia, and *A. undulatum* is reported for northern Africa.

In North America both species are reported from the Pacific Northwest. *Atrichum undulatum* has traditionally been given a wide range in eastern North America, but true *A. undulatum* is actually quite rare (see Ireland, 1969; 1982), and reported from Ontario, Quebec, and the Maritime Provinces of Canada. It is typically found (as in the Urals) in dry roadside ditches, open woods, and other rather dry, "weedy" habitats. The place of *A. undulatum* in eastern North America is taken by another species, *A. altecristatum* (Ren. & Card.) Smyth & Smyth, which is also autoicous, but has higher lamellae and \pm straight, cylindrical capsules. The large, robust *Atrichum* of eastern North America is a dioicous species, *A. crispulum* Schimp. ex Besch. (*A. oerstedianum* sensu Ireland, 1969).

Atrichum flavisetum occurs mostly in humid parts of the northern and central Altai, confined in its distribution to czernevaya taiga. However, there it grows not only in forests, but on soil banks along

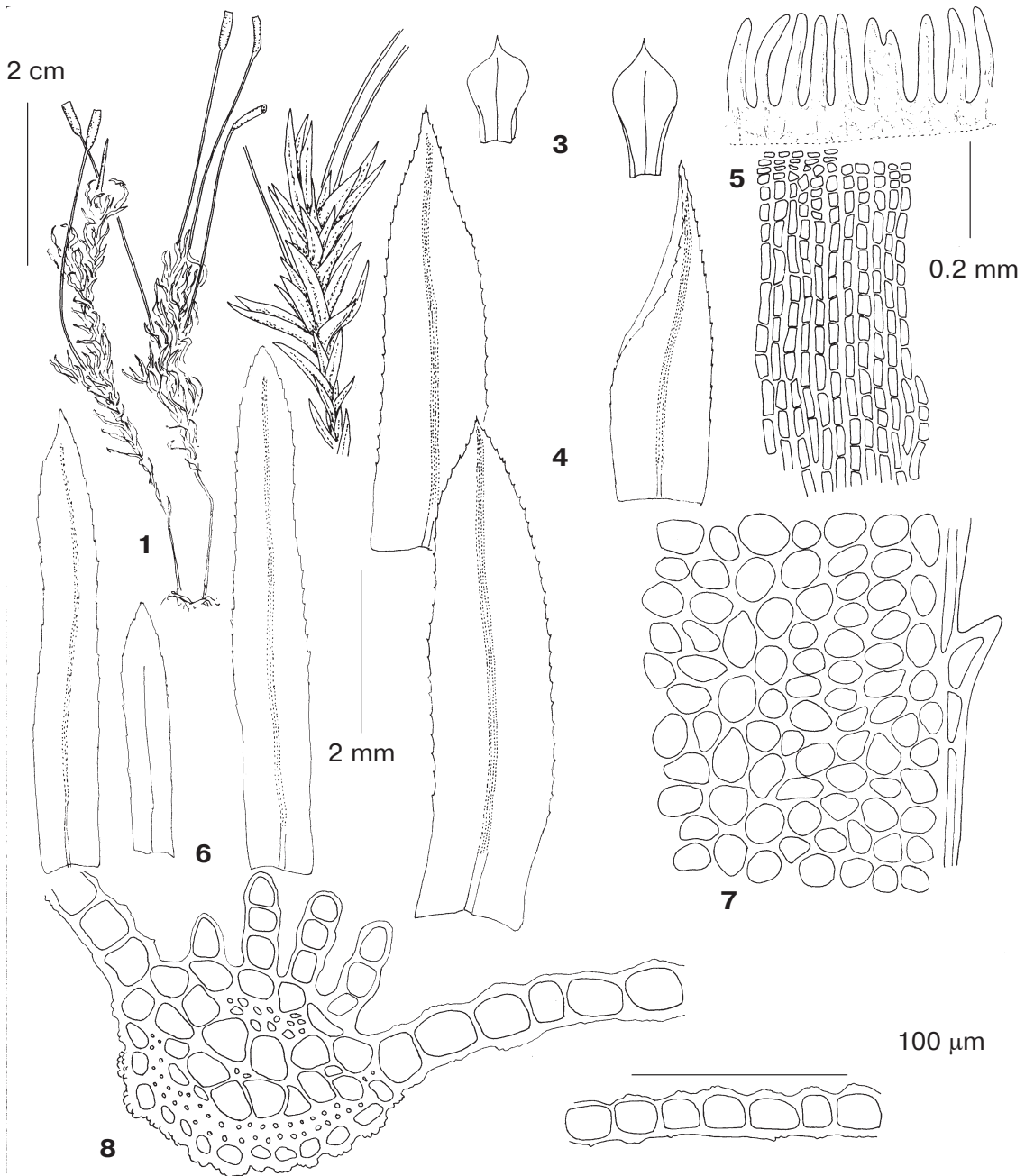


Fig. 36. *Atrichum flavisetum* Wils. ex Mitt. (from *Tura Creek* 1300 m Ignatov 28/21): 1 - habit when dry; 2 - habit when wet; 3 - perigonal leaves; 4 - stem leaves; 5 - portion of peristome and exothecium; 6 - perichaetial leaves; 7 - lamina and border cells; 8 - leaf cross sections. Scale bars: 1 cm - for 1, 2; 2 mm - for 3, 4, 6; 0.2 mm - for 5; 100 μm - for 7, 8.

trails, on rather dry landslips at the shore banks (with *Myuroclada maximowiczii*, *Weissia condensata* and *Bryoerythrophyllum recurvirostrum*), on fresh lawns, etc. In some areas it is a fairly common plant, growing everywhere. It is practically absent in the zone of boreal forests, above 1400 m. In only two places has it been collected at 1800-1900 m:

Karakol Lakes, where there are many tourist trails, along which it is distributed as a weed, and Kayakkatuyarykskij Creek, where because of very steep relief there are numerous landslips.

Specimens examined. *Artybash* 440 m (Bardunov 4.VII.1966); *Ayukol* 1400 m (0/1406); *Bele* 550 m (0/49); *Bolshoi Mianok Creek, at mouth* 440 m (Zolotukhin

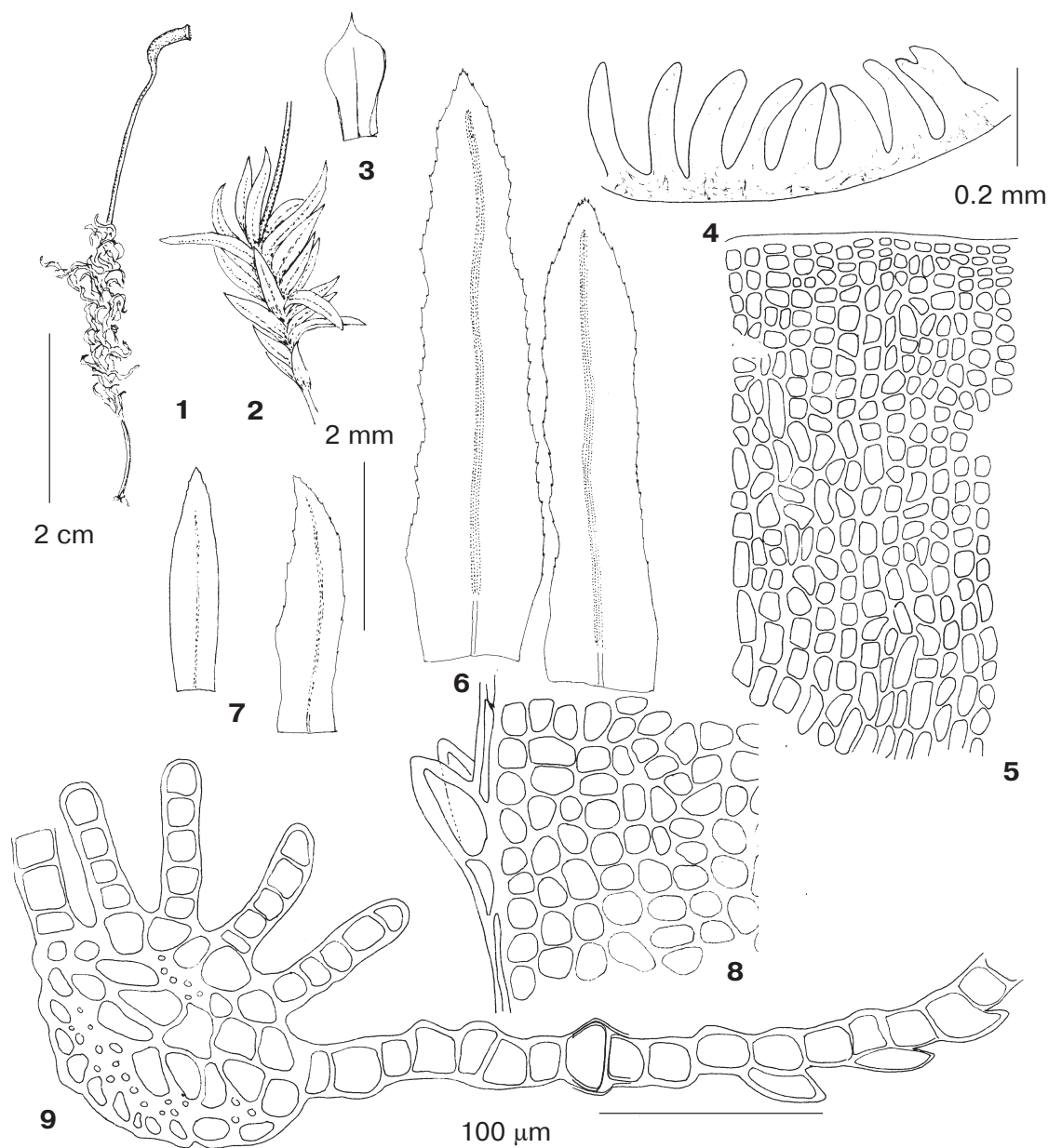


Fig. 37. *Atrichum undulatum* (Hedw.) P. Beauv. (from Yailyu 470 m Ignatov 0/1403): 1 – habit when dry; 2 – habit when wet; 3 – perigonal leaf; 4 – portion of peristome; 5 – portion of exothecium; 6 – stem leaves; 7 – perichaetial leaves; 8 – lamina and border cells; 9 – leaf cross sections. Scale bars: 1 cm – for 1, 2; 2 mm – for 3, 6, 7; 0.2 mm – for 4, 5; 100 µm – for 8, 9.

8.VIII.1988); *Bolshoi Shaltan Creek* 540 m (0/1405); *Bolshoye Istyube Creek* 470 m (18/106); *Chulcha River, in middle course* 1000 m (9/108); *Edikhta Creek* 1100 m (34/137); *Kairu Creek, 16 km upstream* 1400 m (14/35); *Kairu Creek, 8 km upstream* 1000 m (15/50); *Karakol Lakes* 1800 m (26/102); *Kayakkatuyaryskij Creek* 1630 m (8/128); 1850 m (8/295); 1900 m (8/167); *Oimok* 1100 m (Zolotukhin 2.IX.1986); *Tura Creek, in middle course* 1200 m (28/8); 1300 m (28/21); *Ust-Sema* 400 m (24/66); Yailyu 500 m (0/1404).

***Atrichum undulatum* (Hedw.) P. Beauv.,**
Prodr. Aethéog. 42. 1805.

Fig. 37

Polytrichum undulatum Hedw., Sp. Musc.
Fronde. 98. 1801.

Plants green or light green when wet, dark green when dry. Stems simple, to 2 cm high. Leaves spreading when wet, irregularly crisped and contorted when dry, oblong-linear, acute to acuminate up, 1.5 mm

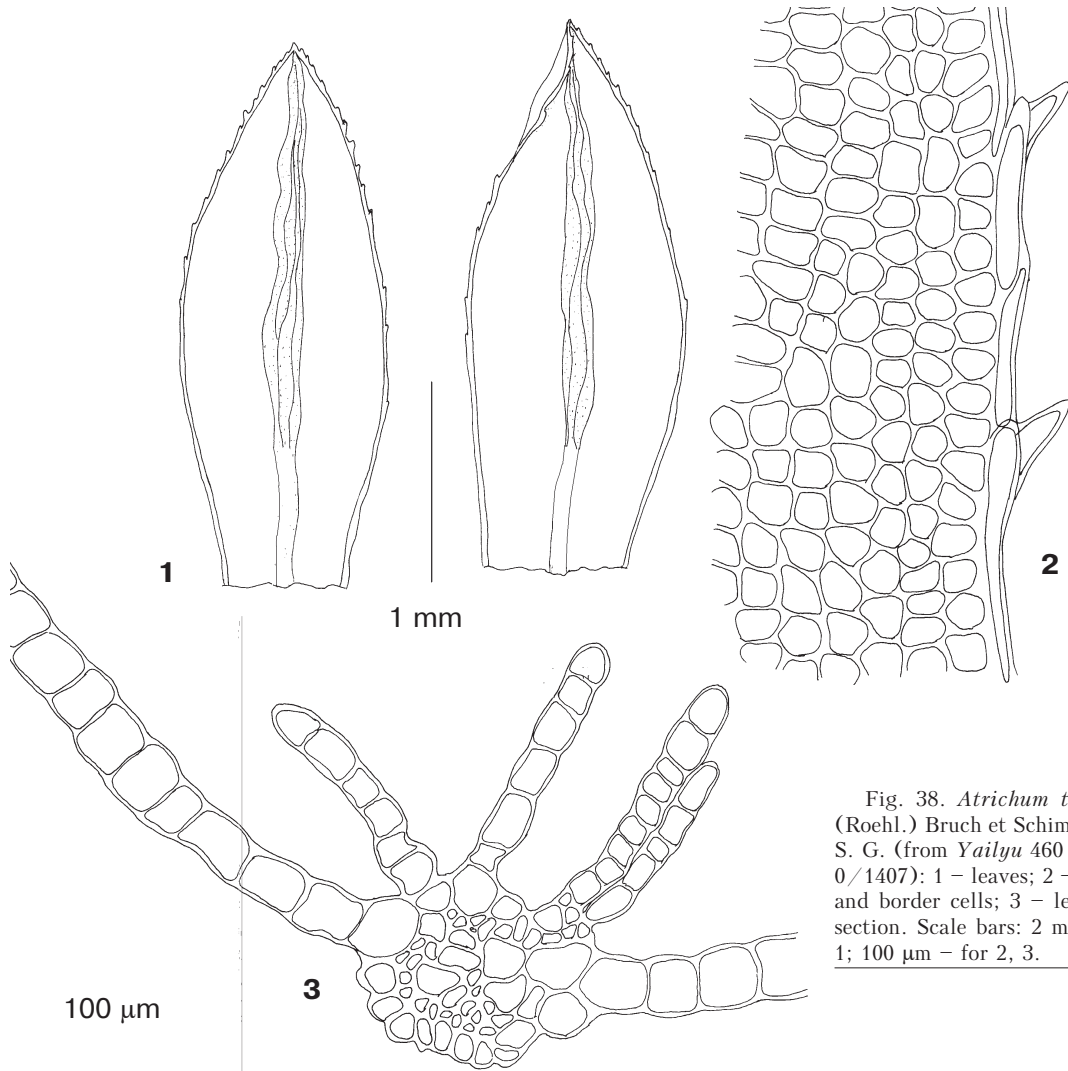


Fig. 38. *Atrichum tenellum* (Roehl.) Bruch et Schimp. in B. S. G. (from *Yailyu* 460 Ignatov 0/1407): 1 - leaves; 2 - lamina and border cells; 3 - leaf cross section. Scale bars: 2 mm - for 1; 100 μ m - for 2, 3.

wide, to 10 mm long, transversely undulate above, toothed all along the margin nearly to the base; toothed on the back of the lamina, the teeth in oblique rows corresponding to the undulations; costa about 0.3 mm wide, a little excurrent to percurrent. Lamellae 4-6, restricted to the narrow costa, 2-4 cells high (or at times somewhat higher). Cells of lamina moderately thick-walled, \pm isodiametric or somewhat transversely elongate, collenchymatous with prominent trigones, ca. 30 μ m wide, becoming elongate-hexagonal towards the base, to 100 μ m long; marginal cells 20 μ m x 80 μ m, forming a distinct 2-3-stratose, 1-2-seriate border. Autoicous, but functionally dioicous. Perigonia terminal, then proliferating to produce a terminal female inflorescence in the following season; unisexual female (and rarely male) shoots also present. Seta single (or rarely 2-3 per perichaetium), rather stout, reddish-brown, 0.8 mm wide, to 3.5 cm long. Capsules cylindric, dis-

tinctly curved to arcuate, horizontal, reddish-brown at maturity, 2 mm wide x 8 mm long. Peristome teeth 32, 0.6 mm high with a low basal membrane. Operculum conic and long rostrate. Spores 16-24 μ m diam., finely papillose. Calyptra cucullate, naked.

For the differences between *A. undulatum* and *A. flavisetum*, see discussion under that species.

Distribution: In Altai, *A. undulatum* was found only a few times in surroundings of Teletzkoye Lake, an area with a rather mild climate. Bardunov (1974) cited another locality from the middle course of Katun River, in Munny. All the collections studied were made from alluvial soil covering big logs in ravines or beside small creeks. It is notable that most of the Altaian collections of *A. undulatum* were made from rotten logs, an unusual habitat for the species.

Specimens examined. *Yailyu* 450 m (Zolotukhina 14.VII.1988); 470 m (0/1403); 500 m (Zolotukhina 4.IV.1988).

Atrichum tenellum (Roehl.) Bruch & Schimp., Bryol. Eur. 4: 237. 1844. Fig. 38

Catharinea tenella Roehl., Ann. Wetterauischen Ges. Gesamte Naturk. 3(2): 234. 1814.

Stems rather small and slender, to 2 cm high. Leaves not undulate, ovate-lanceolate, 1.5 mm wide, to 5 mm long, only sparingly toothed on the back of the leaf above. Lamellae 2-4, 4-7 cells high. Leaf cells subquadrate to hexagonal, rather evenly thin-walled, not or only weakly collenchymatous, about 24 μ m, becoming somewhat larger adjacent to the costa. Dioicous. Only female plants were observed in Altai.

This species was reported from Altai by Bardunov (1974) and Ignatov (1994). Some specimens cited by them were misidentified. However one collection is supposed to be *A. tenellum*, despite it has immature plants without sporophytes. Plants has rather high lamellae, non-undulate leaves and thin-walled lamina cells. However some forms of *A. undulatum*, especially young plants, sometimes have lamellae up to 6 cells high and weakly undulate leaves. Collections with sporophytes are necessary to confirm the occurrence of *A. tenellum* in Altai.

Distribution: Known from Northern and Central Europe and Asia (Savicz-Lyubitskaya, 1954; Nyholm, 1971). In North America, reported from Canada, Wisconsin, and British Columbia. In European Russia and Ural Mts. this species is common in boreal regions on wet sandy soil, often on secondary places, typically growing in abundance, with numerous sporophytes. Eastward of Ural besides Altai, *A. tenellum* it was reported from Middle Ob River, without sporophytes (Savicz-Lyubitskaya, 1954), Middle Yenisey River, without sporophytes (Lindberg & Arnell, 1890). So, the occurrence of *A. tenellum* in Siberia needs additional confirmation.

Specimen examined: *Yailyu* 460 m Ignatov (0/1407).

Pogonatum P. Beauv., Mag. Encycl. 9 Ann. 5: 329. 1804.

Lectotype (Smith, 1971): *Polytrichum aloides* Hedw.

Plants in loose tufts, simple or branched (sometimes repeatedly), rather dull bluish-green to glaucous-green, becoming reddish-brown with age, to several cm tall. Leaves differentiated into sheath and blade, hinge tissue (in ours) present, the sheath (in *P. urnigerum*) hyaline-margined; lam-

ina margins 2-8 cells wide, unistratose or sporadically 2-stratose, serrate with 2-4 celled, reflexed teeth. Lamellae numerous, occupying the full width of the costa; lamellar marginal cells (in ours) thick-walled and coarsely papillose. Dioicous. Male plants often smaller, with 1-several successive perigonia per shoot. Perichaetia terminal, but proliferating by subfloral innovations, 1-3 perichaetia bearing sporophytes on the same shoot. Seta 1-2 per perichaetium. Capsule ovoid to cylindrical, brown to reddish-brown, lacking both a hypophysis and stomata. Exothecium mamillate or papillose, the exothecial cells each with a single papilla. Peristome teeth 32, compound (the outlines of two teeth visible on the face of each tooth), with a narrow, crowded median sinus, the teeth brownish-red pigmented (at least in the median line). Epi-phragm thin, attached to the ventral surface of teeth. Spores 14-24 μ m diam., papillose. Calyptra with a dense matted felt of hairs, yellowish, enclosing most or all of the capsule.

KEY TO THE ALTAIAN SPECIES OF *POGONATUM*

1. Marginal cells of lamellae in cross-section rounded, with a broadly convex distal wall; stems usually branched; sheath hyaline-margined; capsules ovate to cylindrical, broadest in the middle; peristome divided to ca. 0.3 *P. urnigerum*
1. Marginal cells of lamellae in cross-section \pm rectangular, with a flattened distal wall; stems mostly simple; sheath not hyaline-margined; capsules ovate-cylindrical, broadest below the mouth; peristome deeply divided, the basal membrane barely visible above the rim of capsule *P. dentatum*

Both of our species belong to one section:

Pogonatum sect. *Dendroidea* Schimp., Coroll. Bryol. Eur. 90. 1855.

Lectotype (Smith, 1971): *Polytrichum urnigerum* Hedw.

Pogonatum dentatum (Brid.) Brid., Bryol. Univ. 2: 122. 1827. Fig. 39

Polytrichum dentatum Brid., J. Bot. (Schrad-er) 1800(1): 287. 1801.

Stems rarely branching, bluish- to glaucous-green, to 3 cm high. Leaves spreading when moist, somewhat twisted and contorted when dry, 3-5(7) mm long; sheath short oblong to ovate, not hyaline-margined; marginal lamina typically coarsely toothed with teeth stout, multicellular, uncinata, reflexed teeth. Lamellae 20-30, entire in profile, 4-7 cells

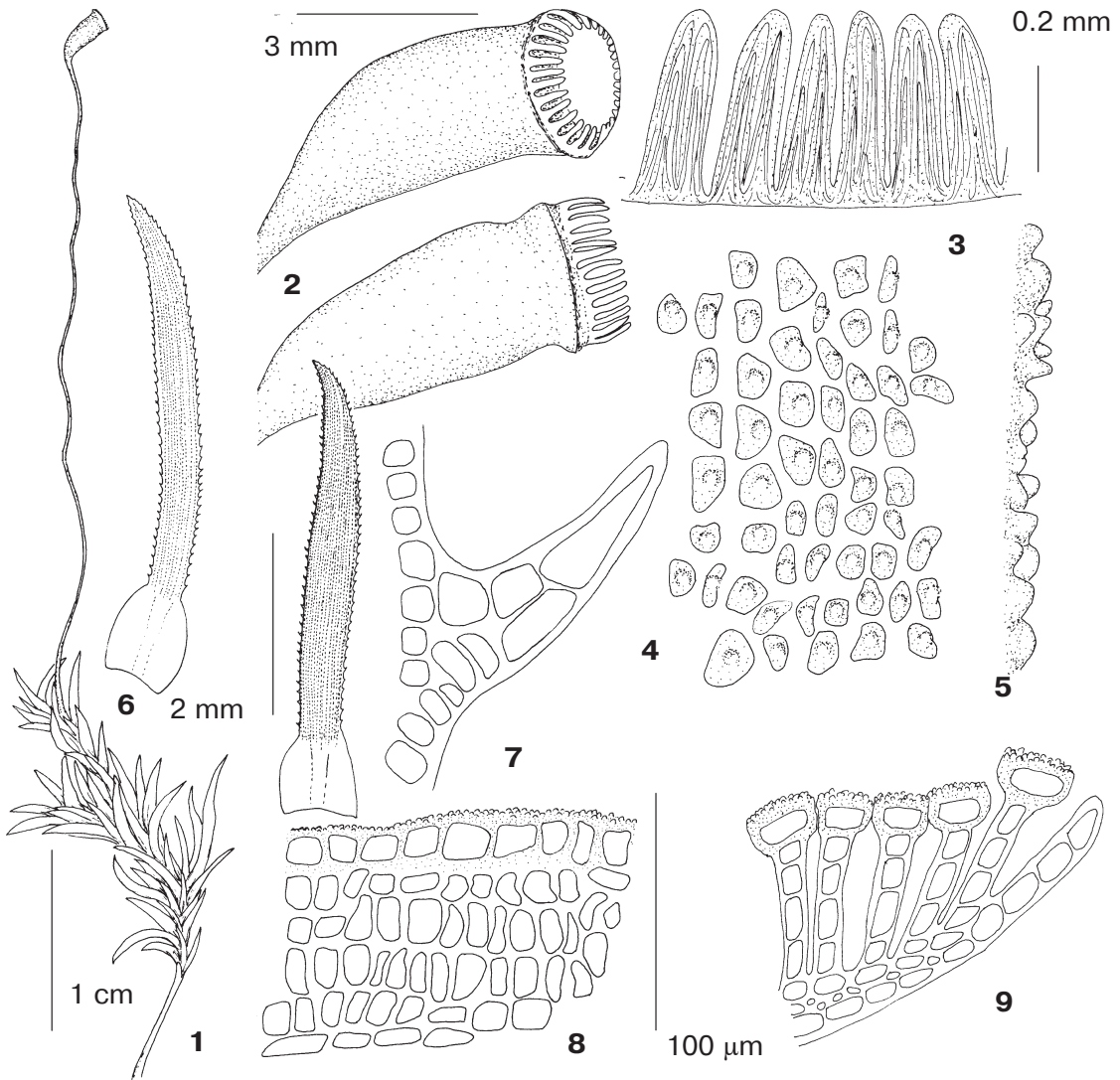


Fig. 39. *Pogonatum dentatum* Brid. (from *Bolshoye Istyube Creek* 470 m Ignatov 0/1391): 1 – habit; 2 – capsules; 3 – portion of peristome; 4 – exothecium cells; 5 – the same, as seen on fold; 6 – leaves; 7 – lamina cells and tooth; 8 – side view of lamella; 9 – leaf cross section. 1 – Scale bars: 1 cm – for 1; 3 mm – for 2; 2 mm – for 6; 0.2 mm – for 3; 100 µm – for 4, 5, 7-9.

high, the marginal cells in cross-section enlarged, \pm rectangular, wider than the cells beneath, thick-walled, the upper wall flat-topped and coarsely papillose, the lumen quadrate. Cells of sheath short-rectangular, 11-12 µm wide x 27-40 µm long; hinge cells at the leaf shoulders unistratose, rather weakly differentiated; lamina cells \pm isodiametric, quadrate, ca. 12-18 µm wide. Male plants somewhat smaller. Seta slender, straight to flexuose, 1-3(5) cm long. Capsules erect to inclined, ovoid to short-cylindric, 1 mm wide x 2-3 mm long. Operculum high-conic. Peristome ca. 0.6 mm high, deeply divided to 5/6, the teeth 32, reddish brown, compound, with a narrow median sinus. Spores (14)19-24 µm diam.,

brownish, papillose.

The most reliable difference between the two Altaian *Pogonatum* species is the shape of the marginal cells of the lamellae: rectangular and flat-topped in *P. dentatum* vs. rounded, with a broadly convex distal wall in *P. urnigerum*. The short, unbranched stems, the stout, hooked teeth of the leaf margins, the glaucous-green color, obconic smaller capsules, and deeply dissected peristome will usually serve, even with a hand-lens in the field, to distinguish this species. *P. dentatum* is often considered as a species smaller than *P. urnigerum*. Though this is so in gen-

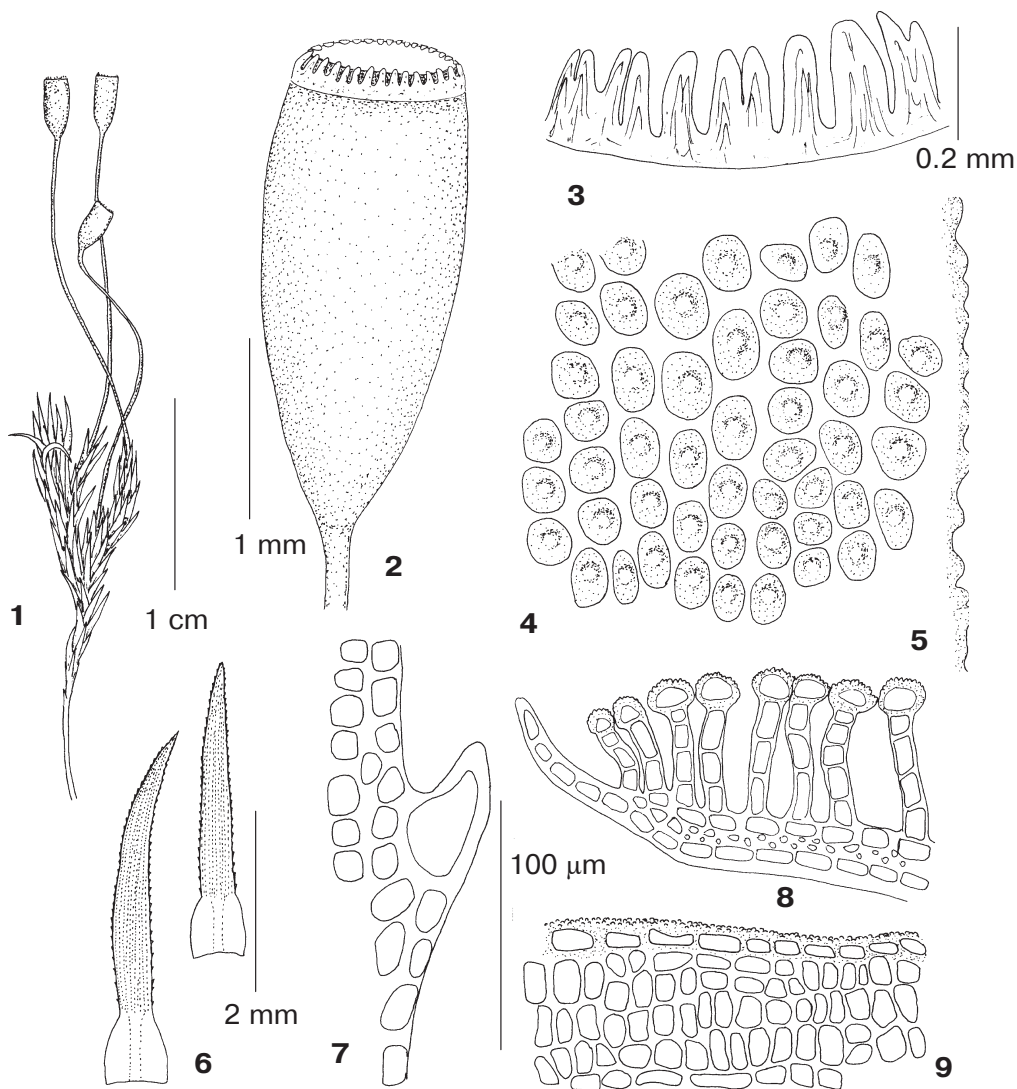


Fig. 40. *Pogonatum urnigerum* (Hedw.) P. Beauv. (from *Srednij Shaltan Creek* 670 m Ignatov 0/1389): 1 – habit; 2 – capsule; 3 – portion of peristome; 4 – exothecium cells; 5 – the same, as seen on fold; 6 – leaves; 7 – lamina cells and tooth; 8 – leaf cross section; 9 – side view of lamella. 1 – Scale bars: 1 cm – for 1; 3 mm – for 2; 2 mm – for 6; 0.2 mm – for 3; 100 μ m – for 4, 5, 7-9.

eral, some forms of *P. dentatum* occurring in Altai at lower elevations are rather robust and have very long seta, up to 6 cm (Fig. 39, 1).

Distribution: This species is widespread in the cool regions of the Holarctic, throughout all the Arctic and mountain areas in Scandinavia, Northern Ural, mountains of Southern Siberia, Mongolia, northwestern and northeastern China, and northern Japan. It occurs in western North America, and in the mountains of eastern North America south to North Carolina, as well as in Greenland and Iceland. Besides these northern and montane areas, *P. dentatum* was recently found in Central European Russia (Tver and Ryazan Provinces) and Estonia,

probably as a result of recent expansion. *Pogonatum dentatum* is fairly common in Altai, especially above the tree line, where it grows both in sheltered places (among rocks, etc.) and on exposed tundra vegetation. In the forest zone, *P. urnigerum* occurs sporadically on landslips on creek banks, and on open or shaded rock outcrops.

Specimens examined: *Adylda Creek* 1100 m (34/155); *Ayukol* 1400 m (0/1397); *Bayas Creek, in middle course* 1400 m (Zolotukhin 15.VII.1983); *Bolshoi Shaltan Creek* 520 m (0/1394); *Bolshoye Istyube Creek* 470 m (0/1391); *Kamga Creek, 14 km upstream* 660 m (0/1395); *Kayakkatuyarykskij Creek* 1750 m (8/105); 1800 m (8/250); 2800 m (7/69a, 7/70); *Kobiguayuk Creek* 2650 m (0/173); 2700 m (0/1396, 0/215); 2830 m (0/1392); 2850 m (0/190); *Oimok* 1100 m (Zolotukhin

2.IX.1986); *Yailyu* 480 m (0/1393).

Pogonatum urnigerum (Hedw.) P. Beauv.,
Prodr. Aetheogam. 84. 1805. Fig. 40

Polytrichum urnigerum Hedw., Spec. Musc.
Fronde. 100. pl. 22: 5-7. 1801.

Stems often branching, bluish-green, brownish with age, to 5 cm high. Leaves spreading when moist, erect-incurved when dry, 4-7(9) mm long; sheath obovate, hyaline-margined, with hinge cells at the junction of sheath and blade; marginal lamina serrate-toothed from apex almost to the shoulders. Lamellae 30-40, entire in profile, 4-5 cells high, the marginal cells in cross-section enlarged, thick-walled, rounded to ellipsoidal, the upper wall broadly convex and coarsely papillose, the lumen rounded pentagonal. Cells of sheath short rectangular; cells at the leaf shoulders (hinge cells) clearly differentiated; lamina cells \pm isodiametric, firm-walled, ca. 14-18 μ m wide and long. Male plants similar in size to female or a little smaller. Seta straight, 1-4 cm long. Capsules erect to inclined, short-cylindric, 1 mm wide \times 2-3 mm long. Operculum rostrate. Peristome ca. 0.3 mm high, divided to 0.3, the teeth 32, reddish brown, compound, with a narrow median sinus. Spores 10-15 μ m diam., papillose.

Pogonatum urnigerum is similar to *P. dentatum* (particularly when suboptimal), but when well-developed the generally more robust, branching stems of *P. urnigerum*, as well as the longer, more bluish-green (rather than glau-

cous-green) leaves, and the ovate-cylindric capsules are diagnostic. Fruiting plants also can be easily identified by the presence of an evident basal membrane of the peristome.

Distribution: *Pogonatum urnigerum* is the most widespread species of the genus, and the only widely distributed Holarctic species, absent only in more xeric areas of north Africa, interior North America, and Middle Asia. Elsewhere, it occurs in the Himalayas, Southern India, and South-East Asia, and extends to the Philippines and New Guinea. Ecological and distributional patterns of this species in Altai are practically the same as in *P. dentatum*. Although *P. urnigerum* is somewhat less common in Altai than *P. dentatum*, as whole it is not a rare moss locally.

Specimens examined. *Bayas Lake* 1750 m (0/1390); 2000 m (0/1368, 0/1388); *Chainary Creek, upper course* 1800 m (34/20); Chiri 450 m (17/100); *Kamga Creek, 1 km upstream* 450 m (Zolotukhin 20.X.1988); *Kayakkatuyaryjskij Creek* 1900 m (8/278); *Kobiguayuk Creek* 2700 m (0/349); 2908 m (0/1387); *Kurkurebazhi Peak* 3100 m (Zolotukhin 13.VIII.1976); *Srednij Shaltan Creek* 670 m (0/1389).

ACKNOWLEDGEMENTS

We are very grateful to L. V. Bardunov for the loan of collections from IRK, to G. V. Serezhkina and E. A. Ignatova for the help with SEM. Research project of the first author was in part supported by the International Science Foundation and the Russian Government, grant N° M97030.

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