

BRYOPHYTES OF ALTAI MOUNTAINS. II.

THE GENERA *AMPHIDIUM* SCHIMP., *ORTHOTRICHUM* HEDW.
AND *ZYGODON* HOOK. & TAYL. (ORTHOTRICHACEAE, MUSCI)

МОХООБРАЗНЫЕ АЛТАЯ. II

РОДЫ *AMPHIDIUM* SCHIMP., *ORTHOTRICHUM* HEDW.
И *ZYGODON* HOOK. & TAYL. (ORTHOTRICHACEAE, MUSCI)

MICHAEL S. IGNATOV¹ & JETTE LEWINSKY-HAAPASAARI²

М. С. ИГНАТОВ¹ и Ж. ЛЕВИНСКИ-ХААПАСААРИ²

Abstract

Two species of *Amphidium*, 15 species of *Orthotrichum* and 1 species of *Zygodon* are reported for Altai. Description, illustration, keys for identification and comments on species distribution are provided for all species. *Orthotrichum cupulatum*, *O. dasymitrium*, *O. laevigatum* subsp. *japonicum*, *O. pellucidum*, *O. rogeri*, *O. vladikavkanum* and *Zygodon rupestris* are reported in Siberia for the first time.

Резюме

Два вида *Amphidium*, 15 видов *Orthotrichum* и 1 вид *Zygodon* выявлены в бриофлоре Алтая. Приводятся описания, иллюстрации, ключи для определения и заметки о распространении всех видов. *Orthotrichum cupulatum*, *O. dasymitrium*, *O. laevigatum* subsp. *japonicum*, *O. pellucidum*, *O. rogeri*, *O. vladikavkanum* и *Zygodon rupestris* впервые приводятся для территории Сибири.

INTRODUCTION

This paper belongs to a series dealing with the bryophyte flora of Altai beginning in this issue of *Arctoa*. We intend to describe, illustrate and discuss all the bryophytes from the region. This paper deals with the family Orthotrichaceae, except for *Ulota*, which is treated separately.

For information about natural characteristics of Altai and history of bryological investigation, as well as for explanation of specimen citation see the introductory paper by Ignatov in this issue.

In the publications of Keller (1914) and Krylov (1925) only the three most common species of *Orthotrichum* in Altai were mentioned: *Orthotrichum anomalum* Hedw., *O. obtusifolium* Brid., *O. speciosum* Nees. Bardunov (1974) added *Orthotrichum rupestre* Schwaegr., *O. alpestre*

Hornsch. and *O. pumilum* Sw. Numerous recent collections add to the Altaian bryoflora two species of *Amphidium*, one of *Zygodon* and eight species of *Orthotrichum*.

ORTHOTRICHACEAE (description based on Altaian representatives).

Plants small to robust, green to brown, dull, in cushions, tufts or mats. Stems erect or ascending, repeatedly branched, with rhizoids below. Leaves elliptic, ovate or lanceolate, acute, acuminate or apiculate, rarely obtuse, more or less keeled, with plane or recurved to revolute margins. Costae ending below the apex or percurrent, strong. Upper cells rounded-hexagonal, thick-walled, papillose to various degree (from high forked to very low inconspicuous papillae). Basal cells elongated, smooth. Autoicous, rarely dioicous. Perichaetial leaves not much differentiated. Setae terminal, erect, short or long. Capsules oblong-cylindric to ovoid, sometimes pyriform, smooth to distinctly ribbed. Annuli present. Opercula rostrate.

¹ - Main Botanical Garden of Russian Academy of Sciences, Botanicheskaya 4, Moscow 127276 Russia - Россия 127276 Москва, Ботаническая, 4, Главный ботанический сад РАН

² - Kuopio Museum of Natural History, Myhkyrinkatu 22, SF-70100 Kuopio, Finland.

Stomata superficial or immersed. Peristomes double, rarely single or absent; prostomes sometimes present. Exostome teeth 16, often united in pairs, narrow triangular to lanceolate, papillose or sometimes striolate. Endostome segments 8 or 16, lanceolate to narrow filiform, smooth or finely papillose. Calyptrae campanulate, hairy or naked. Spores spherical, more or less papillose, small to large, 9-35 μm . - The family includes 18 genera of epiphytic or epilithic mosses; some are restricted to tropical, others to temperate regions, some have their main distribution in the Holoarctic in mesic to meso-xeric habitats, but occur as alpine mosses in the Subtropics and Tropics. The Altaian representatives mostly have their distribution in temperate areas.

KEY TO THE GENERA OF ORTHOTRICHACEAE IN
ALTAI:

1. Cells in upper part of the leaf with numerous round papillae; nerve in cross-section with median guide cells; calyptrae cucullate; saxicolous plants *Amphidium* (p. 30)
1. Cells in upper part of the leaf with conic, sometimes forked papillae; nerve in cross section of almost homogenous cells or only with ventral guide cells; corticolous or saxicolous plants 2
2. Gemmae abundant from leaf axils or rhizoids; leaves apiculate; capsules long exserted on slender setae; calyptrae cucullate, thin, naked *Zygodon* (p. 32)
2. Gemmae absent, rare present on leaves (*O. obtusifolium*, *O. pumilum*); capsules immersed, emergent or short exserted; setae mostly strong; calyptrae campanulate, hairy or naked 3
3. Leaves usually curved or contorted when dry, rarely straight, at base bordered with one to several rows of short, wide, often hyaline cells with thickened transverse walls; median basal cells often yellow, narrow and vermicular; stomata superficial *Ulota*
(see paper of Ignatov & Ochyra, p.59)
3. Leaves appressed, straight or flexuose, rarely contorted when dry, at base without clear distinction between marginal and median cells; stomata superficial or immersed
.... *Orthotrichum* (p. 33)

Amphidium Schimp., *nom. cons.*

Plants in moderately dense, dark-green to brownish cushions. Stems erect, repeatedly forked. Leaves

crisped to contorted when dry, linear to linear-lanceolate, narrowly acute to apiculate, margins entire or slightly denticulate, plane or recurved below. Costae ending in or just below the apices, with large median guide cells. Upper leaf cells isodiametric, pluripapillose. Basal leaf cells rectangular, weakly papillose or smooth. Dioicous or autoicous. Setae short or 2-3 times the length of the urns. Capsulae emergent or exserted, pyriform, when dry and empty somewhat constricted in the middle, strongly eight-ribbed. Annuli and peristomes absent. Stomata superficial. Opercula apiculate or obliquely rostrate. Calyptrae cucullate, smooth, naked. Spores spherical, small.

KEY TO THE SPECIES OF *AMPHIDIUM* IN ALTAI

1. Paroicous, mostly with capsules; leaves strongly contorted when dry; upper leaf cells with dense, rather large papillae making the leaf opaque; capsules emergent *A. lapponicum*
1. Dioicous, rarely with capsules; leaves moderately flexuose to contorted when dry; upper leaf cells with medium-sized rounded papillae, basal leaf cells with linear cuticular papillae making the leaves striolate; capsules exserted *A. mougeotii*

Amphidium lapponicum (Hedw.) Schimp.,
Coroll. Bryol. Eur. 39. 1856. Fig. 1
Anictangium lapponicum Hedw., Sp. Musc. Frond.
40. 1801.

Medium sized mosses in dark-green to brown cushions. Stems up to 3 cm high. Leaves strongly contorted when dry, erect-spreading when moist, narrow-lanceolate, ca. 2 mm long, acute, entire. Upper and middle leaf cells densely papillose with 5-8 rather big papillae per cell making the leaves opaque. Basal leaf cells rectangular, smooth, 1.5-3:1, translucent. Paroicous. Perichaetial leaves sheathing, broad. Setae ca. 1 mm long, about as long as urns. Capsulae emergent. Opercula obliquely rostrate. Spores ca. 10 μm , smooth.

Amphidium lapponicum is often with capsules and therefore easy to identify. When sterile it can resemble some members of Pottiaceae from which it differs by the combination of big, rounded, dense leaf-papillae and strongly contorted dry leaves.

Distribution: Most European countries from Spain, Portugal, Italy and Bulgaria to Iceland, Svalbard and the Fennoscandian Peninsula; in the former USSR in the Arctic especially in montane areas, in the mountains of the Kola Peninsula, the Carpatians, the Caucasus, the Urals, of Middle Asia, Siberia and the southern part of the Far East. Also reported from China, Japan, Mongolia, North America from the

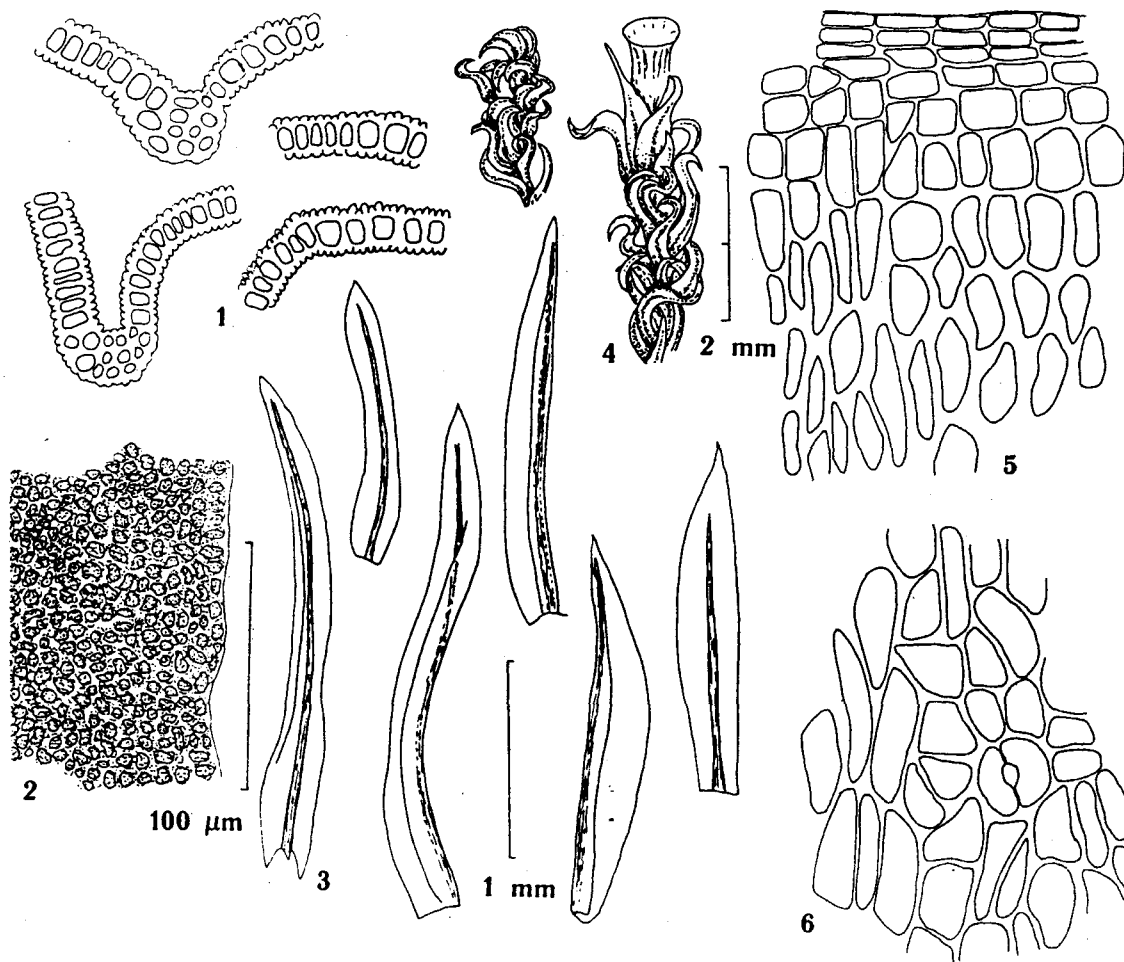


Fig. 1. *Amphidium lapponicum* (Hedw.) Schimp. (*Kobiguayuk Creek* 2220 m Ignatov 0/954): 1 - leaf cross sections; 2 - upper leaf cell; 3 - leaves; 4 - habitus; 5 - exothelial cells below the mouth; 6 - stoma. Scale bars: 100 μ m - for 1,2,5,6; 1 mm for 3; 2 mm - for 4.

Arctic (incl. Greenland) through the mountains south to California, Colorado and North Carolina. In Altai *Amphidium lapponicum* is a relatively rare species, found in the subalpine zone on cliffs wet from seeping water (with e.g. *Ditrichum flexicaule*, *Orthotichum chryseum*, *O. strictum*).

Specimens examined: *Karakol Lakes* 1900 m (28/73); *Kobiguayuk Creek* 2100 m (0/955); 2200 m (0/138); 2200 m (0/954); 2370 m (0/295); *Tokpak Creek, in middle course* 2050 m (36/65).

Amphidium mougeotii (Bruch et Schimp. in B.S.G.) Schimp., *Coroll. Bryol. Eur.* 40. 1856.

Fig. 2

Zygodon mougeotii Bruch et Schimp. in B.S.G., *Bryol. Eur.* 3: 39. pl. 206. 1838.

Medium sized mosses in dark-green to brown cushions. Stems up to 3 cm high. Leaves flexuose to slightly contorted when dry, erect-spreading when moist, narrow-lanceolate, ca. 2 mm long, acute, mi-

nutely denticulate above. Upper and middle leaf cells papillose with 2-4 rather small papillae per cell. Basal leaf cells rectangular, 1.5-3:1, translucent, finely longitudinally papillose-striate from ovate cuticular papillae. Dioicous. Altaian plants sterile.

Amphidium mougeotii is rather easy to identify due to the longitudinal striation of the leaves. This character is best observed in the lower parts of the leaves. This striation also separates it from *Amphidium lapponicum*, which besides is autoicous and in the Altaian populations usually with numerous, half-emergent capsules. Cuticular striolation like the one observed here is also characteristic for the basal leaf cells of *Dicranoweisia crispula*, but this taxon has the leaves distinctly narrowed above its basal part and has smooth upper leaf cells; moreover, the dry leaves are much more crispate than in

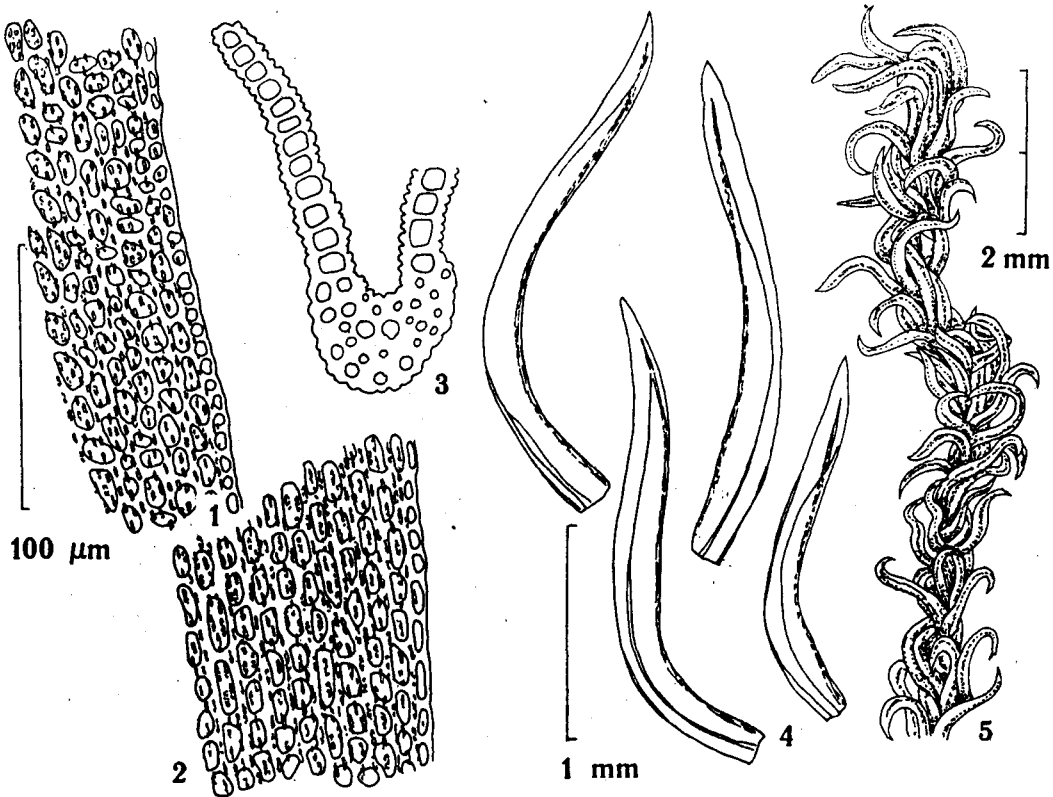


Fig. 2. *Amphidium mougeotii* (Bruch et Schimp. in B.S.G.) Schimp. (*Kayakkatuyarykskij Creek* 1850 m Ignatov 8/55): 1 - upper leaf cells; 2 - lower leaf cells; 3 - leaf cross section; 4 - leaves; 5 - habitus. Scale bars: 100 μ m - for 1-3; 1 mm - for 4; 2 mm - for 5.

A. mougeotii.

Distribution: *Amphidium mougeotii* is widespread in Europe from the North to the Mediterranean Sea, Madeira and the Azores. Also known from Caucasus, Himalaya, Japan and North America. In Siberia the species was reported previously by Kildyushevskij (1956) from the Siberian slope of the Arctic part of the Ural Mts. and in MHA is also a specimen of Kildyushevskij from Yakutia (East Siberia). In Altai it is rather rare on wet cliffs from lower forest to subalpine zone.

Specimens examined: *Bogoyash Creek, upper course* 2400 m (36/334); *Bolshoye Istyube Creek* 470 m (18/104); *Kairu Creek, 8 km upstream* 1000 m (15/25); *Kayakkatuyarykskij Creek* 1850 m (8/55; 8/60); *Kobiguayuk Creek* 2100 m (0/955); 2150 m (0/2086); 2350 m (0/2085).

Zygodon Hook. et Tayl.

Rather small plants in loose to dense tufts, green to yellow-green above, brownish below. Stems erect or ascending, branched, mostly matted with rhizoids. Gemmae numerous, ellipsoid to cylindrical, from rhizoids and leaf axils. Leaves erect or flexuose to contorted, mostly lanceolate, acute to acuminate, entire or dentate above, usually with plane margins. Costae single, strong, ending below the apex. Upper leaf cells

isodiametric, with rather thin walls, smooth or pluripapillose on both sides. Basal leaf cells rectangular, smooth. Dioicous. Sporophytes terminal. Setae longer than urns. Capsulae exserted, subcylindric to pyriform, with long necks usually furrowed when dry. Annuli nearly absent. Stomata superficial. Peristomes lacking, single or double. Calyptrae cucullate, not plicate, naked or rarely hairy. Spores spherical, small to medium-sized.

***Zygodon rupestris* Schimp. ex Lor., Bryol. Notizb. 32. 1865 et Verz. Eur. Laubm. 12. 1865.**

Zygodon viridissimus (Dicks.) Brid. var. *rupestris* Lindb. ex Hartm., Handb. Skand. Fl. ed. 8, 382. 1861.

Plants in moderately dense tufts, green above, brownish below. Gemmae axillary, composed of 3-5 cells, with few vertical divisions. Leaves erect, oblong-lanceolate, up to 1 mm long, gradually narrowed to an acute apex ending in a point of 1-3 cells; margins plane, entire and somewhat undulate. Upper leaf cells isodiametric, ca. 10 μ m, with 2-4 small papillae per cell. Basal leaf cells rectangular, smooth, becoming quadrate towards the margins. Altaian plants sterile.

Zygodon rupestris is easy to identify due to

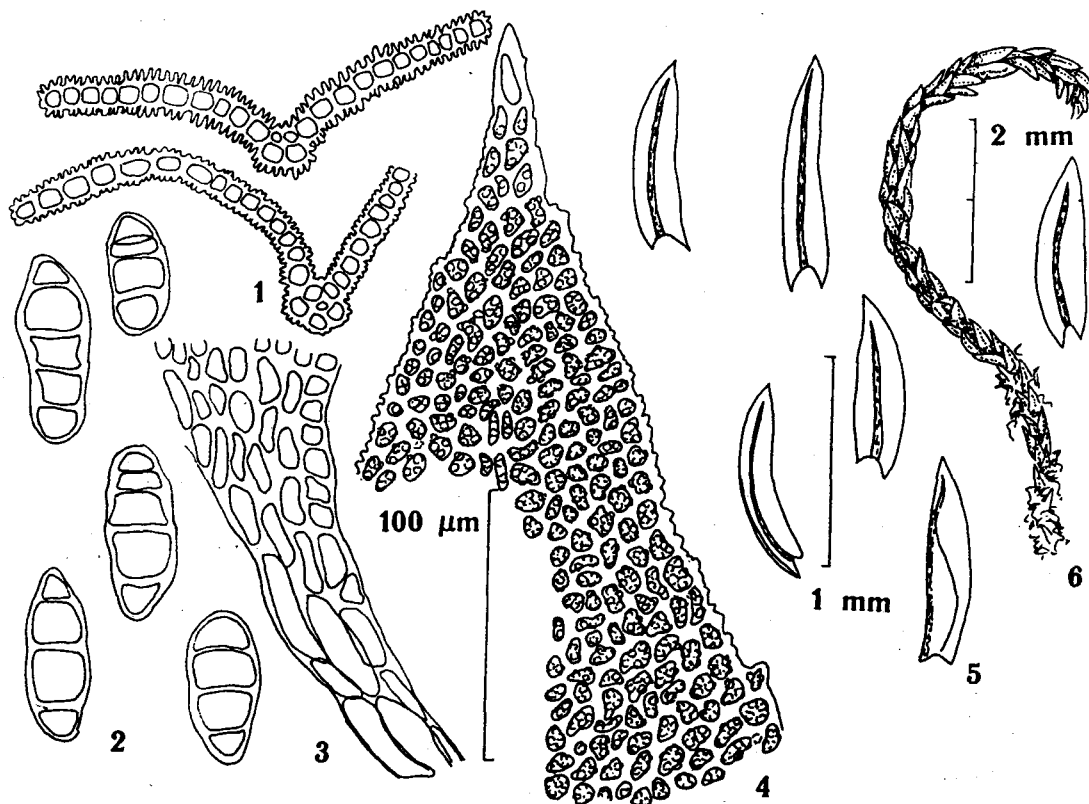


Fig. 3. *Zygodon rupestris* Schimp. ex Lor. (Yailyu 450 m Ignatov 1/86): 1 - leaf cross sections; 2 - gemmae; 3 - cells of leaf base; 4 - upper leaf cells; 5 - leaves; 6 - habitus. Scale bars: 100 μ m - for 1-4; 1 mm - for 5; 2 mm - for 6.

combination of numerous brood bodies and apiculate leaves. South Siberian plants were previously referred by Bardunov (1969) to *Z. conoides*, because he found the specimen to be peristomate. However, a single Bardunov collection of *Zygodon* "with capsules", which we examined, appears to be a mixture of sterile *Z. rupestris* and *Orthotrichum* cf. *pallens* with capsules.

Distribution: *Zygodon rupestris* is known from Europe, Macaronesia, northern Africa, South Urals, mountains of South Siberia and Russian Far East (Amur River Basin), Japan (?) and in North America from Alaska and Nova Scotia to Mexico. In Altai it was found only twice on the northern shore of Teletzkoye Lake, on several trees of *Salix rorida* and *Betula pendula* in open places.

Specimen examined: Yailyu 450 m (1/82, 1/86).

Orthotrichum Hedw.

Plants small to robust, usually growing in tufts on trunks, branches and twigs or on rocks, yellow-green to dark-green above, brownish or blackish below. Leaves mostly erect or slightly twisted when dry, obovate-lanceolate to oblong-lanceolate, acute, rarely obtuse, with recurved to revolute margins.

Costae ending below the apices. Upper and middle leaf cells rounded, with thick walls, more or less papillose. Basal leaf cells rectangular, smooth, shorter towards the margins, but not forming a distinct border. Setae terminal, shorter than or 2-3 times as long as urns. Capsulae immersed, emergent or exerted, oblong-ovoid to subcylindric, smooth or furrowed when dry. Stomata superficial or immersed. Peristomes double, single or absent, prostomes sometimes present. Exostomes of 16 free teeth or united in 8 pairs, triangular to lanceolate, papillose or striolate, entire or cancellate-perforate above. Endostome segments 16, 8 or absent, lanceolate to filiform, as long as teeth or shorter, slightly papillose to smooth. Annuli absent or present. Opercula rostrate. Calyptrae campanulate, longitudinally plicate or rarely smooth, hairy or naked. Spores spherical, papillose, medium to large.

KEY TO THE SPECIES OF *ORTHOTRICHUM* IN ALTAI

- 1. Stomata immersed 2
- 1. Stomata superficial 8
- 2. Exostomes erect-spreading when dry; teeth 16, free; prostomes often present; mostly epilithic 3

2. Exostomes reflexed when dry; teeth mostly in 8 pairs; prostomes usually absent; mostly epiphytic 5
3. Setae longer than urns, capsules exerted
..... *O. anomalum* (p.53)
3. Setae shorter than urns, capsules immersed 4
4. Capsules with 16 striae; leaves ovate-lanceolate, unistratose above, not glaucous
..... *O. cupulatum* (p. 53)
4. Capsules with 8 striae, leaves ligulate-oblong, partially bistratose above, glaucous due to tall leaf papillae
..... *O. pellucidum* (p. 55)
5. Calyptrae with many papillose hairs reaching over the top, slightly plicate; leaf papillae tall, usually forked *O. alpestre* (p. 49)
5. Calyptrae naked or with few hairs, sharply plicate, with plicae somewhat rugose from protruding cell ends; leaf papillae rather low 6
6. Stomata almost completely covered by subsidiary cells; spores 25-28 μm
..... *O. rogeri* (p. 49)
6. Stomata almost free of or somewhat covered by subsidiary cells; spores 14-20 μm
..... 7
7. Leaves ovate-lanceolate, acute, often apiculate with a hyaline apical cell; upper leaf cells more than 13 μm wide; endostome segments 8; calyptrae oblong *O. pumilum* (p. 46)
7. Leaves oblong-lanceolate, acute or narrowly obtuse, not apiculate; upper leaf cells less than 14 μm wide; exostome segments 16; calyptrae conic-oblong *O. pallens* (p. 46)
8. Leaves broadly obtuse with numerous green or brown gemmae .. *O. obtusofolium* (p. 43)
8. Leaves more or less acute without gemmae 9
9. Exostome teeth erect-spreading when dry; mostly epilittic, rarely epiphytic 10
9. Exostome teeth reflexed or revolute when dry; mostly epiphytic, rarely epilittic 11
10. Capsules immersed to emergent, often furrowed when dry; endostome segments nearly smooth, about half as tall as teeth; calyptra-hairs long, reaching well over the top *O. rupestre* (p. 43)
10. Capsules exerted, smooth when dry; endostome segments papillose, about 3/4 as tall as teeth; calyptra-hairs not reaching over the top *O. laevigatum*
- ssp. *japonicum* (p. 41)
11. Capsules more or less exerted 12
11. Capsules immersed or emergent 14
12. Endostome segments 16, almost as broad as teeth; capsules narrow cylindric, smooth when dry *O. vladikavkanum* (p. 34)
12. Endostome segments 8, narrow; capsules oblong or ovoid, smooth or ribbed 13
13. Exostome teeth cancellate and perforate above; capsules distinctly furrowed when dry; endostome segments nearly smooth
..... *O. sordidum* (p. 37)
13. Exostome teeth entire; capsules smooth or indistinctly furrowed when dry; endostome segments papillose *O. speciosum* (p. 40)
14. Capsules smooth when dry, with 2-4 rows of moderately thick-walled cells below mouth; endostome segments broad lanceolate *O. striatum* (p. 37)
14. Capsules distinctly furrowed in uppermost part when dry, with 6-8 rows of very thick-walled cells below mouth; endostome segments lanceolate *O. dasymitrium* (p. 37)

Orthotrichum vladikavkanum Vent. in Husn., Muscol. Gallica 167. 1887. Fig. 4.

Plants up to 2 cm tall, in loose green tufts. Leaves ovate-lanceolate, ca. 3 mm long, acute, entire; margins revolute. Upper leaf cells irregular, isodiametric, 10-15 μm , thick-walled, with many papillae per cell. Basal leaf cells rectangular, with straight walls, becoming shorter towards margins; alar cells slightly differentiated. Gonautoicous. Setae 3-4 mm, longer than urns. Capsulae exerted, oblong-ovoid, gradually narrowed to the setae, not furrowed at all, but irregularly crumpled when dry and empty. Stomata superficial, surrounded by a ring of small radiating cells. Peristomes double, prostomes not observed. Exostome teeth in 8 pairs, reflexed when dry, orange-brown, densely and roughly papillose throughout. Endostome segments 16, two cells wide, as long and almost as wide as teeth, orange-brown, papillose. Opercula conic, shortly rostrate. Calyptrae hairy, with papillose hairs reaching to the top. Spores spherical, brownish to green, moderately papillose, 24-29 μm .

Orthotrichum vladikavkanum can be recognized by the 3-4 mm long setae, the exceptionally narrow-cylindric capsules nearly smooth when shedding the spores, the superficial stomata and the endostome segments almost as broad as the teeth. Altaian plants differ from Caucasian by somewhat larger spores, 24-29 (not 21-25) μm .

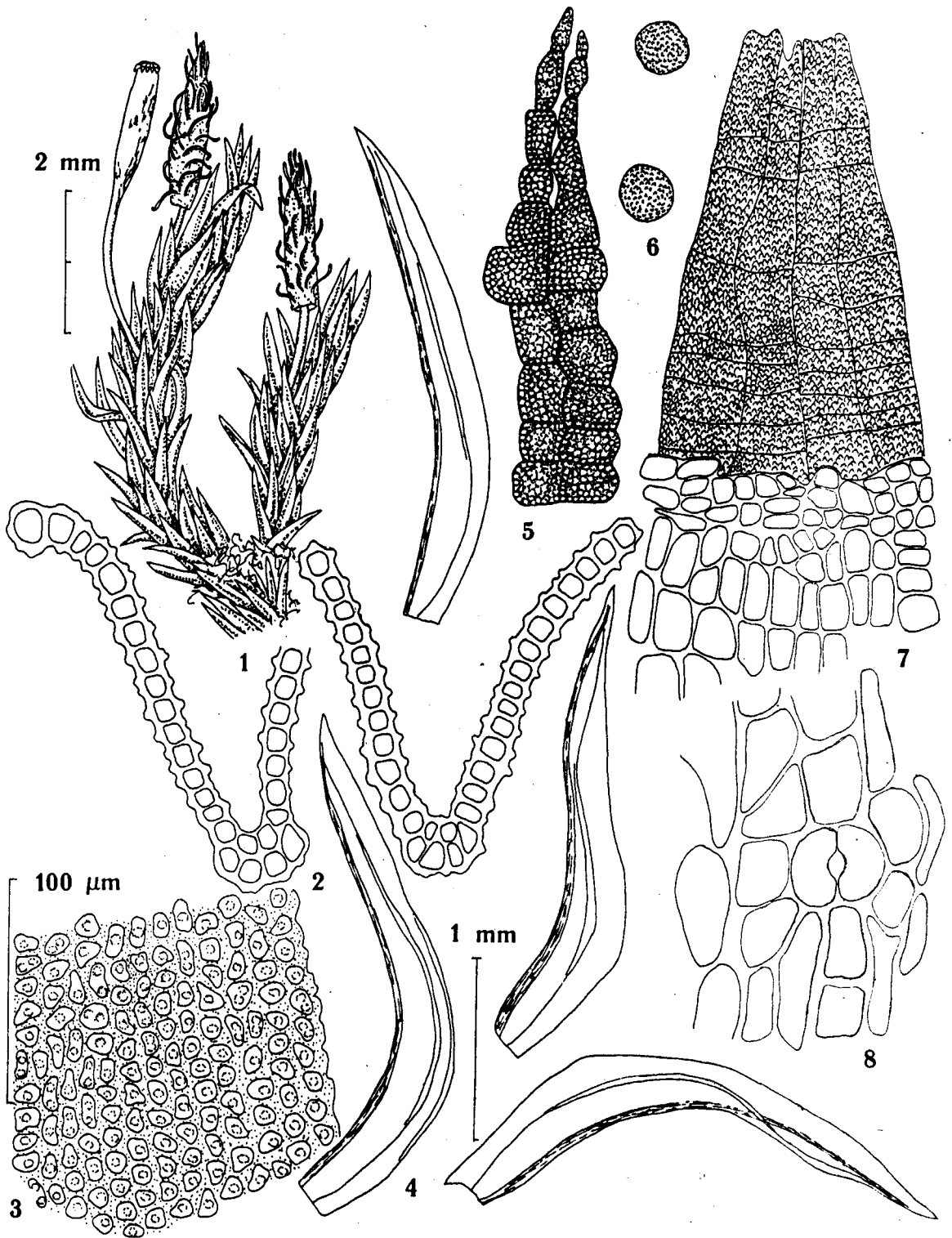


Fig. 4. *Orthotrichum vladikavkanum* Vent. in Gusn. (Bele 500 m Ignatov 0/80): 1 - habitus; 2 - leaf cross section; 3 - upper leaf cells; 4 - leaves; 5 - endostome segment; 6 - spores; 7 - exostome tooth; 8 - stoma. Scale bars: 100 μm - for 2, 3, 5-8; 1 mm - for 4; 2 mm - for 1.

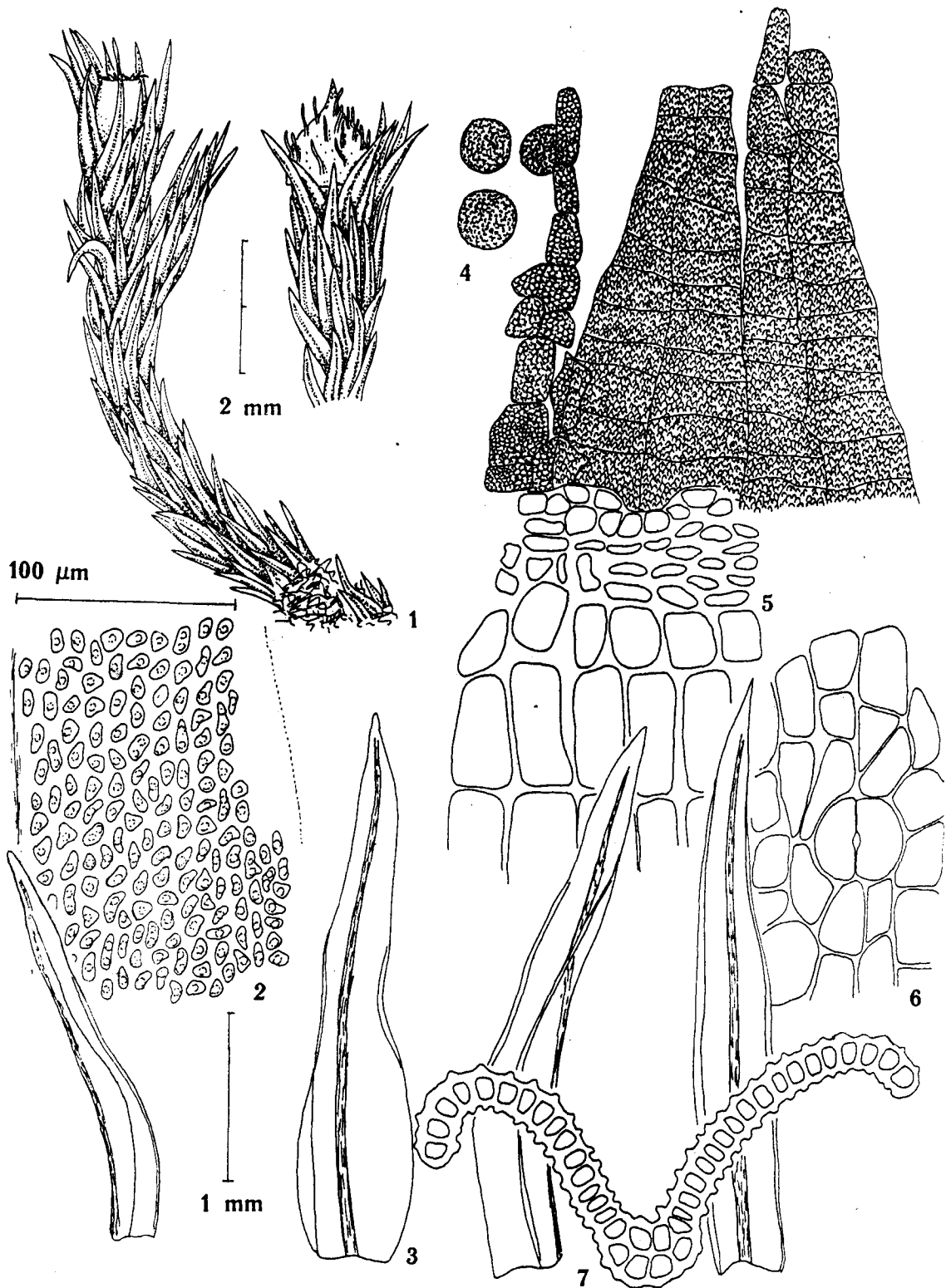


Fig.5. *Orthotrichum striatum* Hedw. (Bolshoye Istyube Creek 470 m Ignatov 18/55): 1 - habitus; 2 - upper leaf cells; 3 - leaf; 4 - spores; 5 - peristome with upper exothecial cells; 6 - stoma; 7 - leaf cross section. Scale bars: 100 μm - for 2, 4-6; 1 mm - for 3; 2 mm - for 1.

The Chinese and Himalayan *O. hookeri* Mitt. related to *O. vladikavkanum* in peristome structure and exerted narrow cylindrical capsula; it differs in larger spores (25)35-53 μm and flexuose leaves with recurved margins.

Distribution: Previously *Orthotrichum vladikavkanum* was only known from the type locality from Ingushetia of Northern Caucasus: Caucaso, Vladikavkaz, 16 Jun V. F. Brotherus 81 et 83, holotype TR, isotype H). In Altai it is rather common in the surroundings of Teletzkoye Lake and also in the valleys of some creeks in Central Altai. *O. vladikavkanum* grows in the same habitats as *O. speciosum* and *O. sordidum*, on trunks of *Padus* and *Salix*, and on twigs of *Abies*, *Caragana* and *Sambucus* in more or less sunny places in wet areas.

Specimens examined: *Adylda Creek* 1100 m (34/6); *Bele* 500 m (0/39; 0/80); *Chemal Creek, 3 km upstream* 450 m (34/10); *Chiri Creek, 0.5 km upstream* 450 m (17/26a); *Edikhta Creek* 1100 m (34/7); *Karagai* 440 m (0/259); *Yailyu* 440 m (Zolotukhina 14 VII.1988).

***Orthotrichum striatum* Hedw., Sp. Musc. Frond. 163. 1801. Fig. 5.**

Plants up to 1.5 cm tall, in dense tufts, yellow-green above to dark-brown below. Leaves erect to slightly flexuose, lanceolate to ovate-lanceolate, 2.5-3.5 mm long, from ovate bases acuminate; margins recurved to reflexed. Upper leaf cells isodiametric, 7-15 μm , thick-walled, with 1-2 rather low papillae per cell. Basal leaf cells rectangular, with sinuose thick walls, shorter towards the margins; alar cells not differentiated. Goniautoicous. Setae ca. 0.3 mm, shorter than the urns. Capsulae immersed, ovoid, quickly narrowed to setae. Peristomes double, prostomes not observed. Exostome teeth 16, free, reflexed when dry, lanceolate, entire, densely and roughly papillose throughout, yellowish-brown. Endostome segments 16, about 2/3 the length of the teeth, lanceolate, two cells wide, with irregular margins, papillose, whitish. Calyptrae with few to many papillose hairs reaching to the top. Spores spherical, brownish to green, densely papillose, 30-35 μm .

Orthotrichum striatum is distinguished by the deeply immersed pale smooth capsules with superficial stomata, the 16 exostome teeth and the 16 rather broad lanceolate endostome segments.

Distribution: Widespread in Europe (except the northern regions) and North Africa, in most of the temperate zone of the European part of the former USSR, Caucasus, Pakistan, North India (Kashmir), Altai and Northeast China; also known from north-western North America. In Altai *Orthotrichum striatum* is not very common. It occurs in wet forests in valleys on trunks of *Padus*, *Salix* and *Sorbus*.

Specimens examined: *Bolshoye Istyube Creek* 470m (0/

959; 18/55); *Chemal Creek, 3 km upstream* 450 m (34/8a; 34/9; 34/10a; 34/50); *Chiri Creek, 0.5 km upstream* 450m (17/26a; 17/27a); *Yailyu* 440 m (0/960).

***Orthotrichum dasymitrium* Lewinsky in T. Kop. et Lou Jian-shing, Bryobrothera 1: 169. 1992. Fig. 6.**

Plants up to 2 cm tall, in dull-green tufts, dark-brownish below. Leaves erect to slightly flexuose when dry, lanceolate to ovate-lanceolate, 2.0-2.6 mm long, acute, entire; margins recurved below or to the middle. Upper leaf cells isodiametric to shortly rectangular, 8-14 μm wide, thick-walled, with usually one papilla per cell. Basal leaf cells elongated with thick, straight to flexuose walls, becoming short-rectangular to quadrate towards the margins; alar cells differentiated. Goniautoicous. Setae 0.6-0.7 mm, shorter than the urns. Capsulae immersed to emergent, oblong-ovoid, ca. 1.5 mm long, rapidly narrowed to the setae, distinctly furrowed just below the mouth when dry; exothelial cells immediately below the mouth thin-walled in one row followed by 7-8 rows of very thick-walled small cells, the latter form deep red ring in upper capsula. Stomata superficial. Peristomes double, prostomes not observed. Exostome teeth 16, almost free, sometimes united near the bases, reflexed when dry, densely and evenly papillose throughout. Endostome segments 16, as long as teeth, lanceolate, two cells wide, smooth on outer surface, papillose inside, with papillae concentrated along the old cell walls. Calyptrae densely hairy with papillose curly hairs. Spores spherical, yellow-brownish, moderately papillose, 28-35 μm .

Orthotrichum dasymitrium is closely related to *O. striatum*, a relationship shown through the similarities in the endostomes. It differs from this species in the strongly hairy calyptrae, longer setae, so capsules are emergent, not deeply immersed, and especially in the 7-8 rows of very thick-walled cells below the capsule mouths.

Distribution: *Orthotrichum dasymitrium* was described from Xizang (Tibet), but is also known from Yunnan, Sichuan and Shanxi provinces of China, by a single collection from each province. In Altai found only once on the northern shore of Teletzkoye Lake, in wet and shaded *Abies* forest on steep slope facing a small creek, on trunk of *Sorbus sibirica*, at about 1.5 m above the ground.

Specimen examined: *Yailyu* 750m (0/958).

***Orthotrichum sordidum* Sull. et Lesq. in Aust., Musci Appal. 30. n. 168. 1870. Fig. 7.**

Plants up to 1.5-2 cm tall, in moderately dense tufts. Leaves erect when dry, ovate-lanceolate to lanceolate, ca. 2 mm long, acute to short-acuminate,

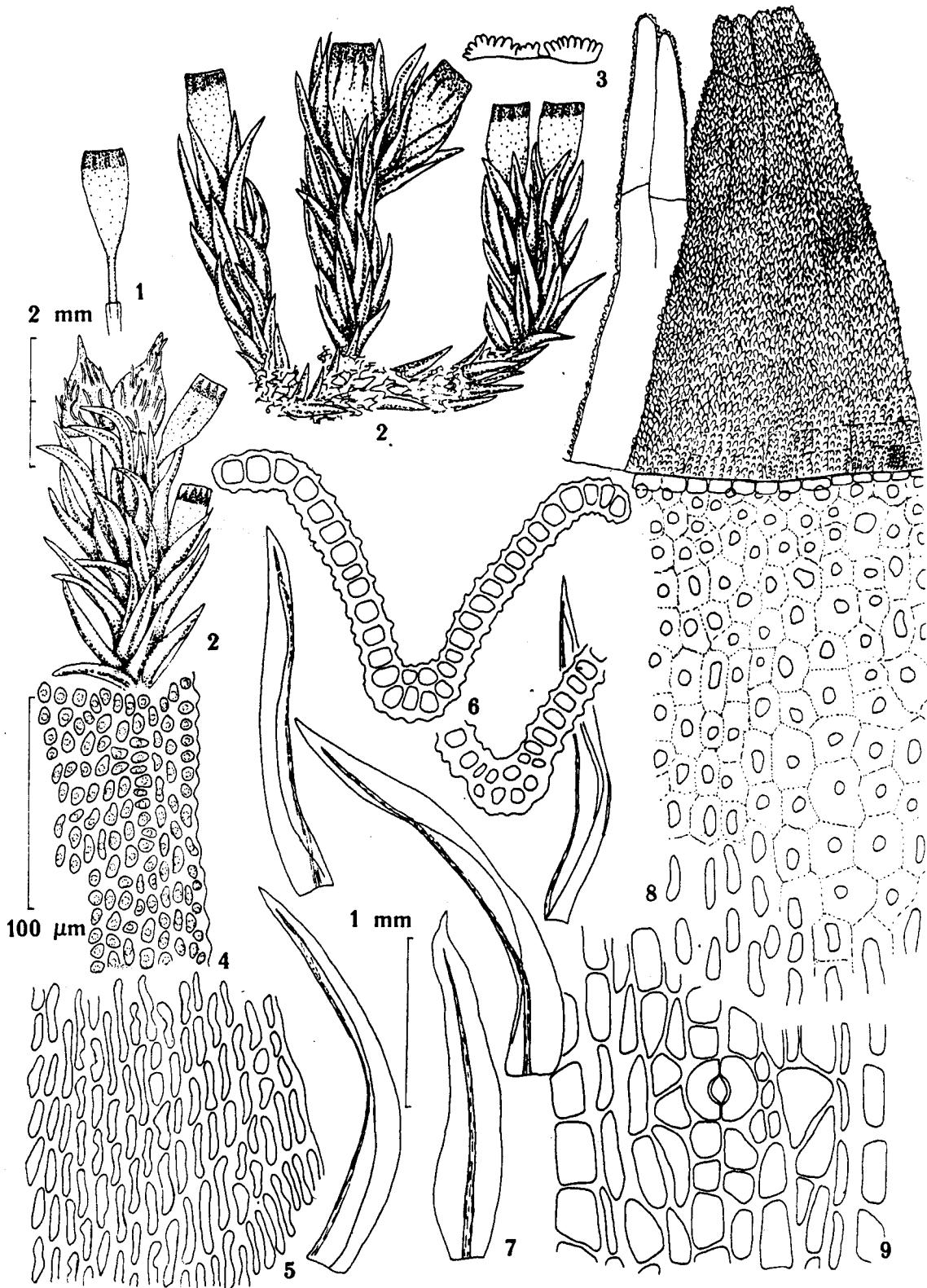


Fig. 6. *Orthotrichum dasymitrium* Lewinsky in T. Kop. et Lou Jian-shing (Yaihyu 750 m Ignatov 0/958): 1 - capsula; 2 - habitus; 3 - cross section of endostome segment; 4 - upper leaf cells; 5 - lower leaf cells; 6 - leaf cross sections; 7 - leaves; 8 - peristome and upper exothelial cells; 9 - stoma. Scale bars: 100 μm - for 3-6, 8, 9; 1 mm - for 7; 2 mm - for 1, 2.

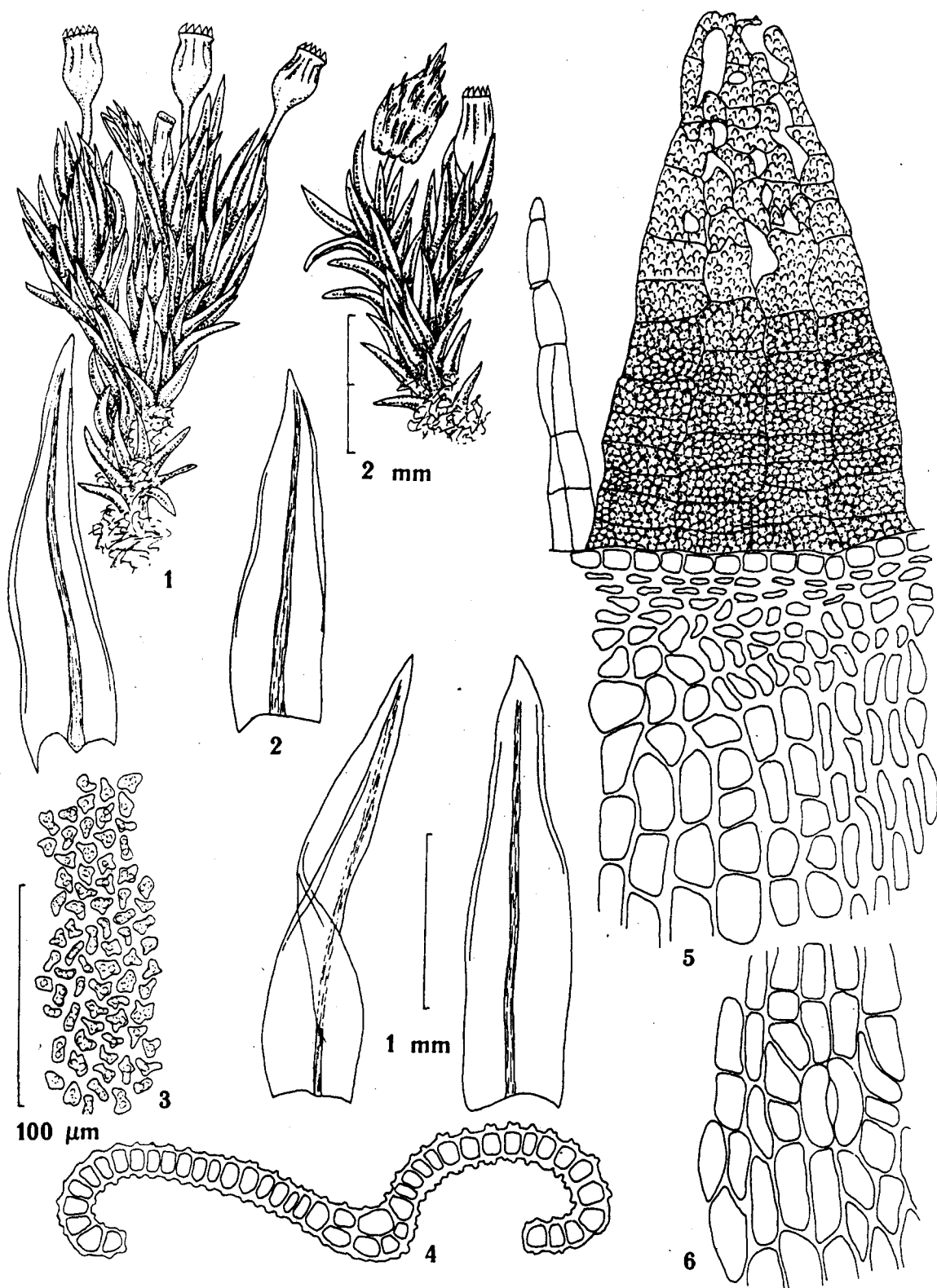


Fig. 7. *Orthotrichum sordidum* Sull. et Lesq. in Aust. (Aedigan 650 m Ignatov 34/18): 1 - habitus; 2 - leaves; 3 - upper leaf cells; 4 - leaf cross sections; 5 - peristome and upper exothecial cells; 6 - stoma. Scale bars: 100 μm - for 3-6; 1 mm - for 2; 2 mm - for 1.

entire; margins revolute. Upper leaf cells rounded isodiametric, 7-14 μm , thick-walled, with 1-2 low papillae per cell. Basal leaf cells rectangular, with straight to slightly flexuose, porose, thick walls, shorter towards the margins; alar cells not differentiated. Goniautoicous. Setae ca. 2 mm long, longer than urns. Capsulae shortly exerted, oblong to oblong-cylindric, rather rapidly narrowed to the setae, furrowed almost the entire length due to 8 stripes of much thickened exothecial cells alternating with 8 less distinct stripes. Stomata superficial. Peristomes double, a low prostome sometimes present. Exostome teeth in 8 pairs, reflexed when dry, perforate and cancellate in upper parts, sometimes perforated along the middle line nearly to the base, papillose below with medium-sized moderately dense papillae, in upper part with more rough papillae tending to be arranged in vertical rows. Endostome segments 8, about $3/4$ the height of the teeth, one cell wide, linear, abruptly broadened at the base, smooth, somewhat hyaline. Calyptrae hairy with few scattered hairs. Spores spherical, brownish, with medium sized papillae, 22-25 μm .

Orthotrichum sordidum is closely related to *O. speciosum* with which it is often associated. Both have exerted capsules with reflexed exostome teeth, eight well developed endostome segments and superficial stomata. In *O. speciosum*, however, the capsules are almost smooth, while in *O. sordidum* they are distinctly ribbed. Another character useful for recognition of *O. sordidum* in the field is the smaller size of plants and capsules. Further *O. sordidum* differs from *O. speciosum* by non-papillose endostome segments (usually one cell wide) and cancellate-perforate upper parts of the exostome teeth.

Distribution: *Orthotrichum sordidum* is distributed mainly in eastern parts of both Eurasia and North America with rare occurrences in other territories (Alaska, western Greenland, Svalbard). Recently Lewinsky (1993) found that *O. caucasicus* Vent. in Husn. (known from Vladikavkaz, Ingushetia) is conspecific with *O. sordidum*. In eastern North America it is known from New England, Labrador and Newfoundland; in East Asia - from Chukotka, Russian Far East, Japan, Korea, China and the mountains of South Siberia, in Baikal surroundings, Sayans and Altai. World distribution has been mapped by Lewinsky (1977). In Altai *O. sordidum* it is rather common in the forest zone, growing on trunks and twigs of many trees and shrubs (*Abies*, *Betula*, *Padus*, *Populus*, *Salix*, *Sorbus*), being locally as common as *O. speciosum*. The most typical habitats are rather open forests and forest edges in relatively wet areas.

Specimens examined: *Adylda Creek* 1100 m (34/6a);

Aedigan 650 m (34/18); *Bele* 500 m (0/65); *Chemal Creek, 3 km upstream* 450 m (34/8a; 34/9a; 34/10a; 34/11a; 34/60); *Chulcha River, in middle course* 960 m (9/80); *Chulyshman River, at Bashkaus mouth* 500 m (Zolotukhin 23.IX.1989); *Elekmonar Creek, 5 km upstream* 700 m (26/1; 26/34); *Ust-Sema* 650 m (24/56); *Yailyu* 460 m (Zolotukhin 6.VIII.1988); 480 m (0/968; 0/989); *Yurga* 440 m (21/25).

Orthotrichum speciosum Nees in Sturm, Deutsch. Fl. (ed.2) 2(3): (fasc. 17): 5. 1819. Fig.8.

Plants up to 3 cm tall, in moderately dense tufts, green or yellow-green above, brownish below. Leaves erect when dry, ovate-lanceolate, up to 3.5 mm long, acuminate, entire; margins revolute. Upper leaf cells irregularly isodiametric, 8-15 μm , thick-walled, with 1-2 low papillae per cell. Basal leaf cells rectangular, with almost straight, thick walls, shorter towards the margins; alar cells sometimes differentiated. Goniautoicous. Setae up to 2 mm, longer than urns. Capsulae exerted, oblong-cylindric, gradually narrowed to setae; smooth or indistinctly furrowed below the mouths. Stomata superficial. Peristomes double, prostomes not observed. Exostome teeth in 8 pairs, not splitting when old, reflexed when dry, densely and uniformly papillose throughout. Endostome segments 8, as long as teeth, two cells wide, linear-lanceolate, openly papillose. Calyptrae hairy, with hairs reaching to the top. Spores spherical, brownish to green, moderately papillose, 18-25 μm .

Orthotrichum speciosum is easily recognized in the field by habitat, relatively large size and well exerted, nearly smooth capsules. It often grows together with *Orthotrichum sordidum* which has furrowed capsules, and *O. vladikavkanum* which has very narrow capsules with 16 broad endostome segments.

Distribution: *Orthotrichum speciosum* is the most widespread species of the genus in northern parts of the Holarctic, occurring commonly in arctic and boreal regions, and becoming rarer in temperate regions. In Siberia and Mongolia it is the most common species, whereas in China it is still only known from very few specimens from Xinjiang and Jilin. In Altai *O. speciosum* is common in the lower forest zone on *Abies*, *Alnus*, *Betula*, *Caragana*, *Padus*, *Picea*, *Populus*, *Ribes*, *Salix*, *Sambucus* and *Sorbus*, and less common in the taiga zone on trunks of *Salix* and *Sorbus* and on boulders.

Specimens examined: *Ayukol* 1350 m (0/989); *Berehtuyaryk* 1600 m (0/990); *Bolshoye Istyube Creek* 470 m (18/52); *Chemal Creek, 3 km upstream* 450 m (34/8a; 34/9a; 34/11; 34/124; 34/210); *Chiri Creek, 0.5 km upstream* 450 m (17/3); *Chulcha River, in middle course* 1000 m (9/45); *Edikhta Creek* 1100 m (34/7a); *Elekmonar Creek, 5 km upstream* 700 m (26/2; 26/34a; 26/41); *Kairu Creek, 6 km upstream* 900 m (15/109); *Kairu Creek, 8 km upstream* 1000 m (15/52); *Karakem River, 6 km upstream* 1600 m (0/985a);

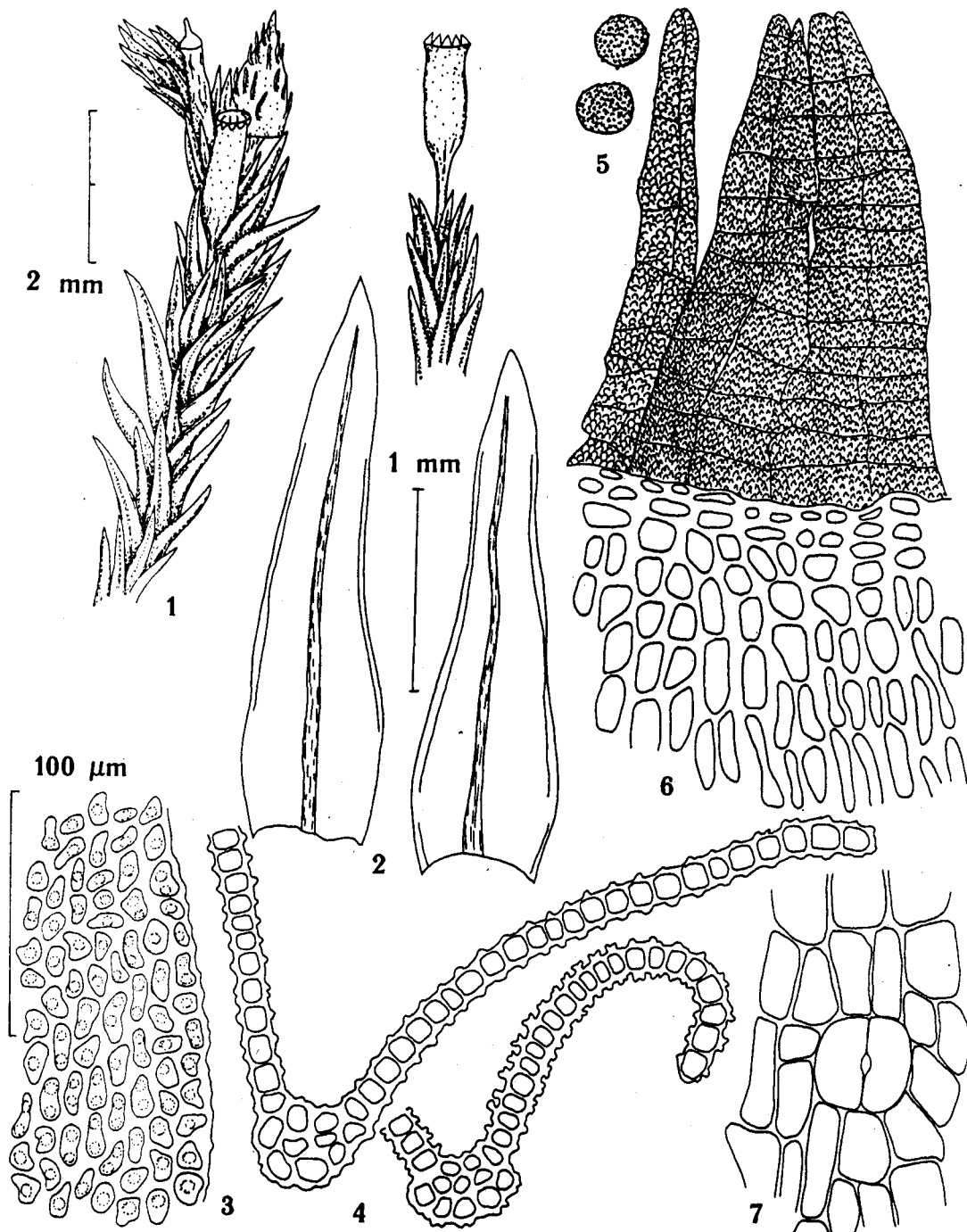


Fig. 8. *Orthotrichum speciosum* Nees in Sturm (*Malyi Yaloman Creek*, 5 km upstream 900 m Ignatov 25/95): 1 - habitus; 2 - leaves; 3 - upper leaf cells; 4 - leaf cross sections; 5 - spores; 6 - peristome and upper exothecial cells; 7 - stoma. Scale bars: 100 μ m - for 3-7; 1 mm - for 2; 2 mm - for 1.

Karaty 1300 m (Zolotukhin 20.II.1990); *Kayakkatuya-rykskij Creek* 1600 m (8/133); *Kyga River*, at mouth 450 m (0/991); *Malyi Yaloman* 1100 m (25/9); *Malyi Yaloman Creek*, 5 km upstream 900 m (25/95); *Malyi Yaloman Creek*, 8 km upstream 1100 m (25/20); *Oimok* 1100 m (Zolotukhin 3.IX.1986); *Tura Creek*, in middle course 1300 m (28/15); *Ust-Sema* 500 m (24/23); *Yailyu* 450 m (Zolotukhina 14.VII.1988).

***Orthotrichum laevigatum* Zett. var. *japonicum* (Iwats.) Lewinsky, J. Hattori Bot. Lab. 72: 42. 1992.**

Fig. 9.

Orthotrichum macounii Aust. var. *japonicum* Iwats., J. Hattori Bot. Lab. 21: 240. 1959.

Plants up to 3 cm tall, in loose tufts, yellowish-

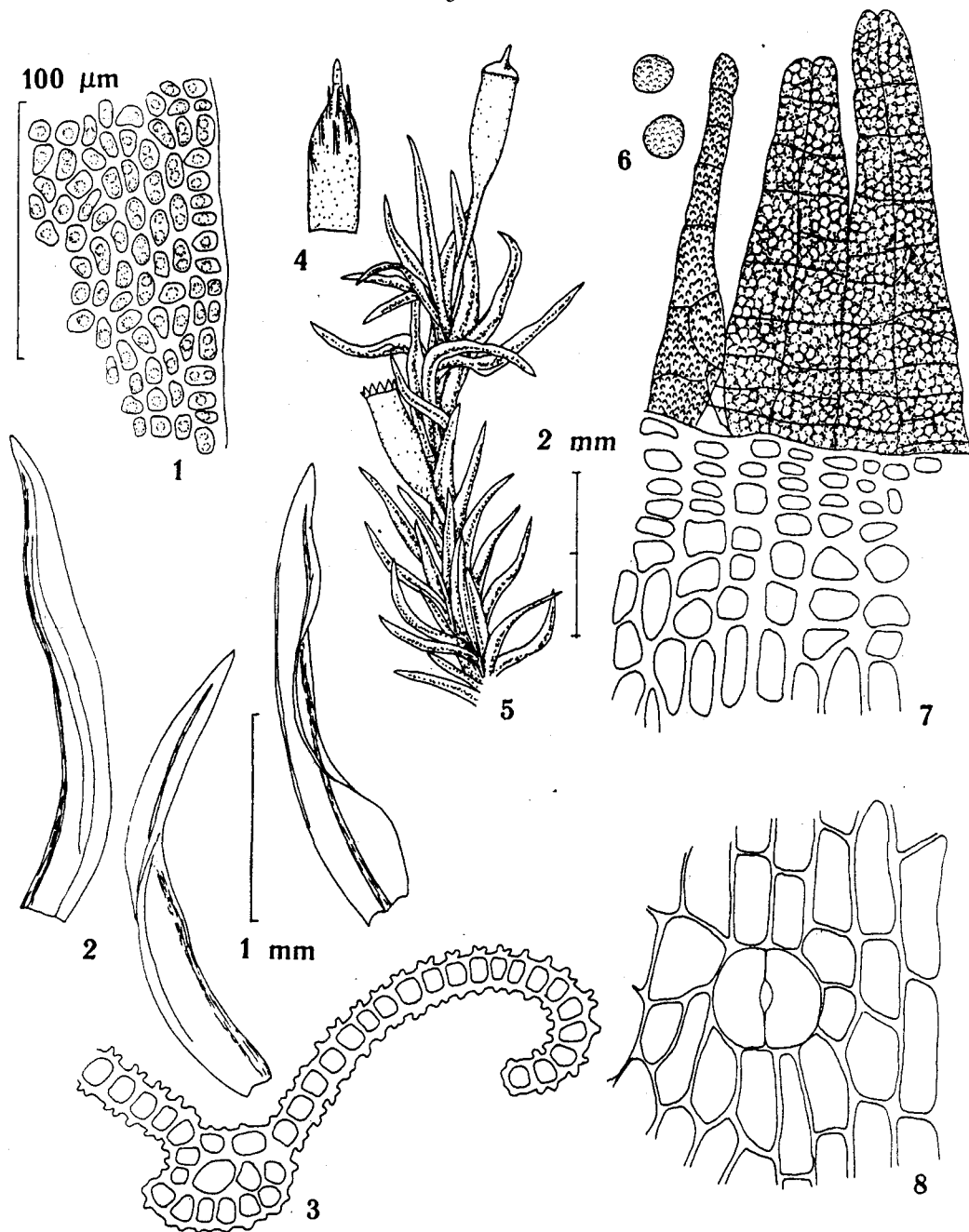


Fig. 9. *Orthotrichum laevigatum* Zett. var. *japonicum* (Iwats.) Lewinsky (Tokpak Creek, in middle course 2600 m Ignatov 36/357): 1 - upper leaf cells; 2 - leaves; 3 - leaf cross section; 4 - calyptra; 5 - habitus; 6 - spores; 7 - peristome with upper exothelial cells; 8 - stoma. Scale bars: 100 μ m - 1, 3, 6-8; 1 mm - for 2; 2 mm - for 4, 5.

green above, dark brown below. Leaves erect to slightly flexuose, from ovate bases lanceolate, 2.0-2.5 mm long, acuminate, entire; margins revolute. Upper leaf cells isodiametric, 10-15 μ m, very thick-walled, with high, sometimes forked papillae. Basal leaf cells rectangular with slightly sinuose, very thick walls, shorter towards margins; alar cells differentiated, yellow-brown. Goniautoicous. Setae ca. 1 mm, about as long as the urns. Capsulae emergent to short-exserted, oblong-cylindric, gradually narrowed to the

setae, smooth, pale-brown. Stomata superficial. Peristomes double, prostomes sometimes present, low. Exostome teeth in 8 pairs, not splitting in old capsules, erect to spreading when dry, slightly papillose throughout. Endostome segments 8, about 3/4 as tall as teeth, linear, pale, densely covered by small papillae. Calyptrae densely hairy, with hairs not reaching the top. Spores spherical, golden to green, finely papillose, 18-22 μ m.

Orthotrichum laevigatum var. *japonicum* shows

relationship to *O. rupestre* by the erect-spreading exostomes and superficial stomata. They can in Altai be separated by the characters listed below:

Character	<i>O. rupestre</i>	<i>O. laevigatum</i>
leaf papillae	rather low	high
capsulae	immersed-emergent furrowed	emergent-exserted smooth
exostome	splitting when old	entire when old
endostome	absent or 1/2 of teeth length, smooth	3/4-1 of teeth length, papillose
calyptra	hairs exceed the top	hairs reach the op

Distribution: *Orthotrichum laevigatum* var. *laevigatum* is known from North America and Europe. *O. laevigatum* var. *japonicum* is known from Japan, Himalaya, Tibet, northern India and the mountains of South Siberia, where it previously was not recognized from *O. rupestre*. In Altai *O. laevigatum* var. *japonicum* is rather widespread in the alpine and subalpine zones growing on more or less sheltered or sometimes also exposed rocks. One collection made by Zolotukhin was labelled "on *Populus tremula*, 780 m", a remarkably low elevation.

Specimens examined: *Ayulyuyuzuk Creek* 2100 m (0/149); 2150 m (0/376); *Bogoyash Creek, at mouth* (Zolotukhin 17.VI.1986); *Bogoyash Creek, upper course* 2400 m (36/338); *Chulcha River, in middle course* 780 m (Zolotukhin 19.IX.1989); *Flakiyash Lake* 2380 m (Zolotukhin 29.VI.1986); *Kayakkatuyarykskij Creek* 1850 m (8/311); 1950 m (3/176); *Kobiguayuk Creek* 2150 m (0/965); 2200 m (0/168); 2300 m (0/201); 2400 m (0/136); *Tabozhok Creek, 8 km upstream* 2050 m (30/45); *Tabozhok Creek, uppermost right branch* 2700 m (36/352); *Tabozhok Peak* 2700 m (31/82); 2750 m (31/84); 2780 m (31/83); *Tokpak Creek, in middle course* 2600 m (36/357); *Yakhansoru Lake* 1850 m (Zolotukhin 28.VI.1990).

***Orthotrichum rupestre* Schleich.** ex Schwaegr., Sp. Musc. Frond. Suppl. 1,2: 27. pl. 53. 1816. Fig. 10.

Plants up to 3 cm tall, in moderately loose, rigid tufts, dark green above, dark brown below. Leaves erect and appressed when dry, from ovate bases lanceolate, ca. 3 mm long, long acute to acuminate, entire; margins revolute. Upper leaf cells isodiametric, ca. 10-12 μ m, thick-walled, more or less bistratose, with one rather low papilla per cell. Basal leaf cells rectangular with sinuose walls, shorter towards margins; alar cells slightly differentiated, brown. Gonautoicous. Setae 0.5-0.7 mm, shorter than urns. Capsulae immersed to emergent, oblong-ovoid, ca. 1.5 mm long, more or less quickly narrowed to the setae, furrowed in the upper parts when dry. Stomata superficial. Peristomes double or single, prostomes irregular, low. Exostome teeth in 8 pairs, with age splitting to 16 more or less fused or totally free teeth, erect or spreading when dry, narrow-lanceolate, openly papillose throughout on the outside.

Endostome segments 8, 1/2-1/3 the height of teeth, linear, smooth, sometimes reduced or absent. Calyptrae hairy with scattered papillose hairs reaching over the top. Spores spherical, brownish, roughly papillose, 18-23 μ m.

Distribution: *Orthotrichum rupestre* is widespread in the temperate Holarctic but also known from many areas outside this region. In West Europe it grows in nearly all countries and regions (except Svalbard). In the former USSR it occurs in the southern half of the European part, Caucasus, Middle Asia and southern Siberia. In Asia also in Mongolia, Northwest India, West China and the Middle East. In North America *O. rupestre* has a mostly western distribution from Alaska to California and New Mexico, while in eastern America it is only known from a few scanty collections from Ontario, Minnesota and Michigan. Outside the Holarctic *O. rupestre* is known from South America, northern, eastern and southern parts of Africa, Macaronesia, Australasia, Hawaii and Antarctica. The species has been considered as rather widespread in the mountains of South Siberia between 600 and 2300 m (Bardunov, 1974). In Altai *O. rupestre* is somewhat rarer than *O. laevigatum* var. *japonicum*, growing in almost the same habitats on rocks, but mostly in the subalpine and taiga zones (rare in lower alpine) and also at lower elevations in forest-steppe regions.

Specimens examined: *Bogoyash Creek, upper course* 2300 m (36/265; 36/342); *Bolshoye Kurkure Creek, upper course* 2300 m (Galanin 9.VIII.1976); *Chodro* 880 m (0/988); *Karakem River, 6 km upstream* 1600 m (0/985); *Kayakkatuyarykskij Creek* 1900 m (8/154); *Kobiguayuk Creek* 2150 m (0/986); 2180 m (0/1236); 2400 m (0/983); *Kukol* 1750 m (0/982); 1800 m (0/984); *Tabozhok Peak* 2200 m (31/85); *Yakhansoru Lake* 2000 m (Zolotukhin 26.VI.1990); *Yazula* 1520 m (0/987).

***Orthotrichum obtusifolium* Brid., Muscol.** Recent. 2(2): 23. 1801. Fig. 11.

Plants small, up to 1 cm tall, in dense tufts, yellow-green above, brownish below. Leaves erect when dry, ovate to ovate-lanceolate, 1.0-2.0 mm long, rounded obtuse, entire or crenulate due to large papillae; margins almost plane. Upper leaf cells rounded, isodiametric, ca. 15 μ m, thick-walled, with one large rounded central papilla on each side. Middle leaf cells with stellate lumens, papillose. Basal leaf cells rectangular, smooth, with straight rather thin walls, shorter towards margins; alar cells not differentiated. Gemmae produced in abundance on leaf surfaces, club-shaped to cylindrical, usually of 4-5 cells in one row, sometimes in two rows or a little branched. Dioicous. Setae 0.2-0.4 mm, shorter than urns. Capsulae emergent, oblong to oblong-cylindrical, rather quickly narrowed to the setae, furrowed almost the entire length when dry. Stomata superficial. Peristomes double, prostomes not observed. Exostome teeth in 8 pairs,

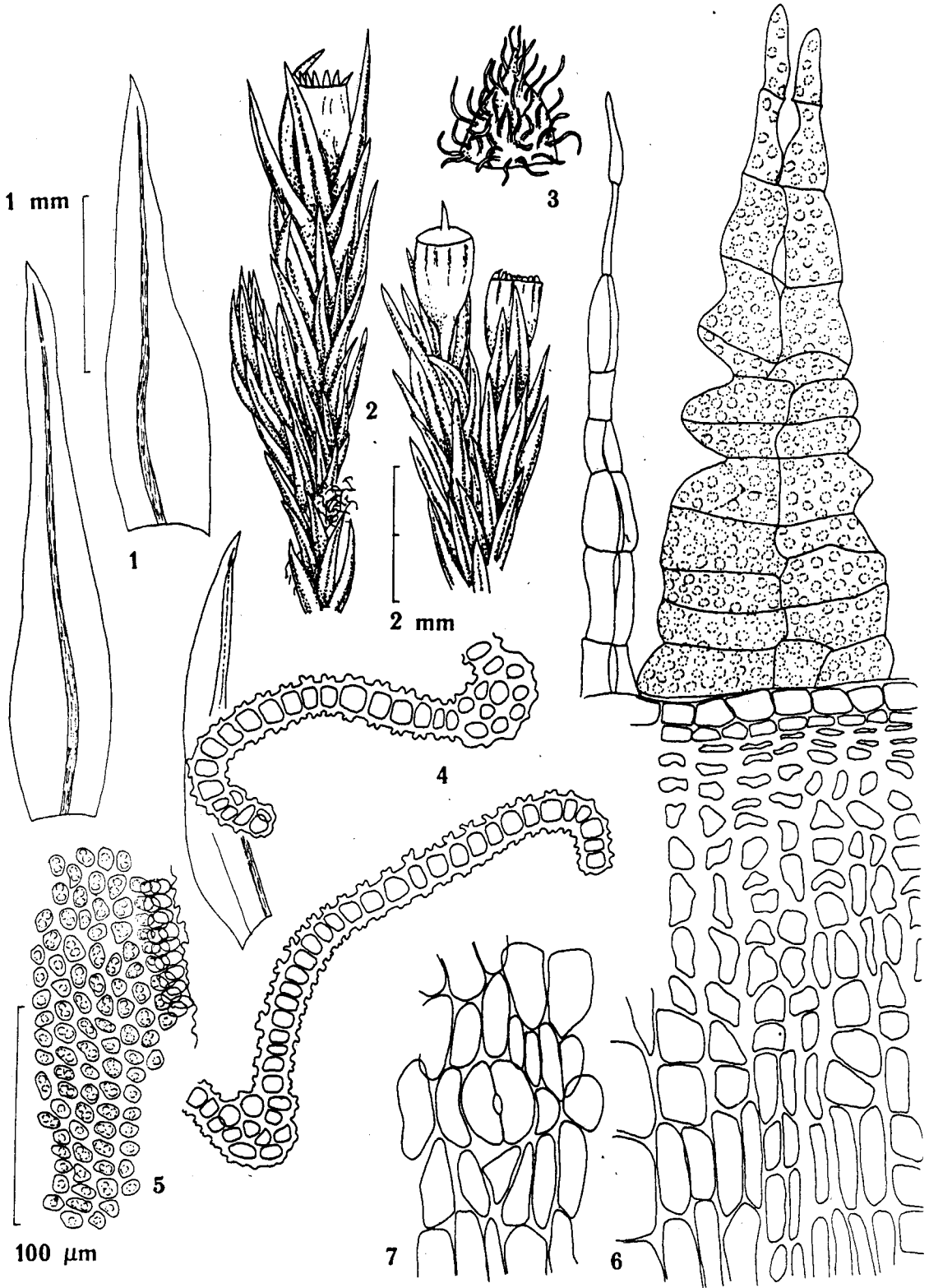


Fig. 10. *Orthotrichum rupestre* Schleicher ex Swaegr. (Kukol 1750 m Ignatov 0/984): 1 - leaves; 2 - habitus; 3 - calyptra; 4 - leaf cross section; 5 - upper leaf cells; 6 - peristome and upper exothecial cells; 7 - stoma. Scale bars: 100 μm - for 4-7; 1 mm - for 1; 2 mm - for 2-3.

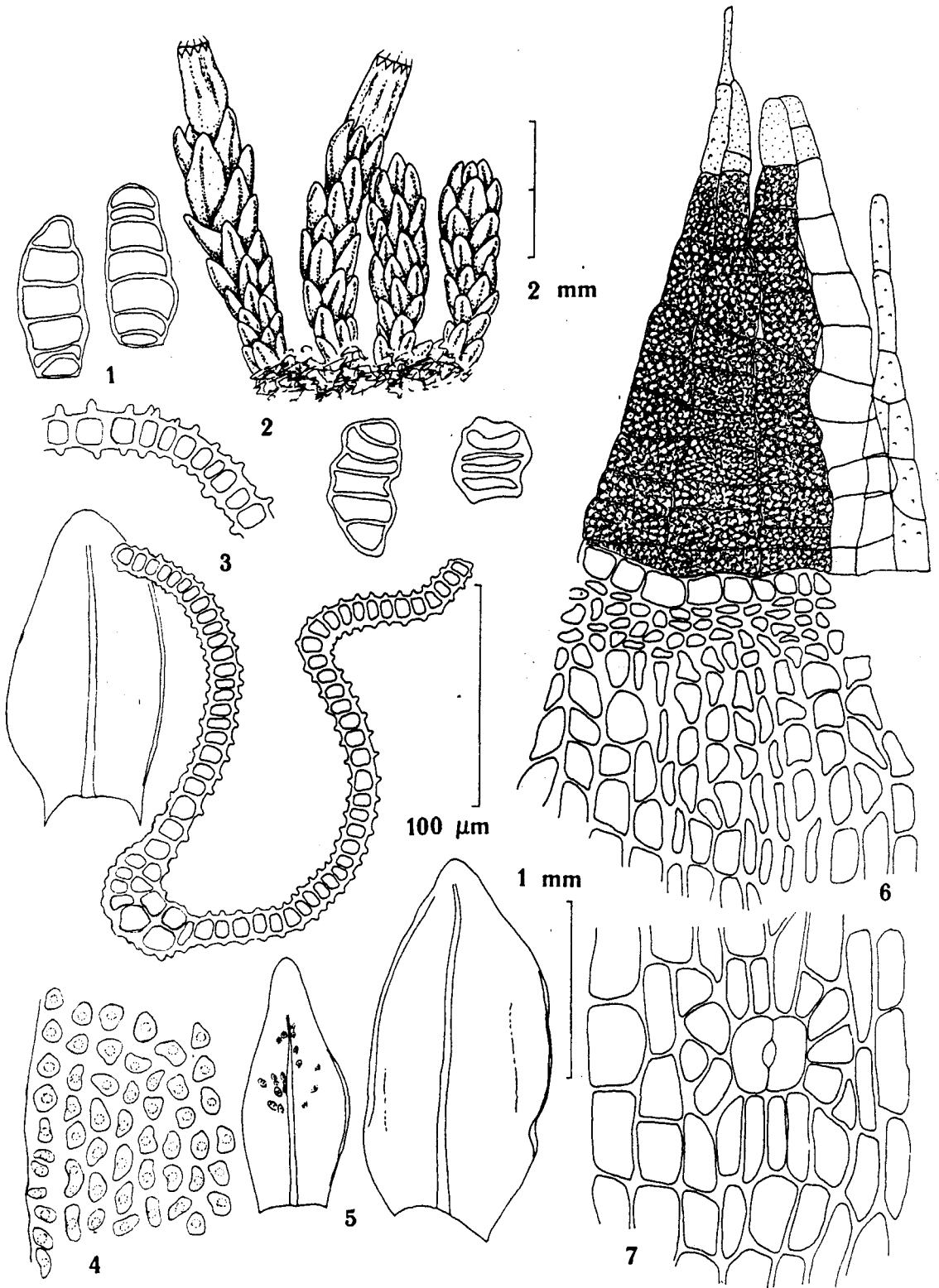


Fig. 11. *Orthotrichum obtusifolium* Brid. (Elekmonar Creek, 3 km upstream 550 m Ignatov 26/33): 1 - gemmae; 2 - habitus; 3 - leaf cross section; 4 - upper leaf cells; 5 - leaves; 6 - peristome and upper exothecial cells; 7 - stoma. Scale bars: 100 μm - for 1, 3, 4, 6, 7; 1 mm - for 5; 2 mm - for 2.

reflexed when dry, evenly papillose below, papillose-striate above. Endostome segments 8, as tall as teeth, linear-lanceolate, papillose, two cells wide. Calyptrae not plicate, naked or with very few hairs. Spores spherical, brownish to green, finely papillose, 15-20 μm .

Small plants with rounded obtuse leaves and numerous gemmae differentiate *Orthotrichum obtusifolium* easily.

Distribution: *Orthotrichum obtusifolium* is widespread in the Holarctic, known from nearly all European countries, Macaronesia, most regions of the former USSR (but in the Arctic only in Chukotka), most provinces of Canada (except the Arctic Archipelago) and most states of the U.S.A. (except some of the southernmost). In Asia *O. obtusifolium* is known from Japan, northern China, Mongolia and northern India. In Altai *O. obtusifolium* grows in the lower forest zone in similar habitats as in other parts of Eurasia, mostly on trunks of *Populus* and *Salix* in rather open stands often in flood-valleys, but also on *Betula*, *Padus*, *Sambucus* and *Sorbus*.

Specimens examined: *Chemal Creek, 3 km upstream* 450 m (34/11a; 34/73); *Chulyshman River, at Bashkaus mouth* 500 m (Zolotukhin 23.XI.1989); *Edikhta Creek* 1100 m (34/7a); *Elekmonar Creek, 3 km upstream* 550 m (26/33); *Elekmonar Creek, 5 km upstream* 700 m (26/2a; 26/34b); *Gorno-Altaysk* 400 m (35/15); *Gorno-Altaysk (SE edge)* 550 m (23/8); *Kairu Creek, at mouth* 500 m (Zolotukhin 11.IX.1987); *Karagai* 440 m (0/260); *Yailyu* 440 m (Zolotukhin 6.VIII. 1988); 480 m (0/956); 580 m (0/957).

***Orthotrichum pallens* Bruch ex Brid., Bryol. Univ. 1: 788. 1827.** Fig. 12.

Orthotrichum pallidum Groenv., Bidr. Kaenned. 15. 1885, *hom. illeg.*

Orthotrichum sibiricum (Groenv.) Warnst., Hedwigia 53: 312. 1913. - *Dorcadion sibiricum* Groenv., K. Svensk. Vet. Ak. Handl. 23(10): 96. 1890.

Plants small, 0.5-1 cm tall, in dense tufts, yellowish-green to green above, darker below. Leaves erect, oblong-lanceolate to lanceolate, ca. 1.5-2.0 mm long, acute or somewhat rounded acute, entire; margins recurved or revolute. Upper leaf cells isodiametric, ca. 10-14 μm , thick-walled, with one or two relatively high, sometimes branched papillae per cell. Basal leaf cells rectangular with straight moderately thick walls, shorter towards margins. Cladautoicous. Setae ca. 1 mm, shorter than urns. Capsulae emergent, oblong-cylindric, rather quickly narrowed to setae, furrowed almost the entire lengths when dry. Stomata immersed, almost free of the subsidiary cells. Peristomes double, prostomes not observed. Exostome teeth in 8 pairs, sometimes splitting in upper parts when old, reflexed when dry, densely and uniformly papillose. Endostome segments 16, 8 as long as and alternating with teeth, 8 intermediate usually shorter.

Calyptrae sharply plicate, naked or with a few hairs. Spores spherical, brownish to green, finely papillose, 15-20 μm .

Orthotrichum pallens is recognized by the emergent capsules with immersed stomata almost free of the subsidiary cells, the 16 endostome segments and the naked or almost naked, sharply plicate calyptrae. The taxonomy of *O. pallidum* and *O. sibiricum* discussed by Lewinsky (1977).

Distribution: *Orthotrichum pallens* is known from many countries in Europe, in the former USSR - from the western and southern European parts (Baltia, Ukraine; including Krym), Caucasus, Middle Asia, Altai and Sayan Mts. in South Siberia and along the Yenissej River to the Siberian Arctic and also Beringian Arctic. In North America from Yukon to Newfoundland, the Arctic Archipelago of Canada and Greenland, southward to Mexico. Also reported from South America (Venezuela). Southernmost localities in Asia are in Pakistan and northern India (Punjab, Kashmir). World distribution has been mapped by Lewinsky (1977). In Altai *O. pallens* was found twice: in wet forest on the shore of Teletzkoye Lake, on *Padus asiatica* trunk (550 m alt.) and at base of *Ribes odorata* in fell-field in the subalpine/lower alpine zone (2100 m).

Specimens examined: *Kayakkatuyarykskij Creek* 2100 m (6/24); *Kobukhta* 550 m (0/225).

***Orthotrichum pumilum* Sw., Monthl. rev. London 34: 538. 1801.** Fig. 13.

Plants small, ca. 2 mm tall, in dense tufts, green to dark-green above, darker below. Leaves erect, ovate-lanceolate, ca. 1.5-2.0 mm long, larger towards the stem apices, acute, often apiculate with a hyaline apical cell, entire; margins revolute almost the entire lengths. Upper leaf cells rounded, almost isodiametric, ca. 14-20 μm , moderately thick-walled, smooth or with 1-2 low papillae per cell. Basal cells rectangular, thin-walled, shorter towards the margins. Gemmae short-cylindric, green, occasional on the leaves. Gonautoicous. Setae ca. 0.2 mm, shorter than urns. Capsulae immersed to emergent, oblong to oblong-cylindric, gradually narrowed to the setae, furrowed almost the entire lengths and constricted below the mouths when dry. Stomata immersed, more or less covered by the subsidiary cells. Peristomes double, prostomes not seen. Exostome teeth in 8 pairs, sometimes splitting to 16 nearly free teeth when old, reflexed when dry, evenly papillose. Endostome segments 8, linear, smooth, hyaline, of 1 or 2 rows of cells. Calyptrae oblong, plicate, with scattered thick short hairs. Spores spherical, papillose, brownish, 13-16 μm .

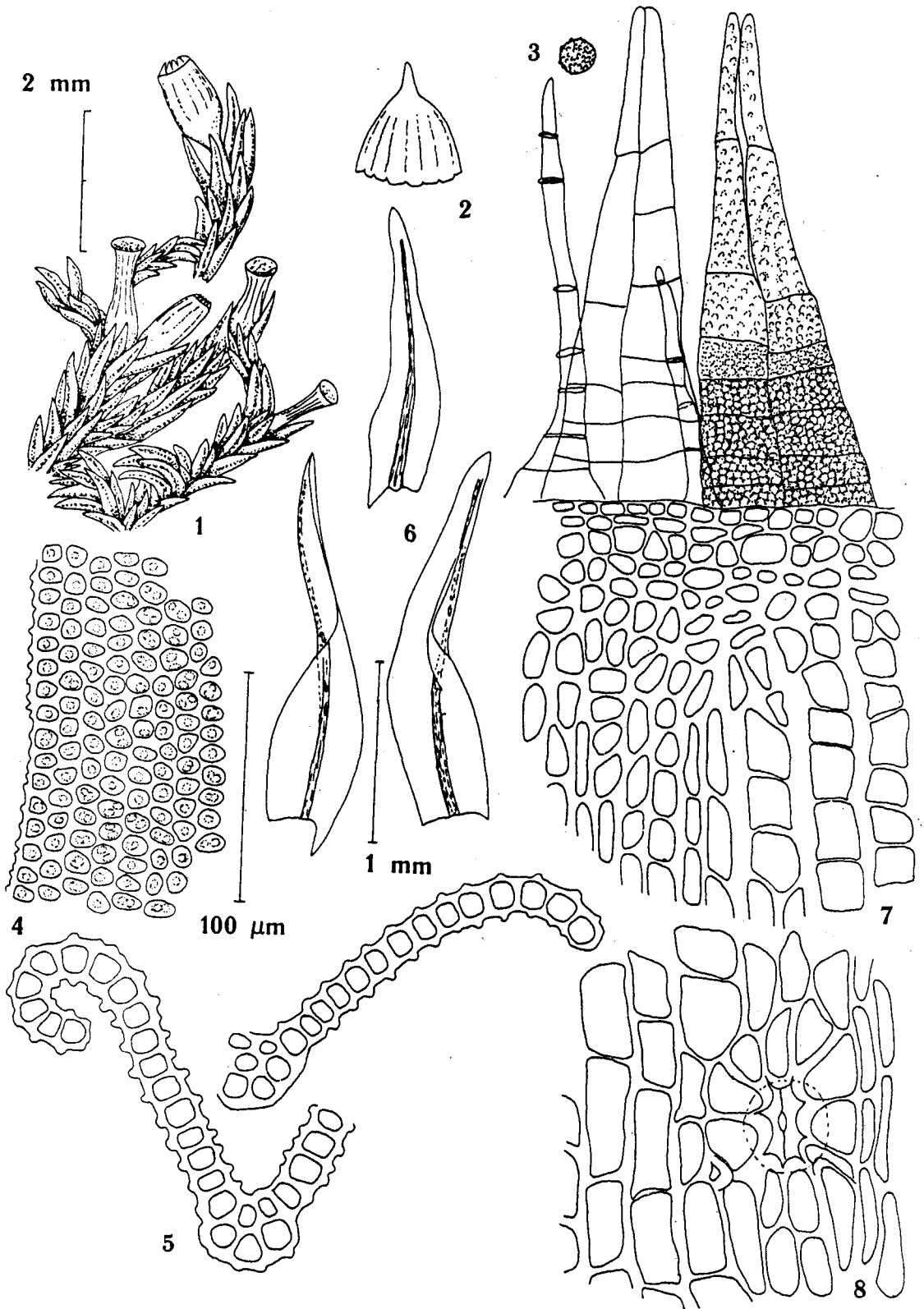


Fig. 12. *Orthotrichum pallens* Bruch ex Brid. (*Kobukhta* 550 m Ignatov 0/225): 1 - habit; 2 - calyptra; 3 - spore; 4 - upper leaf cells; 5 - leaf cross sections; 6 - leaves; 7 - peristome and upper exothelial cells; 8 - stoma. Scale bars: 100 μm - for 3-5, 7, 8; 1 mm - for 6; 2 mm - for 1, 2.

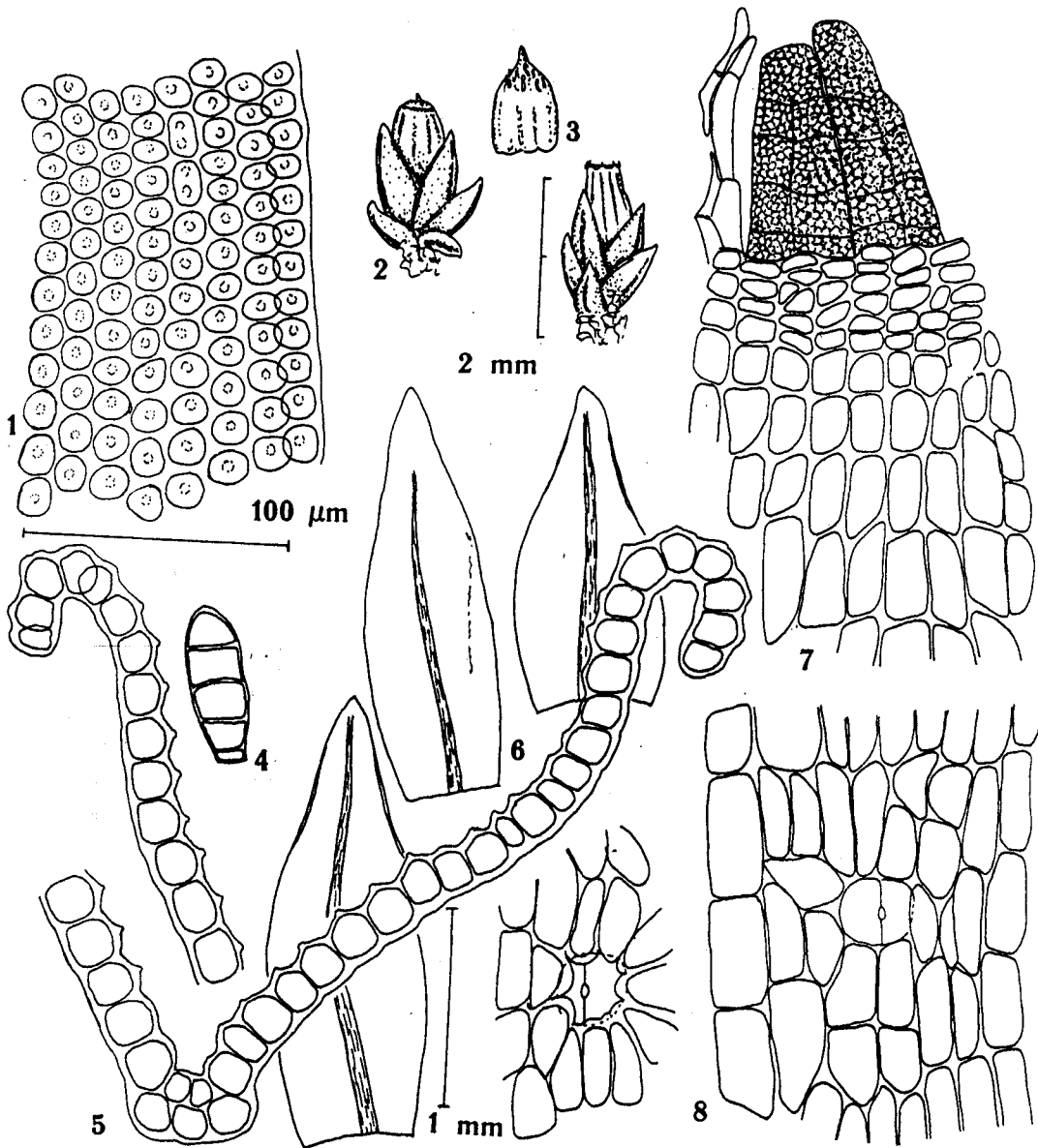


Fig. 13. *Orthotrichum pumilum* Sw. (Chuya River, lower course 800 m (Bardunov 1966 IRK!): 1 - upper leaf cells; 2 - habitus; 3 - calyptra; 4 - gemma; 5 - leaf cross section; 6 - leaves; 7 - peristome and upper exothelial cells; 8 - stoma. Scale bars: 100 μ m - for 1, 4, 5, 7, 8; 1 mm - for 6; 2 mm - for 2, 3.

Orthotrichum pumilum is closely related to *O. pallens*. It can be recognized by the wider leaves, with larger upper leaf cells and the often apiculate apices, the endostomes of only 8 segments, and the gonautoicous condition. Besides gemmae have never been observed in *Orthotrichum pallens*.

Distribution: *Orthotrichum pumilum* has been reported from the lowlands of most European countries extending to North Africa and the Canary Islands. In the former USSR known from the northwestern and eastern regions of the European part,

from the Baltic countries, Belorussia, Central Russia, Ukraine, Moldova, Krym, Southern Ural Mts., Caucasus, southern Siberia and Middle Asia. Otherwise in Asia in eastern China. In North America present in most of the U.S.A. (except from the southwestern and southeastern states) and southernmost Canada. In Altai *Orthotrichum pumilum* has only been collected at the lower course of the Chuya River, where it grew on rocks in steppe at 800 m. The most common habitat for this species is on trees in xeric areas. Only rarely has it been collected from rocks.

Specimen examined: *Chuya River, lower course 800 m* (Bardunov 1966 IRK!).

***Orthotrichum rogeri* Brid., Muscol. Recent. Suppl. 2: 9. 1812.**

Fig. 14.

Plants small, up to 0.5 cm tall, in dark green tufts, blackish below. Leaves erect to slightly flexuose, lanceolate to oblong-lanceolate, up to 2 mm long, acute to obtuse, entire, more or less decurrent; margins almost plane or revolute nearly throughout. Upper leaf cells isodiametric, 8-12 μm , thick-walled, typically with 2 rather low papillae per cell. Basal leaf cells rectangular, with straight rather thin walls, shorter towards margins; in decurrent parts rectangular, enlarged. Cladautoicous. Setae 0.5 mm, shorter than urns. Capsulae emergent, ovoid, rather quickly narrowed to setae, furrowed almost the entire lengths when dry. Stomata immersed, almost covered by the subsidiary cells. Peristomes double, prostomes not observed. Exostome teeth in 8 pairs, reflexed when dry, densely and roughly papillose below, much less papillose above, in the middle sometimes vertically papillose-striate. Endostome segments 16, as long as the teeth, linear, mostly one cell wide or sometimes two cells wide above. Spores spherical, brownish to green, papillose, 25-28 μm . Calyptrae hairy with scattered papillose hairs reaching to the top.

Orthotrichum rogeri can be recognized from *O. pallens* by the stomata almost covered by the subsidiary cells, the larger spores, and the somewhat decurrent leaves. This last character has only been observed in the Altaian populations, which also have larger spores than the European and Indian ones (25-28 not 17-25 μm). From these they further differ in the hairy calyptrae. The leaf shape, spore size and stomata also distinguish *Orthotrichum rogeri* from *O. pumilum*.

Distribution: *Orthotrichum rogeri* is a relatively rare moss only known from a limited number of localities in southern Scandinavia, Central and South Europe, Caucasus, Kashmir in northern India and Altai. In the last place *Orthotrichum rogeri* has been found in wet forests in the valleys, always on trunks of *Padus asiatica* with *O. obtusifolium*, *O. sordidum*, *O. speciosum* and *O. vladikavkanum*.

Specimens examined: Chermal Creek, 3 km upstream 450 m (34/8); Chiri Creek, 0.5 km upstream 450 m (17/26; 17/27).

In one mixed collection of *Orthotrichum* from Chiri Creek (17/26) was observed *O. vladikavkanum*, *O. rogeri* and very little of a yet unidentified *Orthotrichum*. The plants have rather narrow lanceolate leaves with acute or apiculate apices consisting of 1-3 cells; the margins are slightly recurved or plane in the central part.

Upper leaf cells are rather large, 11-16 x 14-16 μm with 1-4 low, rounded papillae per cell. Basal leaf cells are rectangular to quadrate, 16-35 x 11-16 μm , shorter towards margins. Gemmae club-shaped, short, brown. Goniautoicous. Setae very short. Capsulae immersed, ovoid-oblong, furrowed when dry, rather quickly narrowed to setae. Stomata immersed, half to completely covered by subsidiary cells. Peristomes double, prostomes not observed. Exostome teeth united in 8 pairs, reflexed when dry, densely and rather roughly papillose throughout, reddish-brown. Endostome segments 16, 3/4 as tall as teeth, with broad biseriate bases, papillose-rugose, hyaline. Spores spherical, green, medium papillose, 16-18.5 μm . Calyptrae not seen. (Fig. 15).

This moss is related to *Orthotrichum pallens*, *O. pumilum* and *O. rogeri*, but the combination of characters as given above makes it impossible to refer it to any one of these. It could be a yet undescribed species, but due to the little material and lack of calyptrae, we find it better not to describe it formally.

***Orthotrichum alpestre* Hornsch. in. B.S.G., Bryol. Eur. 3: 75. pl. 213. 1849.**

Fig. 16.

Plants small, up to 1 cm tall, in yellowish-green to green tufts. Leaves ovate-lanceolate, ca. 2.0-2.5 mm long, acute, entire or crenulate due to papillae; margins revolute at base only or nearly throughout. Upper leaf cells isodiametric to shortly rectangular, 10-20 x 8-14 μm , thick-walled, with 1 or 2 high branched papillae per cell. Basal leaf cells rectangular with straight to slightly flexuose walls, shorter towards margins; alar cells slightly differentiated. Goniautoicous. Setae 0.5-0.8 mm, shorter than urns. Capsulae emergent, oblong-ovoid, gradually narrowed to setae, distinctly furrowed almost the entire length due to 8 stripes of thickened exothecial cells. Stomata immersed, moderately to almost covered by subsidiary cells. Peristomes double, prostomes not observed. Exostome teeth in 8 pairs, splitting but not deviating above when old, yellowish to brownish, reflexed when dry, densely and roughly papillose below, with papillae arranged in more or less apparent vertical lines above. Endostome segments of 4 long cells, smooth, somewhat hyaline, rigid. Spores spherical, brownish to green, moderately papillose, 10-12 μm . Calyptrae hairy with scattered papillose hairs reaching to the top.

Orthotrichum alpestre can be distinguished from the other Altaian species by a combina-

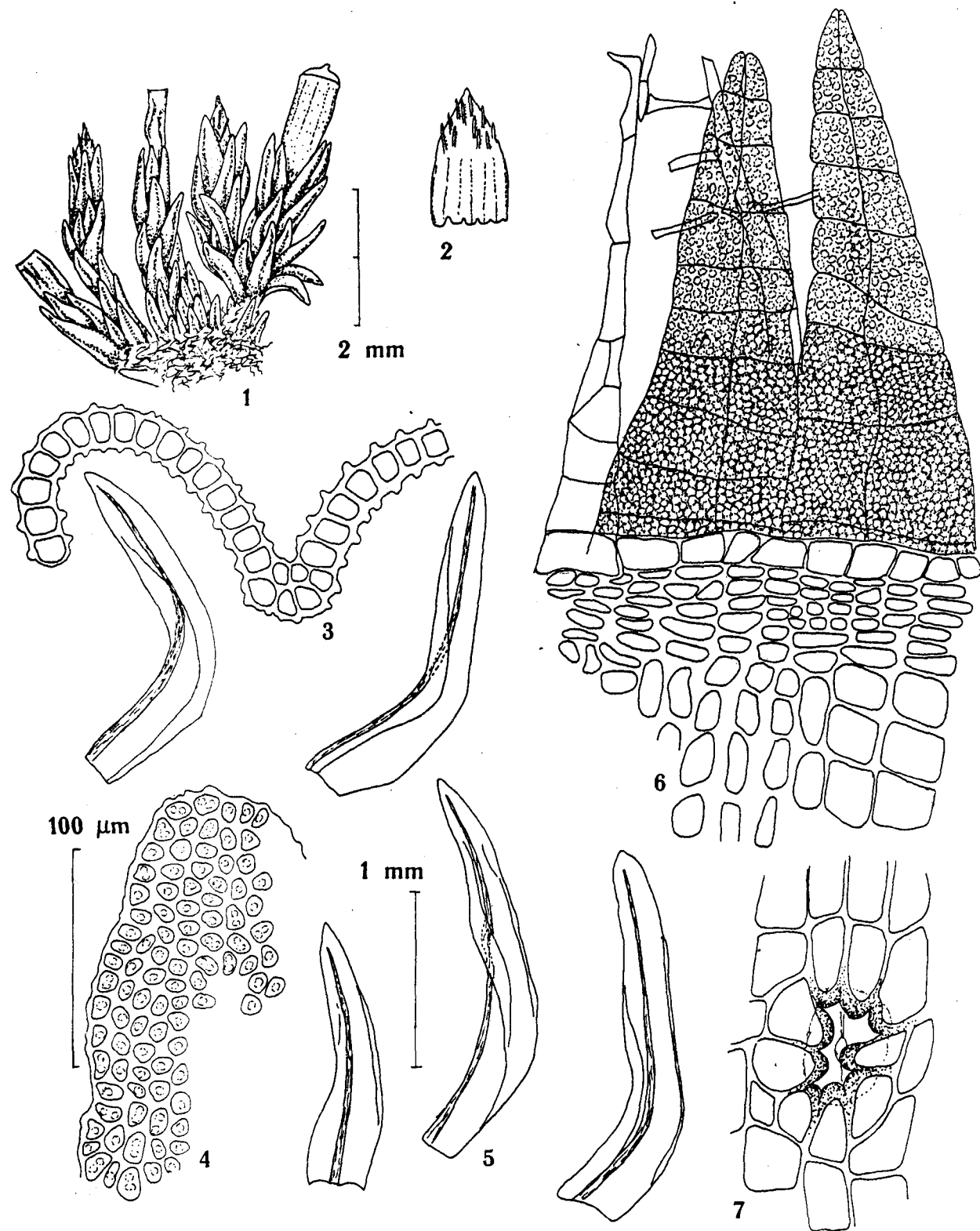


Fig. 14. *Orthotrichum rogeri* Brid. (Chemal Creek, 3 km upstream 450 m Ignatov 34/8): 1 - habitus; 2 - calyptra; 3 - leaf cross section; 4 - upper leaf cells; 5 - leaves; 6 - peristome and upper exothelial cells. Scale bars: 100 μm - for 3, 4, 6, 7; 1 mm - for 5; 2 mm - for 1, 2.

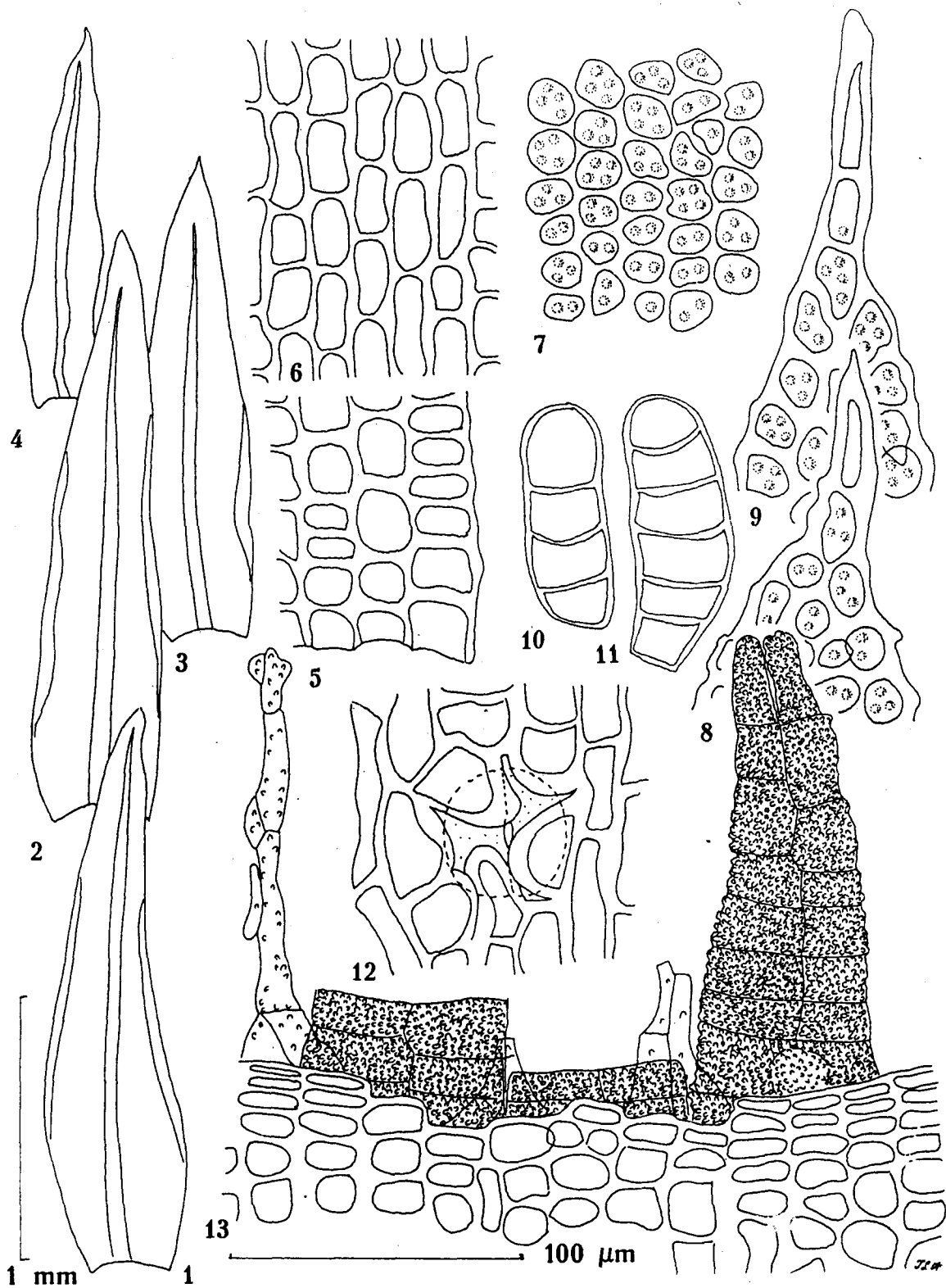


Fig. 15. *Orthotrichum* sp. (see discussion under *O. rogeri*) (Chiri Creek, 0.5 km upstream 450 m Ignatov 17/26a): 1-4 - leaves; 5 - basal leaf corner; 6 - basal leaf cells; 7 - upper leaf cells; 8-9 - leaf apices; 10-11 - gemmae; 12 - stoma; 13 - peristome. Scale bars: 100 µm - for 5-13; 1 mm - for 1-4.

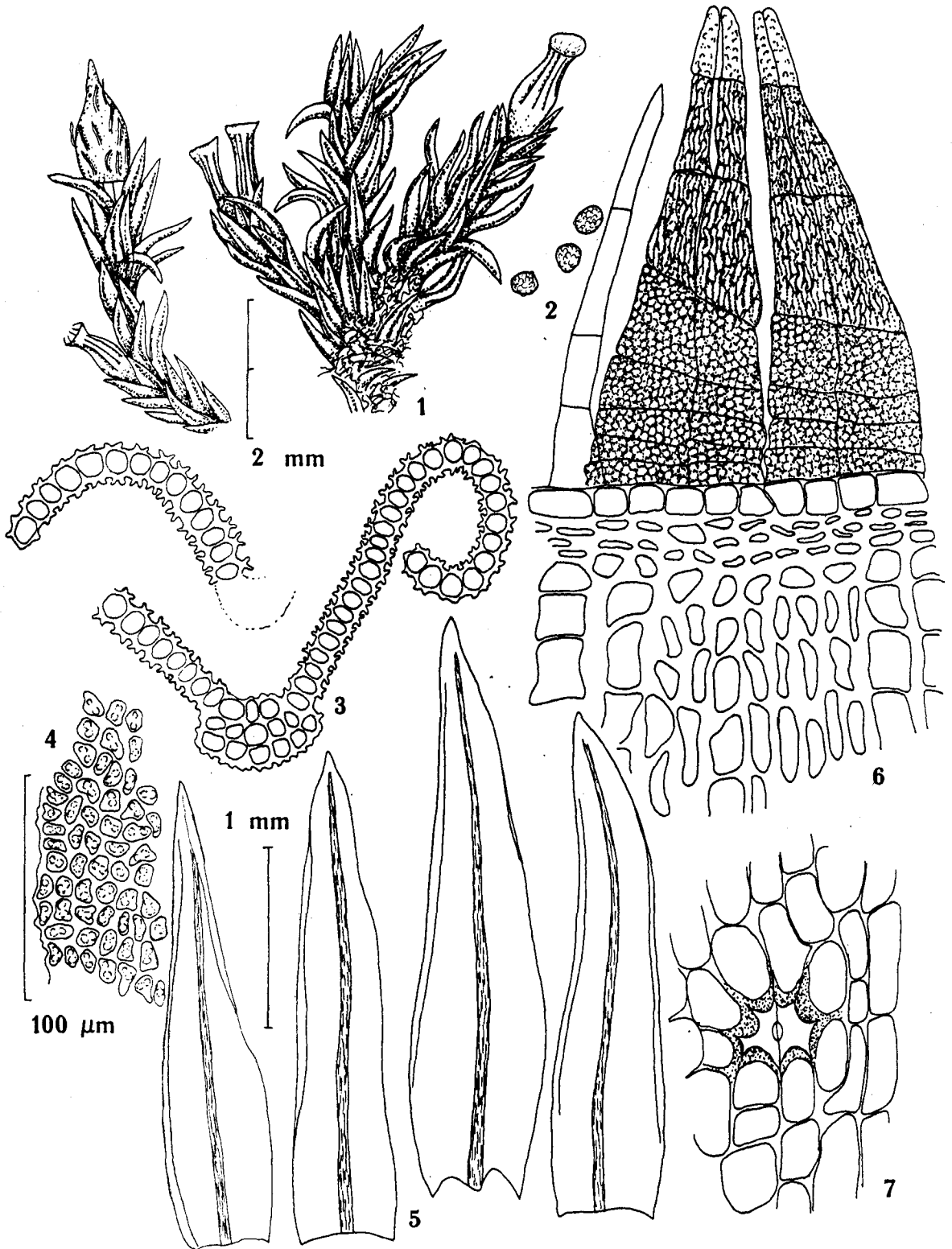


Fig. 16. *Orthotrichum alpestre* Hornsch. in B. S. G. (Ayulyuyuziyuk Creek 2100 m Ignatov 0/150): 1 - habitus; 2 - spores; 3 - leaf cross section; 4 - upper leaf cells; 5 - leaves; 6 - peristome and upper exothecial cells; 7 - stoma. Scale bars: 100 μm - for 2-4, 6, 7; 1 mm - for 5; 2 mm - for 1.

tion of small plant size, emergent capsules with immersed stomata, highly papillose upper leaf cells and narrow linear endostome segments of 3-4 cells with the distant cell being spine-like.

Distribution: *Orthotrichum alpestre* is known from Western Europe, where it is most common in the mountains of the central and northern regions including Iceland and Svalbard. In the former USSR it has been found only in the mountains of the Kola Peninsula, the Carpatians, South Ural, Caucasus, Middle Asia and South and East Siberia. Also known from Turkey, Kashmir and northern Pakistan. In North America *O. alpestre* is widespread in the West from Yukon to California and New Mexico, while rarer in the East where it occurs in Labrador, Newfoundland and Michigan; also in Greenland. World distribution has been mapped by Lewinsky (1977). In South Siberia *O. alpestre* is so far known only from Altai, where it was found several times in the upper taiga and subalpine zones. Here it grew on moderately shaded rocks in open *Pinus sibirica* forest.

Specimens examined: *Ayulyuyuzuyuk Creek* 2050 m (0/979); 2100 m (0/150); *Kobiguayuk Creek* 2050 m (0/368; 0/978); 2300 m (0/324); *Kukol* 1850 m (0/980); *Yakhansoru Lake* 1850 m (Zolotukhin 18.VI.1990); 1870 m (Zolotukhin 18.VI.1990).

***Orthotrichum anomalum* Hedw., Sp. Musc. Frond. 162. 1801. Fig. 17.**

Plants of medium size, up to 2 cm tall, in rigid dense tufts, green to greenish-brown or red-brown above, dark-brown below. Leaves appressed and erect when dry, lanceolate to ovate-lanceolate, up to 3.0 mm long, acute, entire; margins nearly plane to slightly recurved in central parts. Upper leaf cells isodiametric, 6-10 μm , very thick-walled, with 1 or rarely 2 low papillae per cell. Basal leaf cells rectangular, with straight more or less thick walls, smooth, shorter towards margins, rectangular to quadrate. Goniautoicous. Setae up to 3 mm, longer than urns. Capsulae exserted, oblong-ovoid, rather quickly narrowed to setae, 1.5-2.0 mm long, furrowed almost the entire lengths when dry due to 16 stripes of thickened exothelial cells (8 prominent alternating with 8 weaker). Stomata immersed, moderately to completely covered by subsidiary cells. Peristomes double, low prostomes present. Exostome teeth in 8 pairs when young, splitting quickly to 16, erect to spreading when dry, short, only 0.15 mm long, vertically striolate above, horizontally below. Endostome segments 8, easily broken off after the lids have been shed and therefore rarely observed, shorter than teeth, linear, smooth. Opercula with short beaks. Calyptrae hairy with scattered to numerous papillose hairs reaching to the top. Spores spherical, brownish to green, roughly papillose, ca. 15 μm .

The combination of exserted capsules and immersed stomata is enough in the Altaian region to characterize *Orthotrichum anomalum*. Important for its identification are, however, also the relatively large size of the plants, the capsules distinctly ribbed in the upper halves when dry, the usually erect, short exostome teeth splitting into pairs soon after the lids have been shed, and the poorly developed segments observed only in recently opened capsules.

Distribution: Widespread in all Europe (except the northern islands), northern Africa, Caucasus, the Middle East, South Siberia, southern Russian Far East, Middle Asia, northern parts of Afganistan, Pakistan, India, China, Mongolia, Korea and Japan. Also reported from Java, but these data need further confirmation (Lewinsky 1992). In North America *O. anomalum* occurs nearly throughout Canada, except the most northern and arctic regions, reaching southwards to North Carolina and California, and further south to Mexico, Guatemala and Haiti. In Altai *O. anomalum* is fairly common in all regions in more or less xeric habitats, but especially abundant in forest-steppes and steppes. On S-facing slopes in the subalpine/alpine regions in the more xeric highlands of southeastern Altai it reaches an altitude of 2450 m.

Specimens examined: *Bijka Creek, 2 km upstream along Katun* 450 m (34/122); *Bogoyash Creek, at mouth* (Zolotukhin 17.VI.1986); *Bogoyash Creek, upper course* 2300 m (36/332); *Buguzun Creek, at mouth of Sailyugem Creek* 2100 m (Pavlov V.N. 19.VIII.1993); *Chemal* 400 m (29/16); 450 m (Vereshchagin 7.VI.1909 LE!); *Chemal, 10 km upstream along Katun* 450 m (34/117; 34/143); *Chemal, 4 km upstream along Katun* 450 m (34/17); *Chiri* 450 m (17/58); *Chulcha River, in middle course* 1100 m (9/49; 9/164); *Derbogach* 440 m (0/963); *Gorno-Altai (SE edge)* 550 m (23/11); *Iedygem Creek, at mouth* 1160 m (Krylov 23.VI.1903 LE!); *Karagai* 440 m (0/269); *Kobiguayuk Creek* 2300 m (0/962); *Kobukhta* 550 m (0/961); *Kuba Creek* 500 m (Makarov 3.VI.1972); *Kukol* 1900 m (0/964); 2250 m (Zolotukhin 23.VI. 1989); *Maima* 350 m (35/8); *Malyi Yaloman* 950 m (25/159); 1050 m (25/161); *Malyi Yaloman Creek, 7 km upstream* 1050 m (25/34); *Ok-Porok Creek, at mouth* 440 m (Zolotukhina 30.III.1988); *Pustynskoye* (Kusnezov 10.VII.1913 LE! #1818); *Shchebnyukhino* (Kusnezov 12.VII.1913 LE! #1966a); *Tabozhok Creek, 12 km upstream* 2200 m (30/44); *Tabozhok Peak* 2350 m (31/86); 2450 m (31/87); *Ulagan* 1220 m (36/89); *Ust-Sema* 580 m (24/152); *Yailyu* 440 m (0/981).

***Orthotrichum cupulatum* Brid., Musc. Rec. 2(2): 25. 1801. Fig. 18.**

Plants about 1 cm tall, in moderately dense tufts, dark-green to brown above, dark-brown below. Leaves erect, lanceolate to ovate-lanceolate, 1-2.5 mm long, acute, entire; margins recurved almost throughout. Upper leaf cells unistratose, isodiametric, 6-13 μm , thick-walled, with tall and mostly forked papillae.

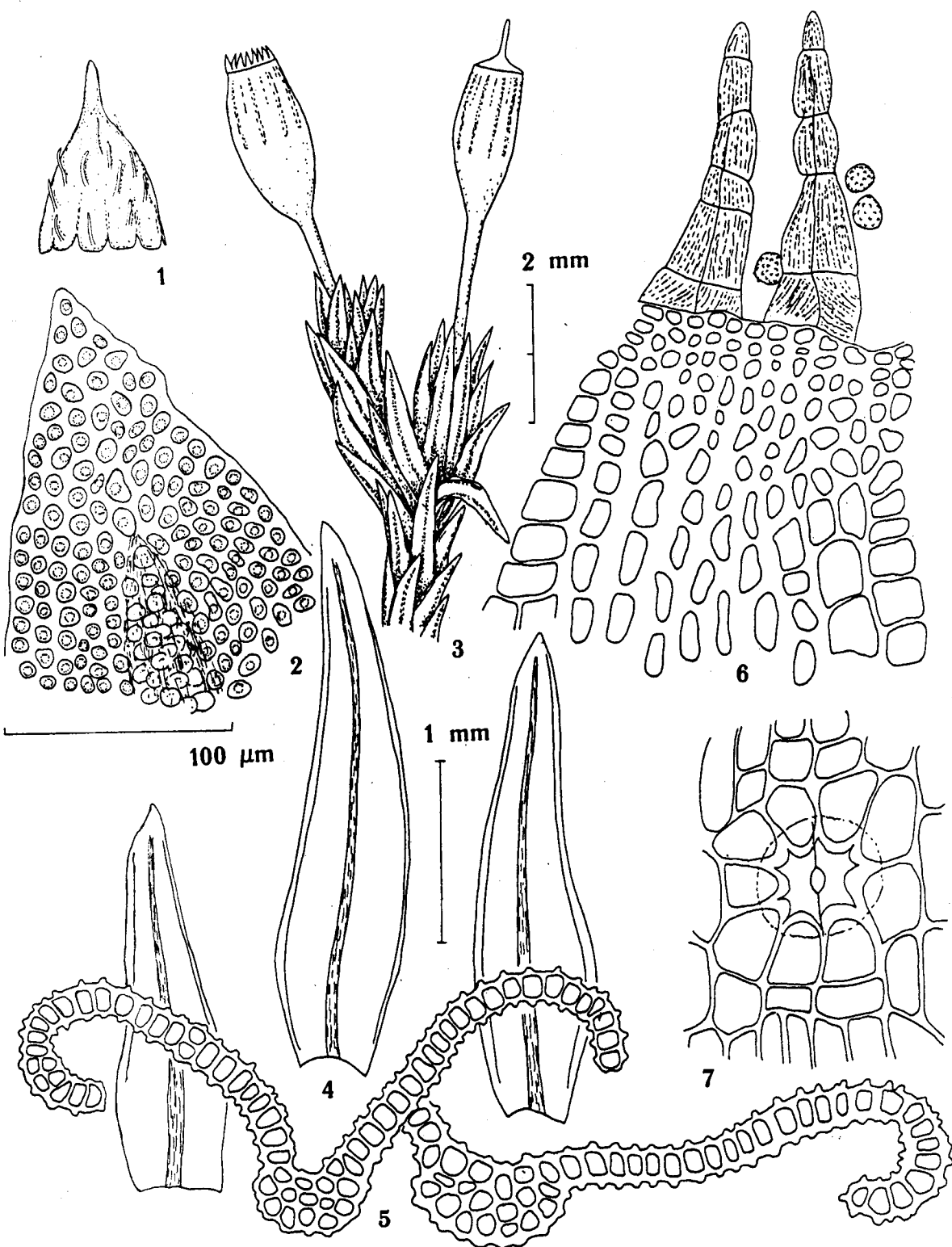


Fig. 17. *Orthotrichum anomalum* Hedw. (Kuba Creek 500 m Makarov 3.VI.1972 MHA): 1 - calyptra; 2 - upper leaf cells; 3 - habitus; 4 - leaves; 5 - leaf cross sections; 6 - peristome and upper exothecial cells; 7 - stoma. Scale bars: 100 μm - for 2, 5-7; 1 mm - for 4; 2 mm - for 1, 3.

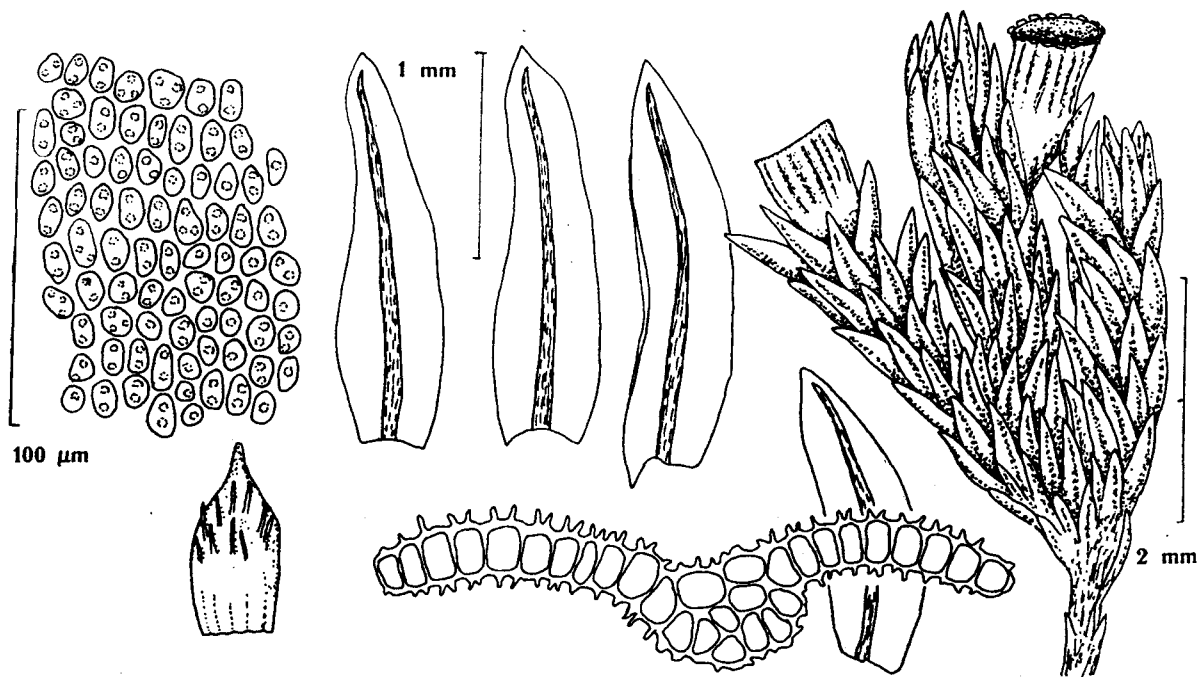


Fig. 18. *Orthotrichum cupulatum* Brid. (Tabozhok Peak 2450 m 31/104): 1 - upper leaf cells; 2 - calyptra; 3 - leaves; 4 - leaf cross section; 5 - habitus. Scale bars: 100 μ m - for 1,4; 1 mm - for 2,3; 2 mm - for 5.

Basal leaf cells rectangular with straight, rather thin walls, towards margins shorter. Goniautoicous. Setae ca. 0.5 mm long, shorter than urns. Capsulae emergent, ovoid, rather quickly narrowed to setae, with constriction about 1/4 from mouth and strongly furrowed when dry due to 16 stripes of thickened exothecial cells. Stomata immersed, almost completely covered by subsidiary cells. Peristomes single, prostomes not observed. Exostome teeth 16, split just after capsule dehiscence, erect-spreading when dry, evenly papillose below, vertically papillose-striate above. Calyptrae with few hairs. Spores spherical, brownish to green, papillose, 15-17 μ m.

Orthotrichum cupulatum is close to *O. pellucidum*, but differs in having 16-ribbed capsules and unistratose, rather acute leaves.

Distribution: In Europe *Orthotrichum cupulatum* occurs in most countries from Iceland south to the Mediterranean; also reported from Cyprus, Turkey, Macaronesia (Madeira) and northern Africa. In the former USSR in the western and southern regions of the European part, Caucasus, Middle Asia and the Altai Mts. in southern Siberia. In Asia also known from Afganistan and northern India. In North America *O. cupulatum* occurs mostly in the West in the Rocky Mountains, from British Columbia southwards to Nevada, Utah and Colorado; also in Ontario. Further known from South America, Australia and New Zealand. In Altai the only collection was made in a

xeric area in the southeastern region in tundra-steppe.

Specimen examined: Tabozhok Peak 2450 m (31/104).

Orthotrichum pellucidum Lindb., Oefvers. Forh. Kongl. Svenska Vetensk.-Akad. 23: 549. 1867. Fig. 19.

Orthotrichum jamesianum Sull., Bot. U. S. Geol. Expl. 40th Parall. Prof. Pap. Eng. Dept. U. S. Army 18, 5: 401. 1871.

Plants about 1 cm tall, in rather loose tufts, dark-green to brownish above, dark-brown below. Leaves erect, lanceolate to ovate-lanceolate, 1.0-1.8 mm long, acute to obtuse, entire; margins revolute almost throughout. Upper leaf cells bistratose, isodiametric, 9-15 μ m, thick-walled, with tall and mostly branched papillae. Basal leaf cells rectangular, with straight, thin walls, shorter towards margins. Goniautoicous. Setae ca. 0.5 mm, shorter than urns. Capsulae emergent, oblong-ovoid, rather quickly narrowed to setae, strongly furrowed almost the entire length when dry due to 8 stripes of thickened exothecial cells. Stomata immersed, nearly covered by subsidiary cells. Peristomes single, prostomes not observed. Exostome teeth 16, split just after capsule dehiscence, erect-spreading when dry, with papillae in vermicular rows. Calyptrae with scattered papillose hairs. Spores spherical, brownish to green, papillose, ca. 15 μ m.

Orthotrichum pellucidum can be distinguished

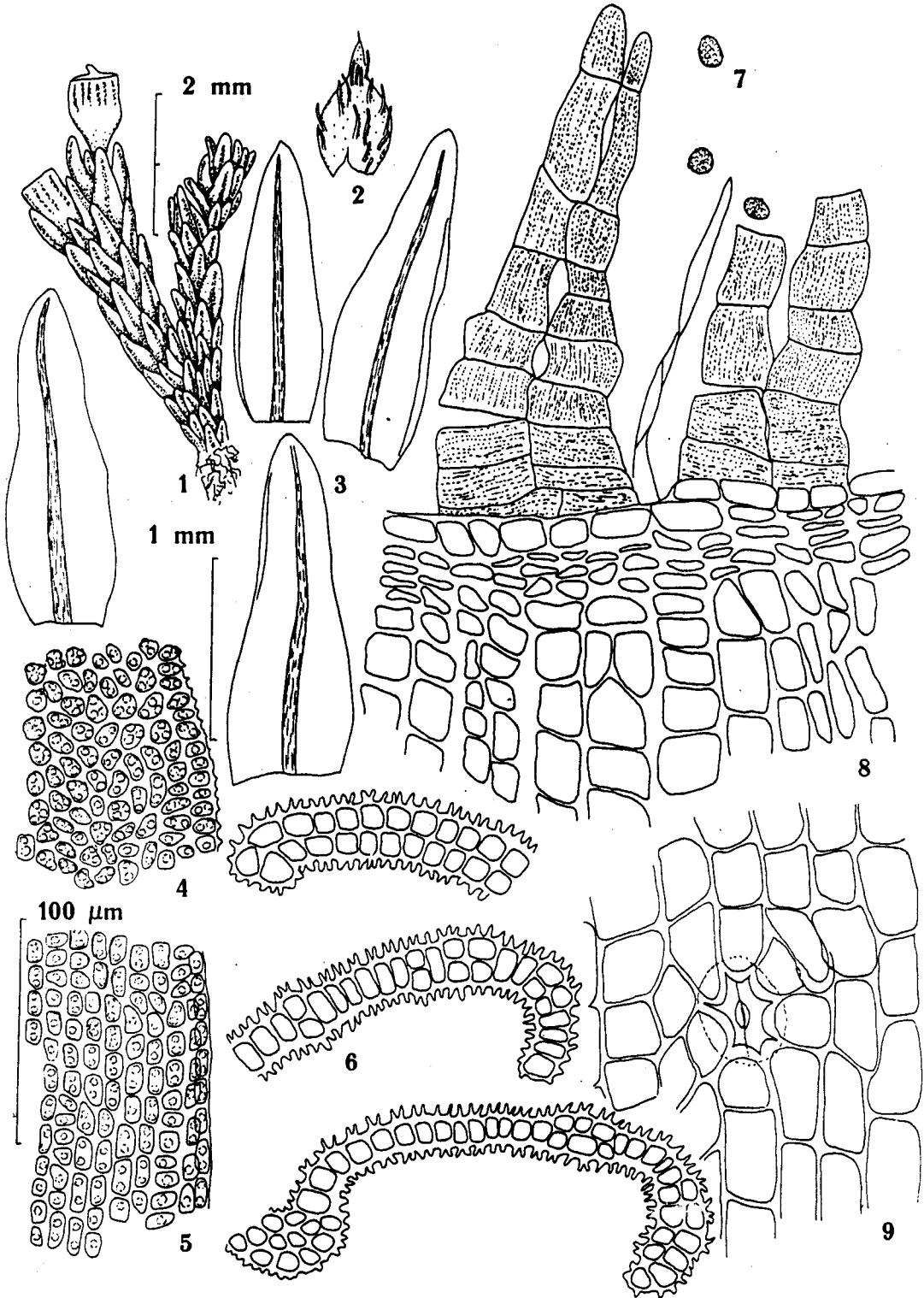


Fig. 18. *Orthotrichum pellucidum* Lindb. (Tabozhok Creek, 12 km upstream 2750 m Ignatov 31/162): 1 - habitus; 2 - calyptra; 3 - leaves; 4 - upper leaf cells; 5 - lower leaf cells; 6 - leaf cross sections; 7 - spores; 8 - peristome and upper exothelial cells; 9 - stoma. Scale bars: 100 μm - for 4-9; 1 mm - for 3; 2 mm - for 1, 2.

by immersed capsules with 16 free teeth and 8 distinct ribs, and by the bistratose upper leaf cells.

Distribution: The world distribution was mapped by Lewinsky (1977) as *Orthotrichum jamesianum*. It includes Svalbard, Greenland, the Arctic Archipelago of Canada and the mountains of western North America from Alaska to Nevada. In Russia *O. pellucidum* was found only recently in Chukotka (Afonina, pers. com.) and in Altai, where it grew on rocks on xeric slopes in cool-steppe (tundra-steppe)

and alpine regions.

Specimens examined: *Kukol* 1850 m (0/1235); *Tabozhok Creek*, 12 km upstream 2200 m (30/47); 2750 m (31/162).

ACKNOWLEDGEMENTS

We are very thankful to Dr. Benito C. Tan for the correction of the English language of the manuscript and to Dr. L. V. Bardunov for the loan of specimens from IRK. The researches of the first author was supported in part by grant M97000 of the International Science Foundation.

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