

FOUR ORTHOTRICHACEAE SPECIES NEW FOR RUSSIAN FLORA

О ЧЕТЫРЕХ НОВЫХ ДЛЯ ФЛОРЫ РОССИИ ВИДАХ СЕМЕЙСТВА ORTHOTRICHACEAE

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Abstract

A revision of Russian specimens of the family Orthotrichaceae brought numerous new records in the genera *Zygodon*, *Lewinskya* and *Orthotrichum*, including four species new to Russia. *Lewinskya transcaucasica*, recently described from Georgia, is found in Dagestan Republic (East Caucasus) and Altai Mts. In addition, specimens identified as *L. striata* from Siberia and Russian Far East were found to be similar to *L. transcaucasica* in ovate, emergent to short exserted capsules and pairwise arranged exostome teeth, but differing from the latter in typically sixteen endostome segments and somewhat smaller spores. Central Asian *Orthotrichum crenulatum* was revealed in Buryatia, Zabaikalsky Territory, and Kotuyskoe Plateau; mostly European *O. tenellum* was found in the West Caucasus, Sochi surroundings; *Zygodon dentatus* was collected in Carachay-Circassian Republic (West Caucasus). Species descriptions and illustrations based on Russian specimens, as well as data on their ecology and distribution are provided.

Резюме

Ревизия российских образцов семейства Orthotrichaceae выявила новые для Российской флоры виды в родах *Zygodon*, *Lewinskya* и *Orthotrichum*. Недавно описанная из Грузии *Lewinskya transcaucasica* выявлена в Дагестане и на Алтае. Образцы из Сибири и с Дальнего Востока, ранее относимые к *L. striata*, отличаются короткими продолговатыми коробочками, выступающими или приподнятыми над перихециальными листьями, и попарно сближенными, частично сросшимися зубцами экзостомы, так что они, судя про всему, ближе к *L. transcaucasica*, но отличаются от нее 16 сегментами эндостомы и несколько более мелкими спорами. Центральноазиатский *Orthotrichum crenulatum* выявлен в Бурятии, Забайкальском крае и на Котуйском плато, преимущественно европейские *O. tenellum* и *Zygodon dentatus* – на Западном Кавказе, в окрестностях Сочи и Карачаево-Черкессии соответственно. Приводятся описания и иллюстрации видов, основанные на Российских образцах, данные об их экологии и распространении.

KEYWORDS: *Lewinskya transcaucasica*, *Orthotrichum crenulatum*, *Orthotrichum tenellum*, *Zygodon dentatus*, biodiversity; biogeography, Russia

INTRODUCTION

According to the Check-list of mosses of East Europe and north Asia (Ignatov *et al.*, 2006), 43 species of the family Orthotrichaceae from 4 genera, namely *Macromitrium*, *Zygodon*, *Ulota*, and *Orthotrichum* were known in Russia, most of them (28 species) from the genus *Orthotrichum*.

Since that time, these numbers have significantly changed. At first, the generic composition of the family has undergone changes since three genera were split. According to the results of molecular phylogenetic reconstructions, all dioicous, gemmiferous, rarely producing sporophytes Orthotrichaceae represent separate lineages that deserve a generic status (Sawicki *et al.*, 2010; Plášek *et*

al., 2015), thus *Orthotrichum obtusifolium* Brid. and *O. gymnostomum* Bruch ex Brid. are considered in the genus *Nyholmia* Holmen & Warncke, and the genera *Pleurogemma* Plášek, Sawicki & Ochyra and *Pulvigrera* Plášek, Sawicki & Ochyra are estimated for *Ulota phyllantha* Brid. and *Orthotrichum lyellii* Hook. & Taylor, correspondingly. The genus *Orthotrichum* was found to be paraphyletic even with the dioicous taxa excluded (Sawicki *et al.*, 2010; 2012; Lara *et al.*, 2016; Plášek *et al.*, 2016; Vigalondo *et al.*, 2016). To solve this problem, the species with superficial stomata were segregated in the genus *Lewinskya* F. Lara, Garilleti & Goffinet (Lara *et al.*, 2015).

Recent field studies in poorly explored areas of the Caucasus and Siberia, as well as a revision of herbarium

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collections brought some records of previously neglected species (Fedosov *et al.*, 2009, Fedosov & Ignatova, 2011), and also previously undescribed *O. dagestanicum* (Fedosov & Ignatova, 2010). Most of new findings were made during an extensive revision of herbarium material in the course of preparation of the fourth volume of “The moss flora of Russia”. The study focused on *Ulota* is considered separately (Fedosov & Ignatova, in press), as well as an integrative taxonomical study of north Siberian *Orthotrichum* (Fedosov *et al.*, 2017, see this volume), while the additions to the list of Orthotrichaceous mosses of Russia, which are mostly based on the Caucasian and south Siberian material, are captured here.

Lewinskya transcaucasica Eckstein, Garilleti & F. Lara, *Journal of Bryology* 37: 2. 2017.

Figs. 1–2; 3: A,C,E–G; 9

Plants rather large, greyish- or olive-green above, blackish below, in compact cushions. *Stems* 1–1.8 [–2.6] cm, dichotomously branched, weakly tomentose in lower part. *Leaves* erect, stout, slightly curved to flexuose distally, spreading when wet, 2.4–3.8×0.5–0.8 mm, lanceolate, acute to acuminate; margins recurved from base to ca. 4/5 of leaf length; *costa* ending just below apex, in upper leaves percurrent to excurrent as a short mucro, papillose on adaxial surface; upper and median *leaf cells* 12–25×10–15 µm, irregularly polygonal to subquadrate, moderately thick-walled, with 1–2(–3) high, simple papillae, basal leaf cells 45–75×10–15 µm, with irregularly incrassate longitudinal walls, poorly colored, smooth, along margins shorter, quadrate to short rectangular, with thinner walls. *Cladautoicous*. *Setae* 1.2–1.4 mm. *Capsules* emergent to short exserted, rather short, ca. 1.2–1.5 mm long, ovate, smooth, slightly narrowed toward mouth, with more or less expressed neck, pale yellow to brownish. Stomata superficial. Peristome double. *Exostome teeth* in 8 pairs, fused, mostly split, but still pairwise arranged when mature, reflexed and appressed to capsule wall when dry, bright orange, fenestrate distally, with outer surface (OPL) finely papillose throughout and inner surface (PPL) with papillae arranged in longitudinal rows and often fused by their bases or even almost totally, forming crest-like ridges in proximal and middle part of teeth, more evenly papillose distally with coarse to fine papillae. *Endostome* of 8 nodose to even segments, composed of two cell rows, smooth on outer surface, densely papillose on inner surface. *Operculum* red-rimmed basally, rostrate. Spores papillose, brownish, 28–32 µm. *Calyptra* mostly conic, opaque, yellow, brownish distally, densely covered with rather short hairs.

Differentiation. With its combination of completely smooth, emergent to shortly exserted capsules, exostome teeth fused in pairs, but often cleft with age, and eight endostome segments, *L. transcaucasica* is intermediate between *L. striata* (Hedw.) F.Lara, Garilleti & Goffinet and *L. elegans* (Schwägr. ex Hook. & Grev.) F. Lara, Garilleti & Goffinet, but can be separated from both these

species due to rather short, oblong or ovate capsules and orange exostome teeth. From the first species it differs also in having mostly 8 endostome segments vs. 16 (see, however, the section “variation” below). Exostome teeth are mostly free in mature capsules of *L. transcaucasica*, while in *L. elegans* they remain paired; endostome segments in *L. transcaucasica* are often nodulose to appendiculate proximally vs. even in *L. elegans*. Emergent to shortly exserted capsules in *L. transcaucasica* provide a distinction from species with rather immersed capsules, e.g. *L. vicaria* (Laz.) F. Lara, Garilleti & Goffinet, *L. acuminata* (H. Philib.) F. Lara, Garilleti & Goffinet, and *L. dasymitria* (Lewinsky) F. Lara, Garilleti & Goffinet. For more detailed comparison with similar Holarctic *Lewinskya* species see Eckstein *et al.* (2017).

Variation. The Russian specimens from the Caucasus and Altai (Chemal) fit the protologue in most respects, though slightly differ in absence of forked papillae, shorter capsules with weaker expressed neck, and predominantly nodulose endostome segments. Since the mature opened capsules in our specimens are old, the orange color of the exostome is not that bright, but teeth are still remarkably darker than, for instance, in *L. striata* and *L. elegans*.

Teeth are very fragile in *L. transcaucasica* and in many collections most capsules have only small teeth remnants around the mouth. Thus the counts of endostome segments is possible only in capsules immediately after operculum removal. However the number of such observation is low, as most collections in herbaria are made in summer, when capsules are already partly opened and partly too young for peristome study. Few studied this way capsules from Dagestan possess only eight segments (Fig. 1: 5), although 16 segments may occur in *L. transcaucasica* according to protologue (Eckstein *et al.*, 2017).

At the same time, 16 segments more commonly occur in Siberian plants, which are similar to *L. transcaucasica* in emergent ovate capsules, orangish peristome and peculiar crest-like ornamentation on the inner surface of exostome teeth (Fig. 3: A, C, G). They have eight longer, more robust segments, and 8 shorter, rather slender segments between them (Fig. 2: 6). Often it is not clear if endostome originally had 8 segments, or fragile shorter segments have fallen off (Fig. 4); however, the study of operculate capsules revealed 16 segments in many collections. Caucasian and Siberian plants are also different in exostome: the former often have teeth becoming free with age (Fig. 3: A), while in the latter teeth remain more closely paired (Fig. 4), being adjoined at bases, while their distal parts are free. Siberian plants also have smaller spores, 21–26 µm vs. 28–32 µm in our Caucasian and one Altai (Chemal) collections. Ten studied Siberian specimens, mostly with broken off peristomes, are not enough to decide either they represent a distinct taxon (or maybe taxa?) or fall in range of *L. transcaucasica* variation. Below these specimens are named *L. cf. transcaucasica*, admitting a putative separate status from *L. transcaucasica* s. str.

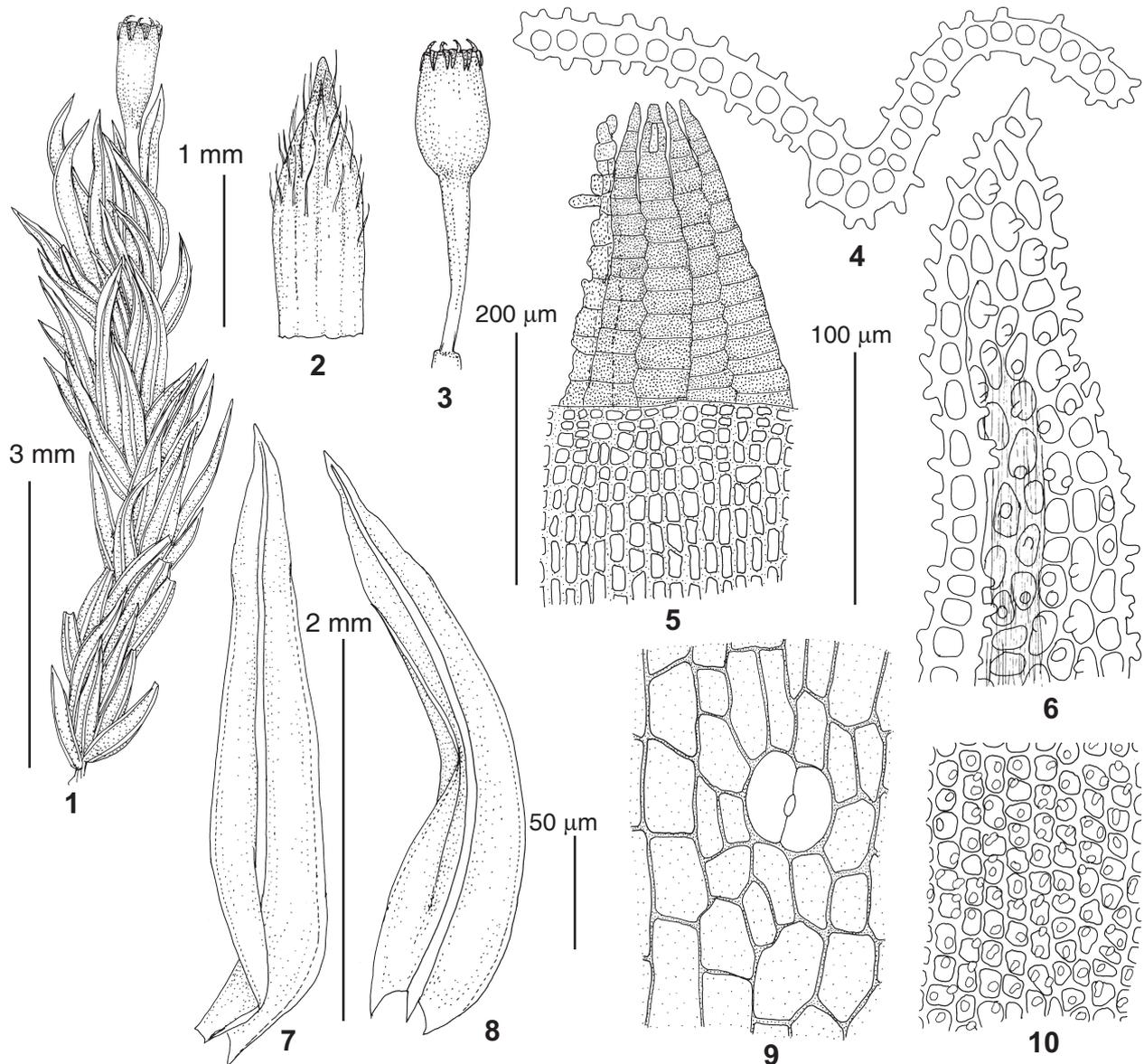


Fig. 1. *Lewinskya transcaucasica* (from: Russia, Dagestan, Gunib, *Abakarova 11-959*, MHA). 1 – habit, dry; 2 – calyptra; 3 – capsule; 4 – leaf transverse section; 5 – peristome from outside and exothecium; 6 – apical portion of leaf; 7–8 – leaves; 9 – exothecial cells and stoma; 10 – median laminal cells. Scale bars: 3 mm for 1; 2 mm for 7–8; 1 mm for 2–3; 200 μm for 5; 100 μm for 6, 10; 50 μm for 4, 9.

Distribution and ecology. *Lewinskya transcaucasica* was recently described from Georgia (Eckstein *et al.*, 2017; Eckstein & Zündorf, 2017), thus here we provide the first range extension of this species. In Russia it was found twice, in Gunib Settlement surroundings, Inner Mountain Dagestan, and in Altai Mts, Chermal Creek. The first locality is ca. 100 km eastward from the closest locality in Georgia. According to Eckstein *et al.* (2017), *L. transcaucasica* grows in birch, oak, willow and rowan forests, mostly within the elevation range of 1700–2300 m, while in Dagestan it was found on birch trunks at ca. 1600 m a.s.l., in the area with rather high amount of annual precipitation, ca. 600 mm; in details the area and its moss flora are discussed by Ignatov *et al.* (2010). Similar

to Georgia, in the area where the species was found in Dagestan, *L. striata* and *L. vladikavkana* (Venturi) F. Lara, Garilleti & Goffinet are the most frequent species of *Lewinskya*, thus indicating that in fact in the Ciscaucasian region *L. transcaucasica* occupies similar environments and that it likely occurs also in other areas of North Caucasus, particularly in North Ossetia. The second locality, in Altai Mts, is strongly isolated from the main area of the species distribution, but since the same pattern of distribution is observed in *L. vladikavkana*, the occurrence of *L. transcaucasica* in Altai is not surprising.

The specimens of the *L. transcaucasica* affinity discussed above are corticolous, growing on aspen, alder, birch, spruce, bird cherry, *etc.*, in rather xeric environ-

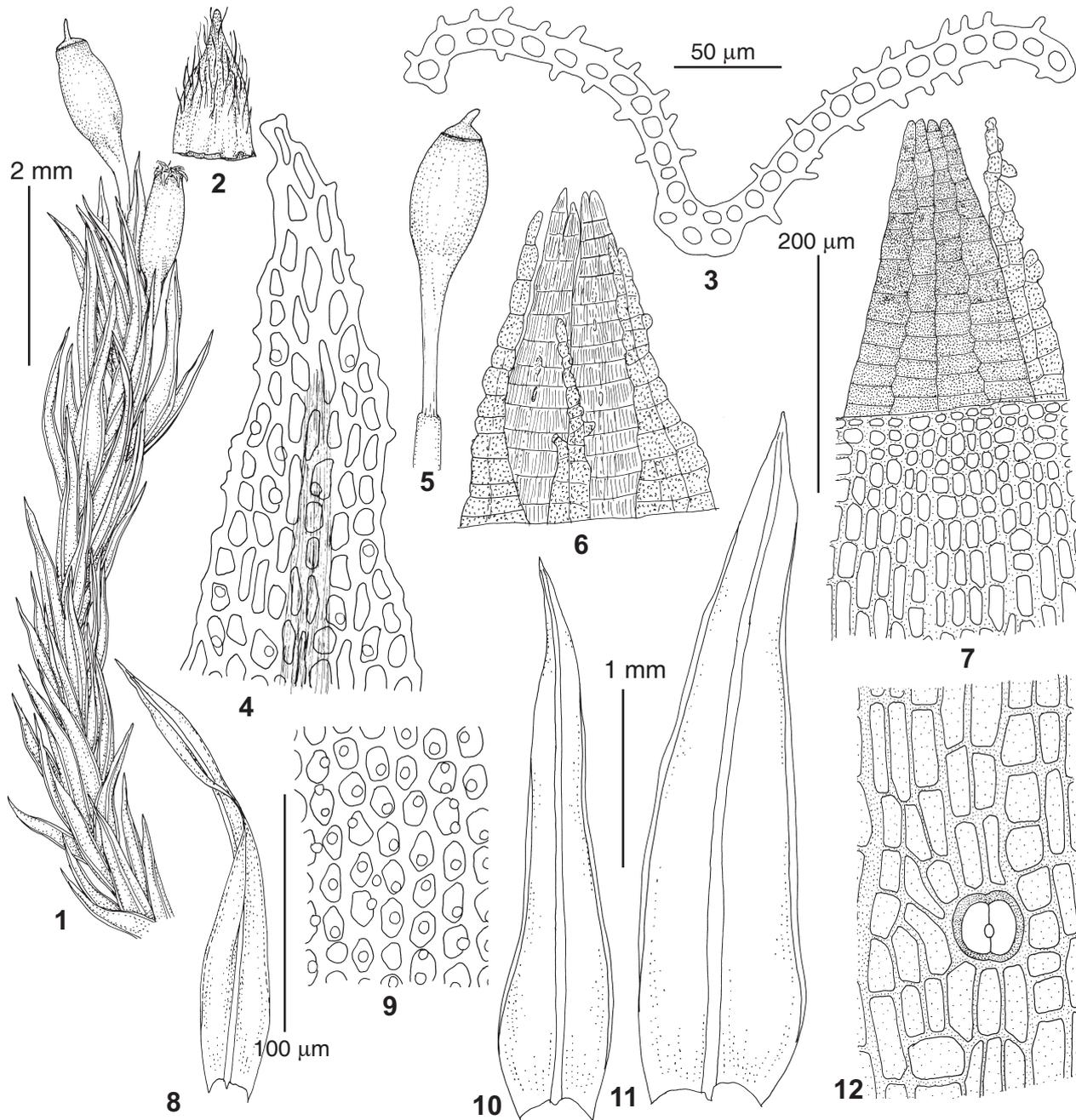


Fig. 2. *Lewinskya* cf. *transcaucasica* (from: Russia, Republic of Buryatia, Kurumkansky Distr., Dzherginsky State Reserve, 10.VII.2002, *Tubanov* 5(II), MW). 1 – habit, dry; 2 – calyptra; 3 – leaf transverse section; 4 – apical portion of leaf; 5 – capsule; 6 – peristome from inside; 7 – peristome from outside and exothecium; 8, 10–11 – leaves; 9 – median laminal cells; 12 – exothecial cells and stoma. Scale bars: 2 mm for 1–2, 5; 1 mm for 8, 10–11; 200 µm for 6–7; 100 µm for 4, 9; 50 µm for 3, 12.

ments at the altitudinal range 400–1100 m. Apparently, this taxon is rather widespread in continental Siberia and southern part of Russian Far East, and most records of *L. striata* from this area in fact should be referred to *L. cf. transcaucasica*. In Altai area both species occur, but *L. striata* inhabits moist, shady forests, where *Ulota rehmannii* Jur. also grows, while *L. cf. transcaucasica* occurs in more xeric and exposed environments.

Specimens examined: *L. transcaucasica* s. str.: CAUCASUS: **Dagestan Republic**, Gunib Distr., near Field Station of

Gorny Botanical Garden, near health camp (42°25'N, 46°55'E, 1600 m. alt.), on birch, 27.IX.2011 *Abakarova* 11-959 (DAG, MHA). ASIAN RUSSIA: **Altai Republic**, Altai Mts., Chermal Creek vicinity, 51°23'N – 86°04'E, 450 m. alt., pine forest, on birch trunk, 12.VII.1993 Ignatov & Ignatova (MHA).

L. cf. transcaucasica: ASIAN RUSSIA: **Altai Republic**: Ulagan Distr., Chulyshman River ca. 6 km upstream its mouth, 51°18'N – 87°43'E, on birch at the edge of birch forest, 17.VIII.2012, *Ignatov & Ignatova* 12-538 (MHA); Turochak Distr., Yajlyu Area, on rowan near lake shore, 2.VI.1989, *Ignatov* (MHA); Ust'-Koksa Distr., left slope of Katun River

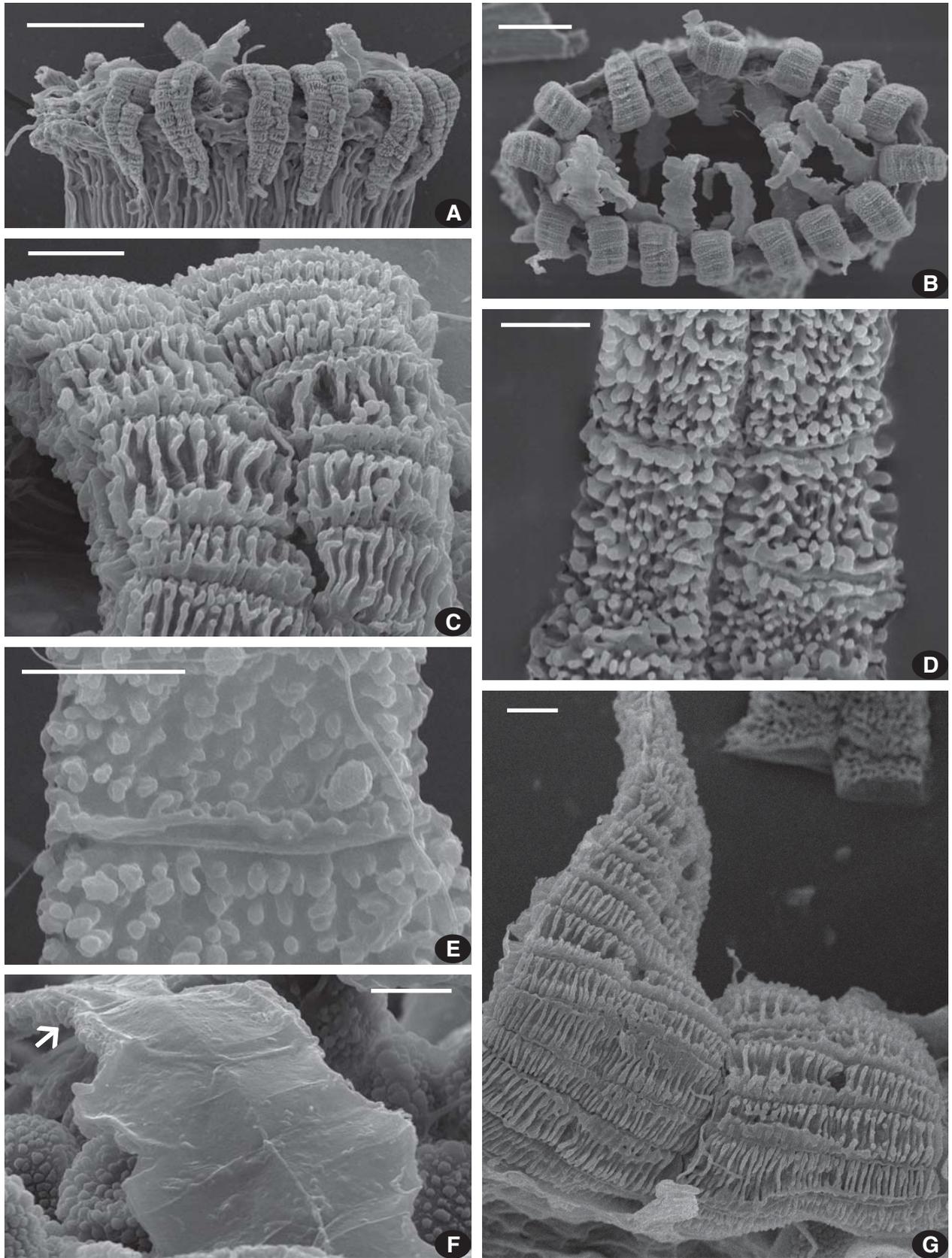


Fig. 3. Peristomes of *Lewinskya*. A, C, E: *L. transcaucasica* (Dagestan, *Abakarova 11-959*, MHA); B, D: *L. striata* (Karachay-Circassian Republic, *Ignatov & Ignatova 05-3525*, MW); F, G: *L. cf. transcaucasica* (Buryatia, 10.VII.2002, *Tubanova 5(II)*, UUH). A, B – peristomes; C, D, G: inner surface of exostome teeth; E: outer surface of exostome teeth in distal part; F: outer surface of endostome segment with partly seen papillose inner surface (arrowed). Scale bars: 100 μ m for A, B; 10 μ m for C–G.

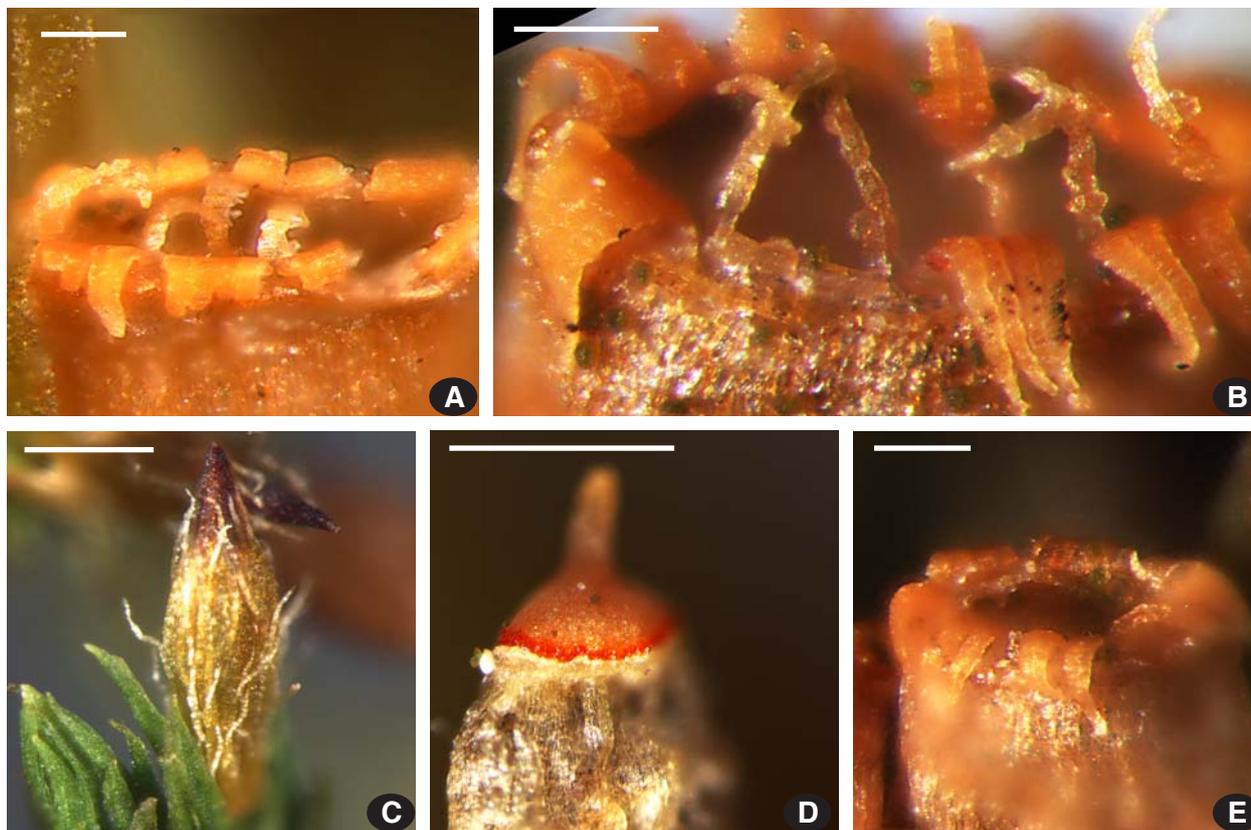


Fig. 4. *Lewinskya* cf. *transcaucasica*: A: Khabarovsk Territory, Bureya, *Ignatov M-311* (MHA); B: Altai, Yailyu, 2.VI.1989, *Ignatov s.n.* (MHA); C: Altai, Kaitanak, *Ignatov & Ignatova 12-810* (MHA); D: Buryatia, Kovyli River, 10.VII.2002, *Tubanova 5(II)* (UUH); E: Altai, Chulyshman River, *Ignatov & Ignatova 12-538* (MHA). A, B, E – peristomes; C – hairy calyptra; D – operculum with red rim. Scale bars: 0.5 mm for C, D; 100 μ m for A, B, E.

valley 5 km upstream Kaitanak Creek mouth, 50°05'N – 85°27'E, 21.VIII.2012, *Ignatov & Ignatova 12-810* (MW 9051379). **Krasnoyarsk Territory, Taimyr municipal District**, left bank of Maymecha River in middle course, ca. 500 m downstream Chopko Creek mouth, 70.8373°N – 100.999°E, ca. 30 m a.s.l., 20.VI.2009, *Fedosov* (MW 9051627). **Republic of Buryatia**, Kurumkansky Distr., Dzherginsky State Reserve, 55°07'N – 111°33'E, 1040 m alt., Kovyli River valley, 10.VII.2002, *Tubanova 5(II)* (UUH). **Zabaikalsky Territory**, Kalarsky Distr., Kodar Range near Leprindo Lake, Pereval'nyi Creak, 56°36'23"N – 117°17'05" E, alt. 1062 m., 9.VIII.2012, *Afonina 8912* (LE); Krasnochikoiskiy Distr., bank of Chikoy River, 50°33'38"N – 109°31'52"E, alt. 790 m., 13.VIII.2011, *Czernyadjeva 26-11* (LE). **Amur Province**, Zeysky Distr., Zeysky State Reserve, vicinity of the 52 km field station, 54.082039°N – 126.887904°E, 760 m a.s.l., 6.VII.2013, *Dudov* (MW 9078415). **Khabarovsk Territory**, Bureinsky State Reserve, Levaya Bureya River 1–2 km upstream of Kuraigagna Creek mouth, 51°58'N – 134°52'E, 840 m a.s.l., 21.VIII.1997, *Ignatov M-311* (MHA).

***Orthotrichum crenulatum* Mitt.**, J. Proc. Linn. Soc., Bot., Suppl. 1: 48. 1859. Figs. 5–6, 9

Plants small, dark-green, brownish to blackish, in compact tufts. *Stems* 0.3–0.6 cm, mostly simple, weakly tomentose in the basalmost part, shoots more or less ju-laceous. *Leaves* straight, appressed or spread when dry, erect to spreading when moist, 1.6–2.2×0.6–0.9 mm, rath-

er short, ovate to ovate-lanceolate or lingulate, concave, rounded or obtuse at apex, upper leaves occasionally acute; *costa* ending just below leaf apex, indistinct, mostly smooth on abaxial surface; lamina unistratose; margins entire or slightly crenulate distally due to protruding papillae and transverse cell walls, widely revolute on both sides from base nearly to apex; upper and median *laminal cells* mostly isodiametric, 12–16(–18)×14–18 μ m, moderately thick-walled, with scattered, simple, low papillae; basal laminal cells short rectangular, (16–)20–36 (–40)×12–17 μ m, shorter toward margins, thin-walled, smooth, mostly hyaline. *Brood bodies* in most cases are very abundant, at least on some plants, born on both leaf surfaces, making leaves to look powdery, elongate to filiform, green to brownish, uniseriate, not branched. *Cladautoicous*. Perichaetial leaves not differentiated. *Setae* ca. 0.2–0.3 mm. *Capsules* immersed to shortly emergent, oblong-cylindrical, later urceolate, mostly 1.2–1.4 mm long, reddish-brown, deeply 8-furrowed at nearly entire urn length, constricted below mouth, rather gradually narrowed to seta. *Stomata* slightly covered by subsidiary cells; exothecial bands of 4–6 cells rows. Peristome double. *Exostome teeth* in 8 pairs, not split when mature, reflexed and appressed to capsule wall when dry, orange-red to brown; outer surface (OPL) finely papillose, papillae becoming looser distally; inner surface

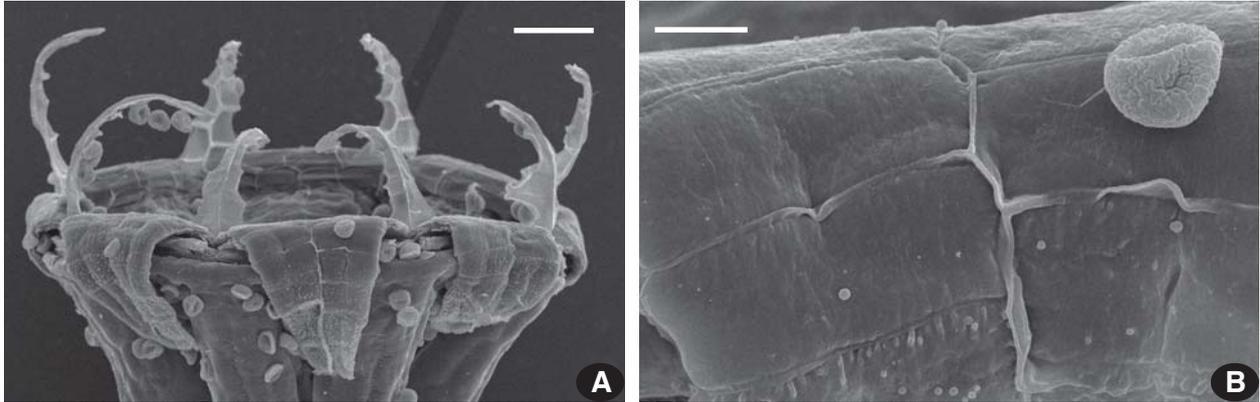


Fig. 5. *Orthotrichum crenulatum* (from: Russia, Zabaikalsky Territory, Maleta, Afonina 0911, LE). A – peristome; B: inner surface of exostome tooth in its proximal part. Scale bars: 50 μ m for A; 10 μ m for B.

(PPL) nearly smooth. *Endostome* of 8 yellow to brownish segments ca. 2/3 of the teeth length, of 2 cell rows, keeled, occasionally united proximally into the basal membrane, weakly appendiculate, smooth. *Operculum* flat, with rather long beak. *Spores* papillose, 14–18 μ m. *Calyptra* conic-campanulate, opaque, rich golden, naked, distinctly plicate.

Variation. Russian specimens of *O. crenulatum* are quite variable in leaf shape: some specimens have most of leaves rounded to obtuse, while in others considerable amount of acute leaves occur, especially in upper part of stems. In addition, Russian specimens differ from most Asian ones in having unistratose leaf lamina, which is occasionally partly bistratose in plants from SE Asia (Lewinsky, 1992) and typically partly bistratose in plants from Middle Asia (Plášek *et al.*, 2014).

Differentiation. With its peculiar dark green coloration, ovate to ovate-lanceolate, mostly rounded or broadly acute leaves, broadly revolute leaf margins and stomata slightly covered by subsidiary cells, *O. crenulatum* is a remarkable species, quite distinct from other representatives of the genus in Russia. However, several specimens from Republic of Buryatia are rather hard to interpret due to mostly acute upper leaves, though lower leaves are typical for the species. Morphologically *O. crenulatum* resembles recently described *O. pamiricum* Plášek & Sawicki, which also has unistratose leaf lamina, but differs from *O. crenulatum* in having 16 endostome segments (Plášek *et al.*, 2014). Among *Orthotrichum* species with rather broad, ovate, obtuse to rounded at apex leaves, there is also quite peculiar species, *O. rivulare* Turner; it occurs in Western Europe and Western North America, growing along streams. It differs from *O. crenulatum* in 16 endostome segments and papillose calyptrae vs. 8 segments and smooth calyptrae. Besides this, plants of *O. rivulare* are robust, 1–2 cm high vs. remarkably smaller plants of *O. crenulatum*. One more similar species from this group, European *O. sprucei* Mont., which was found in Kazakhstan (Goffinet, 2002), differs from *O. crenulatum* in having emergent to slightly exerted capsules, smooth distal leaf cells and stomata almost fully covered by subsidiary

cells vs. immersed to emergent capsules, papillose distal leaf cells and stomata half-covered by subsidiary cells. Furthermore, with its small plant size, dark green coloration, rather short, often obtuse to acute leaves, revolute leaf margins, immersed, strongly ribbed capsules and peristome constitution, *O. crenulatum* can resemble Asian specimens of *O. pumilum* affinity. This complex differs from *O. crenulatum* in having leaves, which are never rounded, and stomata strongly covered by the subsidiary cells. Since *O. crenulatum* often grows in the same environments and habitats as *Nyholmiella obtusifolia* (Brid.) Holmen & E. Warncke and is somewhat similar in leaf shape and numerous gemmae, these species can be confused, though they can be easily distinguished due to coloration (yellowish or olive-green in *N. obtusifolia* vs. mostly dark green to blackish in *O. crenulatum*) and leaf margin (plane in *N. obtusifolia* vs. revolute in *O. crenulatum*).

Distribution and ecology. *Orthotrichum crenulatum* is a Central Asian species, known from Afghanistan, Pakistan, Kyrgyzstan, Kazakhstan, South Siberia, North India (Kashmir), Turkestan, and West Tibet, with isolated locality in Japan (Lewinsky, 1992; Suzuki, 2014). In Russia, it occurs in xeric areas of Transbaikalia and Buryatia, growing in flood plains, mostly on elm (*Ulmus pumila*), willow and poplar trunks.

Specimens examined: ASIAN RUSSIA: **Republic of Buryatia:** Tarbagatay Distr., Desyatnikovo Settlement, 11.VIII.1988, *Bardunov s.n.* (LE); Dzhidinsky Distr., Dzhida River valley westward of Selger Range, 50°34'31.4"N – 105°57'43.7"E, 600 m alt., 17.VII.2010, *Tubanova Dzh-16/1006* (MW); Bichursky Distr near Posel'e Village, 50°36'17.6"N – 107°53'21.4"E, 620 m alt., Hilok Creek bank, *Tubanova Bu-5/1103* (MW); same area, Malkhansky Range spurs near Bichura Village, 50°34'58.9"N – 107°36'23.7"E, 690 m alt., 24.VIII.2011, *Tubanova Bi-9/1105* (MW); same place, 23.VIII.2011, *Tubanova Bi-3/1106* (MW). **Zabaikalsky Territory:** NizhyTsasuchei, valley of Onon River, ~50°31'N – 114°59'E, 1.VIII.1988, *Bardunov s.n.* (LE); Uloty Distr. vicinity of Ablatukan Village, 51°14'41"N – 112°07'18"E, 17.VIII.1964, *Bardunov s.n.* (LE); Petrovsk-Zabaikalsk Distr., near Maleta Settlement, 50°49'34"N – 108°26'34"E, 677 m alt., 8.VIII.2011, *Afonina 0911* (LE); Ononsky Distr., vicinity of Durulgy Settlement, 50°20'N – 114°22' E, 648 m alt., 29.VII.2005, *Afonina 6505* (LE).

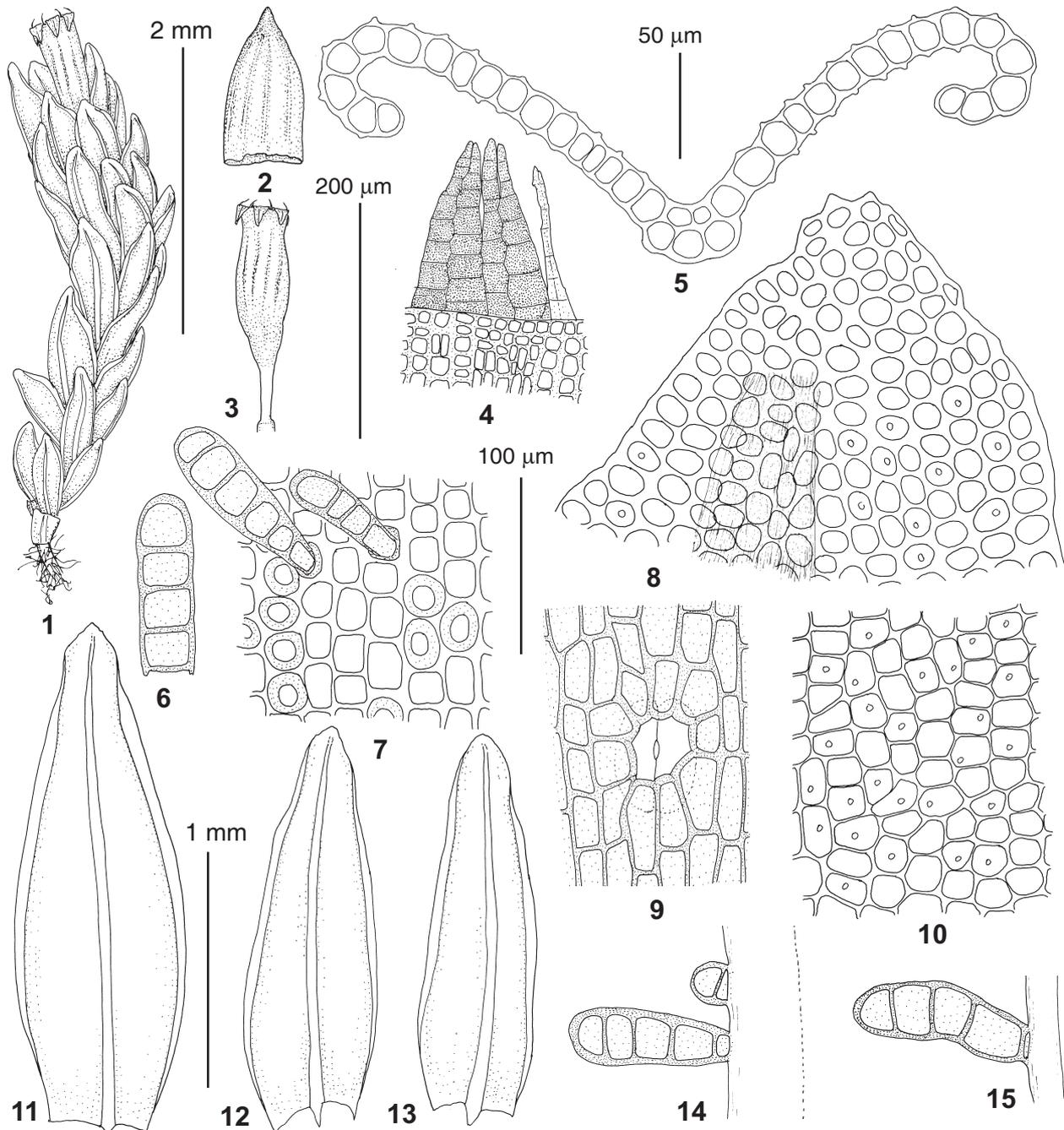


Fig. 6. *Orthotrichum crenulatum* (from: Russia, Republic of Buryatia, Dzhidinsky Distr., 17.VII.2010, *Tubanova Dzh-16/1006*, MW). 1 – habit, dry; 2 – calyptra; 3 – capsule; 4 – peristome from outside and exothecium; 5 – leaf transverse section; 6 – gemma; 7 – gemmae on leaf lamina; 8 – apical portion of leaf; 9 – exothecial cells and stoma; 10 – median laminal cells; 11–13 – leaves; 14–15 – gemmae on leaf margins. Scale bars: 2 mm for 1–3; 1 mm for 11–13; 200 µm for 4; 100 µm for 6–8, 10, 14–15; 50 µm for 5, 9.

Orthotrichum tenellum Bruch ex Brid., *Bryol. Univ.* 1(2): 786. 1827.

Figs. 7, 9

Plants small, dark- to bright-green distally, brownish proximally, in compact tufts. *Stems* 0.3–0.7 cm, poorly branched, weakly tomentose in lower part. *Leaves* appressed or slightly inclined, straight or slightly curved then dry, spreading when moist, 1.4–2.0×0.3–0.5 mm, lanceolate, often with notably straight (*i.e.*, not concave) margins, shallowly keeled, obtuse, with remarkable broad,

blunt, canaliculated apiculus; margins entire or slightly crenulate, recurved from leaf base to near apex on both sides; *costa* green, rather indistinct, ending below leaf apex, smooth on abaxial surface; lamina unistratose; upper *laminal cells* isodiametric, 8–14×9–12 µm, round, round-hexagonal or round-rhomboidal, rarely slightly elongate or transversely elongate, mostly smooth or with 1–2 low simple papillae per cell, moderately thick-walled, at apex with thicker walls; cells in middle part of leaf

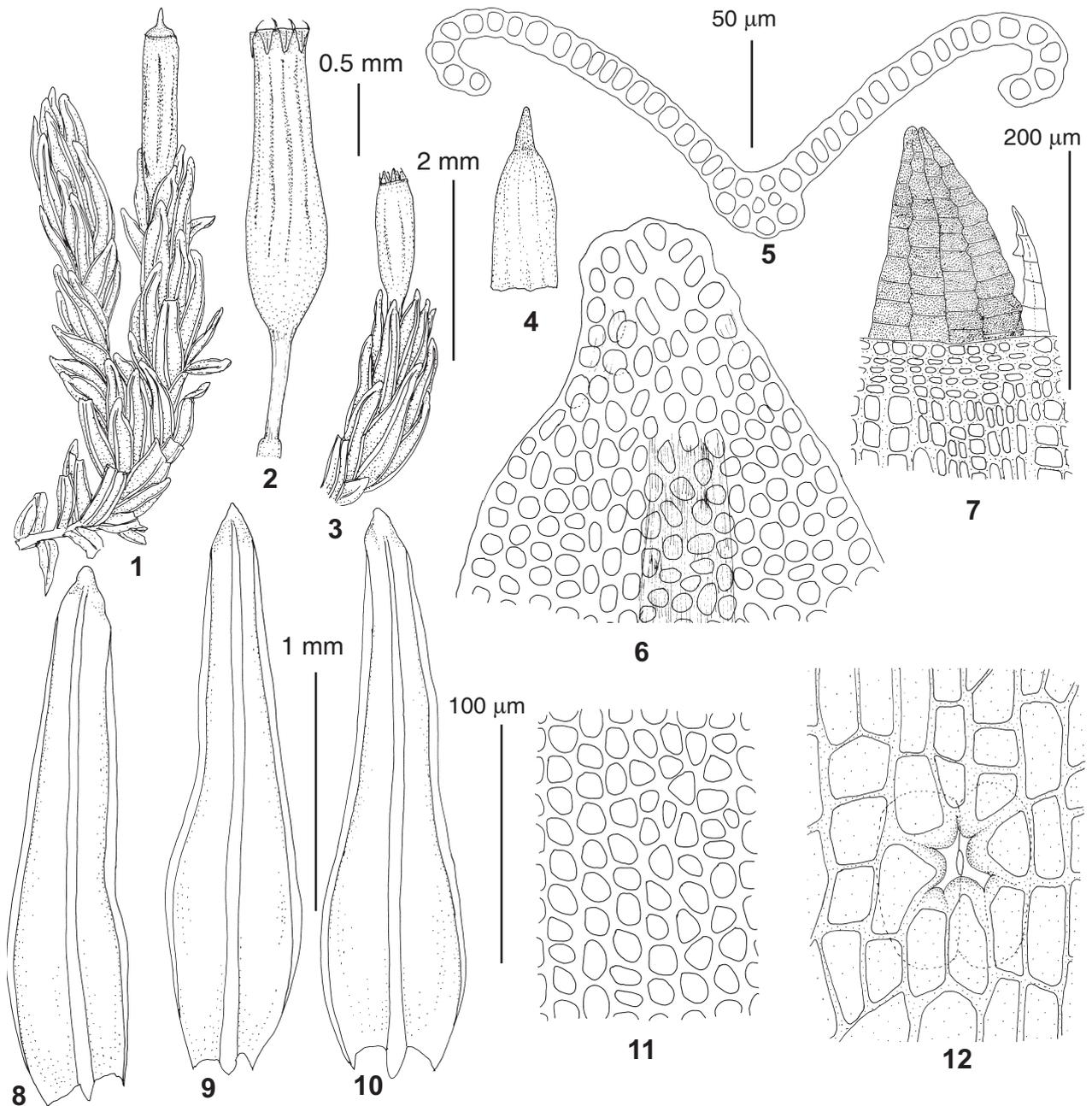


Fig. 7. *Orthotrichum tenellum* (from: Russia, Krasnodar Territory, Khosta Distr., *Ukrainskaya s.n.*, LE 13828). 1, 3 – habit, dry; 2 – capsule; 4 – calyptra; 5 – leaf transverse section; 6 – apical portion of leaf; 7 – peristome from outside and exothecium; 8–10 – leaves; 11 – median laminal cells; 12 – exothecial cells and stoma. Scale bars: 2 mm for 1, 3–4; 1 mm for 8–10; 0.5 mm for 2; 200 µm for 7; 100 µm for 6, 11; 50 µm for 5, 12.

often slightly collenchymatose, with sinuose walls; basal laminal cells rectangular, (12–)16–24(–30)×7–12 µm, thin- or moderately thick-walled, smooth, poorly colored, somewhat narrower and shorter toward margins, short-rectangular to subquadrate, with thickened transverse walls along margin. *Goniautoicous*. Perichaetial leaves not differentiated. *Vaginula* mostly naked or with few short hairs. *Setae* 0.2–0.4 mm, straight. *Capsules* immersed to emergent, 1.4–1.8 mm long, rather long cylindrical, later urceolate, yellowish, later reddish-brown, deeply 8-furrowed at nearly entire urn length, urns abruptly or gradually narrowed to the seta, weakly and gently

constricted in upper part. *Stomata* immersed, strongly covered by subsidiary cells; exostome bands mostly of 4 cells rows. Peristome double, prostome not observed. *Exostome teeth* in 8 pairs, not split when mature, reflexed and appressed to capsule wall when dry, orange-red; outer surface (OPL) finely papillose; inner surface (PPL) indistinctly striolate to nearly smooth proximally, loosely papillose distally. *Endostome* of 8 rather broad, keeled, mostly hyaline, smooth segments. *Operculum* with rather long beak. *Spores* papillose, brownish, 14–18 µm. *Calyptra* campanulate, whitish, indistinctly 8-plicate, naked, smooth.

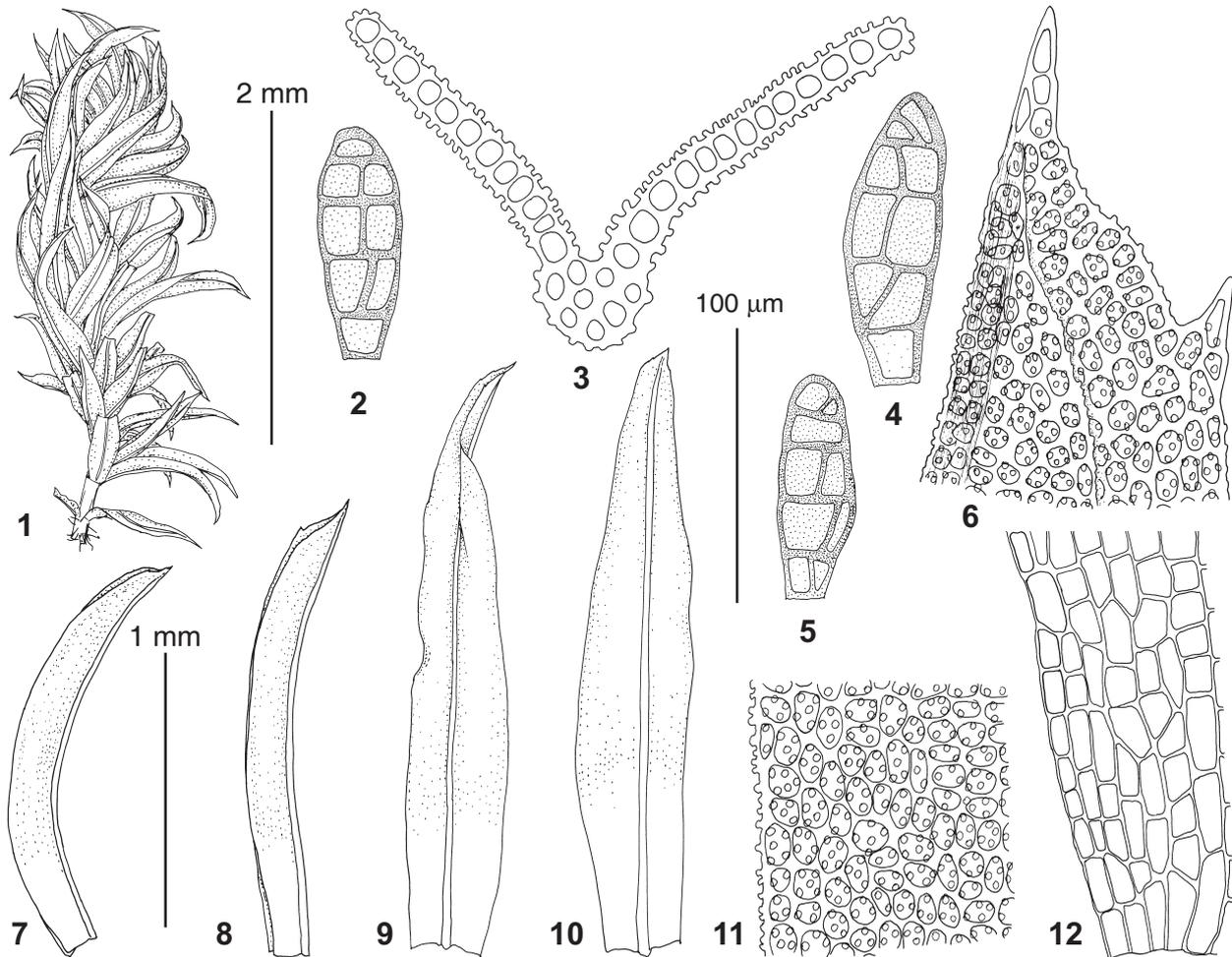


Fig. 8. *Zygodon dentatus* (from: Russia, Karachay-Circassian Republic, Firsikha River, 22.VII.2010, *Ukrainskaya s.n.*, LE). 1 – habit, dry; 2, 4–5 – gemmae; 3 – leaf transverse section; 6 – apical portion of leaf; 7–10 – leaves; 11 – median laminal cells; 12 – basal laminal cells. Scale bars: 2 mm for 1; 1 mm for 7–10; 100 µm for 2–6, 11–12.

Variation. In Europe, the species usually has hairy calyptrae (Lewinsky-Haapasaari, 1995; Smith, 2004) with papillose hairs concentrated in the apical zone (Lönnell, 2008; Lara *et al.*, 2009), while all Russian specimens have naked calyptrae. According to Vitt (2014), in North America both naked and sparsely hairy calyptrae occur. In all other respects Caucasian specimens of *O. tenellum* correspond to morphological conception of this species provided by Lewinsky-Haapasaari (1995) and Lara *et al.* (2009).

Differentiation. The most remarkable character of *O. tenellum* is the shape of leaf apex with rather broad, canaliculate, blunt tips, mostly separated from the upper leaf lamina by abrupt narrowing. Among additional characters, small distal laminal cells, rather long and narrow, strongly emergent capsules, stomata nearly completely covered by subsidiary cells, and peristome 8+8 are useful. Among the species similar in morphology, *O. pumilum* also has apiculate leaves, immersed 8-ribbed capsules with stomata strongly covered by the subsidiary cells, and similar peristome, but it differs in leaf shape (ovate to ovate-lanceolate vs. lanceolate), larger leaf cells (mostly 8–14 µm in *O. tenellum* vs. 12–18 µm in *O. pumilum*)

and shape of apiculus, which is broad, blunt and canaliculate in *O. tenellum*, but narrow, acuminate, and plain in *O. pumilum*. *Orthotrichum stellatum* Brid. differs from *O. tenellum* in having hairy vaginula and not canaliculate leaf apices. *Orthotrichum rogeri* Brid. has larger spores and stout endostome segments; *O. scanicum* Grönvall grows in nearly same area and also has long cylindrical capsules and occasionally canaliculate and denticulate leaf tips, but differs from *O. tenellum* in exostome teeth easily split into 16, then recurved, and 16 mainly appendiculate segments vs. teeth constantly arranged in pairs and 8 non-appendiculate segments in *O. tenellum*.

Distribution and ecology. *Orthotrichum tenellum* has west-western disjunctive, mainly Holarctic distribution, mostly associated with Western Europe, south of Scandinavia, North Africa, Azores and Canarians, and North American Pacific coast from British Columbia to California, though the identity of North American specimens is disputable. In Eastern limit of its Eurasian distribution, it penetrates to a humid part of Russian Black Sea coastal area, where it was collected in 1977 in lower altitudinal belt, on *Lagerstroemia indica* in dendrarium near Sochi Town, and



Fig. 9. Distribution of the newly found species of Orthotrichaceae in Russia: solid squares – *Lewinskya transcaucasica* s.str. ; open squares – *L. cf. transcaucasica*; solid circles – *Orthotrichum crenulatum*; open circles – *Zygodon dentatus*; triangles – *Orthotrichum tenellum*.

in 2003, in nearly the same area, on beech. Previously this species was reported from Kaliningrad Province, that seems to be quite reliable, but we have not seen the specimens. Sofronova *et al.* (2015) published a record of the species from St.-Petersburg City, made by E.N. Andreeva, but the specimen is absent in the herbarium.

Specimens examined: CAUCASUS: Krasnodar Territory, Sochi Town, Khostinsky Distr., Dendrium, ca. 43°33'N – 39°47'E, 50 m. alt., 28.VI.1977, *Pigurnova 280677-4* (LE); the same area, *Ukrainskaya s.n.* (LE 13828); Khosta, *Seregin M-221* (MHA).

Zygodon dentatus (Limpr.) Kartt., Ann. Bot. Fenn. 21: 346. 1984. — *Zygodon viridissimus* var. *dentatus* Limpr. Laubm. Deutschl. 2(14): 12–13. 1890. — *Zygodon viridissimus* subsp. *dentatus* (Limpr.) Amann. Fl. Mouss. Suiss. 1:196. 1916. Figs. 8–9

Plants in loose tufts, green, dark green, or olivaceous. *Stems* 3–5 mm. *Leaves* curved to contorted when dry, spreading to squarrose than wet, linear-lanceolate, (1–) 1.5–2.0×0.35–0.45 mm, acute, slightly keeled, with few denticles at apex and below it, especially distinct on young leaves; margins plane or slightly recurved proximally; *costa* ca. 50 µm wide at leaf base, reaching 0.95 of leaf length and ending below leaf apex; upper *laminal cells* 7–12 µm, round to round-hexagonal, mostly thick-walled, with 2–4 low papillae per cell, 1–3 apical cells smooth, elongate, mostly hyaline; lower *laminal cells* 10–16×8–12 µm, mostly short rectangular, smooth. *Brood bodies* abundant, clavate, born on branched stalks in leaf axils, 30×(50–)70–75(–85) µm, composed of (4–)5–7(–9) cells with longitudinal, oblique and transverse walls (longitudinal and ob-

lique walls usually are thinner and paler than brownish transverse walls). *Sporophytes* unknown in Russia.

Differentiation. *Zygodon dentatus* differs from other Holarctic species of the genus in combination of denticulate upper leaf margins and gemmae with longitudinal, sometimes curved walls. Rather robust plants and rather long leaves also differ it from other Russian *Zygodon* species (Vitt, 2014). Denticulate leaf apex also occurs in European *Z. gracilis* Wils. and American *Z. reinwardtii* (Horns.) Braun. According to Smith (2004), *Z. gracilis* differs from *Z. dentatus* in absence of gemmae and growth on limestone rocks vs. abundant gemmae and corticolous growth, mostly on *Fagus*. Unlike all Russian species of the genus *Zygodon*, *Z. reinwardtii* is characterized by autoicous or synoicous sexual condition; moreover, its gemmae lack longitudinal cell walls (cf. Vitt, 2014). In constitution of gemmae, *Z. dentatus* resembles *Z. viridissimus* (Dicks.) Brid., but differs from the latter in denticulate leaf apices.

Zygodon dentatus is a rather rare and insufficiently known species, which for a long time has been considered as a variety of widespread *Z. viridissimus*. It occurs mostly in Europe (being rather frequent in southern Scandinavia and Alps) with isolated locality in North America (Arizona), and penetrates eastward to Ukraine (Virchenko, 2005) and Georgia (Dylevskaja, 1967). In Russia, it was found in a single locality in Karachay-Circassian Republic, where it was collected on tree trunk in montane beech and hornbeam forest, at a moderate elevation.

Specimens examined: CAUCASUS: Karachay-Circassian Republic, Firsikha River (left tributary of Urup River), 43°46'N – 41°09'E, 1000–1500 m a.s.l., on beech bark, 22.VII.2010, *Ukrainskaya s.n.* (LE).

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