Arctoa (2011) **20**: *197-204*

ON ORTHOTRICHUM PELLUCIDUM AND O. HALLII (ORTHOTRICHACEAE, BRYOPHYTA) IN RUSSIA

ОБ ORTHOTRICHUM PELLUCIDUM И O. HALLII (ORTHOTRICHACEAE, BRYOPHYTA) В РОССИИ

VLADIMIR E. FEDOSOV[1] & ELENA A. IGNATOVA[1]

ВЛАДИМИР Э. ФЕДОСОВ[1], ЕЛЕНА А. ИГНАТОВА[1]

Abstract

As a result of re-examination of specimens of *Orthotrichum cupulatum* Brid. and *O. pellucidum* Lindb. from Russia a rare xeric species, *O. hallii* Sull. & Lesq., was identified from Tyva Republic, southern Siberia; it is new for the moss flora of Russia. Some new localities of *O. pellucidum* in Russia were also revealed. The description and illustration of Russian specimens are provided, distinctive features of species morphology and their distribution are discussed. *Orthotrichum hallii* differs from *O. pellucidum* in completely bistratose leaf lamina, mostly simple papillae and generally southern distribution, associated with xeric regions of Asia and North America, while the latter species is known mainly from Arctic and Subarctic territories, representing a circumpolar distribution.

Резюме

В результате ревизии российских коллекций, определенных как *Orthotrichum cupulatum* Brid. и *O. pellucidum* Lindb., обнаружен новый вид для флоры мхов России, *O. hallii* Sull. & Lesq., характерный для засушливых областей Голарктики; образец был собран в Республике Тува, в Тоджинской котловине и ранее определен как *O. pellucidum*. Также был выявлен ряд новых местонахождений *O. pellucidum* в России. Приводятся описания и иллюстрации российских образцов, обсуждаются отличия в морфологии и распространении видов. В отличие от *O. pellucidum*, *O. hallii* характеризуется полностью двуслойным в верхней части листом с простыми низкими папиллами и южным распространением, в то время как достоверные местонахождения *O. pellucidum* известны в основном в Арктике и Субарктике.

KEYWORDS: *Orthotrichum hallii*, *Orthotrichum pellucidum*, Orthotrichaceae, moss flora, Russia, arctic species, xeric species, rare mosses.

Since a first check-list of mosses of the former USSR (Ignatov & Afonina, 1992) was published, a number of species of Russian moss flora has increased considerably. It has became a result of active floristic investigation of different territories (e.g., Russian Far East, Taimyr, southern Siberia, the Caucasus, etc.), as well as taxonomic revision of some groups. The genus *Orthotrichum* is still waiting for such a revision in Russia. However, several of its species new for the Russian moss flora have been revealed recently (Ignatov & Levinski-Haapasaari, 1994; Akatova et al., 2004; Fedosov et al., 2009) and two species were described as new for science: *O. furcatum* T. Otn. (Otnyukova, 2001) and *O. dagestanicum* Fedosov & Ignatova (Fedosov & Ignatova, 2010).

[1] – Moscow State University, Biological Faculty, Geobotany Dept., Moscow 119991 Russia – Россия 119991, Москва, Московский университет, Биологический факультет, каф. геоботаники; E-mails: fedosov_v@mail.ru; arctoa@list.ru

A present study is based on a revision of herbarium collections of *O. cupulatum*, *O. pellucidum* and partially of *O. anomalum* from MW, MHA and LE. A new species for the Russian moss flora, *O. hallii* Sull. & Lesq., was identified from collections of *O. pellucidum*. It was collected in Todzha Depression in the Republic of Tyva, southern Siberia and at first identified as *O. anomalum* Hedw. and later transferred to *O. pellucidum*. It is worth noting that this specimen represents a mixture of two rare and interesting species, the second one being *O. furcatum*. At the same time, some specimens previously identified as *O. cupulatum*, appeared to be *O. pellucidum*. As these species were a subject of confusion, we provide the description and illustrations of *O. hallii* and *O pellucidum* on the basis of specimens from Russia and a comparison of these species with *O. cupulatum* and *O. anomalum*. All these species share such characters as immersed stomata, ribbed capsules and striate to papillose-striate outer surface of exostome teeth.

Orthotrichum hallii Sull. & Lesq., Icon. Musc. Suppl. 63. 45. 1874. Figs. 1, 3.

Plants dull, yellowish green in upper part, light brownish below. Stem ca. 1 cm long. Leaves stiff, erect-appressed when dry, straight, elongate-lanceolate to lanceolate, 1.3-2.5×0.45-0.65 mm, bluntly acute to narrowly obtuse; margins recurved from somewhat above base to ca. 3/4 the leaf length, plane near apex, entire; distal lamina 2-stratose, rarely with a few 1-stratose areas, distal and median laminal cells rounded-hexagonal to elliptic, 7-12×7-10 µm, thick-walled, opaque, with 1-3 small conical papillae per cell, rarely with admixture of low forked papillae; basal laminal cells rectangular to short-rectangular, 25-40×8-12 µm, thin-walled, gradually becoming shorter at margins. Sexual condition goniautoicous. Setae 0.5-1 mm. Capsules emergent, urns oblong, 1-1.5 mm, 8-ribbed 1/2 to entire length, [rarely with 8 very short intermediate ribs]; stomates immersed; peristome double;exostome teeth in 8 pairs, sometimes irregularly split to 16, spreading when old, rarely reflexed, ca. 250 µm long, striate with small admixture of low papillae [or papillose-striate]; endostome segments 8, short, papillose [or finely longitudinally striate]. Calyptrae plicate, sparsely hairy. Spores 12 [10-18] µm.

Specimen examined: RUSSIA, **Tyva Republic**, Todzha Depression, Kadysh Lake southern shore, 4.IX.1999, *Otnyukova s.n.* (LE, duplicate from KRF).

Distribution. Until recently *O. hallii* has been considered to be an endemic species of the Western North America. It occurs in xeric mountain regions from British Columbia to South Dakota, Colorado and New Mexico (Vitt, 2009, Harpel, 2010). In Asia it was found for the first time in the Altai Mts. in Xinjiang Province of China (Lewinsky-Haapasaari & Tan, 1995) and subsequenty at two localities in Kazakhstan (Lewinsky-Haapasaari, 1996). The new locality in Russia is about 800 km NE from the Chinese one.

Ecology. In Russia, *O. hallii* was collected in crevices of exposed cliffs on the shore of lake, at 1100 m a.s.l. A detailed observation of climate and vegetation of the collecting locality is provided by Otnyukova (2003). The Kazakhstan collections were also from rocks and cliff faces (Lewinsky-Haapasaari, 1996), while in the Altai Mts. in Xinjiang Province of China the species was found growing both on logs and on soil-covered rocks and boulders (Lewinsky-Haapasaari & Tan, 1995). In North America it is reported mostly from rocks, usually limestone or calcareous sandstone, rarely from trunks of deciduous trees.

Species Distinction. *Orthotrichum hallii* differs from other *Orthotrichum* species in Russian moss flora by combination of completely bistratose leaf lamina, emergent capsules with 8 ribs, mostly striate outer surface of exostome teeth and 8 rudimentary endostome segments which are papillose. Its distinction from species of *O. cupulatum*-group is shown in Table 1.

Lewinsky-Haapasaari & Tan (l.c.) emphasized a small difference in peristome structure between the Chinese and North American collections, including 1) yellow to reddish-brown color of exostome teeth vs. whitish to yellowish one; 2) densely ridged-striate outer surface of exostome vs. papillose-striate one; 3) endostome segments papillose vs. finely longitudinally striate; in addition, 4) spores of the Chinese plants are slightly larger than in North American specimens, 12-18 µm vs. (8-) 10-17 µm. Specimens from Kazakhstan agreed with the Chinese ones in all these characters (Lewinsky-Haapasaari, 1996). It is also

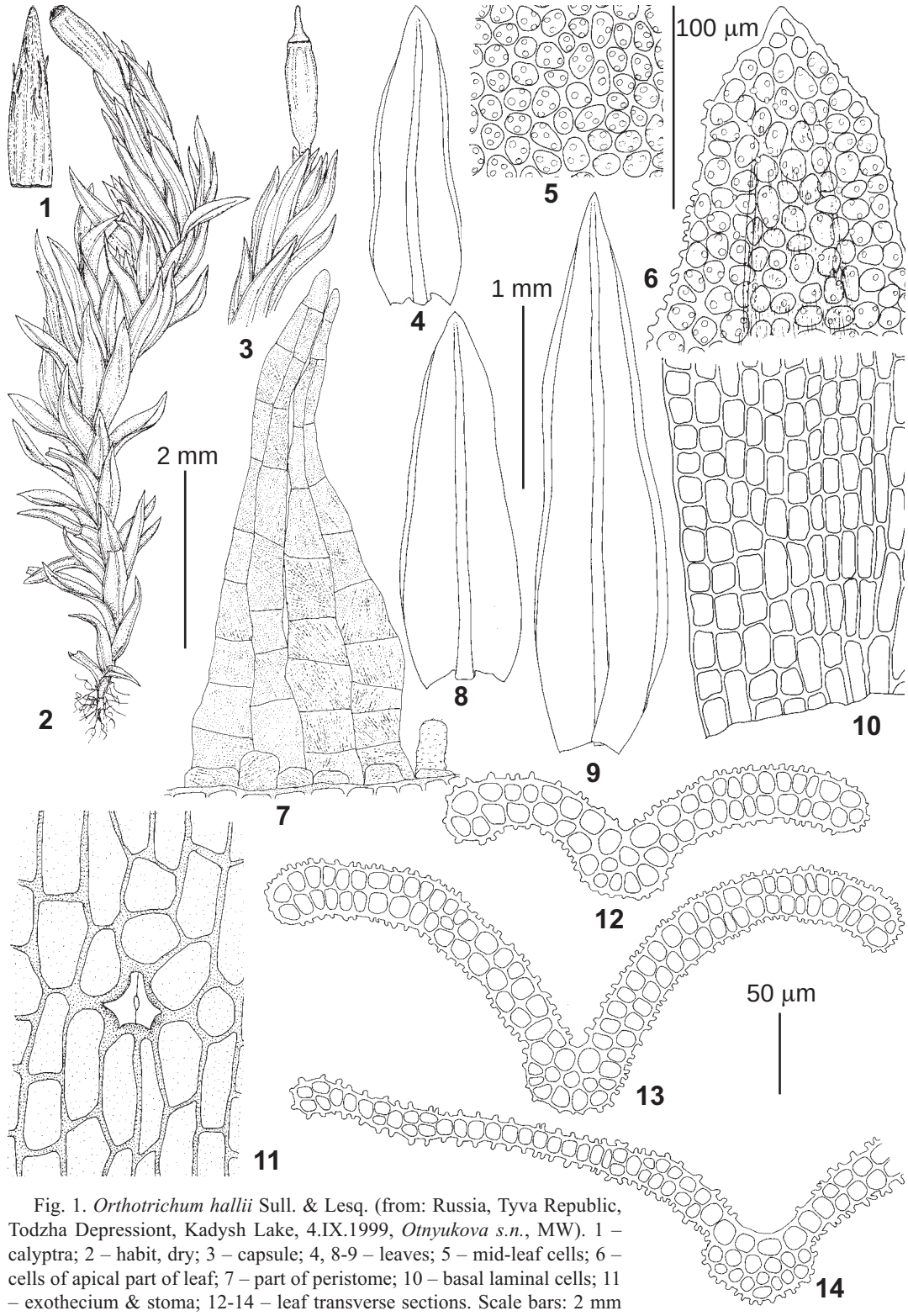
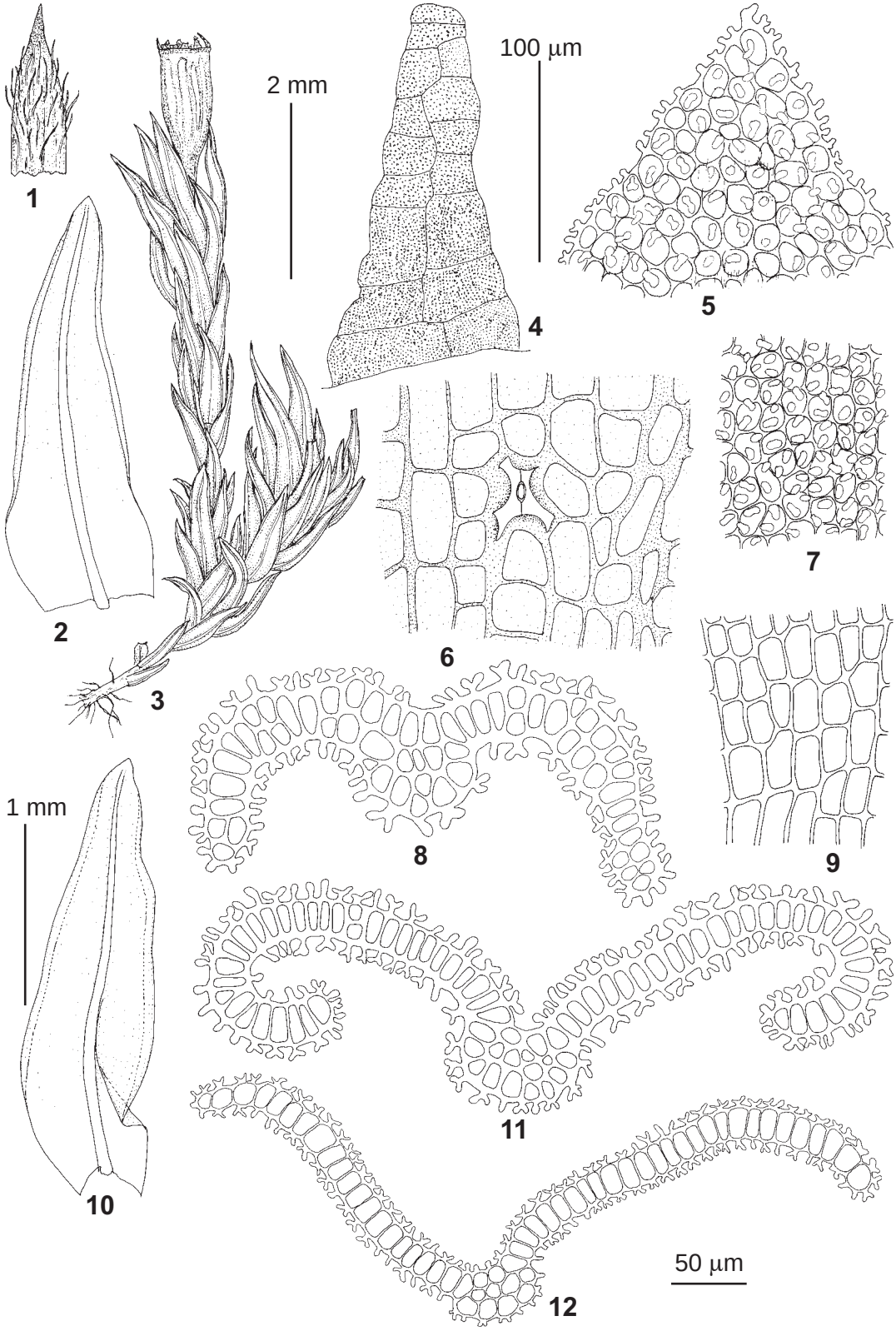


Fig. 1. *Orthotrichum hallii* Sull. & Lesq. (from: Russia, Tyva Republic, Todzha Depressiont, Kadysh Lake, 4.IX.1999, *Otnyukova s.n.*, MW). 1 – calyptra; 2 – habit, dry; 3 – capsule; 4, 8-9 – leaves; 5 – mid-leaf cells; 6 – cells of apical part of leaf; 7 – part of peristome; 10 – basal laminal cells; 11 – exothecium & stoma; 12-14 – leaf transverse sections. Scale bars: 2 mm for 1-3; 1 mm for 4, 8-9; 100 μm for 5-6, 10-11; 50 μm for 7, 12-14.


1
2 mm
2
3
4
100 μm
5
6
7
8
9
1 mm
10
11
12
50 μm

the case of plants from Tyva Republic, except for the spore size, being mostly ca. 12 μm.

Orthotrichum pellucidum Lindb., Öfvers. Förh. Kongl. Svenska Vetensk.-Akad. 23: 549. 1867. – *O. cupulatum* var. *pellucidum* (Lindb.) Podp., Consp. Musc. Eur. 464. 1954. – *O. jamesianum* Sull., Botany (Fortieth Parallel) 18(5): 401. 1871. Figs 2, 3.

Plants dark olive-green, brownish to blackish, glaucous, in dense cushions or tufts; leaves stiff, appressed and incurved when dry, spreading when moist, (1.1-)1.3-2.0(-2.7)×(0.3-)0.34-0.40(-0.45) mm, lanceolate, with margins parallel one to another in most part of leaf, apex rounded, blunt, obtuse to acute, rarely shortly acuminate; margins slightly to moderately recurved from somewhat above base to just below apex; costa broad, occupying ca. 1/7-1/5 of leaf base, 60-80 μm wide, ending below the apex, on dorsal surface covered with green subquadrate papillose cells; upper median cells subquadrate, rounded-hexagonal to hexagonal-elliptic, sometimes sinuose, with slightly incrassate walls, more or less collenchymatose, (6-)7-11(-13)×8-11 μm, with 1-3 high, clavate, Y-shaped or T-shaped papillae on both sides, often giving a glaucous appearance; basal leaf cells short-rectangular to quadrate, 12-22×8-11 μm, with moderately incrassate walls, smooth, greenish to yellowish, along margin in 1 row quadrate to transversely rectangular, 6-10×6-10 μm, hyaline. Goniautoicous. Setae 1-1.5 mm long. Capsules emergent to slightly exserted, oblong, urns strongly 8-ribbed in upper 2/3 of length, stomates immersed, ± completely covered by subsidiary cells; endostome teeth papillose-striate, joined or irregularly spilt, usually 16 when mature, often broken off after spore releasing; endostome none. Calyptrae oblong, with age slightly plicate, with numerous papillose yellowish hairs. Spores 10-15 μm.

Specimens examined: EUROPEAN RUSSIA: **Perm Province**: Vishersky State Reserve, Lyp'ja River Valley, 12.VII.1995, *Bezgodov. & Selivanov #548* (MW) (together with *O. cupulatum*). ASIATIC RUSSIA: **Altai Republic**: Altai Mts, Kuraiskij Range north of Kosh-Agach, Tabozhok Creek 12 km upstream its confluence with Chuya River, 7.VIII.1992, *Ignatov* (MW); Altai Mts., Kuraiskij Range north of Kosh-Agach, near the Peak 2788 m north of Tabozhok Peak, 1.VIII.1992, *Ignatov* (MW); **Krasnoyarsk Territory**: Taimyrsky Municipal District, vicinity of Kotuykan River mouth, 11.VIII.2011, *Fedosov* (MW); **Kamchatsky Territory**: Koryaksky Autonomous District, Southern Chukotka, Vaamochka River vicinity, Yanrapay Mt., 26.VII.1997, *Galanin & Belikovicz* (LE); same place, 26.VII.1997, *Belikovicz* (LE); **Magadan** Province, Srednekansk District, Kolyma River basin, Korkodon River ca. 30 km upstream mouth, Kudley Ridge, 22.VII.2002, *Mochalova* (MW).

CANADA: Alberta, South Twin Creek, 39 km north of the Oldman River crossing on the Forestry trunk road, on shaded limey-sandstone cliff above a small creek in a montane forest, 28.VI.1990, *Hastings* (MW, duplicate from ALTA).

U.S.A.: Wyoming, Shoshone National forest in Wind River Mts, along Hwy 131, SW of Lander, between Sink State Park and Frye Lake (8.4 km NE of Frye Lake), on large pitted dry boulders in forest belt, 5.VI.1990, *Vitt* (MW, duplicate from ALTA).

Distribution of *O. pellucidum* was overviewed by Lewinsky (1977); new localities were added by Ignatov & Lewinsky-Haapasaari (1994) and Afonina (2004). The species is known from North Europe (Lewinsky, 1998), Svalbard (Frisvoll, 1978), Franz Jozef Land Archipelago (Odasz, 1996), Anabar Plateau (Fedosov et al., 2011), Altai Mts. (Ignatov & Lewinsky-Haapasaari, 1994), Chukotka (Afonina, 2004), Koryakskoe Upland (Kuzmina, 2008), North Urals and Magadan Province (present study), Alaska and xeric areas within Rocky Mountains (Yukon, British Columbia, Washington), Greenland (Vitt, 2009).

Ecology. In Russia, *O. pellucidum* grows on more or less calcareous rocks, often limestone and dolomite, in dry steppe or tundra communities, often with *Ditrichum flexicaule, Encalypta longicolla, O. cupulatum, Pseudoleskeella spp., Stereodon vaucherii, Grimmia anodon, G. teretinervis,* etc.

Species Distinction. *Orthotrichum pellucidum* was described from Svalbard in 1867; among

Fig. 2 (opposite page). *Orthotrichum pellucidum* Lindb. (from: Russia, Krasnoyarsk Territory, Taimyrsky Municipal District, Kotujkan River mouth, *Fedosov #3-11-19-37*, MW). 1 – calyptra; 2, 10 – leaves; 3 – habit, dry; 4 – exostome tooth; 5 – cells of apical part of leaf; 6 – exothecium & stoma; 7 – mid-leaf cells; 8, 11-12 – leaf transverse sections; 9 – basal laminal cells. Scale bars: 2 mm for 1, 3; 1 mm for 2, 10; 100 μm for 4-7, 9; 50 μm for 8, 11-12.

Table 1. Distinguishing morphological characters of *Orthotrichum* species from *O. cupulatum*-group

Character	***O. cupulatum***	***O. pellucidum***	***O. hallii***	***O. anomalum***
Color of plants	not or slightly glaucous	strongly glaucous	not or slightly glaucous	not or slightly glaucous
Leaf shape	ovate-lanceolate	lanceolate	lanceolate	ovate-lanceolate
Leaf apex	acute to acuminate	obtuse to acute	obtuse to acute	acute to acuminate
Lamina	unistratose, occasionally with few bistratose patches	unistratose, with ± numerose bistratose patches	almost completly bistratose	unistratose, occasionally with few bistratose patches
Papillae	low to medium-high, simple or forked in lower part (V-shaped)	high, clavate or forked in upper part (T- or Y-shaped)	low, simple	low to medium-high, simple or forked in lower part (V-shaped)
Capsule position	immersed to emergent	emergent to slightly exserted	emergent to slightly exserted	slightly to strongly exserted
Number of ribs	16 long	8 long (rarely +8 short)	8 long (rarely +8 short)	8 long (+8 short)
Exostome teeth	16, not in pairs	in 8 pairs, splitting into 16	in 8 pairs	in 8 pairs
Exostome ornamentation	striate, papillose-striate or papillose-reticulate	papillose-striate	striate with admixture of few small papillae (Asiatic specimens) or papillose-striate (North American specimens)	striate
Endostome segments	none or 8, smooth, 1/4-3/4 the height of the exostome, often missing (easily broken)	none	8, rudimentary, papillose (Asiatic specimens) or slightly striate (North American specimens)	none or 8, smooth, rudimentary to as high as exostome

its characteristic features Lindberg and further Lewinsky (1978, 1998) noted a partly to completely bistratose distal leaf lamina. On the other hand, two other species from the same group, *O. hallii* Sull. & Lesq. with completely bistratose upper part of leaf and *O. jamesianum* Sull. with unistratose leaf lamina, were described from the Rocky Mountains, North America. Later the latter species was synonimized with *O. pellucidum* (Lewinsky, 1978). However, Vitt in his treatment of the genus in ongoing Bryophyte Flora of North America (2009) characterizes the leaf lamina of *O. pellucidum* as unistratose. This description contradicts our observation of partially bistratose distal leaf lamina in two North American specimens (see below). During the re-examination of Russian specimens from this group all studied species, including *O. anomalum* Hedw., *O. pellucidum*, and *O. cupulatum* were found occasionally having a partially bistratose leaf lamina. It seems that this character is not very important for separating species within the studied group.

O. pellucidum differs from other species of the genus by combination of (1) lanceolate leaves with margins ±parallel one to another on most part of leaf; (2) mostly obtuse to acute leaf api-

Fig. 3. Distribution of *Orthotrichum hallii* (star), *O. cupulatum* (squares) and *O. pellucidum* (circles) in Russia. Solid squares and circles are based on studied specimens, open squares and circles show literature records (according to Ignatov, Afonina, Ignatova et al., 2006, etc.).

ces; glaucose appearance caused by high clavate or forked papillae; (3) emergent to slightly exserted capsules mostly with 8 long ribs and rarely with additional 8 short ribs alternating with long ones, and (5) peristome with unpaired 16 teeth. For detailed comparison with each species of *O. cupulatum*-group see Table 1.

Orthotrichum urnigerum Myr., known in Russia from the Caucasus (Ignatova et al., 2008) and also reported from Chukotka on the basis of old records (Afonina, 2004), can be confused with species of *O. cupulatum*-group as well due to emergent capsules with 8 long and 8 short ribs and peristome teeth papillose-striate in proximal part. It however can be separated by strongly hairy vaginulae and 8 or 16 smooth endostome segments. Its leaf lamina is mostly unistratose, leaf cells bear low conic papillae.

ACKNOWLEDGEMENTS

We are grateful to A. Ivanova for improving English of the manuscript. The work was partly supported by the Federal program «Scientific and Educational personalities of innovative Russia 2009-2013 years» (government contracts №№ 16.740.11.0680, 14.740. 11.0165 & 16.740.11. 0177).

LITERATURE CITED

[AFONINA, O.M.] АФОНИНА О.М. 2004. Конспект флоры мхов Чукотки. – [Moss flora of Chukotka] *СПб. БИН РАН [St.-Petersburg, Bot. Inst. RAS], 260 pp.*

AKATOVA, T.V., Z.KH. KHARZINOV, E.A. IGNATOVA & M.S. IGNATOV 2004 [2005]. On three rare species of Orthotrichum (Orthotrichaceae, Musci) in Caucasus. – *Arctoa* **13**: *41-49*.

FEDOSOV, V.E. & E.A. IGNATOVA 2010. Orthotrichum dagestanicum sp. nov. (Orthotrichaceae, Musci) – a new species from Dagestan (Eastern Caucasus). – *Arctoa* **19**: *69-74.*

FEDOSOV, V.E., E.A. IGNATOVA, M.S. IGNATOV & A.I. MAKSIMOV 2011. Rare species and preliminary list of mosses of the Anabar Plateau (Subarctic Siberia). – *Arctoa* **20**: *153-174.*

FEDOSOV, V.E., E.A. IGNATOVA & O.V. IVANOV 2009. Orthotrichum holmenii Lewinsky-Haapasaari (Orthotrichaceae, Musci), a new species for Russian moss flora. – *Arctoa* **18**: *195-200*.

FRISVOLL, A.A. 1978. Twenty-eight bryophytes new to Svalbard. – *Bryologist* **81**(1): *122-136.*

HARPEL, J.A. 2010. A history of bryology in the San Juan Islands, Washington State, U.S.A. – *Botany* **88**(4): *329-335*.

IGNATOV, M.S. & O.M. AFONINA (eds.) 1992. Check-list of mosses of the former USSR. – *Arctoa* **1**: *1-85.*

IGNATOV, M.S., O.M. AFONINA, E.A. IGNATOVA et al. 2006 [2007]. Check-list of mosses of East Europe and North Asia. – *Arctoa* **15**: *1-130*.

IGNATOV, M.S. & J. LEWINSKY-HAAPASAARI 1994. Bryophytes of Altai Mountains II. The Genera Amphidium

Schimp., Orthotrichum Hedw. and Zygodon Hook. & Tayl. (Orthotrichaceae, Musci). – *Arctoa* **3**: *29-57*.

[IGNATOVA, E.A., M.S. IGNATOV, N.A. KONSTANTINOVA, V.I. ZOLOTOV & V.G. ONIPCHENKO] ИГНАТОВА Е.А., М.С. ИГНАТОВ, Н.А. КОНСТАНТИНОВА, В.И. ЗОЛОТОВ, В.Г. ОНИПЧЕНКО 2008. Флора мохообразных Тебердинского заповедника. – [Bryophyte flora of the Teberdinsky Nature Reserve] *Флора и фауна заповедников* [*Flora i fauna zapovednikov*] **112**: *86 pp*.

[KUZMINA, E. YU.] КУЗЬМИНА Е.Ю. 2008. Редкие виды флоры мхов Корякского нагорья. – [Rare species of moss flora of Koryak Upland] *В кн: Фундаментальные и прикладные проблемы ботаники в начале XXI века. Матер. Всерос. конф. (Петрозаводск, 22-27 сентября 2008 г.). Часть 2. Альгология, микология, лихенология, бриология. Петрозаводск [Fundamental'nye i prikladnye problemy botaniki v nachale XXI veka. Materialy Vserossiyskoj konferentsii (Petrozavodsk, September 22-27, 2008). Chast' 2. Al'gologiaya, Mikologiya, Likhenologiya, Briologiya. Petrozavodsk]: 309-312.*

LEWINSKY, J. 1977. The family Orthotrichaceae in Greenland. – *Lindbergia* **4**: *57-103*.

LEWINSKY, J. 1978. The taxonomic status of Orthotrichum pellucidum Lindb. – *Lindbergia* **4**: *199-201*.

LEWINSKY, J. 1998. Orthotrichaceae. – *In: Illustrated flora of Nordic mosses, Fasc. 4. Aulacomniaceae – Meesiaceae – Catoscopiaceae – Bartramiaceae – Tammiaceae – Encalyptaceae – Grimmiacease – Hedwigiaceae – Orthotrichaceae. Copenhagen & Lund, Nordic Bryol Soc: 249-405.*

LEWINSKY, J. & B.C. TAN 1995 Orthotrichum hallii Sull.et Lesq. New to Asia. – *Harvard papers in botany* **7**: *1-6*.

LEWINSKY-HAAPASAARI, J. 1996. Orthotrichum holmenii, a new corticolous species from Kazakhstan with comments on Orthotrichum hallii in Asia. – *Bryologist* **99** (1): *1-5*.

ODASZ, A.M. 1996. Bryophyte vegetation and habitat gradients in the Tikhaia Bay region, Hooker Island, Franz Jozef Land, Arctic Russia. – *Bryologist* **99** (4): *407-415*.

OTNYUKOVA, T.N. 2001. A new species of Orthotrichum (Orthotrichaceae, Musci) from Tuva Republic, South Siberia. – *Arctoa* **10**: *155-156.*

[OTNYUKOVA, T.N.] ОТНЮКОВА Т.Н. 2003. Материалы к флоре листостебельных мхов Тоджинской котловины (республика Тыва, Южная Сибирь). – [Contribution to moss flora of Todzha Valley (Tyva Republic, South Siberia)] *Arctoa* **12**: *97-109*.

VITT, D.H. 2009. Orthotrichum. – *In: Bryophyte Flora of North America, Provisional Publication*. *http://www.mobot.org/plantscience/bfna/v2/OrthOrthotrichum.htm.*