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A NEW SPECIES OF DICRANUM (DICRANACEAE, BRYOPHYTA) FROM ASIATIC RUSSIA

НОВЫЙ ВИД DICRANUM (DICRANACEAE, BRYOPHYTA) ИЗ АЗИАТСКОЙ РОССИИ

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Abstract

During the revision of *Dicranum* in Russia, a number of morphologically distinct specimens were revealed. They are similar to *D. acutifolium* (Lindb. & Arnell) C.E.O. Jensen in leaf shape and leaf transverse section, as well as in lamina areolation, but differ in transversely undulate leaves with sharply protruding upper angles of cells on dorsal side of distal lamina and costa, exhibiting resemblance with *D. drummondii* Müll. Hal., and some collections were found in various herbaria under this name. This morphology corresponds to a small but stable difference in nuclear ITS sequence, so the species is described here as *Dicranum bardunovii* sp. nov.

Резюме

В ходе ревизии гербарных коллекций *Dicranum* из Азиатской России был выявлен ряд образцов, имеющих некоторое морфологическое своеобразие. Они похожи на *D. acutifolium* (Lindb. & Arnell) C.E.O. Jensen по форме листа и его поперечным срезам, а также по характеру клеточной сети, однако отличаются от него поперечной волнистостью листьев, сильной мамиллозностью пластинки и жилки на дорсальной стороне листа в его верхней части, что имеет некоторое сходство с *D. drummondii* Müll. Hal., и некоторые образцы были обнаружены в гербариях под этим названием. Эти морфологические отличия коррелируют с небольшими, но стабильными отличиями в последовательностях ITS ядерной ДНК; поэтому вид описан здесь как *Dicranum bardunovii* sp. nov.

KEYWORDS: Bryophyta, Dicranaceae, *Dicranum*, molecular phylogenetic, new species, Asiatic Russia.

INTRODUCTION

The genus *Dicranum* is one of the largest in the Russian moss flora, and despite many species are common in boreal, mountain and arctic ecosystems, it is still quite insufficiently known. The check-list of mosses of the former Soviet Union recorded 26 species for the Russian territory (Ignatov & Afonina, 1992), the subsequent one added two more species (Ignatov, Afonina, Ignatova et al., 2006); moreover, 3 species were described or resurrected in recent years (Ignatova & Fedosov, 2008; Tubanova et al., 2010), so 32 species have been known in the Russian territory up to now. Two latter publications are similar in that they both involved molecular data in addition to morphological ones. This allows to outline some entities that are quite ambiguous in their morphology, as the number of morphological characters is low and their variation is not well correlated.

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Fig. 1. Fragment of ITS1 alignment of *Dicranum* species, showing unique substitution in 198 position.

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                  150        160        170        180        190        200        210
bardun Bur  ATGTGGATGG GGGGGG-AGA ACTCTG-CTC CCTGGGGCAA AA-CCC--AA CC--GATCGC GCAATGCATC
bardun Ya1  ATGTGGATGG GGGGGG-AGA ACTCTG-CTC CCTGGGGCAA AA-CCC--AA CC--GATCGC GCAATGCATC
bardun Ya2  ATGTGGATGG GGGGGGGAGA ACTCTG-CTC CCTGGGGCAA AA-CCC--AA CC--GATCGC GCAATGCATC
acutif Sa1  ATGTGGATGG GGGG---AGA ACTCTG-CTC CCTGGGGCAA AA-CCC--AA CC--GATTGC GCAATGCATC
acutif Ya2  ATGTGGATGG GGGG---AGA ACTCTG-CTC CCTGGGGCAA AA-CCC--AA CC--GATTGC GCAATGCATC
cf.acu Bur  ATGTGGATGG GGGG---AGA ACTCTG-CTC CCTGGGGCAA AA-CCC--AA CC--GATTGC GCAATGCATC
cf.acu Ya1  ATGTGGATGG GGGG---AGA ACTCTG-CTC CCTGGGGCAA AA-CCC--AA CC--GATTGC GCAATGCATC
brevif Kra  ATGTGGATGG GGGGG--AGA ACTCTG-CTC CCTGGGGCAA AA-CCC--AA CC--GATTGC GCAATGCATC
brevif Ca1  ATGTGGATGG GAAGG--AGA ACTCTG-CTC CCTGGGGCAA AA-CCC--AA CC--GATTGC GCAATGCATC
brevif Ca2  ATGTGGATGG GGGGG--AGA ACTCTG-CTC CCTGGGGCAA AA-CCC--AA C---GATGGC GCAATGCATC
drummo Kom  ---------- ---------- ---------- --TGGGGCAA AA-CCCC-AA CC--GATTGC GCAATGCATC
flexic Zab  ATATGGATGG GGGG---GAA ACTCTG-CTC CCTGGGGCAA AA-CCC--AA CC--GATTGC GCAATGCATC
flexic Pri  ATATGGATGG GGGG---GAA ACTCTG-CTC CCTGGGGCAA AA-CCC--AA CC--GATTGC GCAATGCATC
flexic Kom  ATATGGATGG GGGG---GAA ACTCTG-CTC CCTGGGGCAA AA-CCC--AA CC--GATTGC GCAATGCATC
flexic Kra  ATATGGATGG GGGG---GAA ACTCTG-CTC CCTGGGGCAA AA-CCC--AA CC--GATTGC GCAATGCATC
fusces Per  -TATGGATGG GGGG---GAA ACTCTG-CTC CCTGGGGCAA AA-CCC--AA CC--GATTGC GCAATGCATC
fusces Sak  -TATGGATGG GGGG---GAA ACTCTG-CTC CCTGGGGCAA AA-CCC--AA CC--GATTGC GCAATGCATC
fusces Pri  -TATGGATGG GGGG---GAA ACTCTG-CTC CCTGGGGCAA AA-CCC--AA CC--GATTGC GCAATGCATC
fragil Vol  ATATGGATGG GGTGGGGGGA ACTCTG-CTC CCTGGGGCAA AA-CCC--AA CCCCGATTGC GCAATGCATC
fragil Ark  ATATGGATGG GGTGGGGGGA ACTCTG-CTC CCTGGGGCAA AA-CCC--AA CCCCGATTGC GCAATGCATC
hakkod KuI  ---------- ---------- ---------- ---GGGGCAG AA-CCCACAA CC--GATTGC GCAATGCATC
hakkod Pri  ---------- ---------- ---------- ---GGGGCAG AA-CCCACAA CC--GATTGC GCAATGCATC
pacifi Ka1  ATGTGGATGG GGCGGGAGGA ACTCCG-CTC CCTGGGGCAA AAACCCACAA CC--GATTGC GCAATGCATC
pacifi Ka2  ATGTGGATGG GGCGGGGGGA ACTCCG-CTC CCTGGGGCAA AAACCCACAA CC--GATTGC GCAATGCATC
scopariu 1  ---------- -----GGAGA ACTCTG-CTC CCTGGGGCAA AA-CCC--AA CC--GATTGC GCAATGCATC
septen Ark  ATATGGATGG GGGCG-GGGA ACTCTG-CTC CCTGGGGCAA AA-CCCC-AA CC--GATTGC GCAATGCATC
septen Kam  ATATGGATGG GGGCG-GGGA ACTCTG-CTC CCTGGGGCAA AA-CCCC-AA CC--GATTGC GCAATGCATC
tauric Ca1  ATATGGATGG GGGGG----A ACTCTGGCTC CCTGGGGCAA AA-CCC--AA CC--GATTGC GCAATGCATC
tauric Kur  ATATGGATGG GGGGG----A ACTCTGGCTC CCTGGGGCAA AA-CCC--AA CC--GATTGC GCAATGCATC
tauric Ca2  ATATGGATGG GGGGG----A ACTCTGGCTC CCTGGGGCAA AA-CCC--AA CC--GATTGC GCAATGCATC
viride Tat  ATGTGGATGG GGTGGGGGGA ACTCTG-CTC CCTGGGGCAA AA-CCCACAA CC--GATTGC GCAATGCATC
viride Msc  ATGTGGATGG GGTGGGGGGA ACTCTG-CTC CCTGGGGCAA AA-CCCACAA CC--GATTGC GCAATGCATC
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During our study, a number of specimens with unusual combination of characters were revealed in herbaria. The leaf shape and transverse section, as well as lamina areolation are similar to those of *D. acutifolium* (Lindb. & Arnell) C.E.O. Jensen, while transversely undulate leaves with sharp mamillae on dorsal side of costa and distal lamina resemble *D. drummondii* Müll. Hal. These specimens are studied by morphology and nuclear ITS sequence data and are discussed in the present paper.

MATERIAL AND METHODS

In addition to the traditional morphological study dorsal side of leaf lamina and peristome were examined and photographed under Hitachi TM-1000 SEM.

Two specimens of a presumably new species from Yakutia and one specimen from Buryatia were used for molecular analysis. Nuclear ITS1-2 region was studied, and ITS sequences from our previous analyses as well as Genbank data were used for comparison. Specimen data and Genbank numbers are given in Appendix 1. Protocol used is the same as in the study of Gardiner & al. (2005). Sequences were aligned manually; a part of alignment is presented in Fig. 1. Parsimony ratchet analysis was performed with Nona (Goloboff, 1994) within the Winclada (Nixon, 1999) shell. A phylogenetic tree was rooted on *D. scoparium* Hedw.

We compared ITS1-2 sequences of a presumably new species with those of close species from *D. acutifolium* and *D. fuscescens* complexes (Tubanova et al., 2010) and with a group of species with fragile leaves (Ignatova & Fedosov, 2008). One specimen of *D. drummondii* from Komi Republic was also included in the analysis. ITS1 of this specimen was sequenced only partially due to a very strong secondary structure of a hair-pin which did not allow to read this region.

RESULTS

In the phylogenetic tree (Fig. 2) three specimens of a presumably new species form a low

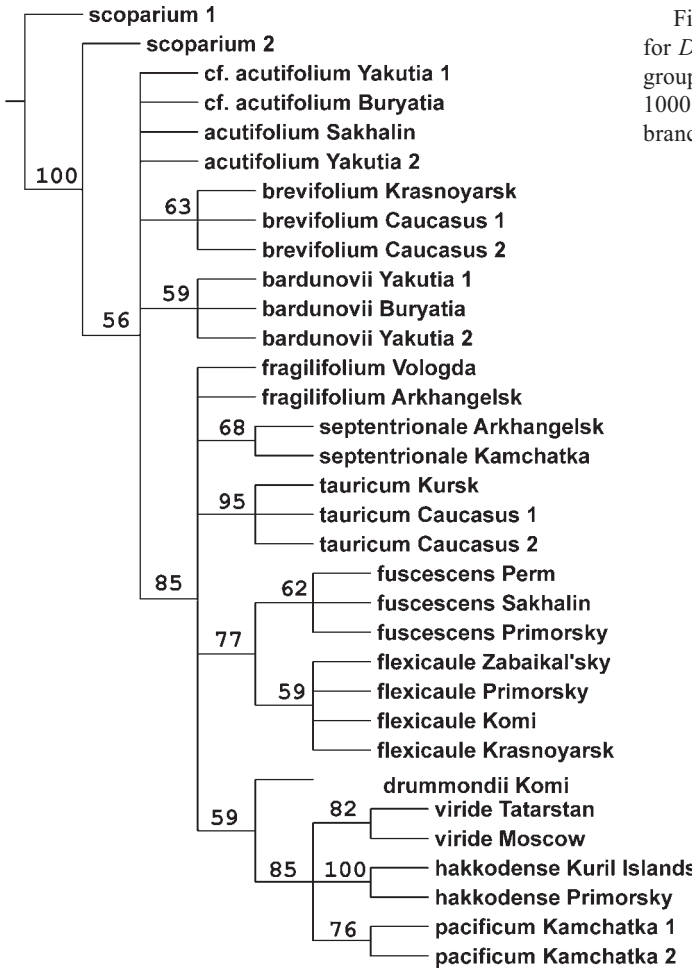

Fig. 2. Maximum parsimony bootstrap tree for *Dicranum* with *D. scoparium* as an outgroup. Support values >50%, calculated by 1000 iterations in Nona, are indicated above branches.

supported clade within a basal grade; this grade includes also several specimens of *D. acutifolium* and a clade of tree specimens of *D. brevifolium* (Lindb.) Lindb. It corresponds to close morphological resemblance of these species, e.g., leaf transverse section "like a pair of tongs", sharply keeled distal portion of leaf with incurved blades, and thick-walled lamina cells. However, some stable morphological differences in combination with small differences in ITS sequences confirm their species status, including a presumably new one. Therefore we describe *D. bardunovii* sp. nova (see below). The difference in ITS1-2 between D. *bardunovii* and *D. acutifolium* includes one substution (Fig. 1); the same situation is in case of *D. brevifolium* and *D. acutifolium*. At the same time, *D. drummondii* shows considerable difference from this group of species in ITS1-2, and it appears in the phylogenetic tree in basal position to a clade formed by *D. viride* (Sull. & Lesq.) Lindb., *D. hakkodense* Cardot and *D. pacificum* Ignatova & Fedosov.

Species description

Dicranum bardunovii Tubanova & Ignatova sp. nov. Figs. 3-5.

Species Dicrano acutifolio similis at superficie foliorum undulata (folia D. acutifolii non undulatae), vena in paginae folii dorsali magis mamillosa (pagina folii D. acutifolii a parce mamillosa ad laevem) et paginae folii dorsali in parte superiore mamilloso-aspera (pagina folii D. acutifolii laevis) differt.

Type: Russia, Republic of Buryatia, Bargusinsky District, Ina River valley, 3.5 km E of Bayangol Settlement, N-faced slope 35°, 680 m

a.s.l., larch forest with *Rhododendron dahuricum*, *Bergenia crassifolia* and moss cover, on soil, 12.VII. 2000, leg. Krivobokov L.V., rel. # 262 (Holotype UUH, isotype MW).

Etymology: The species epithet is in honour of Leonid Vladimirovich Bardunov, who contributed greatly to the knowledge of moss flora of Asiatic Russia.

Plants medium-sized, in loose tufts, green or yellowish green in upper part, brownish below. Stem 5-10 cm long, with whitish tomentum in upper part and brown tomentum at base, loosely foliated. Leaves weakly to moderately flexuose when dry, straight and erect-spreading when wet, (5-)6-7×0.8-1.0 mm, from ovate base gradually longly acuminate, concave proximally, keeled distally; margins entire at base, serrulate in middle part of leaf, strongly serrate in distal part, occasionally bistratose at places and with geminate teeth; distal lamina scabrose due to highly protruding upper cell angles; costa strong, occupying 1/7–1/5 of leaf base, percurrent to shortly excurrent, in transverse section with one row of guide cells and two stereid bands, ventral epidermis not differentiated, dorsal epidermis well differentiated, with some cells strongly mamillose and thick-walled, making dorsal side of costa sharply and densely scabrose; lamina unistratose, transversely undulate when dry and slightly undulate when wet; upper laminal cells (8-)10-15(-20)×6-7(-8) μm, short rectangular, ovate or irregularly angular, partially isodiametric, some cells with strongly protruding upper angles on dorsal side of leaf; basal laminal cells elongate rectangular to linear, (33-)40-60(-70)×6-8(-10) μm, moderately thick-walled, porose, gradually transiting into short median laminal cells; cells of leaf angles brownish, in upper part of alar group 1-2-stratose, not reaching costa, in lower part 2-3-stratose, decurrent; thin-walled hyaline cells between alar group and costa numerous, destroying with age. Dioicous or pseudomonoicous (dwarf male plants were seen in one specimen). Setae 2-2.5 cm. Capsules inclined, urns 2.5 mm, cylindric, slightly curved, furrowed when dry. Annulus not seen. Spores 13-24 μm, papillose.

Other specimens examined: RUSSIA: **Chukotskaya Province**: Pekul'ney Mt. Range, Malaya Vesnovannaya River (left tributary of Anadyr River), 11.VIII.1980, *Afonina s.n.* (LE). **Republic of Sakha/Yakutia**: Aldanskiy District: Bol'shoy Kuranakh River basin, 18.VII.1995, *Ivanova s.n.* (SASY, MHA); Uchur River basin at Kurung-Khokhoe-Aryt Island, E-facing slope, 01.VIII.1991, *Ivanova s.n.* (SASY, MW); Kobjayskiy District, Dyanyshka River, 20.VI.1985, *Volotovskiy s.n.* (SASY, MW); Zhiganskiy District, Undyulyung River upper course, near Byrand'ya Creek mouth, 12.VII. 1990, *Ivanova s.n.* (SASY, MW); Olenekskiy District, Khaymrgastaakh River middle course, 20.VIII.1957, *Ivanova # 94/9* (SASY, MHA); Tomponskiy District, Eastern Verkhoyanskie Mts., Narykchan Creek, 9.V.1955, *Ivanova #24/16* (SASY, MW); Oimyakon District, Suntar-Khayata Mt. Range, Mus-Khaya Mt., Knoriy Creek, 1550 m a.s.l., *Ignatov & Ignatova #11-3017* (MHA). **Krasnoyarsk Territory**: Putorana Plateau, Tonengda River (basin of Severnaya River), 18.VII.1991, *Otnyukova # 5* (KRF, UUH); Taimyrsky Municipal District, near Medvezh'ya River mouth, *Fedosov #05-171* (MW). **Republic of Buryatia**: Barguzinskiy District, valley of Ina River, Bodon Village, NE-facing slope, 790 m a.s.l., 12.VIII. 1999, *Krivobokov #148* (UUH); Ubileyny Village, N-facing slope, 19.VIII.1999, *Krivobokov #186* (UUH); valley of Ina River, 08.VIII.1999, *Krivobokov # 137* (UUH); Kurumkanskiy District, Dzerginskiy Reserve, valley of Birankur River, 850 m a.s.l., 55°04'N, 111°22'E, 09.VII.2003, *Anenkhonov # Ky-11/03* (UUH); Kovyli River valley, high terrace, 1080 m a.s.l., 55°07'N, 111°35'E, 13.VII.2002, *Anenkhonov # Ky-02/22* (UUH); Barguzin River valley, rock-field, N-facing slope, 850 m a.s.l., 04.VII. 1998, *Tubanova # IV (41)* (UUH); Tunkinskiy Mt. Range, Sagan-Shaluty River, near timber-line, 2100 m a.s.l., 04.VI.1959, *Malyshev & Karamyshev s.n.* (IRK). **Zabaikal'sky Territory**: Sokhondinsky Biosphere Reserve, Agutsa River, 1200 m a.s.l., 22.VII. 2010, *Afonina #A5710* (LE); same place, 1126 m a.s.l., 19.VII.2010, *Afonina #A3910* (LE). **Irkutsk Province**: Cheremkhovo District, foothills of Sayan Mts., vicinity of Yulinsk Village, 18.VII.1999, *Dudareva s.n.* (LE). **Amurskaya Province**: Zeyskiy Nature Reserve, Bol'shaya Erakingra River, 18.VII.1979, [*Petelin s.n.*] (IRK); Tukuringra Ridge, 04.08.1980, [*Abramova*] # 761 (M) (IRK).

Distribution. The species is currently known from Asiatic Russia east of Yenissey River: mountain areas of northern and south-western part of Buryatia, Zabaikal'sky Territory and Irkutsk Province, north-western, central and southern Yakutia, Amurskaya Province (Zeya Nature Reserve), Krasnoyarsk Territory (Putorana and Anabar Plateau) and Chukotka.

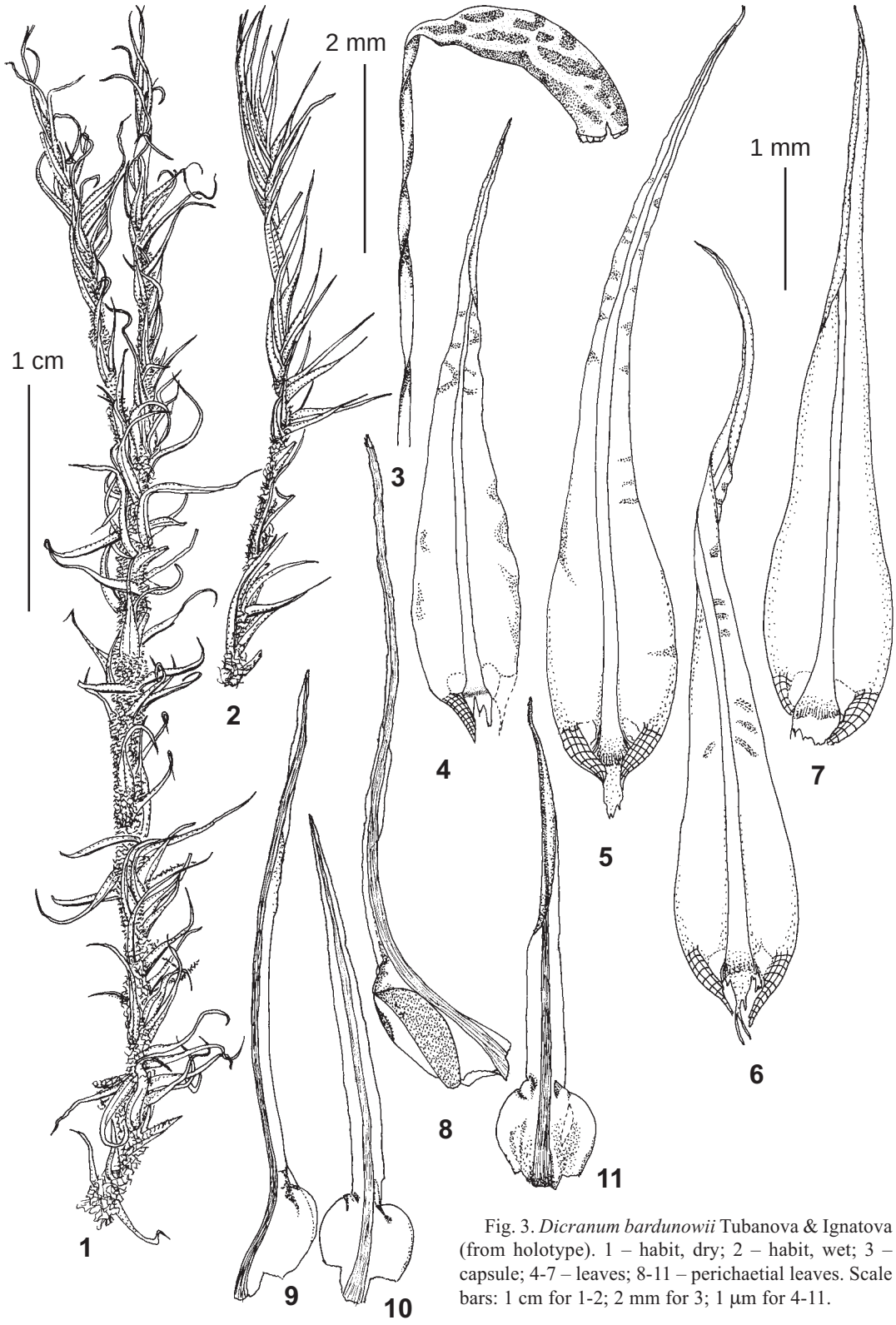

Fig. 3. *Dicranum bardunowii* Tubanova & Ignatova (from holotype). 1 – habit, dry; 2 – habit, wet; 3 – capsule; 4-7 – leaves; 8-11 – perichaetial leaves. Scale bars: 1 cm for 1-2; 2 mm for 3; 1 μm for 4-11.

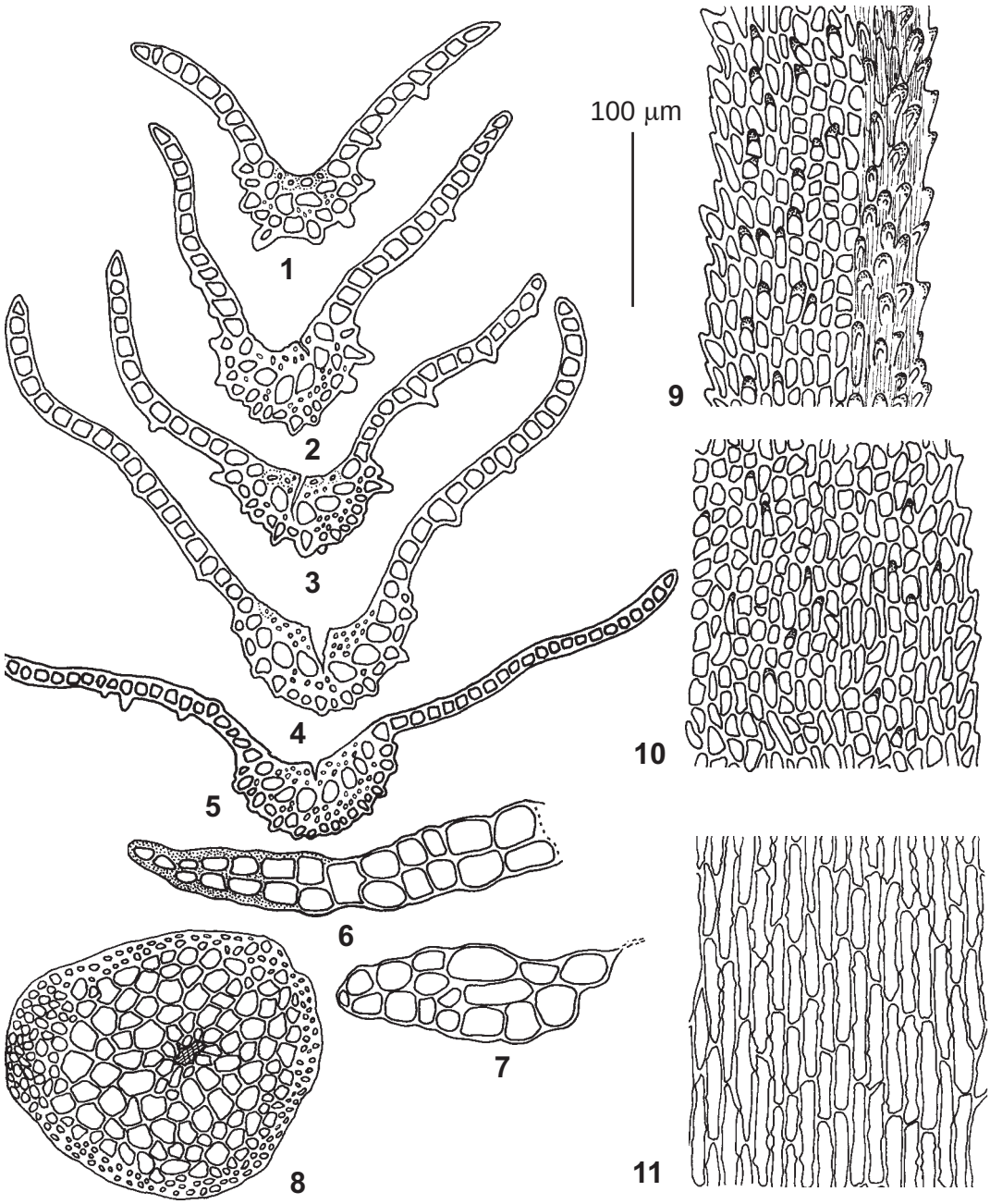

Fig. 4. *Dicranum bardunowii* Tubanova & Ignatova (from holotype). 1-5 – leaf transverse sections; 6-7 – transverse sections of alar region; 8 – stem transverse section; 9-10 – upper lamina cells; 11 – basal lamina cells. Scale bars: 100 μm for 1-11.

Ecology. *Dicranum bardunovii* grows on soil and rotten wood, occasionally also on bases of tree trunks in larch and spruce forests, as well as in mixed, birch and aspen forests, in *Alnus* stand on slope of the river valley, between rocks of rock-fields in subalpine belt; once it was collected between rocks at a brook bank near the timber-line.

Species Distinction. *Dicranum bardunovii* was found in some herbarium collections under the name *D. drummondii*. This does not imply

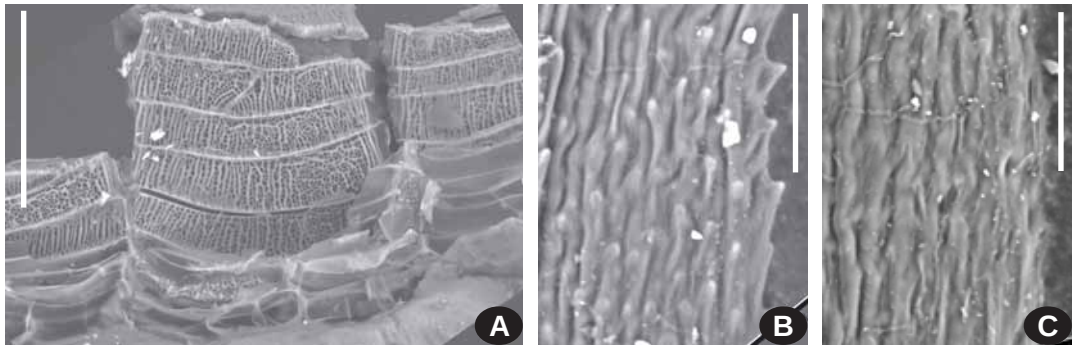

Fig. 5. A, B – *Dicranum bardunowii* Tubanova & Ignatova (from holotype); C – *D. acutifolium* (Lindb. & Arnell) C.E.O. Jensen (from Russia, Buryatia, Kurumkansky District, Dzheginsky Nature Reserve, 12.VII.2003, *Anenkhonov #Ky-24/03*, UUH). A – basal part of peristome teeth, showing longitudinal striolation on their outer surface; B & C – comparison of laminal cells in upper part of leaf, showing projecting upper cell ends in *D. bardunowii* that are smooth in *D. acutifolium*. Scale bars 50 μm.

their great superficial similarity, but rather these species are common in characters used in identification manuals, e.g., ± strongly undulate leaves and strongly prorate cells. However they differ in: 1) leaves gradually narrowed distally, keeled in upper part vs. from ovate base abruptly narrowed into long tubulose acumen; 2) transverse section of leaf in upper part like a pair of tongs vs. rounded; 3) ventral stereid band exposed, surface cells not differentiated vs. ventral surface cells enlargered, well differentiated.

There is much in common between *D. bardunovii* and *D. acutifolium*: leaf shape, transverse leaf section, costa structure and thick-walled laminal cells, linear and porose in proximal part of leaf and irregular in shape in its distal part. However, these two species can be separated by sharply and densely scabrose dorsal side of lamina and costa in distal part of leaf vs. mostly smooth lamina and smooth to finely mamillose dorsal side of costa. In addition, leaves of *D. bardunovii* are longer and more narrowly acute or acuminate; they have more strongly serrate margins in distal part. In dry condition leaves of *Dicranum bardunovii* are usually transversely undulate, and slight undulation remains even when plants become wet which is not a character of *D. acutifolium*.

Scabrose dorsal surface of distal leaf lamina and costa, occasionally in combination with undulate leaf lamina is also known in *D. fuscescens* Turn. This species differs from *D. bardunovii* in falcate-secund leaves in contrast with flexuose when dry and erect-spreading when moist leaves of *D. bardunovii*, and in more thin-walled, ± regularly quadrate upper laminal cells and less porose basal laminal cells. *Dicranum flexicaule* also differs from *D. bardunovii* in falcate-secund leaves which are usually smooth or weakly mamillose on dorsal side of costa, and more weakly serrate upper leaf margins.

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APPENDIX 1. Species of *Dicranum* and Genbank accession numbers for nrITS1-2. New sequences include specimen data, for the rest the voucher specimen labels are given in Tubanova et al. (2010) and Ignatova & Fedosov (2008).

D. cf. *acutifolium* Buryatia HQ830323; *D. acutifolium* Sakhalin HQ830322; *D.* cf. *acutifolium* Yakutia 1 HQ830326; *D. acutifolium* Yakutia 2 HQ830324; *D. bardunovii* Buryatia (Buryatia, 12.VII.2000, *Krivobokov* # 262, UUH) JN897272; *D. bardunovii* Yakutia 1 (Yakutia, 1.VIII.1991, *Ivanova s.n.,* MW) JN897273; *D. bardunovii* Yakutia 2 (South Yakutia, 20.VI.1985, *Volotovskiy s.n.,* MW) JN897274; *D. brevifolium* Caucasus 1 HQ830342; *D. brevifolium* Caucasus 2 HQ830343; *D. brevifolium* Krasnoyarsk HQ830341; *D. drummondii* Komi (Komi, 05.VII.2007, *Kucherov* # 169, MW) JQ037906; *D. flexicaule* Komi HQ830333; *D. flexicaule* Krasnoyarsk HQ830330; *D. flexicaule* Primorsky HQ830332; *D. flexicaule* Zabaikal'sky HQ830331; *D. fragilifolium* Arkhangelsk FJ952597; *D. fragilifolium* Vologda FJ952596; *D. fuscescens* Perm HQ830334; *D. fuscescens* Primorsky HQ830337; *D. fuscescens* Sakhalin HQ830335; *D. hakkodense* Kuril Islands FJ952600; *D. hakkodense* Primorsky FJ952601; *D. pacificum* Kamchatka 1 FJ952605; *D. pacificum* Kamchatka 2 FJ970929; *D. scoparium* 1 DQ294335; *D. scoparium* 2 DQ294327; *D. septentrionale* Arkhangelsk HQ830339; *D. septentrionale* Kamchatka HQ830338; *D. tauricum* Caucasus 1 FJ952594; *D. tauricum* Caucasus 2 FJ952593; *D. tauricum* Kursk FJ952591; *D. viride* Moscow FJ952603; *D. viride* Tatarstan FJ952602.