Three new cleistocarpous species of the genera *Tortula* and *Microbryum* (Pottiaceae, Bryophyta)

T. N. Otnyukova

Krasnoyarsk, Russia
tnotnyukova@gmail.com

Abstract. Three new cleistocarpous species belonging to the genera *Tortula* and *Microbryum* were found among specimens in herbaria LE and MHA identified as *Pterygoneurum kozlovii* (redefined as *Pterygoneurum sibiricum*), *Tortula acaulon*, *Microbryum vlassovii* and *Microbryum curvicollum*. The new species *Tortula arenaria* found in collections from the Republic of Dagestan is similar to *M. curvicollum* in having curved costa but differs in large and roughly papillose spores (vs. smaller and smooth in *M. curvicollum*), branched papillae (vs. simple papillae in *M. curvicollum*). The new species *Microbryum lydiae* found in collections from the Republic of Armenia is similar to *M. vlassovii* in having ventral outgrowths of costa presented as elongated parenchymatous cells but differs in long-mammillose leaf lamina and costa cells (long-mammillose-papillose in *M. vlassovii*); smaller, warty papillose spores (vs. larger, streaky papillose in *M. vlassovii*). The new species *Tortula irinae* is similar to cleistocarpous species of the genus *Pterygoneurum* in having ventral outgrowths of costa, but differs in outgrowths presented as a pad of large, elongated parenchymatous cells (vs. as low lamellae of several rows of small cells in height in *P. kozlovii* and high lamellae in *P. sibiricum*). By ventral outgrowths of costa presented as elongated parenchymatous cells it is also similar to some species of the genus *Microbryum*, from which it differs in leaf lamina and costa cells with several branched papillae (vs. long-mammillose-papillose leaf lamina and costa cells with one branched papilla in *M. vlassovii* and long-mammillose leaf lamina and costa cells with one large mamilla in *M. lydiae*). *Tortula irinae* resembles *T. acaulon* in having cleistocarpous immersed capsule. *Tortula acaulon* is a highly variable species represented by several morphotypes of uncertain taxonomic status but strongly differing in many characters of sporophytes and gametophytes. The most important diagnostic characters are the degree of papillae expression and the shape of leaf and costa papillae. By the degree of papillae expression and the shape of papillae, several morphotypes of *T. acaulon* were revealed: 1 – morphotype without papillae, 2 – morphotype with simple papillae, 3 – morphotype with branched papillae. *Tortula irinae* differs from *T. acaulon* morphotypes in having ventral outgrowths of costa lacking in *T. acaulon* morphotypes. However, of all *T. acaulon* morphotypes studied, *T. irinae* can be most probably confused with *T. acaulon* “branched papillae morphotype” in having strongly branched papillae of costa and leaf cells but easily differing in shape of ventral costa cells protruding as a pad of large, elongated parenchymatous cells in *T. irinae* vs. ventral costa cells smaller, not protruding in *T. acaulon* “branched papillae morphotype”. *Tortula irinae* is widespread in Asian part of Russia [Chukotka Autonomous Area, Republic of Sakha (Yakutia), Trans-Baikal Territory]. It was also found in kept in LE moss collections from Asia (Khazakhtan, Mongolia) and Europe (Ukraine).

Keywords: *Microbryum curvicollum*, *Microbryum lydiae*, *Microbryum vlassovii*, *Phascum cuspidatum*, *Phascum piliferum*, *Pterygoneurum kozlovii*, *Pterygoneurum sibiricum*, *Tortula acaulon*, *Tortula arenaria*, *Tortula irinae*, geography, morphology, moss flora, taxonomy, Russia [Chukotka Autonomous Area, Republic of Dagestan; Republic of Karachayevo-Circassian, Republic of Sakha (Yakutia), Stavropol Territory, Trans-Baikal Territory]; Armenia, Austria, Azerbaijan, Germany, Kazakhstan, Mongolia, Poland, Romania, Tajikistan, Ukraine.

Три новых клейстокарпных вида родов *Tortula* и *Microbryum* (Pottiaceae, Bryophyta)

Т. Н. ОТНЮКОВА

Красноярск, Россия
tnotnuykova@gmail.com

Резюме. Выявлено три новых для науки вида из родов *Tortula* и *Microbryum* в гербариях LE и МНА, определенных как *Pterygoneurum kozlovii*, *Tortula acaulon*, *Microbryum vlassovii* и *Microbryum curvicollum*. Новый вид *Tortula arenaria*, обнаруженный в коллекциях мхов из Республики Дагестан, сходен с *M. curvicollum* согнутой ножкой, отличается крупными, грубо-папиллозными спорами (мелкие и гладкие у *M. curvicollum*), разветвленными папиллами (простые у *M. curvicollum*). Новый вид *Microbryum lydiae*, обнаруженный в коллекциях мхов из Армении, сходен с *M. vlassovii* наличием брюшных выростов жилки, образованных удлинёнными паренхиматическими клетками, отличается длинномамиллозными клетками жилки и пластинки листа (длинномамиллозно-папиллозные у *M. vlassovii*); более мелкими, бородавчато-папиллозными спорами (более крупные, штриховато-папиллозные у *M. vlassovii*). Новый вид *Tortula irinae* сходен с клейстокарпными видами рода *Pterygoneurum* брюшными выростами жилки, но отличается тем, что выросты образованы крупными, удлинёнными паренхиматическими клетками с разветвленными папиллами (выросты образованы низкими ламеллами из нескольких рядов мелких клеток в высоту у *P. kozlovii* и высокими ламеллами у *P. sibiricum*). Брюшными выростами, образованными удлинёнными паренхиматическими клетками, вид также сходен с клейстокарпными видами родов *Microbryum* и *Tortula*, от которых отличается клетками пластинки листа и жилки с несколькими разветвленными папиллами (длинномамиллозно-папиллозные клетки пластинки листа и жилки с одной крупной разветвленной папиллой у *M. vlassovii* и длинномамиллозные клетки пластинки листа и жилки с одной крупной мамиллой у *M. lydiae*). *Tortula irinae* сходен с *T. acaulon* клейстокарпными, погруженными в перихециальные листья коробочками. *Tortula acaulon* очень вариабельный вид, представленный несколькими морфотипами неопределённого таксономического статуса, но строго различающимися по многим признакам спорофита и гаметофита. Наиболее значимыми диагностическими признаками являются: степень выраженности папилл и форма папилл. По степени выраженности и форме папилл выделено несколько морфотипов *T. acaulon*: 1 – морфотип без папилл, 2 – морфотип с простыми папиллами, 3 – морфотип с разветвленными папиллами. *Tortula irinae* отличается от всех морфотипов *T. acaulon* брюшными выростами жилки, отсутствующими у *T. acaulon*. *Tortula irinae* можно спутать только с морфотипом *T. acaulon* с разветвленными папиллами, от которого этот вид легко отличается формой брюшных клеток жилки, у *T. irinae* эти клетки крупные и выступающие как выросты, в то время как у морфотипа *T. acaulon* с разветвленными папиллами брюшные клетки жилки мелкие и не выступающие. *Tortula irinae* широко распространена в Сибири [Чукотский автономный округ, Республика Саха (Якутия), Забайкальский край]. Вид также обнаружен в хранящихся в LE коллекциях мхов из Азии (Казахстан, Монголия) и Европы (Украина).

Ключевые слова: *Microbryum curvicollum*, *Microbryum lydiae*, *Microbryum vlassovii*, *Phascum cuspidatum*, *Phascum piliferum*, *Pterygoneurum kozlovii*, *Pterygoneurum sibiricum*, *Tortula acaulon*, *Tortula arenaria*, *Tortula irinae*, география, морфология, таксономия, флора мхов, Россия [Забайкальский край, Республика Дагестан, Карачаево-Черкесская Республика, Республика Саха (Якутия), Ставропольский край, Чукотский автономный округ], Австрия, Азербайджан, Армения, Германия, Казахстан, Монголия, Польша, Румыния, Таджикистан, Украина.

In moss collections kept in LE and MHA three new cleistocarpous species identified as *Pterygoneurum kozlovii* Laz., *Tortula acaulon* (With.) R. H. Zander, *Microbryum vlassovii* (Laz.) R. H. Zander and *Microbryum curvicolium* (Hedw.) R. H. Zander were found. To verify the generic position of the studied species, a 2% solution of KOH (Zander 1989, 1993) was used. The studied specimens of the two species showed a yellow KOH reaction, which may indicate that they can belong to the genus *Tortula* Hedw. rather than to the genus *Microbryum* Schimp., the third species had a red reaction belonging to the genus *Microbryum*.

The study of specimens defined as *Pterygoneurum kozlovii* (redefined as *Pterygoneurum sibiricum* Otnyukova) led to the discovery of a new species belonging to the genus *Tortula* Hedw. In one specimen identified as *P. kozlovii* (later attributed to *P. sibiricum*) (Otnyukova, 2020) there was an admixture marked as *Phascum cuspidatum* Hedw., which in present paper attributed to belonging to a new species of the genus *Tortula*. So, some specimens kept in LE as *Tortula acaulon* (*Phascum cuspidatum* and *P. piliferum* Hedw.) were studied. New *Tortula* species is characterized by yellow KOH reaction; as well as ventral outgrowths of costa lacking in *T. acaulon*. It is similar to cleistocarpous species of the genus *Pterygoneurum* Jur. in having outgrowths, but differs in that outgrowths consist of one row of large elongated parenchymatous cells with several strongly branched papillae (vs. formed as lamellae consisting of several rows of small cells in height in *P. sibiricum* and *P. kozlovii*).

Due to the fact that *Microbryum vlassovii* also has ventral outgrowths of costa, all specimens of *M. vlassovii* kept in LE were studied and the study led to the discovery of another new species of the genus *Microbryum*. New *Microbryum* species is characterized by red KOH reaction; it is similar to *M. vlassovii* in having ventral outgrowths formed by one row of large elongated parenchymatous cells, but differs in that cells long-mammillose (vs. long-mammillose-papillose in *M. vlassovii*). It is also characterized by smaller, warty-papillose spores (vs. larger, streaky papillose in *M. vlassovii*).

In one specimen of *Tortula acaulon* in LE there was *Microbryum* admixture, which was marked as “*Microbryum curvicolle*” (*M. curvicolium*), but the admixture was redefined as belonging to new species of the genus *Tortula*. So, all specimens of *M. curvicolium* kept in LE were studied. New *Tortula* species is characterized by bright-yellow KOH reaction; it is similar to *M. curvicolium* in having costa curved but differs in large, rough papillose spores (vs. smaller, smooth in *M. curvicolium*). It is also characterized by globose capsules (vs. oval in *M. curvicolium*); branched papillae (vs. simple in *M. curvicolium*).

Thus, all cleistocarpous specimens studied are morphologically distinct and deserve to be separate species.

Tortula arenaria Otnyukova, sp. nov.

(Plate I)

Diagnosis. *Tortula arenaria* is similar to *Microbryum curvicolium* in having strongly curved costa but differs in large and roughly papillose spores (vs. smaller and smooth

Plate I. *Tortula arenaria* Otnyukova, sp. nov.

1, 3, 4, 6, 8 — capsules; 2, 7 — spores; 5 — calyptra; 9–16 — leaves; 17–21 — leaf cross sections;
22 — upper part of leaf lamina with marginal papillae; 23 — leaf cells with branched papillae;
24, 25 — branched leaf papillae, mainly C-shaped with auricles (*in contour*).

Scale bars: 1, 3–6, 8–16 — 1 mm; 2, 17–21 — 80 μ m; 7 — 40 μ m; 22, 23 — 25 μ m; 24, 25 — 8 μ m.

From holotype (17 V 2009, *G. Ukrainskaya* 14100/2, LE).

in *M. curvicollum*); in globose to ovoid capsule (vs. short-ellipsoid in *M. curvicollum*); and in papillae branched (vs. simple in *M. curvicollum*).

Type. **Russia**, Republic of Dagestan, Sary-Kum dune, on soil, 17 V 2009, M. Ignatov, E. Ignatova, G. Ukrainskaya (М. Игнатов, Е. Игнатова, Г. Украинская) 14100/2 (det. by G. Ukrainskaya as *Microbryum curvicolle* being in admixture to *Tortula acaulon*), LE (holotype).

Description. *Plants* up to 2 mm, in loose turfs. *Stems* mainly forked or simple, crowded leafy. *Leaves* loosely appressed, erect or slightly curved when dry, erect-spreading when moist, $1.6\text{--}1.8(2.2) \times 0.35\text{--}0.45$ mm, oblong-lanceolate to ovate-lanceolate, short to $\pm$ long acuminate, keeled; *margins* $\pm$ serrulate due to protruding papillae, plane or narrowly recurved. *Costa* strong, $\pm$ long excurrent, $0.5\text{--}0.6(1.0)$ mm, in cross section with one row of guide cells and $\pm$ protruding dorsal stereid band; *ventral epidermis* large-celled, papillose, *dorsal epidermis* large-celled only near lamina, papillose, and small-celled on the protruding part of costa, epapillose; *ventral cells* in *cross section* elongated, barrel-shaped, $(18)20\text{--}25 \times 15\text{--}20(25)$ μm , *dorsal cells* in *cross section* isodiametric, $15\text{--}18$ μm ; *papillae* of costa 2–4 per cell, branched (in the *upper* part of costa), simple or lacking (in the *lower* part of costa). *Cells* of leaf lamina in the *upper* part isodiametric, quadrate, quadrate-hexagonal,

Plate II. *Microbryum curvicollum* (Hedw.) R. H. Zander.

1, 4 — spores; 2, 5, 6 — capsules; 3 — leaf; 7, 8 — leaf cross sections; 9, 10 — simple leaf papillae, rounded (*in contour*); 11 — lamina cells with papillae; 12 — part of leaf lamina with marginal papillae. Scale bars: 1, 4 — 40 μm ; 2, 3, 5, 6 — 1 mm; 7 — 80 μm ; 8 — 150 μm ; 9, 10 — 8 μm ; 11, 12 — 25 μm . 1, 2, 4 — from 19 X 1903, C. Jensen, LE; 3, 5–12 — from 23 V 2010, G. Ukrainskaya, LE.

13–15(17) × 13–15 µm, in the *middle* short-rectangular, (13)15–20 × 13–15 µm, in the *lower* part rectangular, 25–40 × 15 µm, papillose on both sides above, epapillose below; *papillae* of lamina 2–4 per cell, in the *upper* part strongly branched, C- or C-shaped with auricles, in the *middle* 2-divided or simple, in the *lower* part lacking. *Sexual condition* autoicous. *Sporophytes* one or two per each perichaetium. *Seta* 0.6–0.8 mm long, (0.1)0.15(0.2) mm thick, strongly curved. *Capsule* cleistocarpic, globose to ovoid, (0.7)0.8–1.0 × (0.5)0.6–0.7 mm, with indistinct apex. *Calyptra* up to 0.4 mm, triangular-conical, smooth. *Spores* (30)32–35(37) µm, ± roughly papillose. *KOH color reaction* of leaf lamina bright yellow or somewhat yellow-orange in cells of stem and costa.

Etymology. The species name derives from Latin adjective *arenarius* – inhabiting on sand, sandy.

Distribution. *Tortula arenaria* is found in Caucasus, it is known only from type locality in Sary-Kum dune in Dagestan.

Ecology. *Tortula arenaria* grows in dry conditions on soil.

Differentiation. *Tortula arenaria* is similar to *Microbryum curvicollum* (Plate II) in having strongly curved costa but differs in many other characters. Both species differ in response to KOH, which is bright-yellow in *Tortula arenaria* vs. red in *Microbryum curvicollum*; in length and thickness of seta, which are 0.6–0.8 mm long and up to 0.2 mm thick in *Tortula arenaria* vs. 0.8–0.9 mm long and up to 0.1 mm thick in *Microbryum curvicollum*. *Tortula arenaria* also differs from *Microbryum curvicollum* in capsule larger, globose to ovoid, 0.8–1.0 × 0.6–0.8 mm vs. smaller, short-ellipsoid, 0.7–0.8 × 0.4–0.5 mm; spores larger and roughly papillose, 32–35 µm vs. smaller and smooth, 22–25 µm; cells of ventral epidermis much larger, strongly protruding as ventral outgrowths vs. smaller, not differing from surrounding cells; papillae of lamina and costa large, branched, C-shaped with auricles or C-shaped *in contour* vs. small, simple, rounded *in contour* in *M. curvicollum*.

Selected specimens examined. *Microbryum curvicollum* – **Russia**, Republic of Kalmykia, Ikiburul District, Cholun-Khomur village, career, on soil among fragments of shell rock, 23 V 2010, *G. Ukrainskaya* (Г. Украинская) 136-кл (as *Microbryum curvicolle*), LE; **Denmark**, Zealand, wood at Allindelille, north of Ringsted, 19 X 1903, *C. Jensen* (Bryophyta Danica Exciccata #171 as *Phascum curvicolle* Hedw.), LE; **Poland**, Nakło nad-Notecią. Bewohner der pontischen Hügel ostlich von Nakel, aber nicht alljährlich so schön entwickelt. Gesammelt von V. Torka am 13 Februar 1913 in Gemeinschaft von *Mildea bryoides* (Dicks.) Warnst., *Pterygoneurum subsessile* (Brid.) Jur., *Silene otitis* Sm. (Bryotheca Posnaniensis #61 as *Phascum curvicollum* Ehrh.), LE; **Sweden**, Gotland, Visby, 28 IV 1900, *K. Johansson* (Musci Suecici, a Museo Botanico Upsaliensi Distributi as *Phascum curvicolle* Hedw.), LE; **Turkmenistan**, Kopet-Dag Range, Parkhai Stream, 9 X 1985, *I. V. Sirotina* (И. В. Сиروتина) (det. by A. L. Abramova as *Phascum curvicolle*), LE; **Ukraine**, Askania-Nova Reserve, steppe, 11 V 1923, *V. N. Sukachev* (В. Н. Сукачев) (det. by L. I. Savicz as *Phascum curvicollum*), LE; *ibidem*, 12 V 1923, *V. N. Sukachev* (В. Н. Сукачев) (det. by L. I. Savicz as *Phascum curvicollum*), LE.

Microbryum lydiae Otnyukova, sp. nov.

(Plate III)

Diagnosis. *Microbryum lydiae* is similar to *Microbryum vlassovii* in having ventral outgrowths of costa as large elongated parenchymatous cells but differs in that cells

Plate III. *Microbryum lydiae* Otnyukova, sp. nov. (1–17) and *Microbryum vlassovii* (Laz.)

R. H. Zander (18–27).

1, 20, 24 — capsules; 2, 3, 23 — caliptrae; 4, 5, 20, 27 — spores: warty papillose (5), streaky papillose (27); 6, 8, 12–19, 25, 26 — leaf cross sections; 7 — leaf tip; 9 — part of leaf; 10, 11, 21 — leaves.

Scale bars: 1, 10, 11, 18, 20, 21, 23 — 1 mm; 2, 3, 7, 9, 23 — 0.3 mm; 4, 20 — 25 μm; 5, 27 — 15 μm; 6, 8, 12 — 150 μm; 13, 15, 16, 19, 25, 26 — 80 μm; 14, 18 — 20 μm; 17 — 75 μm. 1, 3, 6, 7, 13–16 — from paratype (7 III 1953, A. G. Abramyan, A. M. Bargesyan, LE); 2, 4, 5, 8–12, 17 — from holotype (3 III 1953, A. G. Abramyan, A. M. Bargesyan); 18–27 — from 10 IV 1963, A. L. Lyubarskaya, LE.

long-mammillose (vs. long-mammillose-papillose cells ending in one branched papilla in *M. vlassovii*); as well as in smaller, warty papillose spores (vs. larger, streaky papillose in *M. vlassovii*).

Type. **Armenia**, Yerevan City, Botanical Garden, 3 III 1958, A. G. Abramyan, A. M. Bargesyan (А. Г. Абрамян, А. М. Баргесян) [det. by A. and I. Abramovy as *Lydiaea vlassovii* (Laz.) Laz.], LE (holotype, LE).

Paratype from the type locality. **Armenia**, Yerevan City, Botanical Garden, *Artemisia erevanica* grouping, 7 III 1958, A. G. Abramyan, A. M. Bargesyan (А. Г. Абрамян, А. М. Баргесян) (det. by A. and I. Abramovy as *Lydiaea vlassovii*), LE.

Description. *Plants* up to 5 mm, scattered or gregarious. *Stems* simple, kidney leafy. *Leaves* gradually becoming larger upward, oval-ovoid, $(1)2-3 \times (0.4-0.7)1.0-1.3$ mm, concave; *margins* entire, widely recurved *above*, plane *below*. *Costa* $\pm$ strong, excurrent, 0.4–0.6 mm, in cross section with one row of guide cells and $\pm$ strong dorsal stereid band; *ventral epidermal* cells large, strongly protruding as ventral outgrowths, in cross section conical, long-mammillose, 35–50 μ m long; *dorsal epidermal* cells $\pm$ smooth. *Cells* of leaf lamina isodiametric, quadrate-hexagonal, in the lower part at margins short-rectangular, $(13-15)17-20 \times 13-17(20)$ μ m, all long-mammillose on ventral side, smooth or somewhat short-mammillose on dorsal side, in the upper part with one large mammilla, in the lower part at margins with $(1)2-4$ low mammillae (or papillae); near costa somewhat long-rectangular, colorless, $25-40 \times 15$ μ m, smooth. *Sexual condition* autoicous. *Sporophytes* immersed. *Seta* short, 0.2–0.3 mm. *Capsule* cleistocarpic, short-ellipsoid, $0.6-0.7 \times 0.4-0.5$ mm, with short, narrowly-triangular blunt apex. *Calyptra* up to 0.3 mm, conical, smooth. *Spores* 18–22(25) μ m, warty papillose. *KOH color reaction* of leaf lamina red or somewhat brownish in cells of stem and costa.

Etymology. The species name is given in honor of Lydia I. Savicz-Ljubitskaja (Savich-Ljubitskaya), the famous Russian bryologist (St. Petersburg, Russia).

Distribution. *Microbryum lydiae* is found in Caucasus, it is known only from type locality in Yerevan Botanical Garden in Armenia.

Ecology. *Microbryum lydiae* grows in dry conditions on soil among grasses.

Differentiation. *Microbryum lydiae* is similar to *M. vlassovii* in having ventral outgrowths of costa presented as elongated parenchymatous cells. Both species differ in shape of cells, which are long-mammillose in *M. lydiae* vs. long-mammillose-papillose in *M. vlassovii*. *Microbryum lydiae* also differs from *M. vlassovii* in capsule small, short-ellipsoid, $0.6-0.7 \times 0.4-0.5$ mm vs. larger, ellipsoid, $0.9-1.0 \times 0.6-0.7$ mm; in spores small, warty papillose, 18–22 μ m vs. larger, streaky papillose, 25–28 μ m; in long-mammillose cells with one large mammilla vs. long-mammillose-papillose cells with one branched papilla in *M. vlassovii*.

Selected specimens examined. *Microbryum vlassovii* – **Azerbaijan**, Masally District, in surroundings of Masally Town, open sites, on soil, 10 IV 1963, A. L. Lyubarskaya (А. Л. Любарская) (det. by A. L. Abramova as *Lydiaea vlassovii*), LE; **Kyrgyzstan**, Kyrgyz Ala-Too (Kyrkysky Ridge), natural boundary Chon-aryk, north exposure slope, 950 m a. s. l., on soil, 10 V 1965, E. Rakhmatulina (Э. Рахматулина) (as *Lydiaea vlassovii*; in admixture to *Pterygoneurum ovatum* (Hedw.) Dixon

and *Syntrichia* sp.), LE; **Tajikistan**, Dushanbe City, Botanical Garden, on moist soil, 23 III 1963, U. K. Mamatkulov (У. К. Маматкулов) 3985 (as *Lydiaea vlassovii*), LE; **Turkmenistan** (Trans-Caspian Region), Mahtumkuli etrap (Karakalinskoye pristavsto), Kopet-Dag Range (Salchy-dag), 22 III 1916, E. G. Tschernjakovskaja (Е. Г. Черняковская) 97 (det. by A. and I. Abramovy in 1963 as *Lydiaea vlassovii*; in admixture to *Phascum acaulon*), LE; **Uzbekistan**, Tashkent Region, Chirchiq River Basin, adyrs, on soil, 17 IV 1963, E. Rakhmatulina (Э. Рахматулина) (det. by A. and I. Abramovy as *Lydiaea vlassovii*; in admixture to *Tortula* sp.), LE; Tashkent City, on ground roofs and soil in open spaces, 15 IV 1926, I. Raykov (И. Райков) (det. by A. and I. Abramovy in October 1963 as *Lydiaea vlassovii*; in admixture with *Pterygoneurum ovatum*), LE.

Tortula irinae Otnyukova, sp. nov.

(Plates IV, V, VI, VII)

Diagnosis. *Tortula irinae* resembles *T. acaulon* in immersed cleistocarpous capsule, but differs in having ventral outgrowths of costa lacking in *T. acaulon*. In ventral outgrowths of costa it is similar to cleistocarpous species of the genera *Pterygoneurum*, *Microbryum* and *Tortula* but differs in having one row of elongated ventral cells (vs. several rows of small cells in height as lamellae in *Pterygoneurum sibiricum* and *P. kozlovii*); from *Microbryum* and *Tortula* species with one row of elongated ventral cells it differs in having cells large, barrel-shaped with several branched papillae (vs. cells long-mammillose-papillose in *M. vlassovii* and long-mammillose in *M. lydiae*).

Type. **Russia**, Trans-Baikal Territory, Sokhondinsky State Natural Biosphere Reserve, surroundings of cordon on river Enda, 49°27'N, 110°51'E, 1070 m a. s. l., stony steppe slope, on bare soil among stones, 14 VII 2010, I. V. Czernyadjeva 19-10 (as *Tortula acaulon*, LE) (holotype, LE).

Paratypes from the same locality. **Russia**, Trans-Baikal Territory, Sokhondinsky State Natural Biosphere Reserve, surroundings of cordon on river Enda, 49°26'N, 110°48'E, 1473 m a. s. l., steppe slope, on bare soil under stones, 28 VIII 2011, I. V. Czernyadjeva 55-11 (as *Tortula acaulon*), LE; *ibidem* 49°26'N, 110°53'E, 1239 m a. s. l., rocky steppe slope, on bare soil, 29 VIII 2011, I. V. Czernyadjeva 57-11 (as *Tortula acaulon*), LE.

Paratypes from the other territories. **Russia**, Chukotka Autonomous Area, Central Chukotka, middle course of Palyavaam River, cryophyte steppe with herb and *Carex*, 21 VII 1989, O. M. Afonina (О. М. Афонина) (as *Phascum cuspidatum*, with capsules; with *Bryum argenteum* Hedw.), LE; *ibidem*, steppe cryophyte grouping on top of outlier, 10 VII 1989, O. M. Afonina (О. М. Афонина) (as *Phascum cuspidatum*; with *Bryum argenteum*), LE; *ibidem*, herb-grass cryophyte steppe, 19 VII 1989, O. M. Afonina (О. М. Афонина) (as *Phascum cuspidatum*; with *Desmatodon latifolius* (Hedw.) Brid. and *Stegonia pilifera* (Brid.) H.A. Crum & L.E. Anderson), LE; *ibidem*, 19 VII 1989, O. M. Afonina (О. М. Афонина) (as *Phascum cuspidatum*), LE; *ibidem*, steppe birch forest on southern slope of hill, 19 VII 1989, O. M. Afonina (О. М. Афонина) (as *Phascum cuspidatum* (marked by O. Afonina as having “low outgrowths on ventral side of costa”); with *Bryum argenteum*), LE; Republic of Sakha (Yakutia), right bank of Indigirka River, near mouth of Ystan-Yuryakh (opposite village of Tyubelyakh), grass meadow steppe with *Helictotrichon* and *Poa*, 1 VIII 1976, O. M. Afonina (О. М. Афонина) (as *Phascum cuspidatum* var. *piliferum*, with capsules), LE; *ibidem*, larch forest edge, herb-grass steppe with *Lycopodium* and epigeous lichens, 29 VI 1976, O. M. Afonina (О. М. Афонина) (as *Phascum cuspidatum* var. *piliferum*, with capsules; with *Bryum argenteum*), LE; *ibidem*, herb-grass mountain steppe with *Alyssum*, *Artemisia*, *Helictotrichon* and *Koeleria*,

Plate IV. *Tortula irinae* Otnyukova, sp. nov.

- 1, 5 — capsules; 2, 9 — calyptrae; 3 — beak of capsule; 4, 10, 16, 20, 21 — stem leaves; 6, 15 — spores;
 7 — outer perichaetial leaf; 8 — outer perichaetial leaf with antheridia; 11 — antheridia;
 12–14, 17–19, 23 — leaf cross sections; 22 — leaf papillae (*in profile*); 24 — young leaf with ventral
 outgrowths; 25 — part of leaf with ventral outgrowths; 26 — upper part of costa with ventral
 outgrowths as a pad of elongated cells. Scale bars: 1, 4, 7, 8, 10, 16, 20, 21 — 1 mm; 2, 5 — 0.5 mm;
 3 — 300 μ m; 6, 15, 17, 26 — 40 μ m; 9 — 350 μ m; 11 — 250 μ m; 12–14, 18, 19, 23 — 80 μ m;
 22 — 20 μ m; 24 — 150 μ m; 25 — 60 μ m. 1–3, 5, 6, 15, 18, 19, 22 — from holotype (14 VII 2010,
Czernyadjewa 19–10, LE); 4, 7, 8, 10, 11, 16, 20, 21 — from paratype (21 VII 1989, *Afonina*, LE);
 12–14, 17, 23–26 — from paratype (22 VII 2010, *Czernyadjewa* 37–10, LE).

Plate V. *Tortula irinae* Otnyukova, sp. nov.

- 1 — upper part of leaf with ventral outgrowths; 2 — ventral outgrowths in the upper part of leaf;
 3–7 — branched leaf papillae, C-shaped and C-shaped with auricles; 8 — leaf lamina cells;
 9 — ventral outgrowths in the lower part of leaf. Scale bars: 1, 2, 8, 9 — 25 μm ; 3–7 — 8 μm .
 1, 2, 4, 5, 8, 9 — from paratype (22 VII 2010, *Czernyadjeva* 37-10, LE); 3, 7 — from paratype
 (21 VII 1989, *Afonina*, LE); 6 — from holotype (14 VII 2010, *I. V. Czernyadjeva* 19-10, LE).

Plate VI. *Tortula irinae* Otnyukova, sp. nov.

1 — leaf cells in the upper part of leaf; 2, 3, 9, 12, 13 — leaf cross sections; 4 — leaf cells in the middle part of leaf; 5 — leaf cells in the lower part of leaf; 6, 7, 11, 15 — branched leaf papillae, C-shaped with auricles (6, 15) and 2-divided (7, 11); 8, 10 — cross section of ventral outgrowths with elongated, barrel-shaped cells; 14 — cells of leaf lamina. Scale bars: 1, 4, 5 — 20 μ m; 2, 3, 9, 13 — 80 μ m; 6, 7, 11, 15 — 8 μ m; 8, 10, 14 — 25 μ m; 12 — 150 μ m.

From paratype (27 VII 1976, *M. Boiko*, LE).

Plate VII. *Tortula irinae* Otnyukova, sp. nov.

1 — branched leaf papillae, C-shaped with auricles; 2, 5 — cells of the ventral outgrowths in the upper part of the leaf; 3 — leaf cells in the upper part of leaf; 4, 9 — leaf lamina cross sections; 6 — cells of the ventral outgrowths in the lower part of the leaf; 7 — simple papillae in the low part of leaf; 8 — branched papillae in the middle part of leaf; 10, 11 — costa cross sections.

Scale bars: 1, 4, 7, 8 — 8 μ m; 2, 3 — 25 μ m; 4 — 20 μ m; 5, 6 — 40 μ m; 9–11 — 80 μ m.

From paratype (20 III 1877, *A. Regel*, LE).

on slope of south exposure, 29 VI 1976, O. M. Afonina (O. M. Афонина) [as *Phascum cuspidatum* var. *piliferum* (Schreb. ex Hedw.) Hook. et Taylor, with capsules], LE; left bank of Indigirka River, above mouth of Inyali River, 18 VI 1976, O. M. Afonina (O. M. Афонина) (as *Phascum cuspidatum* var. *piliferum*, with capsules; with admixture marked by O. Afonina as *Pterygoneurum kozlovii* (redefined as *Pterygoneurum sibiricum*) and *Bryum argenteum*), LE; Oimyakon District, surroundings of Ust-Nera Settlement, 64°32'27.8"N, 142°58'10"E, 585 m a. s. l., left bank of Indigirka River, 957 km along Magadan Road, dry steppe slope, on bare soil among grasses, 31 VII 2015, Ignatov, Ignatova (Игнатов, Игнатова) 15-1020, MHA 9046875; *ibidem*, 60 km upstream Nera River from Ust-Nera Settlement, 64°27'20"N, 144°21'30"E, 650 m a. s. l., 60 km to east from Ust-Nera Settlement, right bank of Nera River Valley near mouth of Topol' Stream, steppe slope, on soil under stone, 5 VIII 2015, Ignatov, Ignatova (Игнатов, Игнатова) 15-1483, MHA 9046873; Trans-Baikal Territory, Kyrynsky District, Sokhondinsky State Natural Biosphere Reserve, surroundings of cordon on Agutsa River, 49°27'N, 110°51'E, 1070 m a. s. l., steppe slope, on bare soil, 22 VII 2010, Czernyadjeva (Чернядьева) 37-10 (as *Tortula acaulon*), LE; *ibidem*, Enda River, 49°26'N, 110°52'E, 1117 m a. s. l., forb-grass steppe on stony slope, 14 VII 2010, O. M. Afonina (O. M. Афонина) A2510 (as *Tortula acaulon*), LE; *ibidem*, Khukhe-Byatsa Creek, 49°27'50"N, 110°52'11"E, 1214 m a. s. l., dry rocky outcrops on S-facing slope, 28 VIII 2011, O. M. Afonina (O. M. Афонина) 7611 (as *Tortula acaulon*), LE; Ononsky District, near Nizhni Zasuchey, slope of Onon River terrace, 59°32'N, 114°59'E, 737 m a. s. l., 18 VII 2006, O. M. Afonina (O. M. Афонина) 5406 (as *Tortula acaulon*; with *Bryum argenteum*), LE; Borsinsky District, Kululbey Ridge, surroundings of Perednaya Byrka village, 50°45'39"N, 116°46'23"E, 880 m a. s. l., rocky outcrops on S-facing slope, on bare soil among stones, 27 VII 2012, Czernyadjeva (Чернядьева) 34-12 (as *Tortula acaulon*; with *Weissia* Hedw.), LE; Olovyansky District, surroundings of Olovyanyi village, 50°59'01"N, 115°35'43"E, 566 m a. s. l., Onon River bank, rocky outcrops on bank, 29 VII 2012, Czernyadjeva (Чернядьева) 36-12 (as *Tortula acaulon*), LE; Nerchinsko-Kuenginsky Ridge, Uldurga River, a tributary of Nercha River, 52°37'40"N, 115°24'11"E, 620 m a. s. l., rocky outcrops on S-facing slope, in crevices of stones, 17 VII 2012, Czernyadjeva (Чернядьева) 13-12 (as *Tortula acaulon*), LE; Daursky Ridge, Aratsa River, tributary of Ingoda River, 51°54'50"N, 114°25'06"E, 900 m a. s. l., roadside, on bare soil, 14 VII 2012, Czernyadjeva (Чернядьева) 4-12/2 (indicated by I. Czernyadjeva as *Phascum cuspidatum*; in admixture with *Pterygoneurum kozlovii*, redefined as *Pterygoneurum sibiricum*), LE; Borschovka Ridge, surroundings of Baley Town, near Sukhoi Fall, on stony (granites) outcrops, 12 VII 1957, I. Abramov (И. Абрамов) (as *Phascum piliferum*), LE; — **Khazakhstan**, Almaty (Werny), Almatinka minor pr. Werny, 20 III 1877, A. Regel (det. by A. Abramova in 1961 as *Phascum cuspidatum*), LE; **Mongolia**, Dorkot aimak, Bayan-Dun somon, Sogoot-Ula Mountains, 1220 m a. s. l., on soil, 22 VII 1974, N. Golubkova, U. Tsogt (Н. Голубкова, У. Цогт) (det. by A. and I. Abramovy as *Phascum cuspidatum*), LE; Ulaanbaatar, Bogdo Ula Mountain, fall Zaisan, NW exposure slope, herb steppe with *Festuca*, on soil, 12 VI 1974, Ts. Tsegmed (Ц. Цэгмэд) 896 (as *Phascum cuspidatum*), LE; **Ukraine**, Kherson Region, Askania-Nova Reserve, steppe, 27 VII 1976, M. Boiko (М. Боїко) (as *Phascum piliferum*), LE.

Description. *Plants* up to 2 mm, in loose turfs, scattered or gregarious. *Stems* crowded leafy. *Leaves* loosely appressed, curved or slightly twisted when dry, erect-spreading when moist, (0.6–0.9)1.2–1.8(2.2) × 0.4–0.5(0.6) mm, ovate to oblong-lanceolate, ± concave; *margins* narrowly recurved from base to apex, in the upper part plane, serrulate due to protruding papillae. *Costa* strong, ± long excurrent, awn 0.4–0.6(1.0) mm; *ventral epidermal* cells large, strongly protruding as ventral outgrowths, in cross section elongated, barrel-shaped, (25)30–35 × (15)20–25 μm, papillose; dorsal epidermis small-celled, papillose; papillae of costa 2–4 per cell, in the *upper* part of costa branched, 2–4(5)-divided, in the *lower* part of cos-

ta simple or lacking. *Cells* in the *upper* part of leaf lamina isodiametric, quadrate, $13\text{--}15(17) \times 13\text{--}17\ \mu\text{m}$, in the *middle* short-rectangular, $17\text{--}20(25) \times 13\text{--}15\ \mu\text{m}$, papillose; papillae 1–3(4) per cell, on both sides; in *upper* lamina cells strongly branched, 2–4(5)-divided, in the *middle* 2-divided or simple, *lower* lacking. *Sexual condition* sinoicous. *Sporophytes* immersed. *Seta* very short, 0.05–0.1 mm, at base strongly bulbiform. *Capsule* cleistocarpic, globose, 0.5–0.6 mm, with distinct short, wide-triangular blunt apex; peristome absent; operculum not differentiated. *Calyptra* small, 0.2–0.3 mm, narrowly conical, smooth. *Spores* 20–25 μm , $\pm$ densely papillose. KOH color reaction of leaf lamina yellow.

Etymology. The species name is given in honor of Irina V. Czernyadjeva, the bryologist from Komarov Botanical Institute, St. Petersburg, Russia, a collector of this species.

Distribution. *Tortula irinae* is widespread in the Asian part of Russia (Siberia), including Trans-Baikal Territory, Republic Sakha (Yakutia) and Chukotka Autonomous Area. The species also found in Asia (Khazakhtan, Mongolia,) and Europe (Ukraine). It is logical to assume that species is more widespread in the world.

Ecology. *Tortula irinae* grows on soil in dry conditions. In Siberia it grows on the steppe slopes among grasses. It is very often found together with *Pterygoneurum sibiricum* in separate small turfs or in admixture to mosses.

Differentiation. In cleistocarpous capsules *T. irinae* resembles *T. acaulon*, but differs in having ventral outgrowths (Plates IV–VII) lacking in *T. acaulon* (e. g., Zander, Eckel, 2007), as well as strongly papillose distal laminal cells (Plates IV–VII), weakly simply papillose or smooth (Savicz-Ljubitskaja, Smirnova, 1970 as *Phascum cuspidatum*; Ignatov *et al.*, 2003 as *T. acaulon*; Zander, Eckel, 2007 as *T. acaulon*).

Tortula irinae may be confused with *T. acaulon*, a highly variable species represented by several morphotypes of uncertain taxonomic status (Plates VIII–X). These morphotypes were revealed in the course of comparative study of *T. irinae* in LE collections, briefly characterized and keyed out below. They described here to delineate better the differentiation of *T. irinae* and deserve further special study.

All cleistocarpous specimens “looking like *T. acaulon*” studied in LE are strongly distinct in the following contrast characters: ventral outgrowths of costa (present or lacking); the degree of leaf papillae expression (present or lacking); shape of papillae (branched or simple); shape of capsule (spherical or ellipsoid). Length of costa is a variable character. Among specimens “looking like *T. acaulon*” studied in LE several morphotypes were found, differing in the severity of ventral outgrowths of costa and leaf papillae.

1. Ventral outgrowths of costa present *T. irinae* (Plates IV–VII)
 – Ventral outgrowths of costa lacking *T. acaulon* morphotypes (2)
2. Leaf and costa cells smooth *T. acaulon* “smooth morphotype” (Plate VIII)
 – Leaf lamina and costa cells $\pm$ papillose; papillae 1–4 per cell (3)
3. Papillae simple, sometimes 2-divided *T. acaulon* “simple papillae morphotype” (Plate IX)

Plate VIII. *Tortula acaulon* morphotype without papillae ("smooth morphotype").

1, 2, 18 — capsules; 3–5, 12, 13, 19, 21 — stem leaves; 6, 10, 20, 22 — leaf cells;
 7, 11, 14, 16 — spores; 8, 9, 15, 17 — leaf cross sections. Scale bars: 1–5, 12, 13, 18, 19, 21 — 1 mm;
 6, 10, 20, 22 — 20 μm ; 7, 11, 14, 16 — 40 μm ; 8, 9 — 80 μm ; 15, 17 — 150 μm .
 1–7, 10, 11, 12–14 — from 11 III 1993, G. Ukrainskaya, LE; 8, 9, 15, 17 — from 20 IV 1873,
 E. Zickendrath, LE; 18–22 — from 14 VIII 1993, G. Ukrainskaya, LE.

— Papillae branched, 2–4(5)-divided *T. acaulon* “branched papillae morphotype” (Plate X)

Tortula acaulon “smooth-morphotype” (morphotype without papillae) is characterized by lacking ventral outgrowths; leaf and costa cells smooth (Plate VIII).

Tortula acaulon “simple papillae morphotype” (morphotype with simple papillae) is characterized by lacking ventral outgrowths; leaf and costa cells papillose; papillae 1–4 per cell, simple or 2-divided (Plate IX).

Tortula acaulon “branched papillae morphotype” (morphotype with branched papillae) is characterized by lacking ventral outgrowths; leaf and costa cells strongly papillose; papillae 1–4 per cell, branched, 2–4(5)-divided (Plate X).

Of all *T. acaulon* morphotypes studied, *T. irinae* can be most probably confused with *T. acaulon* “branched papillae morphotype” in having strongly branched papillae of lamina and costa cells, but differs in shape of ventral costa cells protruding as a pad of large, elongated parenchymatous cells in *T. irinae* vs. ventral costa cells smaller, not protruding in *T. acaulon* “branched papillae morphotype”.

Selected specimens of *Tortula acaulon* examined: morphotype without papillae — **Russia**, Stavropol Territory, District of Caucasian Mineral Waters, surroundings of city of Kislovodsk, on ground in cracks between stones, 11 VIII 1993, *G. Ukrainskaya* (*Г. Украинская*) кмв-32 (as *Tortula acaulon*), LE 13475; *ibidem*, surroundings of Gorny village, 43°57' N, 42°51' E, on soil among grounds, 2 V 2009, *G. Ukrainskaya* (*Г. Украинская*) (as *Tortula acaulon*), LE 13939; Karachayevo-Circassian Republic, Bechisyn Plateau, on soil, 14 VIII 1993, *G. Ukrainskaya* (*Г. Украинская*) (as *Tortula acaulon*), LE 15698; — **Austria**, Vienna (Wien), Mödling (Kreuzberg bei Moedling), 20 IV 1873, *Ernst Zickendrath* 47 (as *Phascum cuspidatum* var. *piliferum*), LE; morphotype with simple papillae — **Russia**, Stavropol Territory, District of Caucasian Mineral Waters, Beshtau Mountain, Kozii Skaly, on ground in grass, 7 V 2009, *G. Ukrainskaya* (*Г. Украинская*) (as *Tortula acaulon*; with *Barbula unguiculata*), LE 15287; **Khazakhstan**, Ak-mola Region (Tselinograd Region), Kogalzhyn village, island in northeast of Tengiz Lake, on soil among *Halocnemum*, 15 VII 1988, *T. V. Sidorova* (*Т. В. Сидорова*) (det. by O. M. Afonina as *Phascum cuspidatum* var. *piliferum*), LE; *ibidem*, Tengiz Lake, northeast coast, on soil among *Halocnemum*, 15 VII 1984, *T. V. Sidorova* (*Т. В. Сидорова*) (det. by O. M. Afonina as *Phascum cuspidatum* var. *piliferum*; with *Physcomitrium pyriforme*), LE; *ibidem*, 40 km south-southwest of Kogalzhyn village, northeast coast of Kogalzhyn Lake, on ground in meadow community, 30 VI 1979, *T. V. Sidorova* (*Т. В. Сидорова*) (as *Phascum cuspidatum*), LE; **Poland** (Polonia), Wyżyna Lubelska, Lublin, ad terram loessaceam in oppido, 4 IV 1966, *K. Karczmarz* (*Musci Exciccati Palatinatus Lublinensis*—Polonia # 132 as *Phascum piliferum* Schreb.), LE; morphotype with branched papillae — **Russia**, Republic of Dagestan, Sary-Kum dune, on soil, 17 V 2009, *M. Ignatov*, *E. Ignatova*, *G. Ukrainskaya* (*М. Игнатов, Е. Игнатова, Г. Украинская*) 14100 (det. by G. Ukrainskaya as *Tortula acaulon*; in admixture with *Tortula arenaria*), LE; *ibidem*, Sary-Kum dune, from the dune, 17 V 2009, *M. Ignatov*, *E. Ignatova*, *G. Ukrainskaya* (*М. Игнатов, Е. Игнатова, Г. Украинская*) (det. by M. Ignatov and E. Ignatova as *Tortula acaulon*; with admixture of mosses), МНА 9110440; **Armenia**, Yerevan, semi desert with *Artemisia*, III 1936, *A. Takhtajan* (*А. Тахтаджян*) (det. by A. and I. Abramovy as *Phascum cuspidatum*), LE; **Germany**, Carlsruh (in XXIV # 5 as *Phascum piliferum*), LE; **Romania**, Transylvania (*Siebenburgen*), 27 II 1897, *M. Péterfi* (*Musci Frondosi Transsilvaniae* #47 as *Phascum piliferum*), LE; **Tajikistan**, Hissar Range, gorge of Varzob River, 30 km north from Dushanbe (as Stalinabad), on stony slope, 26 III 1926, *P. Polyakov* (*П. Поляков*) (det. by A. L. Abramova and I. I. Abramovas *Phascum piliferum*; in admixture with *Tortula inermis*), LE; *ibidem*, Varzob River Basin, Kondara Gorge, in thicket of almond, 120 m a. s. l., on soil, 28 II 1966, *U. Mamatkulov* (*У. Маматкулов*) (as *Phascum cuspidatum*), LE.

Plate IX. *Tortula acaulon* morphotype with mostly simple papillae (“simple papillae morphotype”).

1–3, 23 – capsules; 4, 7, 9, 10, 20, 22, 24 – stem leaves; 5 – marginal papillae;
6, 12, 18, 19, 25–27 – leaf cells; 8 – leaf margin; 11, 21 – spores; 13, 14 – leaf cross sections;
15 – perigonial leaf with antheridia; 16 – perigonial leaf; 17 – tip of leaf.

Scale bars: 1–4, 7, 9, 10, 15, 16, 20, 22, 24 – 1 mm; 5, 6, 12, 18, 19, 25–27 – 20 μ m;
8, 11, 21 – 40 μ m; 13, 14 – 80 μ m; 17 – 300 μ m. 1–12 – from 7 V 2009, G. Ukrainskaya, LE;
13, 14, 18, 19 – from 4 IV 1966, K. Karczmarz, LE; 15–17, 20–27 – from 15 VIII 1988,

T. V. Sidorova, LE.

Plate X. *Tortula acaulon* morphotype with mostly branched papillae (“branched papillae morphotype”) 1, 2 – capsules; 3 – calyptra; 4–9, 15 – stem leaves; 10, 11 – leaf cross sections; 12 – spora; 13, 14 – tip of leaves; 16–18, 22, 24 – leaf lamina cells with papillae: branched papillae in upper part of leaf (16, 22, 25), simple and 2-divided in the middle (17), simple papillae in the lower part (18); 19, 20 – costa cells with papillae: branched papillae in the middle (19), simple and 2-divided in the lower part of costa (20); 21, 23, 25 – branched papillae: C-shaped with auricles (21, 23), divided into 2–4(5) lobes (25). Scale bars: 1–9, 15 – 1 mm; 10, 11 – 80 μ m; 12 – 40 μ m; 13, 14 – 300 μ m; 16–20, 22 – 25 μ m; 21, 23 – 8 μ m; 24, 25 – 20 μ m. 1–11, 13–21, 24, 25 – from 27 II 1897, *M. Péterfi*, LE; 12, 22, 23 – from 17 V 2009, *G. Ukrainskaya*, LE 14100.

Besides differentiation of *T. irinae* from *T. acaulon* it is necessary to discuss its distinctions from some cleistocarpous species of the family *Pottiaceae* Hampe with ventral outgrowths. *Tortula irinae* is similar to cleistocarpous species of the genus *Pterygoneurum* in ventral outgrowths of costa, but differs in outgrowths presented as a pad of large, elongated parenchymatous cells (vs. as low lamellae of several rows of small cells in height in *P. kozlovii* and high lamellae in *P. sibiricum*). By ventral outgrowths of costa presented as elongated parenchymatous cells it is also similar to some species of the genus *Microbryum*, from which it differs in leaf lamina and costa cells with several branched papillae [vs. long-mammillose-papillose leaf lamina and costa cells with one branched papilla in *M. vlassovii* and long-mammillose leaf lamina and costa cells with one (below (1)2–4) mamilla in *M. lydiae*].

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