

THE GENUS PSEUDOCROSSIDIUM R.S.WILLIAMS  
(POTTIACEAE, MUSCI) IN RUSSIA

РОД PSEUDOCROSSIDIUM R.S.WILLIAMS  
(POTTIACEAE, MUSCI) В РОССИИ

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Abstract

The genus *Pseudocrossidium* is represented in Russia by two species, *P. hornschurchianum* (Schultz) R.H.Zander and *P. obtusulum* (Lindb.) H. A. Crum & L. E. Anderson. The latter species has been known from Europe and North America, but recently it was collected on Anabarskoe Plateau (subarctic Siberia), Middle Ural Mts. in Perm Province and in Rostov-na-Donu Province (southern part of European Russia). A revision of two available herbarium collections of *P. hornschurchianum* from Asian Russia revealed that one of them also belongs to *P. obtusulum* (from subarctic Yakutia, middle course of Indigirka River), while the other is not a member of this genus. Thus *P. hornschurchianum* is excluded from the flora of Asian Russia, but it is confirmed for the southern and south-eastern regions of European Russia, and an unconfirmed record remains for Kaliningrad Province. *Pseudocrossidium revolutum* (Brid.) R.H.Zander is excluded from the moss flora of Russia. Descriptions, illustrations, ecological data, and key for species identification are provided. Also *Pseudocrossidium obtusulum* is reported as a new species for Turkmenistan.

Резюме

Род *Pseudocrossidium* представлен на территории России двумя видами: *P. hornschurchianum* (Schultz) R.H.Zander и *P. obtusulum* (Lindb.) H. A. Crum & L. E. Anderson. Последний вид ранее был известен только из Северной Америки и Европы. Недавно он был собран на Анабарском плато (Северная Сибирь), на Среднем Урале в Пермской области и в Ростовской области. К этому виду отнесен также образец с северо-востока Якутии (р. Индигирка), ранее приводившийся под названием *P. hornschurchianum*. Прочие указания на находки *P. hornschurchianum* в Сибири были основаны на неверно определенных образцах. В России *P. hornschurchianum* достоверно известен с юга и юго-востока европейской части; остается неподтвержденным его указание для Калининградской области. *Pseudocrossidium revolutum* (Brid.) R.H.Zander исключен из флоры мхов России. Даны ключ для определения, описания, рисунки, экологическая характеристика видов; кроме того, *P. obtusulum* приводится впервые для Туркменистана.

In the previous check-list of mosses of Russia and adjacent countries (Ignatov & Afonina, 1992), two species of *Pseudocrossidium* were listed: *P. hornschurchianum* (Schultz) R.H.Zander – for Eastern Siberia, and *P. revolutum* (Brid.) R.H.Zander – for Arctic Eastern Siberia and Southern Siberia. Both species were recorded in Caucasus, which, however, was considered in a broad sense including Russian Caucasus, Georgia, Azerbaijan and Armenia, but no exact records from Russian Caucasus in fact exist. Somewhat

later, Suragina & al. (2002) found *P. hornschurchianum* in south-eastern European Russia.

In course of the study of the moss flora of Anabarskoe Plateau (Taimyr, Northern Siberia) the first author made extensive collections in a limestone area near Afanasjevskiye Lakes. Several specimens of this collection were referred to the genus *Pseudocrossidium* because of the costa structure (mainly the lack of ventral stereid band and presence of a crescent-shaped dorsal stereid band) and the strongly revolute leaf margins. How-

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ever, the rather short, wide, ovate to deltoid leaves of these plants distinguished these from *P. horns-chuchianum* and *P. revolutum*. Comparison with the description and illustrations in Zander (2002) and Cano (2006) revealed that these specimens belong to *P. obtusulum* (Lindb.) H. A. Crum & L. E. Anderson.

Our attempt to locate previous *Pseudocrossidium* specimens from Siberia in LE and SASY revealed the following. There is the single collection in LE, gathered by O.M.Afonina in the middle course of Indigirka River (reported as *P. horns-chuchianum* by Afonina & al. (1979)); it belongs to *P. obtusulum*. No more specimens of the genus from the territory of Russia were found in LE. Collections of *P. horns-chuchianum* in SASY include two specimens of *Pseudocrossidium* identified as *P. horns-chuchianum* and *P. revolutum*, and they both belong to other taxa (*Bryoerythrophyllum ferruginascens* (Stirt.) Giacom. and *Grimmia incurva* Schwägr., respectively).

Quite recently *P. horns-chuchianum* was found in Rostov-na-Donu Province by V.Sereda, however one of two of her collections was demonstrated to be *P. obtusulum*.

Thus no collections of *P. horns-chuchianum* are confirmed from Asian Russia, and the distribution of this species includes only few recent records from Astrakhan Province (Suragina & al., 2002); Rostov-na-Donu Province (Sereda, 2006), and Volgograd Province (Seregin, unpubl.). An unconfirmed record from Kaliningrad Province (Napreenko, 2006) is based on old literature records which remain to be checked.

*Pseudocrossidium revolutum* was reported for the Arctic portion of Yakutia by Egorova & al. (1991) and for Central Yakutia by Kuvaev (1960), but these records are not supported by herbarium specimens. We also failed to find additional information about the record of *P. revolutum* in southern Siberia (Ignatov & Afonina, 1992). Therefore *P. revolutum* should be excluded from the moss flora of Russia, although its presence there is quite possible, as it is known from Estonia, Ukraine, Georgia and Turkmenistan (Ignatov, Afonina, Ignatova & al., 2006).

The following description is based on the material from the territory of Russia. In some cases data from the literature are given in brackets.

***Pseudocrossidium*** R.S.Williams, Bull. Torrey Bot. Club 42:396. 1915.

Plants small, in loose or dense cushions or turfs, or growing by separate shoots, yellowish green or brownish. Stems 2-7 [20] mm, hyalodermis absent, sclerodermis of 1-2 rows of cells, central strand present, well-developed. Stem leaves appressed, straight or spirally twisted when dry, erect spreading to widely spreading when moist, ovate-lanceolate, ovate or deltoid, keeled in the proximal half, narrowly or widely acute to obtuse, leaf margins entire, strongly revolute in proximal 3/4 of leaf; costa strong, excurrent in short awn or mucro, convex dorsally and ventrally, guide cells 2-3, dorsal stereid band well-developed, crescent in shape, ventral stereid band usually absent, ventral epidermis well-developed, dorsal epidermis weakly developed or absent; ventral cells of costa subquadrate, papillose, dorsal cells of costa rectangular to linear in proximal part of leaf, smooth throughout or smooth in central part and papillose in side part of costa, more rarely slightly papillose throughout; lamina unistratose, distal lamina cells subquadrate to transversely elongated, with moderately and evenly thickened walls, in transverse section weakly convex, densely papillose, papillae large, bifid or multiplex; proximal lamina cells subquadrate to shortly rectangular, subhyaline or brownish, smooth, with evenly thickened, sometimes slightly porose walls, or transverse walls of marginal cells more strongly thickened; KOH color reaction yellow to orange. Asexual reproduction absent or rarely present, gemmae rounded, ovate or clavate, multicellular, born in leaf axils or on ventral surface of costa. Sexual condition dioicous. Sporophytes not known in collections from Russia. [Seta 1-2 cm. Capsule cylindrical, 1-2 mm, peristome of 32 linear, yellow teeth, straight or twisted counterclockwise a half turn, operculum conic to conic-rostrate. Spores yellow, smooth, 8-12  $\mu\text{m}$ .]

According to Zander (1993, 2002), the genus is differentiated mainly by the absence or very small size of ventral stereid band, crescent shape of dorsal stereid band and yellow to orange KOH reaction of laminal cells; leaf shape (ovate to ovate-lanceolate) and small laminal cells are also its diagnostic characters. 16 species are known in the world, 2 species in flora of Russia.

KEY FOR IDENTIFICATION OF SPECIES OF  
PSEUDOCROSSIDIUM AND SUPERFICIALLY  
SIMILAR SPECIES OF BRYOERYTHROPHYLLUM

1. Costa >100 µm wide at leaf base, narrowing distally, ventral stereid band present . . .  
. . . . . *Bryoerythrophyllum recurvirostrum* var. *latinervium*  
— Costa less strong, < 80 µm wide at leaf base, wider distally, ventral stereid band absent . . . 2
2. Leaves narrowly acuminate, costa excurrent in a rather long mucro, asexual reproduction absent . . . . . *P. hornschurchianum*  
— Leaves broadly acute to obtuse, costa ending in short apiculus, asexual reproduction by ovate or clavate multicellular gemmae sometimes present . . . . . 3
3. Leaves ovate to deltoid, 0.7-0.8 [1.2] x 0.3-0.45 mm . . . . . *P. obtusulum*  
— Leaves elongate-lanceolate to lingulate, 0.8-1.4 x 0.2-0.3 mm . . . . . [*P. revolutum*]

***Pseudocrossidium hornschurchianum*** (Schultz) R.H.Zander, *Phytologia* 44:205. 1979. – *Barbula hornschurchiana* Schultz, *Flora* 5 (Syll.): 36. 1822.

Plants in loose turfs or growing by single stems, yellowish-green to brownish. Stems 3-5 mm. Stem leaves 0.7-1.1 [1.5]x0.3-0.4 mm, appressed and twisted when dry, widely spreading when moist, ovate-lanceolate, narrowly acuminate, leaf margins strongly revolute in distal 4/5-3/4 of leaf; costa excurrent, forming rather long mucro, slightly widened in distal half of leaf; distal laminal cells subquadrate to transversely elongate, 10-13 µm. Asexual reproduction absent. Only sterile plants are known from the territory of Russia. [Perichaetial leaves strongly differentiated. Seta ca. 1 cm. Capsule ca. 1.7 mm, peristome teeth 32, linear, yellow, twisted counterclockwise a half turn, operculum conic. Spores 8-10 µm (from Zander, 2002)].

This species grows in xeric habitats: on soil in steppes, on calcareous and gypsum substrates in karst depressions and hill slopes.

*Specimens examined from Russia:* EUROPEAN RUSSIA: **Astrakhan Province**, Bogdo-Baskunchak Nature Reserve, W-facing slope of Bogdo Mt., on bare soil, 2.V.2002, *Suragina s.n.* (MHA); same place, Kristalnaya Cave surroundings, steppe site,

on soil between grasses, 5.V.2002, *Suragina s.n.* (MHA); same place, karst crater, on hypsum outcrops covered by soil, in crevice, 14.VII.2002, *Suragina s.n.* (MHA); **Volgograd Province**, Ilovinskij District, 4 km E-SE from Kachalino railway station, steppe on ravine slope, on soil, *Seregin #M-956* (MW). **Rostov-na-Donu Province**, Myasnikovskij District, Nedvigovka, 15.VII.2004, *Sereda s.n.* (MW).

*Distribution outside Russia:* most regions of the Europe, Macaronesia, North and South Africa, Middle East, Caucasus (Azerbaijan, Armenia, Georgia), Middle Asian countries, Australia and Tasmania; North America (three localities, two of them in gardens, once in natural habitat, cf. Zander, 2002).

***Pseudocrossidium obtusulum*** (Lindb.) H. A. Crum & L. E. Anderson, *Bryologist* 92: 533. 1989 (Fig. 2). – *Barbula obtusula* Lindb., *Musci Scand.* 22. 1879 – *Barbula revoluta* var. *obtusula* (Lindb.) Mönk., *Laubm. Eur.*, 1927. – *Barbula hornschurchiana* var. *obtusula* (Lindb.) Podp., *Consp.* 212. 1954 – *Desmatodon ellesmerensis* Brassard, *Bryologist* 74: 208. f. 1-11. 1971 – *Pseudocrossidium revolutum* var. *obtusulum* (Lindb.) B. C. Tan, R. H. Zander & T. T. Taylor, *Lindbergia* 7: 41. 1981.

Plants small, yellowish-green to brownish, in dense cushions or loose turfs. Stems 3-7 [20] mm. Stem leaves crowded and appressed when dry, weakly spreading when moist, ovate to ovate-deltoid, 0.7-0.8 [1.2]x0.3-0.45 mm; leaf margins strongly revolute, entire; leaf apex broadly acute to obtuse; costa strong, widened in distal half of leaf, shortly excurrent and forming small apiculus, shining, brownish, smooth on dorsal side; distal laminal cells 10-13 µm, subquadrate to transversely rectangular, with moderately thickened walls. Specialized asexual reproduction occasionally present, gemmae multicellular, spheric, elliptic or clavate, 30-50 µm, born on stem in leaf axil or on the ventral surface of the costa. All specimens from the territory of Russia are sterile or male, antheridia in terminal buds, sometimes persistent for the next year and in this case looking lateral due to development of subterminal innovations. [Perichaetial leaves not or weakly differentiated. Seta 1-2 cm. Capsule 1-2 mm, peristome of 32 linear,

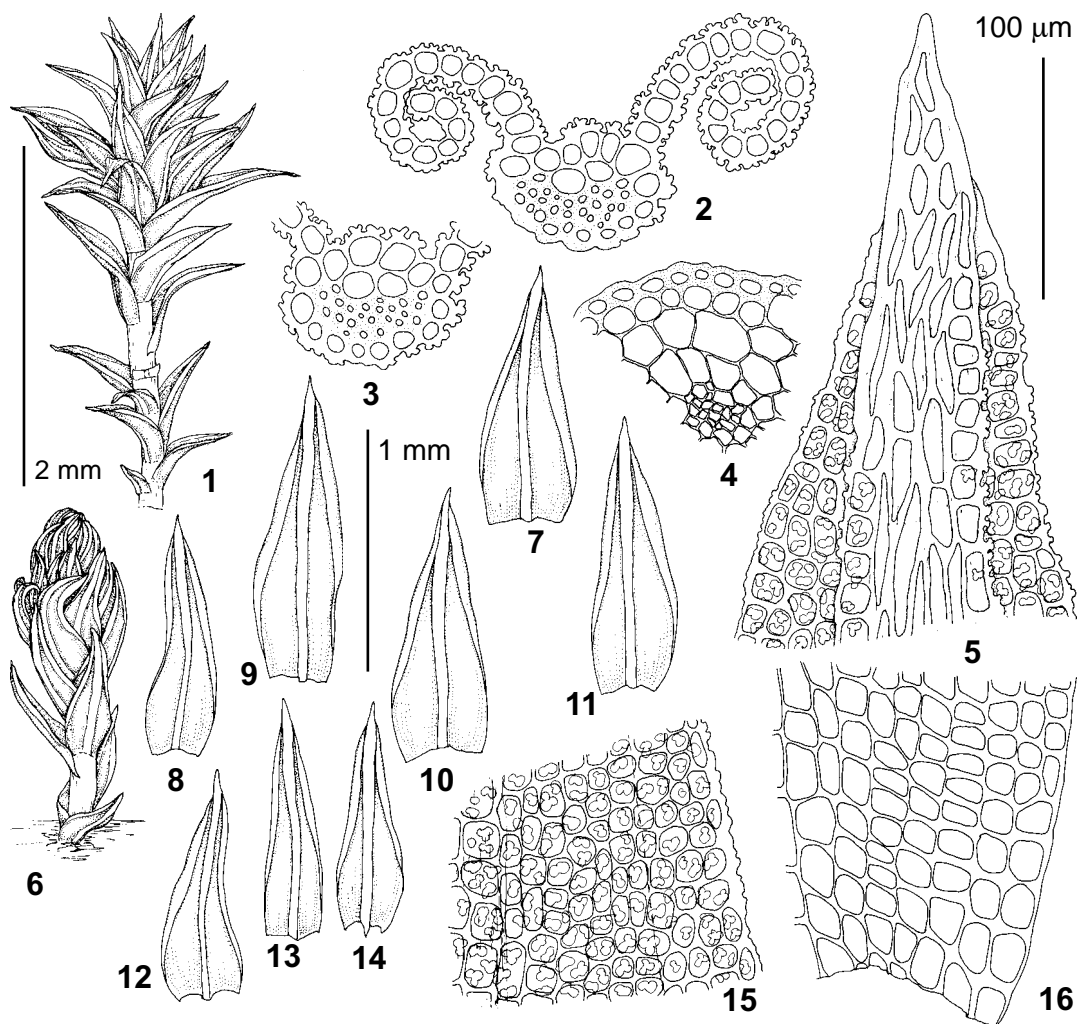


Fig. 1. *Pseudocrossidium hornsuschianum* (from: Astrakhan Province, Bogdo-Baskunchak Nature Reserve, *Suragina s.n.*, MHA): 1 – habit, wet; 2, 3 – leaf transverse sections; 4 – stem transverse section; 5 – lamina cells of leaf apex and dorsal cells of costa; 6 – habit, dry; 7-14 – leaves; 15 – lamina cells of mid-leaf and ventral cells of costa; 16 – basal leaf cells. Scale bars: 2 mm – for 1, 6; 1 mm – for 9-14; 100 µm – for 2-5, 15-16.

yellow teeth, straight or twisted counterclockwise a half turn, operculum conic-rostrate. Spores 8-12 µm (from Zander, 2002).]

In xeric habitats, mostly on steppe slopes, on limestone, shell-rock or other calcareous substrates.

*Specimens examined from Russia:* EUROPEAN RUSSIA: **Rostov-na-Donu Province**, Rodionovo-Nesvetajevskij District, Nesvetaj, *Sereda*, #187 (MW); Perm Province, Kungur, 22.X.1988, *Ignatov s.n.* (MHA) **Perm Province**, Kungur, 22.IX.1988, *Ignatov s.n.* (MHA). ASIAN RUSSIA: **Taimyr Autonomous District**, Khatangsky Distr., vicinity of Afanas'evskie Lakes: 71.611° N, 106.071° E, on cliff

ledge, covered with melkozem layer, *Fedosov*, # 06-84 (MW); same place, 71.5998° N, 106.01° E, lumpy placer on creek canyon slope, on dry limestone marl, *Fedosov*, # 06-264 (MW); same place, 71.611° N, 106.071° E, in crevice of limestone cliff remnant or melkozem, *Fedosov*, # 06-328 (MW); same place, 71.611° N, 106.071° E, in limestone cliff niche covered with humus, *Fedosov*, # 06-389 (MW); same place, 71.5461° N, 105.73° E, on limestone marl at the base of cliff remnant on creek canyon slope, *Fedosov*, # 06-493 (MW). **Republic Sakha/Yakutia**, left bank of Indigirka River in its middle course, upstream In'yali River mouth, steppe slope, 15.VI. 1976, *Afonina s.n.* (LE).

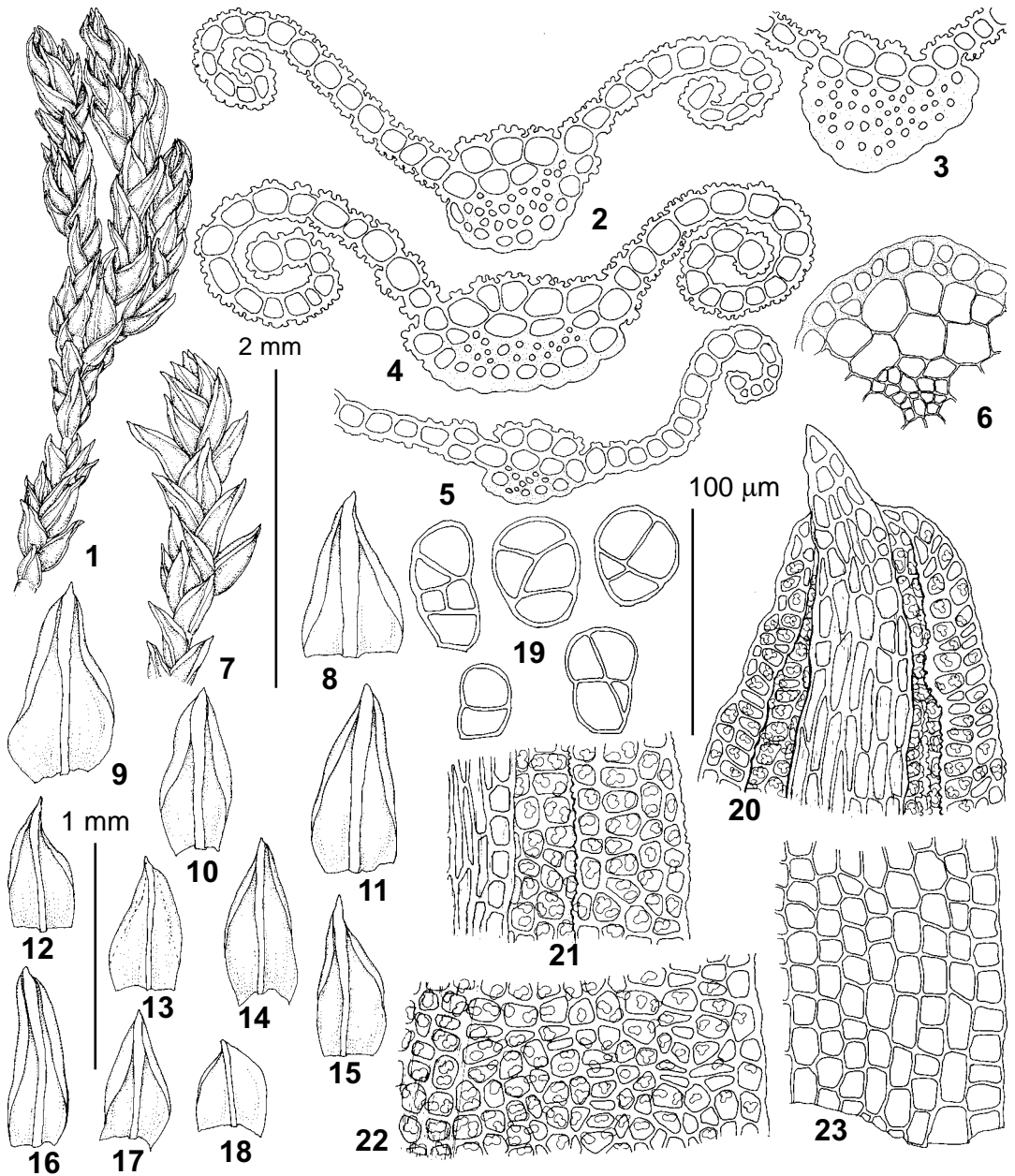


Fig. 2. *Pseudocrossidium obtusulum* (from: Taimyrsky Autonomous District, Anabar Plateau, Fedosov, #06-264, MW): 1 – habit, dry; 2-5 – leaf transverse sections; 6 – stem transverse section; 7 – habit, wet; 8-18 – leaves; 19 – gemmae; 20 – lamina cells of upper leaf and dorsal cells of costa; 21 – lamina cells of mid-leaf and dorsal cells of costa; 22 – lamina cells of mid-leaf and ventral cells of costa; 23 – basal leaf cells. Scale bars: 2 mm – for 1, 7; 1 mm – for 8-18; 100  $\mu\text{m}$  – for 2-6, 20-23.

*Distribution outside Russia:* In Europe *P. obtusulum* is known from few localities in Sweden (Nyholm, 1989), central Germany (Podpera, 1954), Spain and Andorra (Cano, 2006), Sicilia (specimen cited in <http://mobot.mobot.org/cgi-bin/>

search\_vast). It is likely that it is more widespread but still remains neglected due to its inclusion into *P. revolutum* until the recent publication underlined its status of a good species (Eckel et al., 1996; Cano, 2006).

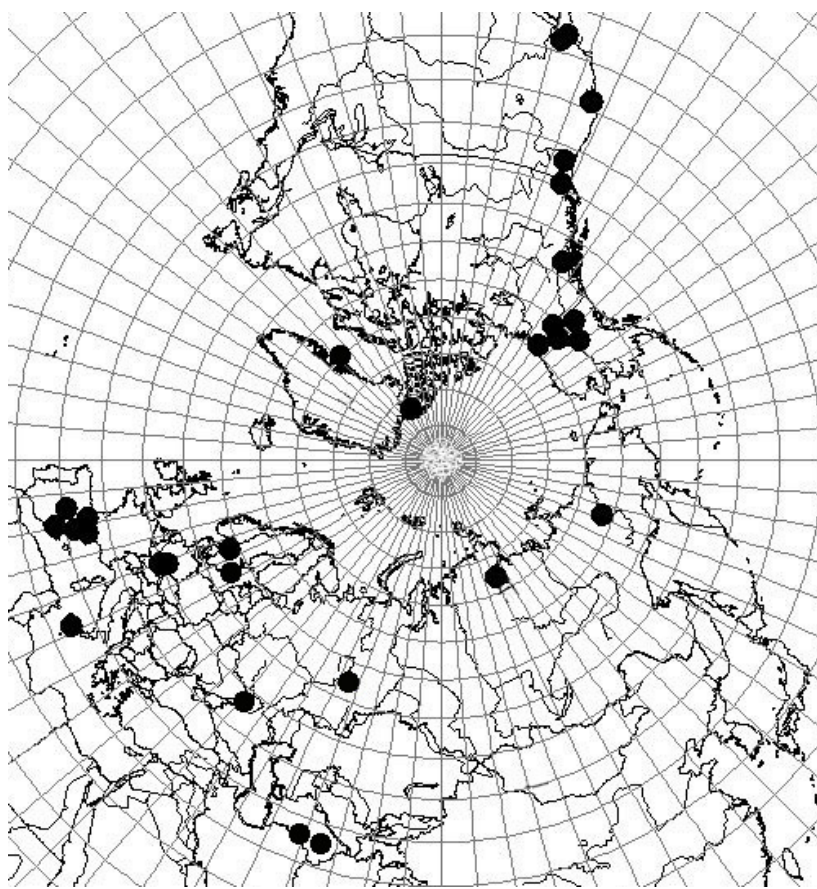


Fig. 3. World distribution of *Pseudocrossidium obtusulum*.

In Asia, Mamatkulov (1990) gave the descriptions of *Pseudocrossidium* from Tadjikistan, specifying that among *P. hornschurchianum* there are plants with the markedly shorter leaves. We did not see these collections from that country, but two specimens of *P. obtusulum* were found from the nearby Turkmenistan: 1) Central Kopet-Dag, Geok-Tepinskij Distr., Dushak Mt., 6.V.1986, *Sirotnina s.n.* (LE, as *P. hornschurchianum*); 2) 10 km from railway station Zau toward the Spring Bairamali, 8.IX.1965, *Leontieva s.n.* (LE, as *P. revolutum*).

In North America, *P. obtusulum* occurs in Arctic from Greenland to Northwest Territories, in mountains along Pacific coast from Alaska and Yukon to southern California, and also in Montana and New-Mexico (Eckel et al., 1996).

**Ecology:** *Pseudocrossidium obtusulum* in North America and Europe occurs mostly in xeric steppe plant communities (Eckel et al., 1996;

Murray, 1992), being confined to calcareous substrates (Zander, 2002; Murray, 1992).

The localities in Anabarskoe Plateau are in gentle plateau of 200-300 m elev., formed by Cambrian limestones. The vegetation is represented by various tundra communities alternating bare soils; *Larix* forests are restricted to bottoms of river valleys. *Pseudocrossidium obtusulum* is frequent throughout the plateau on limestone cliff ledges, rock fields, fine soil near rock outcrops. It is often associated with *Encalypta vulgaris*, *E. rhamnifolia*, *Syntrichia laevipila*, *S. norvegica*, *Distichium capillaceum*, *D. inclinatum*, *Ditrichum flexicaule*, *Hymenostylium recurvirostrum*, *Tortula mucronifolia*, *Grimmia anodon*, *Schistidium frivolianum* and other mosses.

According Afonina & al. (1979), the locality in Yakutia, middle course of Indigirka River is very xeric (annual precipitation less than 200 mm while in summer many days are very hot). Steppe vegetation is widespread not only on S-facing slopes

but also on bottoms of valleys, W- and E-facing slopes of mountains and upper terraces of rivers. Mosses are not abundant in steppes, growing as small patches on bare soil between grasses. *Pseudocrossidium obtusulum* was found only once. Other species in the same type of habitats are: *Syntrichia ruralis*, *Abietinella abietina*, *Rhytidium rugosum*, *Ceratodon purpureus*, *Tortula acaulon*, *Pterygoneurum subsessile*, *P. kozlovii*.

The locality of *P. obtusulum* in European Russia, Rostov-na-Donu Province is situated in steppe zone; the species was collected on slope of ravine, on shell-rock outcrop, it was represented by more or less extensive tuft (contrary to *P. hornschurchianum* which was usually collected in very small amount in all known localities from Russia) and produced abundant gemmae.

The locality in Perm Province is situated on the south-faced steppe slope near the entrance to the Kurgur Cave (one of the largest caves in Russia), on gypsum.

**Differentiation.** The most helpful characters to distinguish *P. obtusulum* from *P. hornschurchianum* are (1) the leaf shape (ovate to deltoid, broadly acute vs. ovate-lanceolate, narrowly acuminate), and (2) the ending of costa (in short apiculus vs. more or less long mucro or short awn). Leaves are generally shorter in *P. obtusulum* (0.7-0.8 mm vs. 0.7-1.1 mm in specimens from Russia), non-twisted when dry (usually twisted in *P. hornschurchianum*) and only weakly spreading when wet (widely spreading to recurved in *P. hornschurchianum*). Costa is more strongly widened in the distal part of leaf in *P. obtusulum* (only slightly widened in *P. hornschurchianum*) and slightly papillose to smooth on dorsal side in distal part of leaf (vs. more strongly papillose laterally on dorsal side in distal part of leaf in *P. hornschurchianum*, see Fig. 1-2,3). Presence of gemmae in leaf axils or on ventral side of costa also differentiates *P. obtusulum* from *P. hornschurchianum*, but this character is not always observed (found only

in one specimen in collections from Asian Russia and abundant in collections from European Russia). According to Zander (2002) there is a difference in perichaetial leaves (weakly differentiated in *P. obtusulum* vs. strongly differentiated, enlarged in *P. hornschurchianum*), but in collections from Russia all specimens of *P. obtusulum* are male or sterile, and *P. hornschurchianum* is represented by sterile material only.

*Pseudocrossidium revolutum* shares with *P. obtusulum* broadly acute to obtuse leaf apices, costa excurrent in very short apiculus and presence of multicellular gemmae in leaf axils. It differs from the latter species by more narrow and long leaves, contorted when dry, and more strongly revolute leaf margins.

The first author also collected in Anabar Plateau one specimen which we identified as *Bryoerythrophyllum recurvirostrum* (Hedw.) Chen var. *latinervium* (Holmen) B. Murr. This plant resembles greatly *Pseudocrossidium* spp. in very revolute leaf margins, and also crescent-shaped dorsal stereid band of costa and subquadrate, papillose surface cells on ventral side of costa, showing clearly differentiated ventral epidermis. It differs from *Pseudocrossidium* species known in Russia in much more wide costa that is narrowing distally and subpercurrent, with 4-6 guide cells, well-developed ventral stereid band and very strong stem central strand.

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