

THE GENUS *ANOMOBRYUM* (BRYACEAE, MUSCI) IN RUSSIA

РОД *ANOMOBRYUM* (BRYACEAE, MUSCI) В РОССИИ

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Abstract

The genus *Anomobryum* is represented in Russia by three species. *A. concinatum* is circum-holarctic and known from the Caucasus, southern Siberia, Taimyr, Yakutia, Russian Far East (from Primorsky Territory to Chukotka), and was recorded also from Kola Peninsula. *A. julaceum* s. str. was not found among many herbarium collections from Russia that we studied. Mainly European, *A. bavarium* was recently reported from Transbaikalia and is also newly found in Primorsky Territory and Verkhoyansk Range in Yakutia. Temperate Asian *A. nitidum* is newly found in Russia with a wide range, from Altai Mts. to Transbaikalia and also in the Far East, from Primorsky Territory to Commander Islands. Key to the identification of *Anomobryum* species in Russia, their descriptions, illustrations and distribution in the country are provided.

Резюме

Род *Anomobryum* представлен в России тремя видами. Циркумголарктический *A. concinatum* распространен на Кавказе, юге Сибири, Тамыре, в Якутии и на российском Дальнем Востоке от Приморского края до Чукотки; он указывался также для Мурманской области. Присутствие *A. julaceum* s. str. в России не подтверждено гербарными коллекциями. Преимущественно европейский вид *A. bavarium*, недавно выявленный в Забайкалье, обнаружен также в Якутии на Верхоянском хребте и в Приморском крае. Азиатский *A. nitidum*, ранее известный из Индии, Пакистана, Китая и Японии, выявлен на Алтае, в Забайкалье, а также на Дальнем Востоке от Приморского края до Командорских островов. Дан ключ для определения видов *Anomobryum*, встречающихся в России, описания, иллюстрации и данные о их распространении в стране.

KEYWORDS: mosses, *Anomobryum*, Russia, new records

INTRODUCTION

The genus *Anomobryum* Schimp. was established in 1860, with the type species *Anomobryum julaceum* (Schrad. ex G. Gaertn., B. Mey. & Scherb.) Schimp. which was described in 1802 in the genus *Bryum*. However, its taxonomic status was challenged later: e.g., Crum & Anderson (1981) included it in *Pohlia*, while Ochi (1980, 1994) placed it in *Bryum*. Some other authors emphasized a close relationship of *Anomobryum* with *Bryum*, but considered it as a separate genus (Shaw & Fife, 1984; Allen *et al.*, 2002). Its generic status is also accepted by Nyholm (1993), Noguchi (1988), Smith (2004) and Spence (2014). Separation of *Anomobryum* from *Bryum* s. str. was confirmed by recent DNA studies (Holyoak & Pedersen, 2007). Among discriminating morphological characters, elongate and often vermicular laminal cells in *Anomobryum* vs. comparatively short and rhomboidal ones in *Bryum* are most reliable.

The genus *Anomobryum* includes ca. 47 species in the world (Crosby *et al.*, 1999), with the main diversity in mountain regions of Central and South America.

Some Eurasian taxa were recently revised by Holyoak & Köckinger (2010), who recognized five species there. Two of them, *A. julaceum* and *A. concinatum*, are widespread in Eurasia and common also with North America, where only these two species were accepted in the recent revision of Spence (2014).

Other species have the following distribution, according to these authors: *A. lusitanicum* (I.Hagen ex Luisier) Thér. is restricted to the Iberian Peninsula; *A. bavarium* (Warnst.) Holyoak & Köckinger was thought to be an endemic of European Alps, while *A. nitidum* (Mitt.) A. Jaeger is a principally temperate Asian species.

Peristome structure in this rarely fruiting genus was observed by Shaw & Fife (1984).

According to Holyoak & Köckinger (2010), *A. julaceum* is the most widespread species of the genus, known from almost all continents, including the Antarctic, but not in Australia. In many floras this species is treated in a broad sense, including *A. concinatum*, without recognizing any intraspecific taxa, e.g., in Moss

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Flora of China (Da-chen *et al.*, 2007), Great Britain (Smith, 2004), Ukraine (Bachurina & Melnichuk, 1989). Some authors distinguish *A. julaceum* var. *concinatum* in addition to the type variety, *e.g.*, in Flora Briofítica Ibérica (Elías, 2010), Muschi d'Italia (Cortini Pedrotti, 2001), Flora of Mexico (Ochi, 1994, as *Bryum filiforme* var. *concinatum* (Spruce) Boulay), New Catalog of Mosses of Japan (Iwatsuki, 2004), Illustrated Flora of Nordic mosses (Nyholm, 1993), New List of Bryophytes of Korea (Park & Choi, 2007). Authors of the recent taxonomic study of the genus in Europe and Asia have shown that *A. concinatum* clearly differs from *A. julaceum* and deserves a species status (Holyoak & Köckinger, 2010). This point of view is accepted by, *e.g.*, Spence (2014) in Moss Flora of North America, Hill *et al.* (2006) in the Check-list of Europe and Macaronesia, and Tsegmed (2010) in Moss Flora of Mongolia, *etc.*

Until recently, only one species of the genus, *Anomobryum julaceum*, was reported from the territory of Russia. Some Russian handbooks and local bryofloras included *Anomobryum julaceum* (= *A. filiforme*) *sensu lato*, without separating *A. concinatum* (Abramova *et al.*, 1961; Bardunov, 1969; Melnichuk, 1970; Bardunov & Cherdantseva, 1982; Schljakov & Konstantinova, 1982; Ignatov *et al.*, 2004; *etc.*). Stepanova (1986) recognized both *Anomobryum filiforme* and *A. filiforme* var. *concinatum*, in her "Moss flora of tundra zone of Yakutia", though later Ivanova *et al.* (2005) reported *A. julaceum* s.l. for the whole territory of the republic. Afonina (2004) reported both taxa for Chukotka too, but all specimens from this region were re-identified later as *A. concinatum*. At the same time, Savicz-Lyubitskaya & Smirnova (1970) in the "Handbook of Acrocarpus Mosses of the USSR" stated that only *A. filiforme* var. *concinatum* is known in the country. However, in the latest check-list of mosses of this territory (Ignatov, Afonina, Ignatova *et al.*, 2006) *Anomobryum julaceum* was recorded for NW European Russia, Caucasus and the whole territory of Asian Russia, while for *A. julaceum* var. *concinatum* only few regions of the Russian Far East were mentioned. An evident reason of this disagreement is that the check-list was based on local floras and lists that have variously treated these taxa and therefore may not reflect the real distribution of these species.

In addition, two other species of the genus were recently revealed to be present in Russia: *A. bavaricum* was collected by one of the authors (OMA) in Transbaikalia (Afonina & Köckinger, 2014), and *A. nitidum* (Mitt.) A. Jaeger was identified from the collections of another author (EAI) from the Primorsky Territory.

In the present paper we summarize the results of revision of all available herbarium collections from Russia (in LE, MHA, MW and SASY). We confirm the absence of *Anomobryum julaceum* s. str. in these collections, though its discovery in European Russia cannot be excluded. According to Holyoak & Köckinger (2010), it is

present in Mongolia, China and Japan and so can be expected in southern Siberia and Russian Far East. Most of the studied specimens from aforementioned herbaria belong to *A. concinatum*.

KEY TO IDENTIFICATION OF *ANOMOBRYUM* SPECIES IN RUSSIA

1. Bulbils numerous, 15-30 per axil, attached to a round projection in leaf axil; bulbil bodies vine-red or reddish-brown; primordia on the top of a bulbil not leaf-like, small, cells of primordia thin-walled and somewhat inflated; leaves acute, sometimes apiculate, costa percurrent to shortly excurrent
..... *A. nitidum*
- Bulbils 1-15 in leaf axil, round projection in leaf axil absent or inconspicuous; bulbil bodies green, yellowish, reddish-brown or brown; primordia leaf-like, on the top or scattered along the mature bulbil body, cells of primordia firm-walled, not inflated; leaves acute or acuminate, costa percurrent or excurrent, rarely ending just below leaf apex 2
2. Leaves acuminate; costa mostly excurrent; axillary bulbils 7-15 in leaf axil, primordia in distal half of bulbil body *A. bavaricum*
- Leaves acute to blunt, sometimes apiculate; costa percurrent or ending just below leaf apex; axillary bulbils 1-8 in leaf axil to absent, large when mature, with primordia both in distal and in proximal part of bulbil body 3
3. Shoot tips obtuse; leaf apex blunt or shortly acute; axillary bulbils absent, rarely few deciduous flagelliform shoots present; sporophytes frequent; peristome perfect [*A. julaceum*]
- Shoot tips ± cuspidate; leaf apex acute or occasionally apiculate; axillary bulbils present; sporophytes rare [never found in Russia]; peristome reduced
..... *A. concinatum*

Anomobryum Schimp., Syn. Musc. Eur. cxxxviii, 382–383. 1860.

Plants small, pale-green, whitish or yellowish, slightly glossy, growing as individual shoots on fine soil or among other mosses, sometimes forming loose tufts. Stem erect, often slender and thread-like, 0.3–2.0 cm, not or weakly branching, brownish, becoming dark reddish-brown proximally, with numerous papillose rhizoids, julaceous, densely and evenly foliated, with central strand, occasionally very weak. Leaves ± imbricate when dry, erect-spreading or loosely appressed when wet, concave or weakly so, oblong, ovate or oblong-ovate, not decurrent, margins plane throughout or narrowly recurved near leaf base, entire, or occasionally with weakly projected angles of few cells near leaf tip; costa single, in transverse section without guide cells, with large central stereid band and enlarged cells on ventral and dorsal surfaces; laminal cells smooth, ± thick-walled, not porose, elongate-

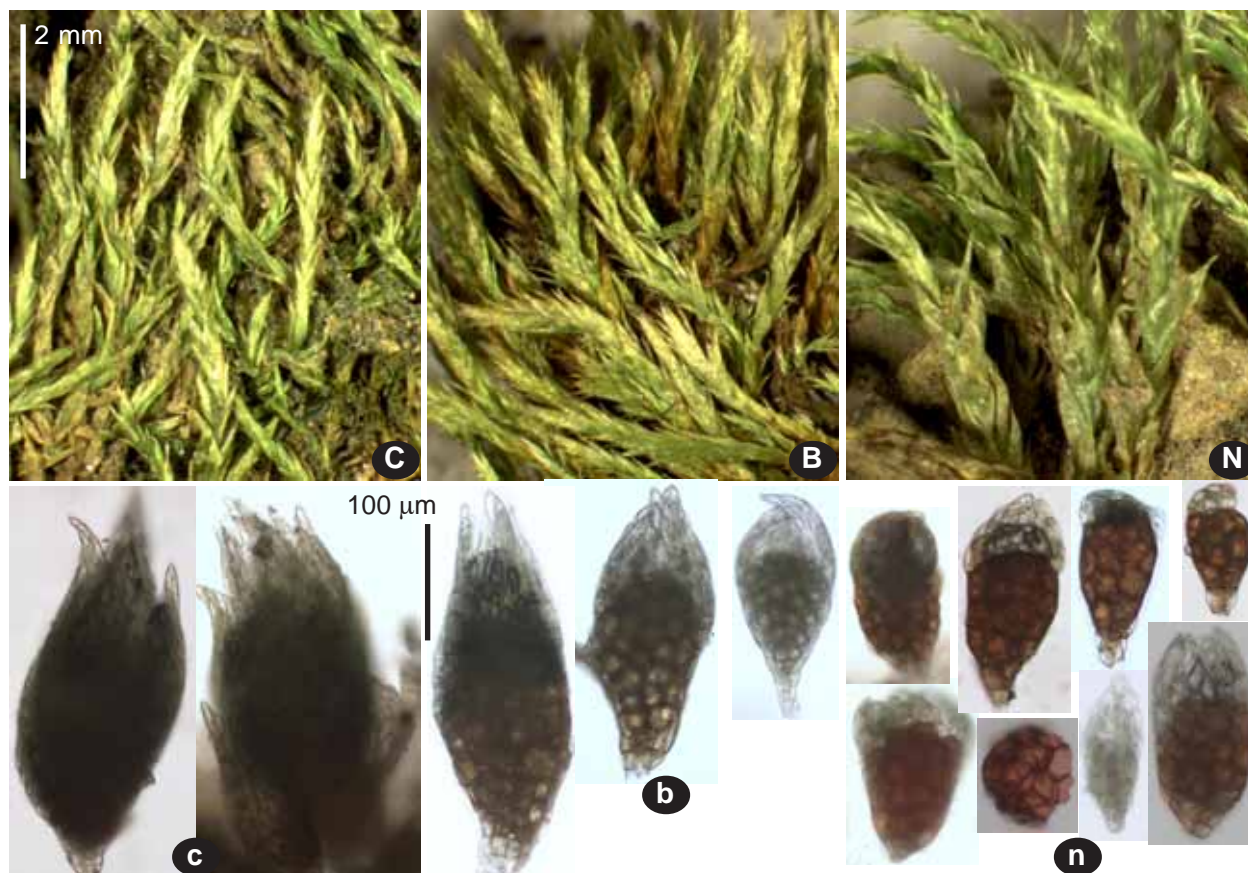
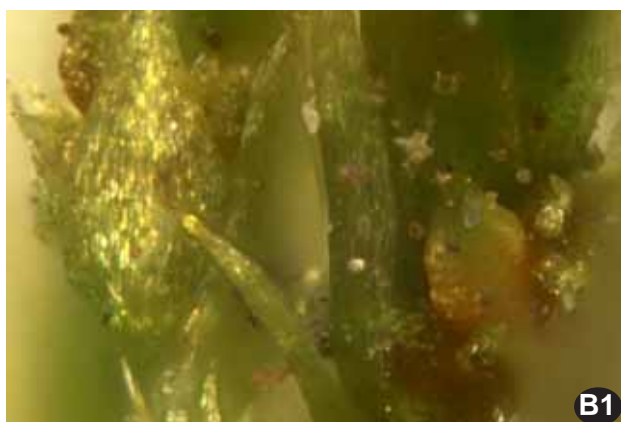
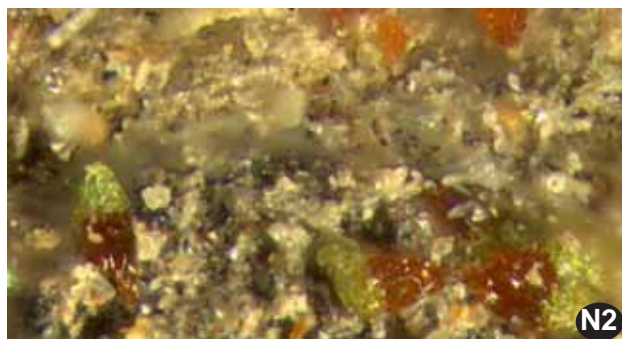


Fig. 1. Habit and axillary bulbils of *Anomobryum* species from Russia. C, c – *A. concinnatum* (from: Khabarovsk Territory, Ignatov 97-503, MHA); B, b – *A. bavaricum* (from: Primorsky Territory, Ignatov 07-47, MHA); N, n – *A. nitidum* (from: Primorsky Territory, Ignatov 07-60, MHA).

rhomboidal to linear-vermicular; marginal cells narrower, forming poorly delimited border; basal laminal cells quadrate, short-rectangular or rectangular, lax, thin-walled, alar cells not differentiated, lamina not decurrent; cells at leaf insertion and lower part of costa sometimes reddish. Dioicous, sporophytes unknown in Russia. [Perichaetia and perigonia terminal. Perichaetial leaves similar to stem leaves. Seta to 2 cm. Capsule pendent, inclined or suberect, ovate-cylindric or oblong, 1-3 mm long; exothecial cells flexuose, rhomboidal to oblong; peristome double, exostome teeth lanceolate, papillose, endostome with high or low basal membrane, well-developed segments and cilia or variously reduced; annulus of 2-3 cell rows; operculum with short beak]. Specialized asexual reproduction by axillary bulbils arising from oval area shortly above the leaf insertion centre, where branch initials commonly originate. Bulbils develop from almost flat surfaces or on conspicuous projection formed inside the leaf axil.

Anomobryum concinnatum (Spruce) Lindb., Öfvers. Förh. Kongl. Svenska Vetensk.-Akad. 18(6): 277. 1861. — *Anomobryum filiforme* var. *concinnatum* (Spruce) Loeske, Rev. Bryol. Lichénol. 5: 200. 1933. — *Anomobryum julaceum* var. *concinnatum* (Spruce) J.E. Zetterst., Kongl. Svenska Vetensk. Acad. Handl., n.s. 5(10): 34. 1865. — *Bryum concinnatum* Spruce, Musci Pyren. n. 121. 1847. Figs. 1c, 2c, 3-4.

Plants small, pale-green, often whitish, rarely yellowish, slightly glossy, growing by solitary shoots on fine soil or among other mosses, rarer forming loose tufts. Stems erect, often thread-like, 0.3–2.0 cm long, not or weakly branching, green, whitish or yellowish distally, brownish in the middle part, dark reddish-brown proximally, with abundant papillose rhizoids, densely and evenly foliated, ± julaceous; shoot tips ± cuspidate. Leaves ± imbricate when dry, erect-spreading to loosely appressed when wet, flat or slightly concave, 0.8–1.2 × 0.3–0.7 mm, oblong, ovate, oblong-ovate, widened proximally, acute to apiculate, often with short, reflexed apiculus when dry; margins plane, sometimes weakly recurved at leaf base, entire or occasionally with projecting angles of some cells near leaf apex; costa 30–40 µm wide at base, often gradually narrowed in upper part, mostly percurrent or very shortly excurrent, rarely ending below leaf apex (mostly in leaves from lower portion of stem); laminal cells ± thick-walled, in some specimens with cell walls to 3.5 µm thick, not porose, elongate-rhomboidal to linear-vermicular, (56–)64–110(–120) × (5–)6.5–9.5(–11) µm, with length/width ratio 7–15:1, upper laminal cells shorter, 30–50 µm long, marginal cells in 1-3 rows narrower and thinner-walled, (48–)64–100(–120) × (2.5–)3.0–5.0(–5.5) µm, with length/width ratio 15–30:1, forming a weakly



delimited border; basal laminal cells differentiated, rectangular to quadrate, lax, thin-walled, not porose, (16–) 18–40(–50)×(9–)11–16(–18) μm, with length/width ratio 1–5:1, often with numerous chloroplasts and more intensively colored in comparison with the rest leaf portion; cells and proximal portion of costa at leaf insertion sometimes reddish, especially in leaves from the middle and lower part of stem; distal parts of leaves at shoot ends often colorless. Dioicous. Sporophytes unknown from the territory of Russia. Specialized asexual reproduction by axillary bulbils arising by 1–8 on almost flat surface in leaf axils; bulbils very variable in size and shape; mature bulbils mostly oblong, 300–900×125–400 μm, occasionally to 1500 μm long; bulbil body greenish-yellow to brownish, often dark, reddish-brown; primordial leaves 5–20, well-developed, often scattered throughout the bulbil body, both in its distal and proximal portion, but mainly on its top, distalmost primordia comprising to 50–70% of the bulbil length, light green, acute; juvenile bulbils light green, various in shape, from rounded to oblong-ovate.

Differentiation. *Anomobryum concinnatum* was often treated as a variety of *A. julaceum* or even lumped with the former species. However, recent studies confirmed their distinction at the species level (Shaw & Fife, 1984; Holyoak & Köckinger, 2010). Their differentiating characters include: shoot tips ±cuspidate in *A. concinnatum* vs. obtuse or rounded in *A. julaceum*; leaves acute vs. obtuse; costa percurrent or very shortly excurrent vs. ending below apex or rarely percurrent; axillary bulbils usually present, 1–7 per axil vs. absent or rarely few deciduous flagelliform shoots present in leaf axils; capsules very rare, suberect vs. often present, pendent; peristome greatly reduced, with cilia lacking vs. peristome perfect, with cilia developed.

Anomobryum concinnatum differs from *A. nitidum* and *A. bavaricum* by having a wider and shorter acute leaf apex, often with very short apiculus, whereas in *A. nitidum* leaves are more narrowly acute and in *A. bavaricum* they are acuminate. Costa ends in leaf apex or, in lower leaves, shortly below it, sometimes slightly excurrent in *A. concinnatum*, while it is percurrent to shortly excurrent in *A. nitidum* and rather longly excurrent in *A. bavaricum*. Axillary bulbils differ contrastingly between *A. concinnatum* and *A. nitidum*: in the former species, they develop by 1–7 per axil, being large, often green or dark brown, with well-developed leaf primordia scattered along the whole bulbil body, cells of primordia firm-walled, while in the latter species, they are 15–30 per axil, small, with vine-red body and small, very thin-walled primordia restricted to the top of bulbil. Difference in bulbil structure between *A. concinnatum* and *A. bavaricum* is less sharp, but they can be recognized by the number per axil (1–7 vs. >10), color (green or dark brown

vs. light to dark brownish, but always with some reddish or orangish pigmentation) and by the primordia position (both in upper and lower half of bulbil body vs. only in its upper half, correspondingly).

There were a number of *Pohlia* specimens, mostly *P. drummondii* (Müll. Hal.) A.L. Andrews, that were misidentified as *Anomobryum* in herbaria, evidently due to the presence of similar axillary bulbils. The most reliable difference between these two genera is their leaf cell areolation: cells of *Anomobryum* are linear-vermicular in the upper and median part of leaf, becoming narrower and thinner-walled at margins and forming weakly delimited border, and the basal leaf cells are well differentiated, quadrate and short rectangular, while *Pohlia* is characterized by having shorter laminal cells, not narrowing toward the margins and the basal laminal cells not clearly differentiated. In addition, leaf margins of *P. drummondii* are serrulate, while they are always entire in *Anomobryum*. In few cases specimens of *Bryum argenteum* with axillary brood bodies of similar shape were labelled as *A. concinnatum*; however, this species can be easily recognized by acuminate leaves with costa ending far below apex and shorter laminal cells.

Ecology. *Anomobryum concinnatum* occurs mostly in mountain regions, usually at low and middle elevations, ca. 300–1500 m, rarely up to 2500 m (Caucasus, Altai) or, in coastal areas, on seashore cliffs at 5–50 a.s.l. The species grows on bare soil, fine soil covering rocks and in rock and cliff crevices, on moist cliffs, roadsides and other disturbed places, at river banks, on bare soil within birch, larch and poplar & fir forests, in *Dryas* tundras; occasionally between tree roots in flood valley willow stands and on logs in poplar forest in flooded valley. This species grows often individually by having a separate shoot, rarer in loose tufts or among other mosses, including *Bryoerythrophyllum recurvirostrum*, *B. ferruginascens*, *Bryum argenteum*, *Didymodon icmadophilus*, *D. zanderi*, *Encalypta ciliata*, *Fabronia ciliata*, *Fissidens bryoides*, *Haplcladium angustifolium*, *Hypnum cupressiforme*, *Myurella julacea*, *Pohlia prolifera*, *Tortula leucostoma*, *T. mucronifolia*, etc.

Distribution. *A. concinnatum* is distributed mainly in mountain regions of the boreal and temperate areas of the northern hemisphere. It is known from Europe (Austria, Czech Republic, Finland, France, Great Britain, Iceland, Ireland, Italy, Northern Ireland, Norway, Poland (Tatra), Spain, Sweden, Switzerland); Asia (Bhutan, China, Georgia, India, Japan, Korea, Macaronesia, Mongolia, Turkey); North America (Canada, Greenland, Mexico, USA) (Noguchi, 1988; Ochi, 1994; Smith, 2004; Park & Choi, 2007; Holyoak & Köckinger, 2010; Tsegmed, 2010). Its distribution area in Russia includes Cau-

Fig. 2 (opposite page). Habit and axillary bulbils of *Anomobryum* species from Russia. C – *A. concinnatum* (from: Khabarovsk Territory, Ignatov 97-503, MHA); B – *A. bavaricum* (from: Primorsky Territory, Ignatov 07-47, MHA); N – *A. nitidum* (from: Primorsky Territory, Ignatov 07-60, MHA).

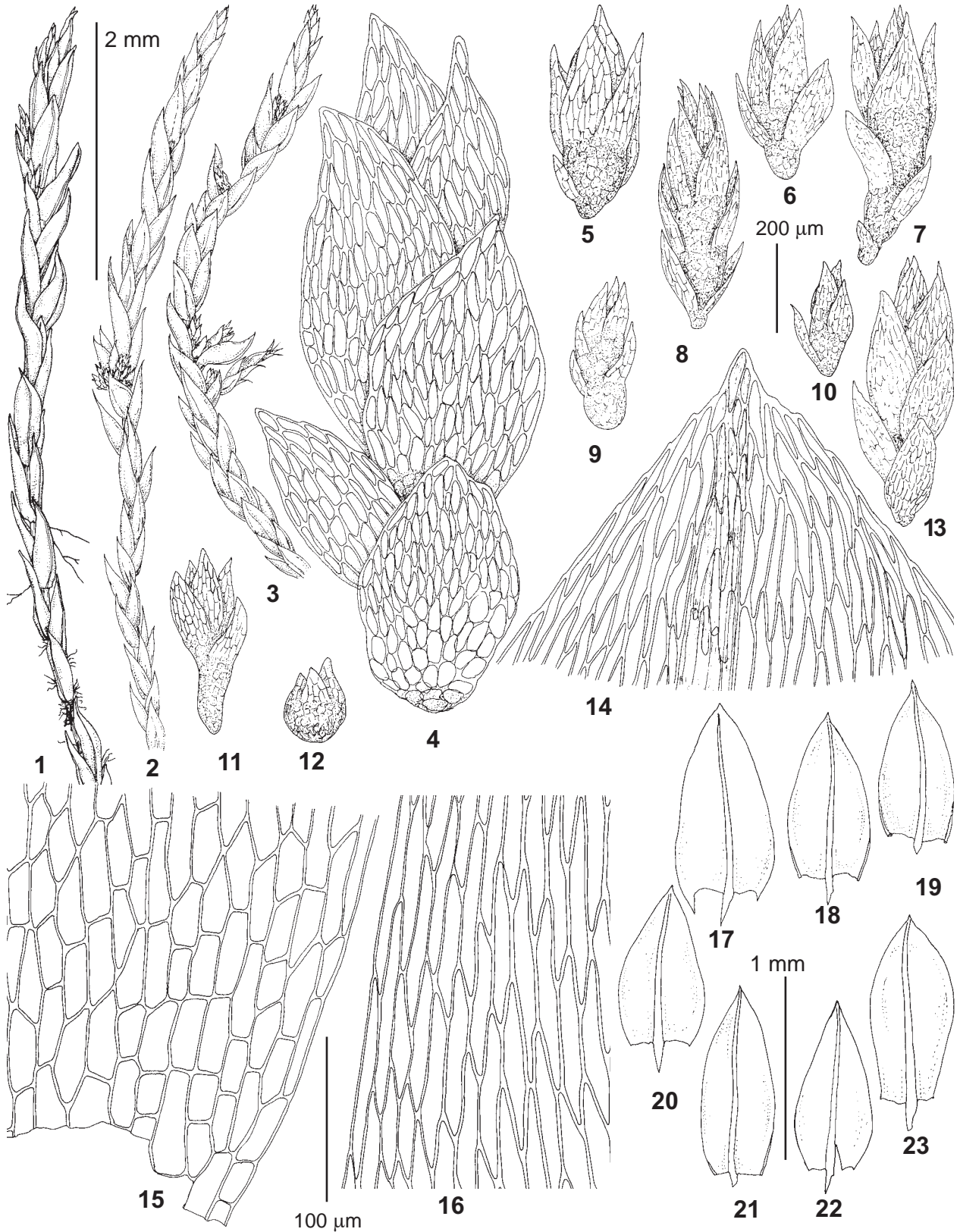


Fig. 3. *Anomobryum concinnatum* (Spruce) Lindb. (1-2, 5, 11, 13-16, 19-23 – from: Russia, Khabarovsk Territory, *Ignatov 97-507*, MHA; 3 – from: Taimyr, *Fedosov 09-443*, MW; 4, 6, 9, 17-18 – from: Yakutia, *Ignatov 11-4325*, MHA; 7-8, 12 – from: Altai, *Ignatov 8/7*, MHA; 10 – from: Altai, *Ignatov 0/1159*, MHA). 1-3 – habit, dry; 4-13 – axillary bulbils; 14 – upper laminal cells; 15 – basal laminal cells; 16 – median laminal cells; 17-23 – leaves. Scale bars: 2 mm for 1-3; 1 mm for 17-23; 200 µm for 5-13; 100 µm for 4, 14-16.

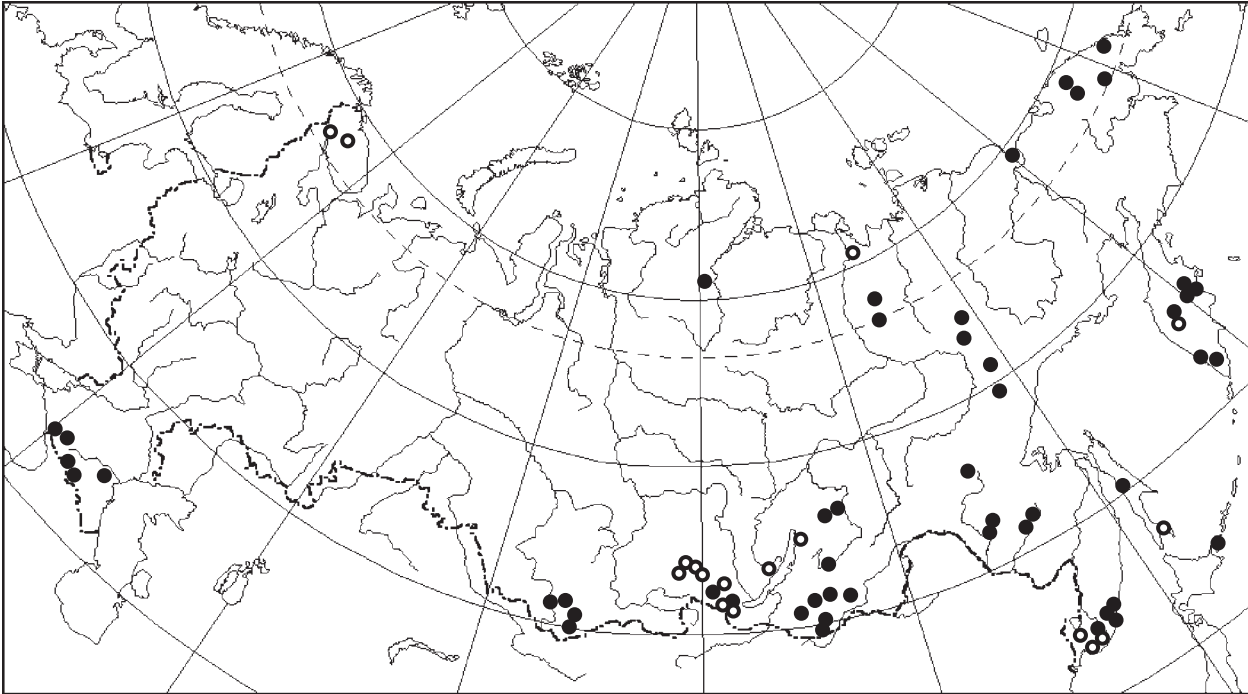


Fig. 4. Distribution of *Anomobryum concinnatum* in Russia, based on specimens studied (solid circles) and literature data (open circles). Sources of literature data are as follow: Bardunov, 1965; Schljakov & Konstantinova, 1982; Bardunov & Cherdantseva, 1982; Stepanova, 1986; Ignatov *et al.*, 2004; Fedosov, 2010, 2012; Pisarenko *et al.*, 2012.

casus, southern Siberia, Yakutia and Far East from Primorsky Territory to Chukotka Peninsula; scattered records are also reported from Taimyrsky Autonomous District. Schljakov & Konstantinova (1982) reported this species from Kola Peninsula, but we failed to find specimens from the latter area for our study.

Selected specimens examined: **RUSSIA:** CAUCASUS:

Karachaevo-Cherkessia: Teberdinsky Nature Reserve (43°27'N, 41°45'E), 1350 m alt., 5.IX.2005, *Ignatov & Ignatova 05-1247* (MW); Daut River (43°34'N, 42°05'E), 1340 m alt., 4. VIII.1993, *Doroshina 13917* (LE). **Kabardino-Balkaria:** Cherek-Bezengiysky River (43°06'N, 43°08'E), 2500 m alt., 2.VIII.2004, *Ignatov, Ignatova & Kharzinov s.n.* (MHA); Adylsu River (43°14'N, 42°47'E), 2500 m alt., 4. VIII.1991, *Doroshina 15789* (LE); **Dagestan,** Gunukh (42°18'N, 46°46'E), 1800 m alt., 7.IV.2011, *Ignatov & Abakarova 11-165* (MHA). **SIBERIA:** **Altai Republic:** Ulagan District, Chulyshman River (50°55'N, 88°12'E), 750 m alt., 18.VIII.2012, *Ignatov & Ignatova 12-719* (MHA); Kosh-Agach District (49°57'N, 87°50'), 2500 m alt., 11.VIII.2012, *Ignatov & Ignatova 12-875a* (MHA); Shebalino District, Katun River (51°39.5'N, 85°45'E), 300 m alt., 8.VIII.2012, *Ignatov & Ignatova 12-315* (MHA); Teletzkoe Lake (51°45'N, 87°35'E), 400 m alt., 8.VI.1989, *Ignatov s.n.* (MW); Altaisky Nature Reserve (51°50'N, 87°45'E), 550 m alt., 7.VI.1989, *Ignatov 0/1159* (MHA); Kurkure Range (51°06'N, 88°09'E), 1760 m alt., 2.VII.1991, *Ignatov 8/7* (MHA). **Krasnoyarsk Territory,** Taimyrsky Autonomous District, northern bank of Kogotok Creek, 2.VII.2009, *Fedosov 09-443* (MW). **Irkutsk Province:** Slyudyanka District, Slyudyanka River (51°37.5'N, 103°39'E), 650 m alt., 8.VI.2005, *Ignatov & Kazanovskiy s.n.* (MHA). **Republic of Buryatia:** East Sayan Mts, Tunkinsky Range, 1250 m alt., 2.VIII.1960, *Bardunov s.n.* (LE). **Zabaikalsky Territory:** Kalar District, Yuzhno-Muysky Range (56°13'59.5'N, 115°52'59.5'E), 600 m alt., 7.VII.2013, *Afonina*

8212 (LE); Kalar District, Kodar Range (56°54'43"N, 117°50'29"E), 1060 m alt., 7.VII.2013, *Czernyadjeva 24-13* (LE); Ulota District, Ingoda River (50°49'45"N, 111°28'43"E), 867 m alt., 5.VIII.2011, *Afonina 0311* (LE); Kyra District, Sokhondo Reserve, Agutza River (49°41'N, 111°26'E), 1120 m alt., 21.VII.2013, *Czernyadjeva 47-13* (LE); Kyra District, Sokhondo Reserve, Bukukun River (49°38'N, 111°01'E), 1646 m alt., 23.VIII.2011, *Czernyadjeva 42-11* (LE); Kyra District, Sokhondo Reserve, Enda River (49°27'N, 110°51'E), 1070 m alt., 11.VII.2010, *Czernyadjeva 7-10* (LE); Kyra District, Gornaya Step Reserve (49°23'N, 111°57'E), 31.VII.2005, *Afonina 7805* (LE); Agin-Buryat Autonomus Area, National Park Alhanai (50°50'N, 113°22'E), 1048 m alt., 24.VII.2007, *Afonina 08307* (LE); Chita District, Onon River (50°31'N, 115°00'E), 23.VII.2005, *Afonina 4005* (LE); Krasnochikoisky District, Maloarkhangelsk Settlement (50°27'59"N, 108°47'31"E), 902 m alt., 7.VIII.2011, *Czernyadjeva 7-11* (LE); Tungokochinsky District, Nerchinsko-Kuenginsky Range (52°37'40"N, 115°24'11"E), 620 m alt., 16.VII.2012, *Czernyadjeva 12-12* (LE). **Yakutia:** Aldan River, El'ge River, 30.VII.1928, *Korzhevin 790* (LE); Eveno-Bytantaysky District, Orulgan Range, (68°16'N, 128°25'E), 900 m alt., 6.VIII.2011, *Ignatov 11-4514* (MHA); Ust-Maya District, Allakh-Yun Settlement, (61°08'N, 138°03'E), 600 m alt., 23.VIII.2000, *Ignatov 00-645* (MHA); Ust-Maya District, Yugorenok Settlement (59°50'N, 138°00'E), 380 m alt., 9.IX.2000, *Ignatov 00-16* (MHA); Kobyaysky District, Undyulyng River, 8.VII.1990, *Baryshev 67* (SASY); Tomponsky District, Tuora-Tukulan River, 5.IX.1990, *Kirillina 68* (SASY); Neryungy District, Bolshoe Toko Lake, 4.VIII.1995, *Volotovskiy 71* (SASY); Nizhnekolymsk District, Kolyma River, Petushki Settlement, 26.VII.1984, *Stepanova 66* (SASY). **FAR EAST:** **Amurskaya Province:** Norsky Reserve (52°57'N, 130°08'E), 250 m alt., 7.VII.2010, *Bezgodov 269* (MHA); Selemdzha River (52°23'30"N, 129°56'E), 200 m alt., 21.VI.2011, *Bezgodov 384*

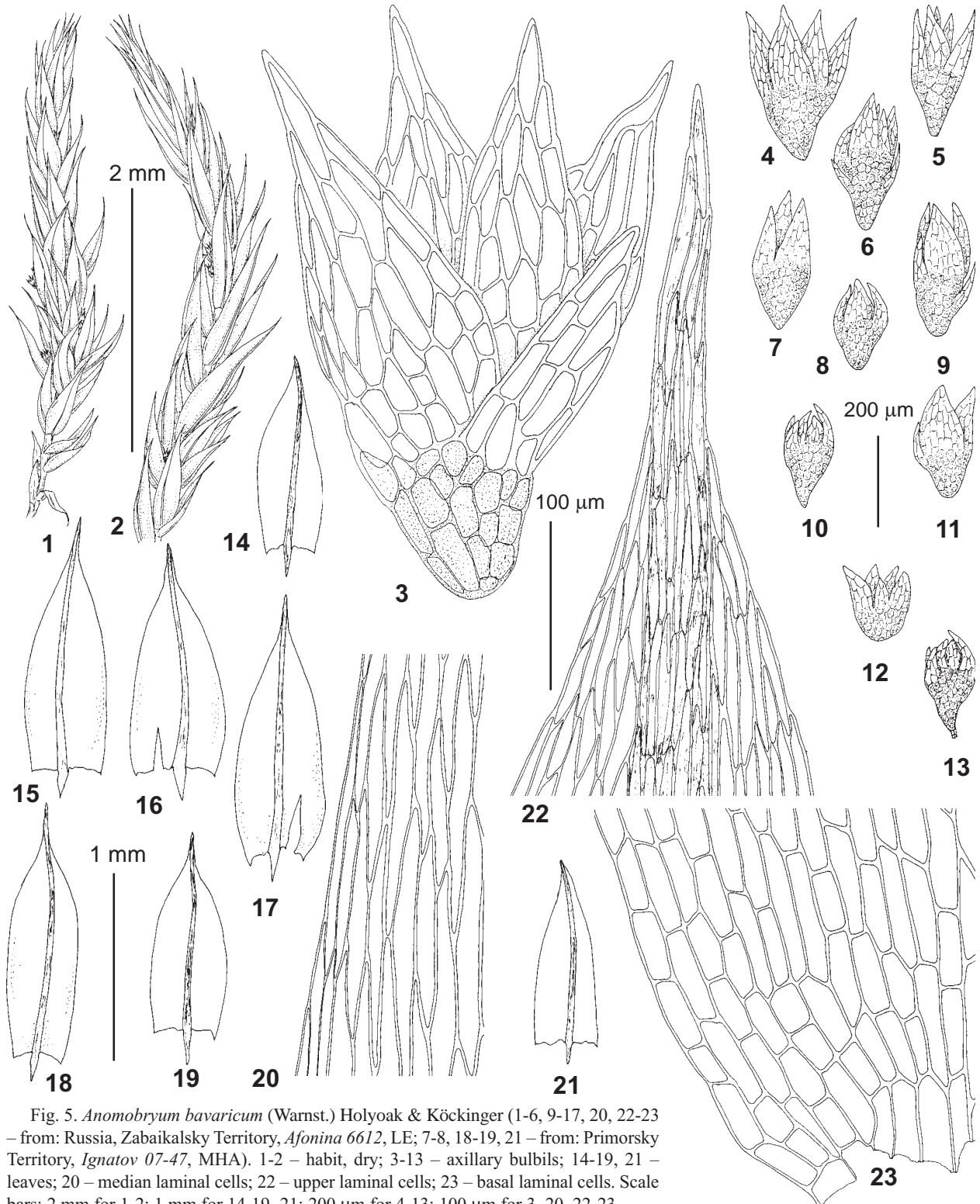


Fig. 5. *Anomobryum bavaricum* (Warnst.) Holyoak & Köckinger (1-6, 9-17, 20, 22-23 – from: Russia, Zabaikalsky Territory, *Afonina* 6612, LE; 7-8, 18-19, 21 – from: Primorsky Territory, *Ignatov* 07-47, MHA). 1-2 – habit, dry; 3-13 – axillary bulbils; 14-19, 21 – leaves; 20 – median laminal cells; 22 – upper laminal cells; 23 – basal laminal cells. Scale bars: 2 mm for 1-2; 1 mm for 14-19, 21; 200 µm for 4-13; 100 µm for 3, 20, 22-23.

(MHA); **Khabarovsk Territory:** Bureinsky Nature Reserve (51°39'N, 134°22'E), 590 m alt., 9.VIII.1994, *Petruk* s.n. (MW); Bureinsky Nature Reserve (51°43'N, 134°18'E), 580 m alt., 27.VIII.1997, *Ignatov* 97-504 (MHA); Bureya River (51°32'N, 133°54'E), 470 m alt., 7.VIII.1997, *Ignatov* 97-503 (MHA); **Chukotsky Autonomous District:** Pekulnei Range (67°57'N, 174°37'E), 28.VII.1977, *Korobkov* s.n. (LE); Palyavaam River (68°45'N, 173°49'E), 10.VII.1989, *Afonina* (LE); Amguema River

(67°44'N, 178°35'W), 10.VII.1989, *Afonina* (LE); Tanyuner River (66°39'N, 176°40'E), 14.VII.1979, *Afonina* (LE). **Kamchatsky Territory:** Kluchevskaya group of volcanoes, Tolbachik volcano (55°44'N, 160°11'E), 650m alt., 25.VIII.2007, *Czernyadjeva* 47 (LE); Kluchevskaya group of volcanoes, Bilchenok glacier (56°11'N, 160°21'E), 550 m alt., 22.VII.2003, *Czernyadjeva* 47 (LE); Kluchevskaya group of volcanoes, Ushkovsky volcano (55°58'N, 160°15'E), 1250 m alt., 22.VII.2003, *Czernyadjeva* 47 (LE).

yadjeva 47 (LE); Khadutka Bay (51°46'N, 158°00'E), 5 m alt., 20.VII.2002, *Czernyadjeva* 5 (LE); Left Kihchik River (53°25'N, 156°40'E), 600 m alt., 18.VIII.2001, *Czernyadjeva* 116 (LE); Esso Settlement (55°55'N, 158°42'E), 700 m alt., 19.VIII.2003, *Czernyadjeva* 104 (LE); **Sakhalinskaya Province:** Sakhalin, Khodzhi Cap (50°50'N, 142°06'E), 30 m alt., 6.IX.2009, *Pisarenko op03188* (MHA); Kuril Islands, Kunashir Island, Tyatya volcano (44°18'N, 146°18'E), 100 m alt., 15.IX.2006, *Ignatov 06-1787* (MHA). **Primorsky Territory:** Olga District, Milogradovka (43°27'N, 134°30'E), 50 m alt., 22.VIII.2007, *Ignatov 07-607* (MHA); Chuguevka District, Izvilinka Creek (43°50.8'N, 134°36'E), 500 m alt., 15.VIII.2007, *Ignatov 07-585* (MHA); Partizansk District, Ol'khovaya Mt. (43°20'N, 133°39'E), 1600 m alt., 21.IX.2006, *Ignatov, Ignatova & Cherdantseva 06-2208* (MHA); Khanka District, Novokachalinsk Settlement (45°09'32.9"N, 131°59'56"E), 90 m alt., 21.IX.2006, *Ignatov, Ignatova & Cherdantseva 06-2208* (MHA).

Anomobryum bavaricum (Warnst. in Hamm.) Holyoak & Köckinger, J. Bryol. 32(3): 160. 2010. — *Bryum bavaricum* Warnst., Mitt. Bayer. Bot. Ges. 1(39-41): 512. 1906. — *Pohlia bavarica* Warnst. in Hamm., Mitt. Bayer. Ges. 2(7): 105. a, b. 1908. — *Anomobryum concinnatum* subsp. *cuspidatum* J.J. Amann, Rev. Bryol., n. Ser. 3: 167. 1-3. 1931. Figs. 1b, 2b, 5, 7

Plants small, ±julaceous, in rather lax tufts, pale green, pale yellowish to glossy golden, brownish at base. Stems evenly foliate, erect, to 0.5–1.0 cm, unbranched or weakly branched, reddish-brown to yellowish distally, radiculose at base, rhizoids papillose; shoot tips cuspidate. Leaves imbricate, erect to erecto-patent and slightly flexuose when dry, erect to erecto-patent when moist; 0.8–1.2×0.3–0.5 mm, not or slightly concave, ovate to ovate-lanceolate, widest in basal half of leaf, shortly acuminate; margins entire or occasionally with some cells with projected angles near apex, plane throughout; costa strong, often brownish, usually excurrent as a short smooth mucro, rarer percurrent or vanishing in acumen, 35–45 µm wide at base; mid-leaf cells elongate-rhomboidal to linear-vermicular, with non-porose walls, (60–)70–110(–125) × (8–)9.5–11(–13) µm, with length/width ratio 6–11:1; distal laminal cells shorter, to 50–70 µm long; cells in 1–3 marginal rows narrower and thinner-walled, (56–)70–110(–136) × (3–)4–6.5 µm, with length/width ratio 16–28:1, forming a weakly delimited border; basal laminal cells differentiated, rectangular to short-rectangular, lax, thinner-walled, not porose, (25–)30–45(–60) × 14.5–19 µm, with length/width ratio 1.2–3:1. Dioicous. Sporophytes and male plants unknown. [Perichetia at stem apices but often appearing laterally. Perichaetial bracts imbricate, erect, longer than leaves, up to 1.6×0.5 mm, oblong-lanceolate, with shortly acute apex, slightly concave, basal half brown, costa stout but vanishing below leaf apex (see Holyoak & Köckinger, 2010)]. Specialized asexual reproduction by axillary bulbils arising 8–15 on stem between leaves and in leaf axils, on the “oval fields of initial cells” (Holyoak & Köckinger, 2010). Mature bulbils usually oblong to ovate or almost round, (120–)160–250 × (60–)75–125(–200) µm, red-brown,

brown to yellowish, with 2–4 green leafy primordia restricted to the apical 1/3–1/2 of the bulbil, bulbils usually produced on 2–3 cells long stalk. Juvenile bulbils light-green, variable in shape, from round to oblong-ovate.

Differentiation. *A. bavaricum* differs from the similar *A. concinnatum* by having acuminate (vs. acute) leaf apex, mostly ±longly excurrent costa (vs. usually percurrent or ending just below leaf apex), more numerous, reddish-brown bulbils with leaf primordia mostly confined to the upper half (vs. less numerous, green or dark brown bulbils with leaf primordia arising usually also from the basal part). However, the latter character is rather variable (Afonina & Köckinger, 2014). The differences from *A. nitidum* are discussed under the latter species.

Ecology. The species was collected in Russia in mountain areas, at low elevations between 50–870 m a.s.l. In Transbaikalia, it grew on mossy rocks in canyon, on detritus in non-shaded crevice of calcareous rock outcrop in the low forest belt composed of *Larix dahurica* Turcz., *Betula platyphylla* Sukaczew, *Pinus silvestris* L., *Populus tremula* L. and *P. suaveolens* Fisch.; in Primorsky Territory it was collected on fine soil on rock outcrops on south-faced slope, on roadside and on soil at creek bank; on Verkhoyansk Range in Yakutia it was found on open gentle slope covered by small schist pieces alternating with bare soil patches, on soil mixed with *Aloina*, *Pterygoneurum*, *Didymodon*, etc.; this mountain slope contrastingly differs from nearby ones by almost no vegetation cover (apparently due to high contents of heavy metals). The species grows as separate shoots on fine soil or in small loose tufts, occasionally with an admixture of *Hypnum cupressiforme*.

Distribution. Until recently, *Anomobryum bavaricum* was considered as endemic of the European Alps (Holyoak & Köckinger, 2010). In Europe it was known in Austria, Germany, Italy, and Switzerland. In Russia it is now found in southern Siberia (Zabaikalsky Territory), Yakutia (at 63° N) and Far East (Primorsky Territory).

Specimens examined: **RUSSIA:** SIBERIA: **Zabaikalsky Territory:** Kalar District, Yuzhno-Muisky Range, Canyon of Koyra Creek (56°13'59.5"N, 115°52'17.9"E), 594 m alt., 5.VIII.2012, *Afonina 6612* (LE). **Yakutia:** Tomponsky District, Sette Daban Mts, right slope of Kuraanakh River valley 10 km southward of Razvilka Settlement (63°02'16.1"N, 138°22'53.2"E), 615 m alt., 21.VII.2015, *Ignatov & Ignatova 15-1*. (MHA). **FAR EAST:** **Primorsky Territory,** Partizansk District, Chandolaz Mt. (43°00'N, 133°01'E), 400 m alt., 26.VIII.2007, *Ignatov 07-47* (MHA); Olga District, Milogradovka (43°27'N, 134°30'E), 50 m alt., 22.VIII.2007, *Ignatov 07-616* (MHA).

Anomobryum nitidum (Mitt.) A. Jaeger, Ber. Thätigk. St. Gallischen Naturwiss. Ges. 1873–74: 142 (Gen. Sp. Musc. 1: 604). 1875. — *Bryum nitidum* Mitt., J. Proc. Linn. Soc., Bot., Suppl. 1: 67. 1859. Figs. 1n, 2n, 6-7

Plants small, pale green, golden or whitish in color, slightly glossy, growing as separate shoots on fine soil or among other mosses, rarer forming loose tufts. Stems erect, often slender and thread-like, 0.3–2.0 cm long, not

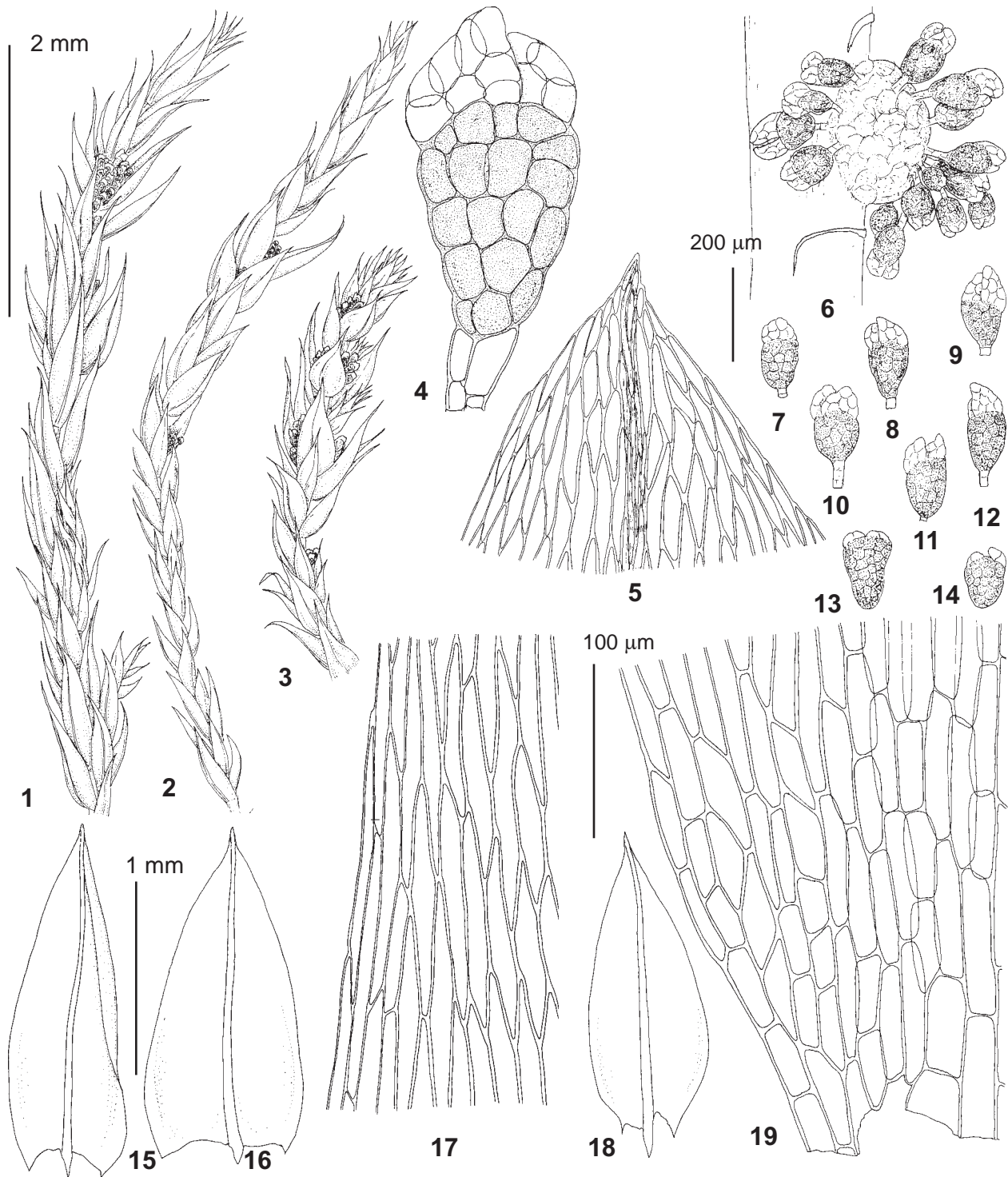


Fig. 6. *Anomobryum nitidum* (Mitt.) A. Jaeger (1, 3-12, 15, 17-19 – from: Russia, Primorsky Territory, Chandolaz Mt., Ignatov 07-60, MHA; 2, 13-14, 16 – from: Primorsky Territory, Vladivostok, Ignatov *et al.* 06-3385, MHA). 1-3 – habit, dry; 4, 6-14 – axillary bulbils; 5 – upper laminal cells; 15-16, 18 – leaves; 17 – median laminal cells; 19 – basal laminal cells. Scale bars: 2 mm for 1-3; 1 mm for 15-16, 18; 200 µm for 6-14; 100 µm for 4-5, 17, 19.

or weakly branched, green or yellowish distally, brownish in the middle part, often dark red-brown in proximal portion, with abundant papillose rhizoids, densely and evenly foliate, shoot tips cuspidate. Leaves \pm imbricate when dry, erect-spreading when wet, flat or slightly concave, (0.9–)1.0–1.3(–1.6) \times (0.4–)0.5–0.6(–0.7) mm,

oblong, ovate or oblong-ovate, wider in lower part, gradually tapering distally, acute; margins flat, occasionally weakly recurved in basal part of leaf, entire or sometimes with few projecting upper cell angles; costa 30–50 μ m wide at base, mostly shortly excurrent, rarer percurrent; laminal cells \pm thick-walled, walls occasionally to

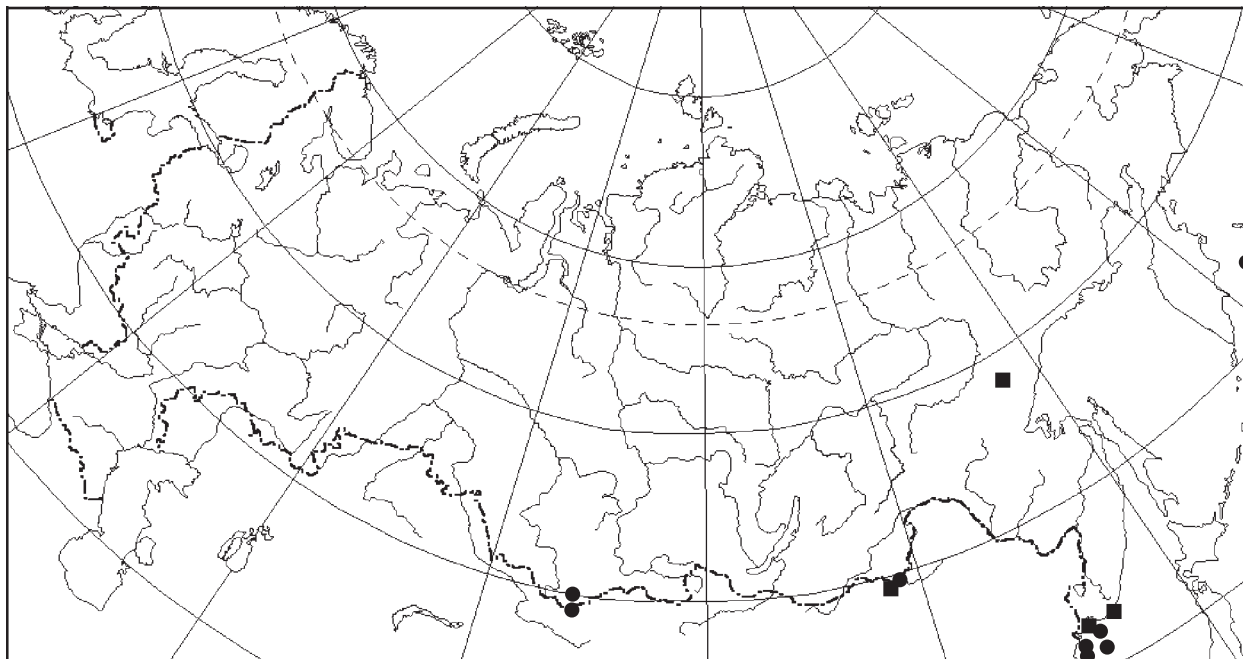


Fig. 7. Distribution of *Anomobryum bavaricum* (squares) and *A. nitidum* (circles) in Russia, based on specimens studied.

2.5 μm thick, not porose, oblong-rhomboidal to linear-vermicular, (60–)80–130(–150) \times (6–)8–14(–16) μm , with length/width ratio 6–12:1, upper laminal cells shorter, to 40–70 μm long, marginal cells in 1–3 rows narrower and thinner-walled, (60–)80–135(–150) \times (2.0–)3.0–6.0(–6.5) μm , with length/width ratio 20–35:1, forming weakly delimited border; basal laminal cells differentiated, rectangular to short-rectangular, lax, thinner-walled, not porose, (25–)30–45(–60) \times (9–)12–18(–24) μm , with length/width ratio 1.3–5:1, often with numerous chloroplasts and darker color in comparison with the rest part of lamina; cells at leaf insertion and lowermost part of costa sometimes reddish, especially in the middle and lower portion of shoots; distal portion of leaves often colorless. Dioicous. Sporophytes unknown in the territory of Russia. Specialized asexual reproduction by means of numerous axillary bulbils, 15–30 per axil, sitting on a bud-like, round stem projection; mature bulbils oblong or ovate and ellipsoidal, 200–120 \times 100–60 μm , bulbil body vine-red to red-brown, primordia only on the top, 1–4, light-green, formed of very thin-walled, somewhat inflated cells, at base of bulbil body with a stalk of 2–4 cells long.

Differentiation. *A. nitidum* differs from both other species known in Russia in having the smallest and most numerous axillary bulbils, 15–30 per axil; bulbils sit on round projection of stem located shortly above leaf axil. Bulbils of *A. nitidum* have a vine-red body and the few primordia formed with thin-walled cells; they are different from those seen in both other species that have bulbil bodies colored reddish-brown, orangish, brownish or greenish and bulbil primordia with firm-walled cells. Additional differences from *A. bavaricum* are the acute rather than acuminate leaves and shorter excurrent costa.

Ecology. In Russia, this species was found mostly in mountain areas, at lower elevations between 400–700 m a.s.l.; in Vladivostok, specimens were collected on cliffs at sea shore and at ca. 50 m a.s.l. *A. nitidum* grows on bare soil on slopes with sparse vegetation, on fine soil covering rock outcrops, on rocks with fine soil layer at roadside, on rock covered by loam on landslide, and on soil bank along brook. Individual plants grow as separate shoots and are scattered on fine soil or among other mosses, rarer forming loose tufts. *A. nitidum* is associated with pioneer mosses such as *Bryoerythrophyllum recurvirostrum*, *Bryum* sp., *Ceratodon purpureus*, *Bryum argenteum*, *Didymodon* sp., and *Funaria hygrometrica*.

Distribution. *Anomobryum nitidum* is an Asian species known from Bhutan, Burma, China, India (Himalayas), Japan, Nepal, Pakistan (Himalayas), and Philippines (Holyoak & Köckinger, 2010; Hipol *et al.*, 2007). In Russia, it was found in southern Siberia (Altai Republic, Zabaikalsky Territory) and Far East (Kamchatsky and Primorsky Territories).

Specimens examined: **RUSSIA:** SOUTH SIBERIA: **Altai Republic:** Altaisky Nature Reserve (51°50'N, 87°45'E), 530 m alt., 3.VI.1989, *Ignatov 0/1158* (MHA); Ulagan District, Chulyshman River (51°18'N, 87°43'E), 470 m alt., 17.VIII.2012, *Ignatov & Ignatova 12-764* (MHA). **Zabaikalsky Territory:** Nerchinsky Zavod Settlement (51°19'03.7"N, 119°35'53.1"E), 658 m alt., 25.VII.2012, *Afonina 3812* (LE). FAR EAST: **Kamchatsky Territory,** Aleutsky District, Bering Island, 11.VIII.2010, *Fedosov 10-3-622* (MW). **Primorsky Territory:** Partizansk District: Chandolaz Mt. (42°59'59"N, 133°00'20"E), 400 m alt., 9.IX.2013, *Ignatov & Ignatova 13-1914* (MHA); Chandolaz Mt., (43°01'N, 133°01'E) 500 m alt., 7.IX.2006, *Ignatov, Ignatova & Cherdantseva 06-2719* (MHA); Chandolaz Mt. (43°00'N, 133°01'E), 600 m alt., 26.VIII.2007, *Ignatov 07-60* (MHA); Vladivostok, 30.IX.2006, *Ignatov & Ignatova 06-3504* (MHA);

Vladivostok (43°11.5'N, 131°59'E), 50 m alt., 24.IX.2006, Ignatov, Ignatova & Cherdantseva 06-3385 (MHA).

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LITERATURE CITED

- [ABRAMOVA, A.L., L.I. SAVICZ-LYUBIYSKAYA & Z.N. SMIRNOVA] АБРАМОВА А.Л., Л.И. САВИЧ-ЛЮБИЦКАЯ, З.Н. СМИРНОВА. 1961. Определитель листостебельных мхов Арктики СССР. – [The Handbook of mosses of the Arctic of USSR] *М., Л. [Moscow, Leningrad]*, 824 pp.
- [AFONINA, O.M.] АФОНИНА О.М. 2004. Конспект флоры мхов Чукотки. – [Moss flora of Chukotka] *СПб [St.Petersburg]*, 260 pp.
- AFONINA, O.M. & H. KÖCKINGER. 2014. *Anomobryum bavaricum* (Warnst. in Hamm.) Holyoak et Köckinger. – In: Ellis, L.T. (ed.) *New national and regional Bryophyte records. Journal of Bryology* **32**(2): 140–147. DOI: <http://dx.doi.org/10.1179/037366810X12578498135913>
- ALLEN, B., D. HALL, J. MUÑOS, R.A. PURSELL & W.R. BUCK. 2002. Moss Flora of Central America. Part 2. Encalyptaceae – Orthotrichaceae. – *St. Louis, Missouri Botanical Garden Press*, 699 pp.
- [BACHURINA, G.F. & V.M. MELNICHUK] БАЧУРИНА Г.Ф., В.М. МЕЛЬНИЧУК. 1989. Флора мхов Української РСР. – [Moss flora of Ukraine] *Київ [Kiev]*, 176 pp.
- [BARDUNOV, L.V.] БАРДУНОВ Л.В. 1965. Листостебельные мхи Восточного Саяна. – [Mosses of East Sayan] *М., Л. [Moscow, Leningrad]*: 161 pp.
- [BARDUNOV, L.V.] БАРДУНОВ Л.В. 1969. Определитель листостебельных мхов Центральной Сибири. – [Handbook of mosses of Central Siberia] *Л., Наука [Leningrad, Nauka]*, 319 pp.
- [BARDUNOV, L.V. & V.YA. CHERDANTSEVA] БАРДУНОВ Л.В., В.Я. ЧЕРДАНЦЕВА. 1982. Листостебельные мхи Южного Приморья. – [Mosses of South Primorie] *Новосибирск [Novosibirsk]*, 208 pp.
- CORTINI PEDROTTI, C. 2001. Flora dei muschi d'Italia. I parte. – *Roma*: 1–817.
- CROSBY, M.R., R.E. MAGILL, B. ALLEN & S. HE. 1999. A checklist of the Mosses. – *Missouri Botanical Garden*, 309 pp.
- CRUM, H.A. & L.E. ANDERSON. 1981. Mosses of Eastern North America. Vol. 1. – *New York*: 1–663.
- DA-CHEN, Z., L.XING-JIANG & S. HE. 2007. Bryaceae. – In: He, S. (ed.) *Moss Flora of China. Vol.4. Science Press (Beijing, New York) & Missouri Botanical Garden Press (St. Louis)*: 3–92.
- ELÍAS, M.J. 2010. *Anomobryum*. – In: Guerra, J. et al. (eds.) *Flora Briofítica Ibérica. Vol. IV. Murcia*: 98–103.
- FEDOSOV, V.E. 2010. The moss flora of Kostin and Balkhach Mts. (Sredinnyj Kamchatsky Range, Russian Far East). – *Arctoa* **19**: 253–258.
- FEDOSOV, V.E. 2012. New moss records from Murmansk Province. 3. – In: Sofronova, E.V. (ed.) *New bryophyte records. 1. Arctoa* **21**: 275–300.
- HILL, M.O., N. BELL, M.A. BRUGGEMAN-NANNENGA et al. 2006. An annotated checklist of the mosses of Europe and Macaronesia. – *Journal of Bryology* **28**(3): 198–267. DOI: [10.1179/174328206X119998](http://dx.doi.org/10.1179/174328206X119998).
- HIPO, R.M., D.B. TOLENTINO, E.S. FERNANDO & N.M. CADIZ. 2007. Life strategies of mosses in Mt. Pulag, Benguet Province, Philippines. – *Philippine Journal of Science* **136** (1): 11–18.
- HOLYOAK, D.T. & H. KÖCKINGER. 2010. A taxonomic revision of some European and Asian bulbiferous species of *Anomobryum* (Bryophyta: Bryaceae). – *Journal of Bryology* **32**: 153–169. DOI: [10.1179/037366810X12735734836214](http://dx.doi.org/10.1179/037366810X12735734836214).
- HOLYOAK, D.T. & N. PEDERSEN. 2007. Conflicting molecular and morphological evidence of evolution within the Bryaceae (Bryopsida) and its implications for generic taxonomy. – *Journal of Bryology* **29**: 111–124. DOI: [10.1179/174328207X189198](http://dx.doi.org/10.1179/174328207X189198).
- IGNATOV, M.S., O.M. AFONINA, E.A. IGNATOVA et al. 2006. Checklist of mosses of East Europe and North Asia. – *Arctoa* **15**: 1–130.
- [IGNATOV, M.S., E.A. IGNATOVA & G.A. PRONKINA] ИГНАТОВ М.С., Е.А. ИГНАТОВА, Г.А. ПРОНЬКИНА. 2004. Мхи. – [Mosses] *В кн.: Современное состояние биологического разнообразия на заповедных территориях России. Выпуск 3. Лишайники и мохообразные (ред. Афонина О.М., Голубкова Н.С.) [In: Afonina, O.M. & Golubkova N.S. (eds.) The Present-day State of Biological Diversity within Protected Areas in Russia. Issue 3. Lichens and Bryophytes] М. [Moscow]*: 274–366.
- [IVANOVA, E.I., E.A. IGNATOVA, M.S. IGNATOV, V.I. ZOLOTOV & K.K. KRIVOSHARIN] ИВАНОВА Е.И., Е.А. ИГНАТОВА, М.С. ИГНАТОВ, В.И. ЗОЛОТОВ, К.К. КРИВОШАПКИН. 2005. Листостебельные мхи. – [Mosses] *В кн.: Разнообразие растительного мира Якутии (ред. Данилов Н.С.) [In: Danilov, N.S. (ed.) Raznoobrazie rastitel'nogo mira Yakutii] Новосибирск [Novosibirsk]*: 105–125.
- IWATSUKI, Z. 2004. New catalog of the mosses of Japan. – *Journal of the Hattori Botanical Laboratory* **96**: 1–182.
- [MELNICHUK, V.M.] МЕЛЬНИЧУК В.М. 1970. Определитель листовых мхов Средней полосы и юга Европейской части СССР. – [Handbook of mosses of middle and southern parts of European USSR] *Киев, Наукова Думка [Kiev, Naukova Dumka]*: 442 pp.
- NOGUCHI, A. 1988. Illustrated moss flora of Japan. Part 2. – *Nichinan, Hattori Botanical Laboratory*: 239–491.
- NYHOLM, E. 1993. Illustrated Flora of Nordic Mosses. Fasc. 3. – *Copenhagen, Lund*: 142–244.
- OCHI, H. 1980. A revision of the neotropical Bryoidae, Musci (First Part). – *The Journal of the Faculty of Education, Tottori University, Natural Science* **29**: 49–154.
- OCHI, H. 1994. *Bryum*. – In: Sharp, A.J., H. Crum & P.M. Eckel (eds.) *The Moss Flora of Mexico. Part one. Sphagnales to Bryales. Bronx, New York*: 454–489.
- PARK, K.W. & K. CHOI. 2007. New list of bryophytes in Korea. – *Korea National Arboretum, Pocheon*, 150 pp.
- [PISARENKO, O.YU., M.S. IGNATOV, V.YA. CHERDANTSEVA & E.A. IGNATOVA] ПИСАРЕНКО О.Ю., М.С. ИГНАТОВ, В.Я. ЧЕРДАНЦЕВА, Е.А. ИГНАТОВА. 2012. Конспект мхов. – [Conspectus of moss flora] *В кн.: Бриофлора Сахалина [In: Bryophytes of Sakhalin] Владивосток [Vladivostok]*: 123–268.
- [SAVICZ-LYUBIYSKAYA, L.I. & Z.N. SMIRNOVA] САВИЧ-ЛЮБИЦКАЯ Л.И., З.Н. СМИРНОВА. 1970. Определитель листостебельных мхов СССР. Верхоплодные мхи. – [The Handbook of mosses of the USSR. The mosses acrocarpous] *Л., Наука [Leningrad, Nauka]*, 824 pp.
- SCHIMPER, W.P. 1860. Synopsis Muscorum Europaeorum praemissa introductione de elementis bryologicis tractante. – *Stuttgart*, 733 pp.
- [SCHLJAKOV, R.N. & N.A. KONSTANTINOVA] ШЛЯКОВ Р.Н., Н.А. КОНСТАНТИНОВА. 1982. Конспект флоры мохообразных Мурманской области. – [Bryophyte Flora of Murmansk Province] *Апатиты [Apatity]*: 228 pp.
- SHAW, J. & A.J. FIFE. 1984. The evolutionary and taxonomic significance of peristome morphology in *Anomobryum* (Bryaceae, Musci). – *Journal of the Hattori Botanical Laboratory* **57**: 285–298.
- SMITH, A.J.E. 2004. The moss flora of Britain and Ireland. Second edition. – *Cambridge university press*, 1012 pp.
- SPENCE, J.R. 2014. *Anomobryum* – In: *Flora of North America. Vol. 28. Bryophytes: Mosses, part 2. New York, Oxford: Oxford University Press*: 120–122.
- [STEPANOVA, N.A.] СТЕПАНОВА Н.А. 1986. Конспект флоры мхов тундры Якутии. – [Moss flora of tundra of Yakutia] *Якутск [Yakutsk]*: 120 pp.
- [TSEGMED, Ts.] ЦЭГМЭД Ц. 2010. Флора мхов Монголии. – [Moss flora of Mongolia] *М. [Moscow]*, 634 pp.