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DICHELYMA (FONTINALACEAE, BRYOPHYTA) IN RUSSIA

DICHELYMA (FONTINALACEAE, BRYOPHYTA) В РОССИИ

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Abstract

Four species of *Dichelyma* are known at present in Russia: *D. capillaceum* (With.) Myrin, *D. falcatum* (Hedw.) Myrin, *D. japonicum* Cardot and *D. uncinatum* Mitt. The latter species is newly reported for the country. It was discovered in herbarium collections from Commander Islands (Kamchatsky Territory), Chukotka and Anabar Plateau (Krasnoyarsk Territory, Taimyr District). All these specimens were previously identified as *D. capillaceum*. Distribution of the latter species in Russia is restricted to central and northern parts of European Russia and West Siberia (middle course of Ob River). *Dichelyma falcatum* is not rare in the northern part of European Russia and in montane areas of southern Siberia, southern Taimyr and Chukotka, known also in central European Russia (south to Tver Province), Urals, West Siberia, Republic Sakha (Yakutia), and Kamchatka. *Dichelyma japonicum* is known from a single locality in Iturup Island (Kuril Islands). Key to identification, descriptions, data on distribution in Russia and ecology are provided for all species, illustrations of *D. capillaceum* and *D. uncinatum* are also included.

Резюме

В настоящее время на территории России известны 4 вида из рода *Dichelyma*: *D. capillaceum* (With.) Myrin, *D. falcatum* (Hedw.) Myrin, *D. japonicum* Card. и *D. uncinatum* Mitt. Последний вид впервые приводится для России. Он был выявлен в коллекциях с Командорских островов (Камчатский край), Чукотки и Анабарского плато (Красноярский край, Таймырский Автономный район), первоначально определенных как *D. capillaceum*. Ареал *D. capillaceum* в России охватывает центр и север европейской части, доходя на восток до Западной Сибири (среднего течения Оби). *Dichelyma falcatum* нередко встречается на севере европейской России, в горах юга Сибири, на юге Таймыра (Анабарское плато) и на Чукотке, вид также известен по спорадическим находкам из центра европейской части (на юг до Тверской области), на Урале, в равнинной части Западной Сибири, в Якутии и на Камчатке. *Dichelyma japonicum* найдена в России в одном местонахождении на о. Итуруп (Курильские острова). Приводятся ключ для определения, описания всех видов, данные по их распространению в России и экологии, для *D. capillaceum* и *D. uncinatum* также даны рисунки.

KEYWORDS: *Dichelyma,* mosses, new records, Russia.

In the first check-list of mosses of the former USSR (Ignatov & Afonina, 1992), the genus *Dichelyma* was represented only by one species, *D. falcatum*, having overlooked a record of *D. capillaceum* for Karelian Isthmus in NW European Russia (Brotherus, 1923). Subsequent floristic exploration brought a number of new localities of the latter species from different regions of Russia, including its European and Asian parts (Czernyadjeva, 2002; Afonina, 2006; Volosnova *et al*., 2012; Fedosov *et al*., 2011, 2012). In addition, *Dichelyma japonicum* was collected recently on Iturup, Kuril Islands (Bakalin *et al*., 2009); this species was considered to be endemic to Japan before this finding. In the course of preparation of a treatment of the genus for the Moss Flora of Russia, we revised herbarium collections in LE, MHA, MW, VLA, KPABG, NS, and SYKO and found that some specimens of *D. capillaceum* from the Asian Russia actually belong to *D. uncinatum*. These two species are widespread in North America; they have clear differences in sporophyte structure whereas their gametophytic characters are more variable and overlapping. All collections from European Russia lack sporophytes, while they were found in some specimens from Bering Island (Commander Islands), Chukotka and Anabar Plateau (Southern Taimyr), supporting identification of the species. *Dichelyma uncinatum* is newly reported for Eurasia. We provide a key to identification of species known in Russia, species descriptions, overview of their ecological patterns and distribution in Russia, as well as illustrations for *D. capillaceum* and *D. uncinatum*.

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Dichelyma Myrin, Kongl. Vetensk. Acad. Handl. 1832:273. 1933.

Plants slender to robust, growing in loose tufts, rarely mixed with other mosses in moist persistent habitats, occasionally submerged in water; glossy to dull when dry; yellowish, greenish, yellowish-brown distally, dark greyish-brown in proximal parts. Stems prostrate or pendent, sparsely irregularly branched, reddish-brown, brown to blackish, glossy; stem and branch tips erect-ascending to strongly falcate-secund or circinate; paraphyllia absent; proximal branch leaves partly reduced[1]; central strand and hyalodermis absent; rhizoids densely clustered in areas of plant attachment to substrate, brown to dark red, not or irregularly branched, finely papillose. Leaves densely or distantly arranged, stem invisible or visible among leaves, leaves strongly to obscurely 3-ranked, erect-spreading to strongly falcate-secund or circinate, keeled, ovate, lanceolate to linear-lanceolate, gradually narrowed to obtuse or acute tip or very long acuminate apex, not or weakly decurrent; margin plane or narrowly recurved, entire or rarely with few denticulations in lower part, weakly serrulate to serrate distally; costa single, in cross-section formed by homogeneous cells, subpercurrent, percurrent to excurrent in a long, aristate, denticulate or smooth subula; median laminal cells linear, slightly flexuose, thin-walled, smooth, eporose, upper laminal cells shorter, basal laminal cells shorter and wider, incrassate and porose, brownish, alar cells not or weakly differentiated.

Dioicous. Perigonia budlike, lateral, small, 1.1-1.4 mm long, perigonial leaves elliptical to ovate, acute to cuspidate, ecostate, margin entire. Perichaetial leaves strongly elongating after fertilization, forming cylindrical perichaetium, sheathing the setae, spirally twisted around seta, covering or not covering the capsule, inner perichaetial leaves linear-lanceolate, to 9 mm long, ecostate, margin entire. Seta short or long. Capsule ovoid, oblong, oblong-cylindrical to cylindrical, immersed, laterally emergent, emergent or exserted; stomata absent; exothecial cells short, irregular, collenchymatous; annulus lacking; operculum conic to obliquely long-rostrate; exostome teeth inserted somewhat below mouth, linear, trabeculae widely spaced, yellow, brown or orange, spiculose-papillose or papillose, perforate along median line; endostome segments longer than exostome teeth, brown, red to brownish-orange, spiculose to finely papillose, keeled and joined by lateral appendages, forming trellis-like cone, joined by lateral bars only distally (trellis imperfect) or throughout (trellis perfect). Calyptra large, long-cucullate, covering the capsule, finally split along one side. Spores spherical, smooth or finely papillose.

Type – *Dichelyma capillaceum* (With.) Myrin. The genus includes five species distributed mainly in arctic and boreal regions of the Northern Hemisphere; four species are known in Russia. Worldwide revision of the genus was provided by Welch (1960).

[1] – For partial reduction of proximal branch leaves in Fontinalaceae see Spirina & Ignatov, 2011.

KEY TO IDENTIFICATION OF *DICHELYMA* SPECIES IN RUSSIA

1. Leaves filiform-acuminate; costa excurrent in a long aristate subula 2
— Leaves lanceolate to ovate, acuminate to obtuse; costa subpercurrent to shortly excurrent 3
2. Leaves erect-spreading to weakly falcate, 3.5-5.5×0.3-0.5 mm, with length/width ratio 8-14:1; [seta 2-4 mm; capsule immersed or emergent; endostome segments joined only at their tips and often looking free, not joined laterally with each other] ..... *Dichelyma capillaceum*
— Leaves strongly falcate-secund to circinate, 3.0-5.0×0.4-0.6 mm, with length/width ratio 6-10:1; seta 7-15 mm; capsule exserted; endostome segments joined laterally thoughout and forming strongly perforate cone ..... *Dichelyma uncinatum*
3. Leaves 3.5-6.0×0.8-1.3 mm, with length/width ratio 4-6:1, acute to acuminate; costa shortly excurrent ..... *Dichelyma falcatum*
— Leaves 2.5-3.5×0.7-1.0 mm, with length/width ratio 3-5:1, obtuse; costa subpercurrent ..... *Dichelyma japonicum*

Dichelyma capillaceum (With.) Myrin, Kongl. Vetensk. Acad. Handl. 1832: 274. 1833. — *Fontinalis capillacea* With., Syst. Arr. Brit. Pl (ed. 4) 3: 773. 1801.
Figs. 1, 2 (B, C), 3.

Plants moderate in size to slender, irregularly and sparsely branched, yellowish, greenish-brown to dark greyish-brown at base, dull or weakly glossy when dry. Stems 5-9 cm, yellowish-brown, brown to blackish, stem and branch tips erect-ascending, flexuose-spreading to weakly falcate-secund**.** Leaves ±distant, stem often seen among leaves, leaves obscurely 3-ranked, erect-spreading to weakly falcate-secund, twisted when dry, weakly keeled, linear-lanceolate, gradually narrowed to very long narrowly acuminate apex, not or weakly decurrent, (3.5-)4.0-5.0(-5.5)×0.3-0.5 mm, with length/width ratio 8-14: 1; margin plane, entire or rarely with few denticulations in proximal part, weakly serrulate distally; costa, 40-75 μm wide at base, excurrent in a long, aristate, denticulate or smooth subula of about 30-50 % the leaf length; median laminal cells (65-)80-100(-140)×5-10 μm, linear, slightly flexuose, thin-walled, smooth, eporose, upper laminal cells shorter, basal laminal cells shorter and wider, incrassate and porose, alar cells not differented. All specimens from Russia lack sporophytes. [Perichaetial leaves to 7 mm, covering the capsule. Seta 2-4 mm. Capsule 1-2 mm long, oblong-cylindrical, immersed or emergent; operculum obliquely longly rostrate; exostome teeth spiculose-papillose; endostome segments longer than exos-

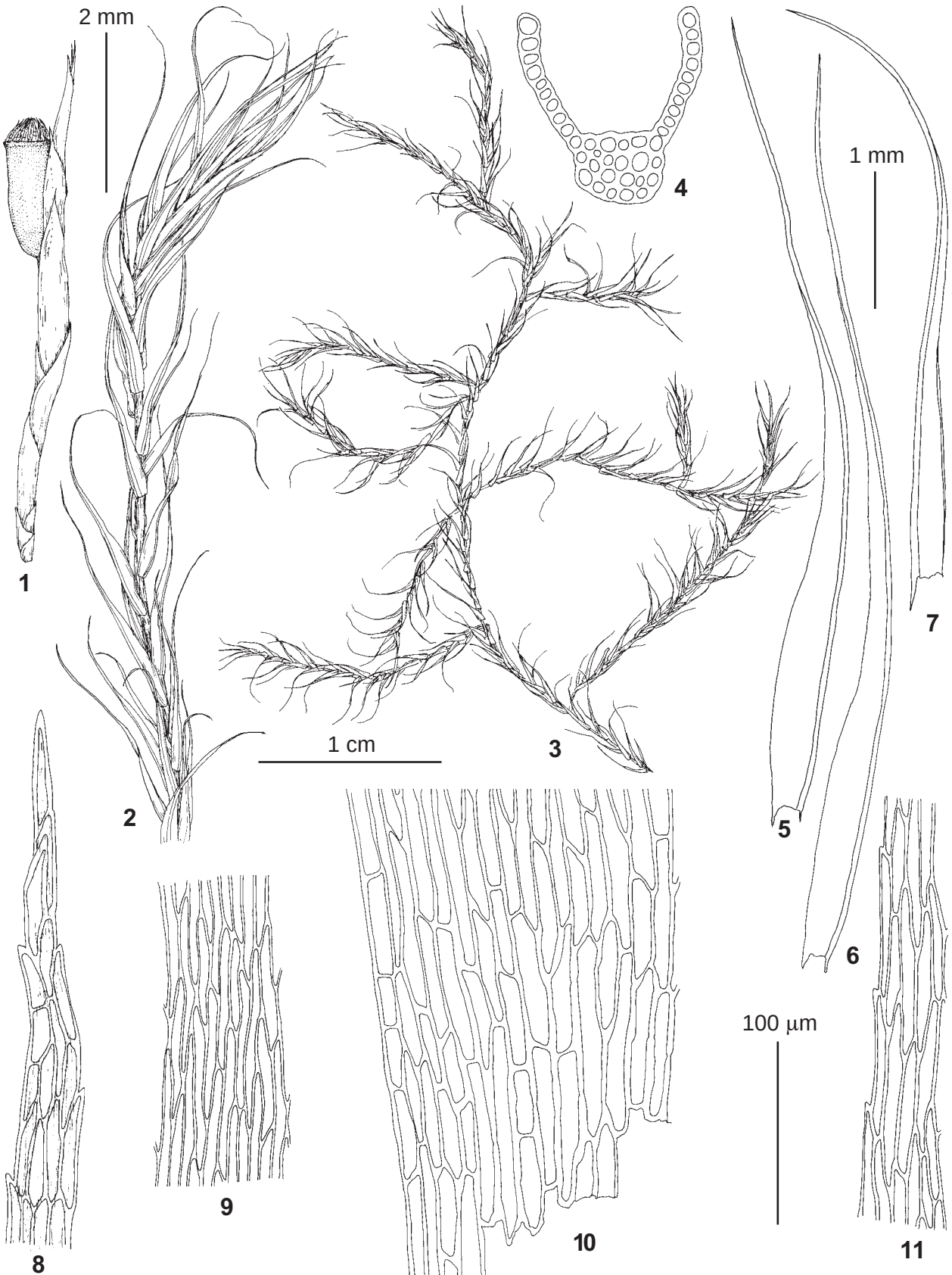

Fig. 1. *Dichelyma capillaceum* (With.) Myrin (1 – from Sweden, Stochholm, 14.IX.1864, *S.O. Lindberg s.n.,* LE; 2-11 – from: Russia, [Leningrad Province], Karel'sky Isthmus, 20.VI.1914, *H. Lindberg s.n.*, LE): 1 – perichaetium & capsule, dry; 2-3 – habit, dry; 4 – leaf transverse section; 5-7 – leaves; 8 – upper laminal cells; 9, 11 – median laminal cells; 10 – basal laminal cells. Scale bars: 1 cm for 3; 2 mm for 1-2; 1 mm for 5-7; 100 mm for 4, 8-11.

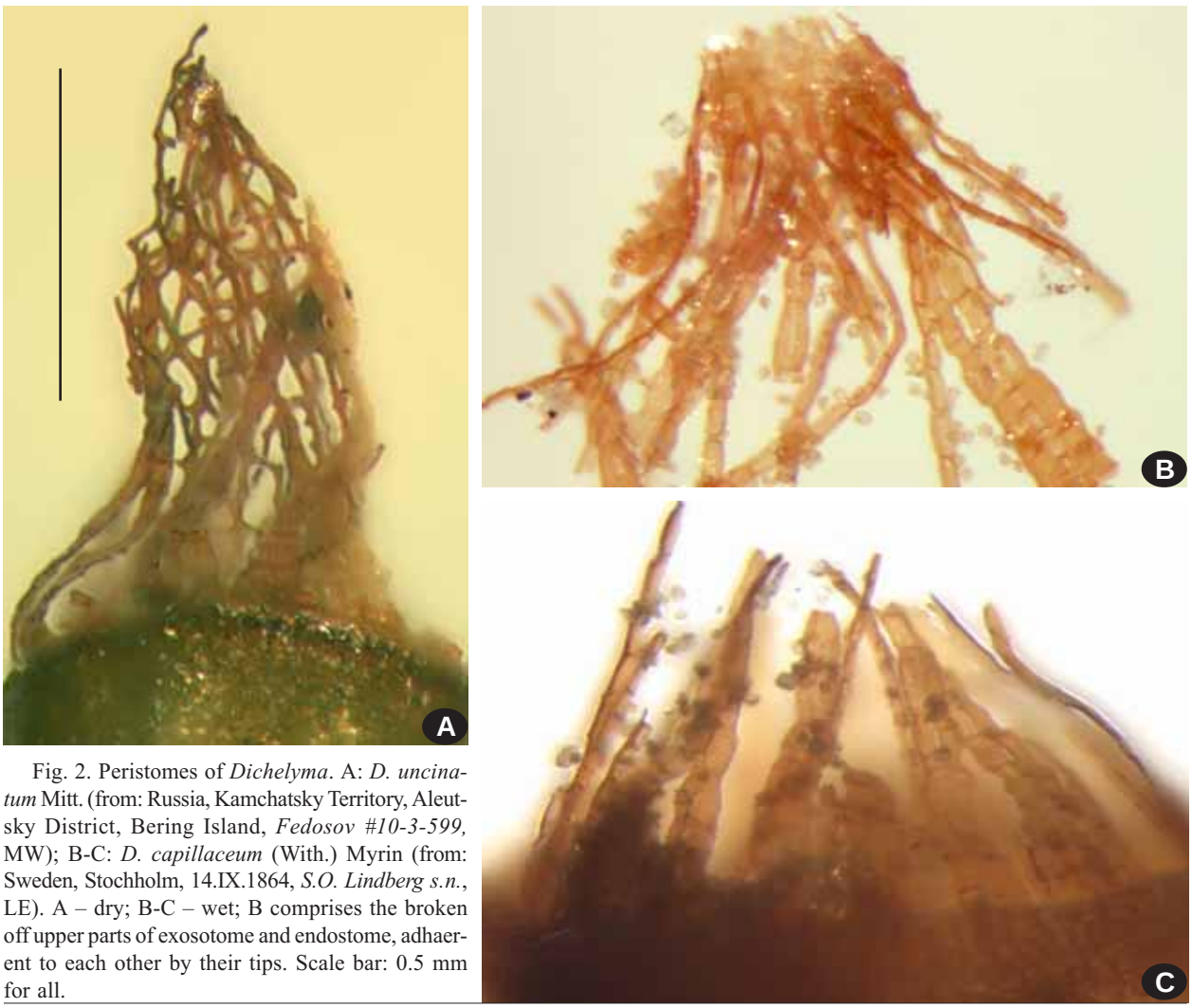

Fig. 2. Peristomes of *Dichelyma*. A: *D. uncinatum* Mitt. (from: Russia, Kamchatsky Territory, Aleutsky District, Bering Island, *Fedosov #10-3-599,* MW); B-C: *D. capillaceum* (With.) Myrin (from: Sweden, Stochholm, 14.IX.1864, *S.O. Lindberg s.n.*, LE). A – dry; B-C – wet; B comprises the broken off upper parts of exosotome and endostome, adhaerent to each other by their tips. Scale bar: 0.5 mm for all.

tome teeth spiculose-papillose; endostome segments longer than exostome teeth, joined only at apices, forming imperfect trellis, reddish or brownish-orange, spiculose-papillose. Spores 10-15 μm]

Differentiation. The species is characterized by a very longly excurrent costa, with excurrent part to 30-50% of leaf length, and distantly foliated shoots. It shares these caracters with *D. uncinatum,* which possesses considerable difficulties in identification of sterile plants. Stem and branch tips and leaves of *D. capillaceum* are typically erect, contrary to strongly falcate ones of *D. uncinatum*; however, this character is rather variable in the former species, and some collections from European Russia and West Siberia exhibit more or less falcate shoots. There are some small differences in leaf width and length and their ratios (see the key and Table 1) between two species. In *D. capillaceum*, shoots are slightly more distantly foliated, while in *D. uncinatum* leaves are denser, though stem is also visible among them. At the same time, specimens with sporophytes are easily separated due to the difference in seta length, 2-4 mm in *D. capillaceum* vs. 7-15 mm in *D. uncinatum*, and capsules immersed vs. exserted. There is also a difference in peristome structure: endostome segments are joined only by their tips and form an incomplete trellis in *D. capillaceum*, while they are joined by lateral appendages the whole length and form a complete trellis in *D. uncinatum*. Unfortunately all specimens of *D. capillaceum* from Russia lack capsules (in spite of both archegonia and anteridia being present), and we refer them to the species on the basis of gametophyte characters and distribution pattern. At the same time, capsules were found at least in some collections of *D. uncinatum* in every region where it was revealed.

In spite of a considerable difference in size of plants and leaf shape between *D. capillaceum* and *D. falcatum*, in some cases it is difficult to separate them. In the latter species, leaves from lower and middle parts of shoots may have a longly excurrent costa; in such cases leaves from distal parts of shoots should be checked, as they have a percurrent or only shortly excurrent costa, in contrast to the always very longly excurrent one in *D. capillaceum*. In addition, leaves of *D. capillaceum* are narrower (0.3-0.5 mm wide) and only weakly keeled vs. wider (0.8-1.3 mm wide) and strongly keeled leaves in *D. fal-*

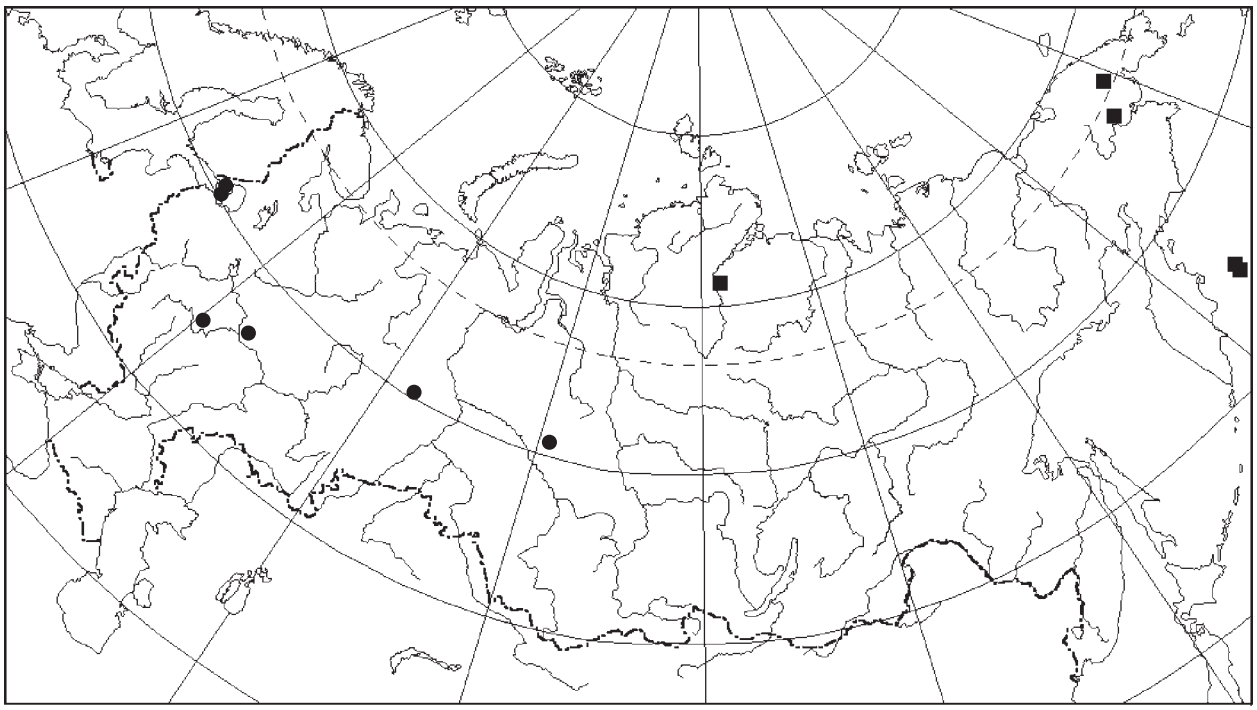

Fig. 3. Distribution of *Dichelyma capillaceum* (With.) Myrin (circles) and *D. uncinatum* Mitt. (squares) in Russia.

catum. It is also a problem to identify *D. falcatum* when it grows in rapidly running streams and has many leaves with strongly destroyed laminae, and therefore resembling narrow leaves of *D. capillaceum*; checking of some entire leaves is helpful in such cases. Difficulties in separation of these two species in Europe were discussed by K. Hylander (1999).

Distribution. *Dichelyma capillaceum* is widespread in the boreal zone of eastern North America, with a few localities in the inner parts of the continent in Oklahoma, U.S.A. and Manitoba, Canada (Crum & Anderson, 1981; Ireland *et al.*, 1987). In Europe, *D. capillaceum* is a rare species; it is included in Red Data Book of European Bryophytes (1995) and Red Data Book of East Fennoscandia (1998). It is distributed in southern Sweden and central Finland, and also some scattered records are known from Denmark, France, Germany, Poland, Italy, and Romania (Red Data Book…,1995). The range of *D. capillaceum* was reviewed by Toivonen (1972) and Hedenäs *et al.* (1996) who referred it to the group of species with boreal amphiatlantic distribution. Ingerpuu & Vellak (1998) recorded *D. capillaceum* for Estonia. In Russia, it was known for a long time from a single locality in the Leningrad Province (NW Russia), where it was collected by H. Lindberg in 1914 (Brotherus, 1923). In 2000, it was discovered in West Siberia, Khanty-Mansijsk Autonomous District (Vah River, middle Ob River) by the senior author (Czernyadjeva, 2002); additional collections from this area ("Kondinskie Lakes" Nature Park) were provided in 2006 by E.D. Lapshina (Herbarium of Yugorsky State University). It was also reported later from Oksky State Reserve, Ryazan Province (Volosnova *et al.*, 2012), collected in Kerzhensky State Reserve (S.Yu. Popov, MHA) and in St.-Petersburg City (E.N. Andreeva, LE). All records from Chukotka (Afonina, 2006), Taimyrsky Autonomous District (Fedosov *et al.*, 2011) and Kamchatsky Territory (Fedosov, 2010) are erroneous: they are based on specimens which were re-identified as *D. uncinatum*.

Ecology. In Russia, the species grows in flood valley habitats represented by willow, oak and birch woods; it occupies rotten wood, roots and branches of trees near water courses, usually above water and rarely submerged. It forms pure mats, and only a specimen from Vah River (Western Siberia) contains an admixture of *Leskea polycarpa* Hedw.

Specimens examined: **RUSSIA**. EUROPEAN RUSSIA: **Leningrad Province**: Karel'sky Isthmus, par. Muola, ad ostia omnis Saaretjoki, 20.VI.1914, *H. Lindberg s.n.* (LE); Sankt-Petersburg, Kurortny District, Glukhoe lake, 11.IX.2009, *Andreeva s.n.* (LE); **Ryazan Province**: Oksky Nature Reserve, 16.X.2009, *Volosnova s.n.* (MW); **Nizhegorodsky Province**: Kerzhensky Reserve, 16.IX.2001, *Popov s.n.* (MHA); ASIAN RUSSIA: **Khanty-Mansijsk Autonomous District**: Middle Ob River, Lower Sabun River, 4.VIII.2000, *Czernyadjeva & E.Yu. Kuzmina #57* (LE); "Kondinskie Lakes" Nature Park, 9.VII.2006, *Lapshina, rel. #356* (Herbarium of Yugorsky State University, duplicate in MHA).

SWEDEN: Stockholm, 30.VI.1864, *S.O. Lindberg s.n.* (LE); Dalsland, 2.X.1913, *Larsson s.n.* (LE); Småland, 10.VI.1956, *Christoffersson s.n.* (LE); Stockholm, 30.VI.1864, *S.O. Lindberg s.n.* (LE); Scania, Osby, Skansen, X.1935, *Hovgard # 315* (LE); **GERMANY**: Köln, *Andres #2989* (LE); **CANADA:** Québec, Rouville, 15.X.1956, *Fabius # 7790* (LE); Ontario, Brant Co., 24.XII.1943, *Cain #1609* (LE); Nova Scotia, Lunenburg County, 20.VII.1974, *Ireland s.n.* (LE); **U.S.A.**: Missouri, Ripley County, 9.VI.1973, *Redfearn #28638* (LE);

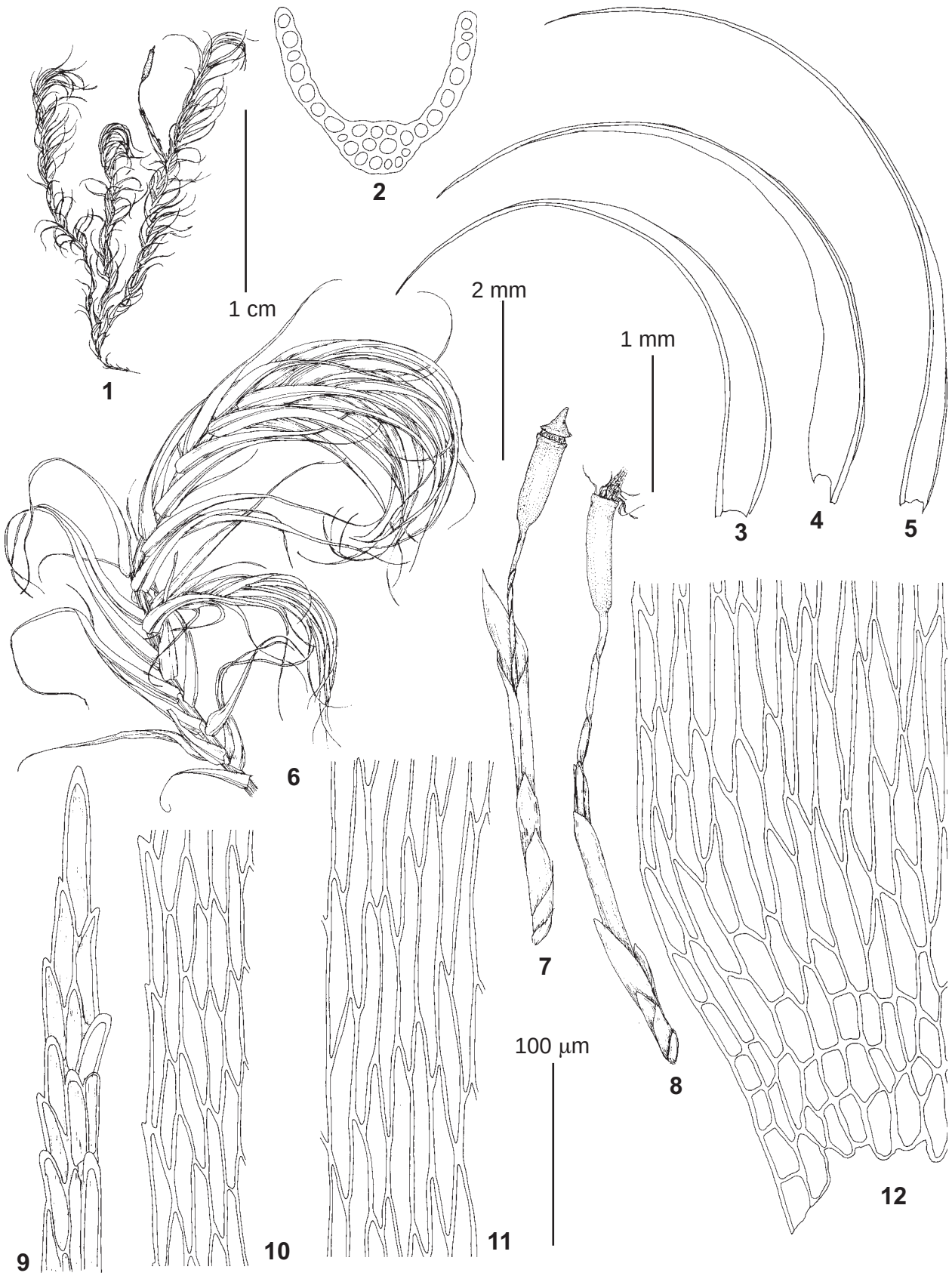

Fig. 4. *Dichelyma uncinatum* Mitt. (from: Russia, Kamchatsky Territory, Aleutsky District, Bering Island, *Fedosov #10-3-599,* MW): 1, 6 – habit, dry; 2 – leaf transverse section; 3-5 – leaves; 7 – perichaetium and capsule with operculum; 8 – perichaetium and open capsule; 9 –upper laminal cells; 10-11 – median laminal cells; 12 – basal laminal cells. Scale bars: 1 cm for 1; 2 mm for 6-8; 1 mm for 3-5; 100 mm for 2, 9-12.

Maine, Waldo Co., 26.X.1951, *Johnson #37* (LE); North Carolina, Greene Co., 20.X.1949, *Conard s.n.* (LE); Florida, Wakulla Co., 13.V.1950, *Wagner #2464* (LE); Indiana, Porter Co., 27.VII.1935, *Welch #9695* (LE).

Dichelyma uncinatum Mitt., J. Linn. Soc., Bot. 8: 44. 1864. — *Dichelyma cylindricarpum* Austin, Bot. Gaz. 2: 111. 1877; *Dichelyma uncinatum* var. *cylindricarpum* (Austin) Cardot, Mém. Soc. Sci. Nat. Math. Cherbourg 28: 139. 1892; *Dichelyma falcatum* var. *uncinatum* (Mitt.) E.Lawton, Moss Fl. Pacif. N.W., 231. 1971. Figs. 3-4.

Plants of moderate size, irregularly and sparsely branched, yellowish, greenish brown to dark greyish-brown at base, silky glossy when dry. Stems to 5-11 cm, reddish brown, brown to blackish, stem and branch tips strongly falcate-secund to circinate**.** Leaves ±distant, making stem hardly visible, obscurely 3-ranked, strongly falcate-secund to circinate, weakly keeled, linear-lanceolate, gradually narrowed to very long, narrowly acuminate apex, not or weakly decurrent, (3.0-)3.5-4.5 (-5.0)×0.5-0.7 mm, length/width ratio 6-10: 1; margin plane, entire or with few denticulations in proximal part, weakly serrulate to serrulate distally; costa 50-75 μm wide at base, excurrent in a long, aristate, denticulate or smooth subula of about 25-45 % the leaf length; median laminal cells (65-)80-100(-140)×5-8(-10) μm, linear, slightly flexuose, thin-walled, smooth, eporose, upper laminal cells shorter, basal laminal cells shorter and wider, incrassate and porose, alar cells not differentiated. Perichaetial leaves to 8 mm long, sheathing the setae, not covering the capsule. Seta 7-15 mm. Capsule 1.5-2.5 mm long, oblong-cylindrical to cylindrical, exserted; operculum conic; exostome teeth spiculose-papillose; endostome yellowish or brownish orange, longer than exostome teeth, spiculose-papillose, trellis perfect. Spores 12-15 μm, smooth.

Differentiation. The main diagnostic characters of the species include a longly excurrent costa, with the excurrent part 25-45% of the leaf length, ±distantly foliate shoots and strongly falcate-secund leaves and branch tips. Differences from *D. capillaceum* are discussed under that species. Sometimes *D. uncinatum* can be also confused with *D. falcatum*; it differs from the latter species in the same way as *D. capillaceum*.

Distribution. The species is common in western North America and rare in its eastern part, with few records in Québec and Ontario, Canada (Crum & Anderson, 1981). Its presence in herbarium collections from Asian Russia greatly extends its area westward. It is a first record of *D. uncinatum* from Eurasia. It was found in Commander Islands, Chukotka and westward to Southern Taimyr (Anabar Plateau).

Ecology. Similar to *D. capillaceum*, *D. uncinatum* grows in flood-valley willow stands, at trunk bases and on rotten wood near water courses; it also occupies rocks at stream and river banks. It forms pure mats or can be mixed with *Dichelyma falcatum, Leptodictyum riparium* (Hedw.) Warnst. or *Sanionia uncinata* (Hedw.) Loeske.

Specimens examined: **RUSSIA**: **Kamchatsky Territory**: Aleutsky District, Bering Island, Poludennaya bay, 16.VIII.2010, *Fedosov #10-3-599, #10-3-599a* (MW); Aleutsky District, Bering Island, Kommander bay, 9.VIII.2010, *Fedosov #10-3-432* (MW); **Taimyrsky Autonomous District**: Khatanga, Medvezh'ya River, 19.VIII.2011, *Fedosov #11-543* (MW); **Chukotsky Autonomous District**: Anadyrsko-Koryaksky District, Belaya River, 1.VII.1980, *Afonina s.n.* (LE); Anadyrsky District, Anadyr' River basin, Baran'e Lake, 4.VIII.1980, *Afonina s.n.* (LE).

CANADA: British Columbia: Aleza Lake, 2.IX.1957, *Boas #133* (LE); Moresby Island, 25.VIII.1961, *Schofield #15554* (LE); Squamish River, 17.VIII.1962, *Schofield #19542*(LE); **U.S.A.**: Alaska, 18.VII.1998, *Schofield #110438* (LE); Oregon, 24.VI.1947, *Mackaness s.n.* (LE); Washington, XI.1905, *Leiberg #1147* (LE); Idaho, Vootenai County, 1888, *Leiberg #81* (LE); California, 29.IV.1981, *R. & I. Duell #AZ8687* (LE).

Dichelyma falcatum (Hedw.) Myrin, Kongl. Vetensk. Acad. Handl. 1832: 274. 1833. — *Fontinalis falcata* Hedw., Sp. Musc. Frond. 299. 1801. Fig.5. Illustrations: Ignatov & Ignatova, 2004; *http://arctoa.ru/Flora/taxonomy-ru/Dichelyma-ill.pdf*.

Plants moderate in size to robust, irregularly and sparsely branched, yellowish, greenish, yellowish-brown to dark greyish-brown at base, silky glossy when dry. Stems to 5-7(-15) cm, reddish brown, brown to blackish, stem and branch tips falcate-secund to erect-ascending**.** Leaves rather dense, making stem invisible (rarely hardly visible), strongly 3-ranked, strongly keeled, falcate-secund to erect-spreading, lanceolate, acute or acuminate, not or weakly decurrent, 3.5-6.0×0.8-1.3 mm, length/width ratio 4-6: 1; margin plane or rarely very narrowly recurved, entire or rarely with few denticulations proximally, serrate at distal part; costa 50-80 μm wide at base, percurrent to excurrent in a short denticulate point of about 3-10 % the leaf length, rarely subpercurrent; median laminal cells (70-)100-160(-200)×5-8(-12) μm, linear, slightly flexuose, thin-walled, smooth, eporose, upper laminal cells shorter, basal laminal cells shorter and wider, incrassate and porose, alar cells not or weakly differentiated. Perichaetial leaves to 9 mm long, sheathing the setae, not covering the capsule. Seta to 14 mm. Capsule 1-2.5 mm long, oblong to oblong-cylindrical, exserted; operculum high conic or obliquely long-rostrate; exostome teeth yellowish-brown, papillose; endostome segments longer than exostome teeth, finely papillose, trellis perfect. Spores 10-13 μm, smooth.

Differentiation. The species is characterized by the plants size largest size for the genus, densely foliated shoots and clearly 3-ranked leaves with acute apices. Its differences from *D. japonicum, D. capillaceum* and *D. uncinatum* are discussed under these species. Presence of costa separates it from species of *Fontinalis*, and strongly keeled leaves and absence of differentiated alar group differentiate it from aquatic and subaqiatic species of Amblystegiaceae and Calliergonaceae.

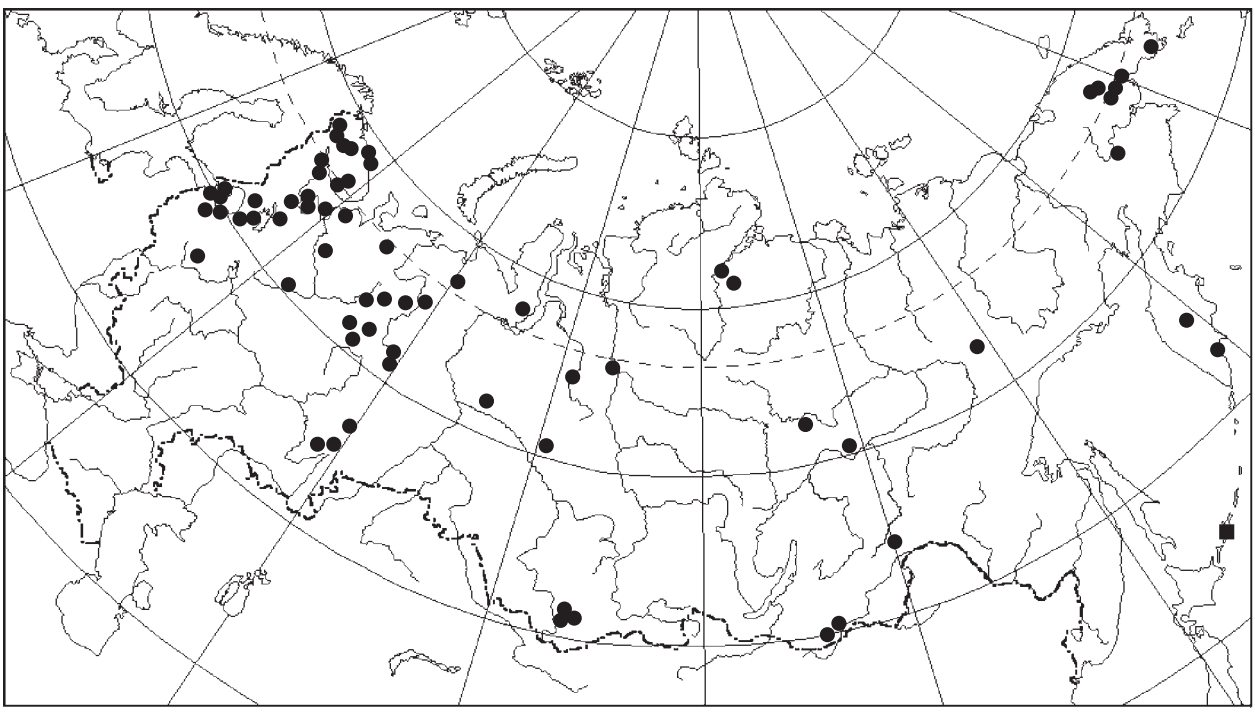

Fig. 5. Distribution of *Dichelyma falcatum* (Hedw.) Myrin (circles) and *D. japonicum* Card. (square) in Russia.

Distribution. *Dichelyma falcatum* has a mainly montane distribution throughout the Holarctic, with scattered localities in lowlands where it does not exceed the boreal and southern arctic zone. It is the most widespread species of the genus, growing in North and Central America, in Eurasia penetrating to Mongolia and NW China and found also in Morocco in Africa. In Russia, it is not rare in Murmansk Province, Karelia, Leningrad and Arkhangelsk Provinces, Komi Republic, in mountains of southern Siberia and Chukotka; it has also been collected sporadically in the central part of European Russia (south to Tver Province, while one record from Moscow Province by Ignatov & Ignatova (1990) was found to be erroneous), Urals, West Siberia, Republic Sakha/Yakutia and Kamchatka.

Ecology. The species grows in running water and on temporary flooded banks of streams, rivers and lakes. It settles on rocks, roots of trees, pendent branches of bushes, rotten trunks, rarely on soil. In North America, it is reported mainly from rocks, while in Russia it occupies more diverse habitats. It grows in pure mats or, rarely, mixed with other mosses, *e.g., Calliergon cordifolium* (Hedw.) Kindb., *Fontinalis antipyretica* Hedw., *Leptodictyum riparium, Scorpidium cossonii* (Schimp.) Hedenäs, *S. revolvens* (Sw. *ex* Anon.) Rubers, *Sanionia uncinata, Sciuro-hypnum reflexum* (Starke) Ignatov & Huttunen, and *Scouleria aquatica* Hook.

Selected specimens examined: **RUSSIA.** EUROPEAN RUSSIA: **Murmansk Province**: Ponoi River, Kanevka, 16.VIII. 1928, *Zinserling s.n.* (LE); Khibiny Mts, Ajkuajvenchjok River (KPABG); Kharlov Island, 5.VII.1965, *Breslina s.n.* (LE); Varzuga River, Vishennyj Island, 21.VIII.1999, *Belkina* s.n. (KPABG); Laplandsky Reserve, Sal'nye tundry, 20.VIII.2001, *Belkina s.n* (KPABG); Lovozersky Mts, 20.VIII.2001, *Belkina s.n* (KPABG); Voron'ya River, 26.VIII.2004, *Belkina s.n* (KPABG); Lavnatundra Mts, 2.VIII.1987, *Belkina s.n* (KPABG); Kandalakshsky gulf, Por'ya bay, 19.VIII.1991, *Lichachev s.n* (KPABG); **Karelia**: Belomorsk District, Nyuhcha River, 8.VII. 1975, *Volkova s.n* (LE); Muezersk District, Tikscha, 11.VIII. 1970, *Volkova #99* (LE); Muezersk District, Sandal Lake, 24.VIII.1920, *Savicz #1208* (LE); Pudozh District, Vodlozero Lake, 18.VII.1977, *Volkova s.n* (LE); Loukhi District, Kuonsu-Yarvi Lake, 13.VII.1978, *Volkova s.n* (LE); Prionezhsky District, Petrozavodsk, 11.VI.1997, *Bakalin & Bakalina # 27* (LE); **Leningrad Province**: Karel'sky Isthmus, Roshchno, 9.IX.1954, *Abramov & Abramova s.n.* (LE); Vyborg District, Severnyj Berezovyj Island, 19.VII.2005, *Kurbatova s.n.* (LE); Tikhvin District, Kanzhaya River, 18.VIII.1997, *Kurbatova s.n.* (LE); Kingisep District, Kopansky Peninsula, 13.IV.2007, *Kushnevskaya s.n.* (LE); Podporozhsky District, Yaroslavichi, 15.VI. 2007, *Kurbatova s.n.* (LE); Luga District, Zhelezo, 24.VII.1972, *V'yunova #379* (LE); **Arkhangelsk Province**: Solovetskie Islands, 21.VII.1890, *Birulya s.n.* (LE); Kelda (Telda) River, Kuloj River basin, 23.VII.1932, *Korchagin s.n.* (LE); Nenetsky District, Pechora River, 12.VIII.1998, *Lavrinenko s.n.* (LE); Onezhsky District, Nizhmozero, 9.VII.2000, *Churakova #910* (MW); Primorsky District, Izhma River, 12.VI.2001, *Churakova #975* (MW); Onezhsky District, Ukhhta River, 9.VII.2000, *Churakova #125* (MW); Verkhhnetoemsky District, Palen'ga River, 15.VIII.2000, *Churakova #1458* (MW); **Komi Republic**: Uct'-Tsilemsky District, Tsilma River, 6.VIII.1973, *Zheleznova #150* (SYKO); Izhma District, Sebys' River, 7.VII.2001, *Shubina #15* (SYKO); Uhtinsky District, Cjuz'yu River, Chut'insky Reserve, 31.VII.2005, *Dulin #483* (SYKO); Ust'-Vymsky District, Vychegda River, 29.VII.1997, *Kustysheva #310* (SYKO); Ukhtinsky District, Vol' River, 13.VII.1982, *Zheleznova #833* (SYKO); Syktyvdinsky District, Vazh'el'yu River, 26.VI.2005, *Teteryuk #05-012* (SYKO); Syktyvdinsky District, Vychegda River, 26.VII.1998, *Dulin #25* (SYKO); Ust'-Kulomsky District, Nema

Table 1. Diagnostic characters of *Dichelyma* species known in Russia.

species	*D. capillaceum*	*D. uncinatum*	*D. falcatum*	*D. japonicum*
leaves	linear-lanceolate, filiform-acuminate	linear-lanceolate, filiform-acuminate	lanceolate, acute to acuminate	ovate to lanceolate, obtuse to acute
leaf length, mm	3.5-5.5	3.0-5.0	3.5-6.0	2.5-3.5
leaf width, mm	0.3-0.5	0.4-0.6	0.8-1.3	0.7-1.0
ratio leaf length/width	8-14: 1	6-10:1	4-6: 1	3-5:1
costa	excurrent 30-50%	excurrent 25-45%	percurrent to excurrent 3-10%	subpercurrent to percurrent
leaf arrangement	weakly 3-ranked	weakly 3-ranked	strongly 3-ranked	3-ranked
leaf density	loose, stem often seen among leaves	loose, stem often seen among leaves	rather dense, stem invisible among leaves	rather dense, stem invisible among leaves
stem and branch tips	erect-spreading to	strongly falcate-	falcate-secund	erect-ascending
capsule	weakly falcate-secund immersed or laterally emergent	secund to circinate exserted	to erect-spreading exserted	to weakly falcate-secund exserted

River, 6.VIII.1983, *Zheleznova #909* (SYKO); North Ural, Daseyu River, 26.VII.1932, *Govorukhin s.n.* (MW); **Vologda Province**: Tot'ma District, Kamchuga River, 29.VII.1926, *Korchagin s.n.* (LE); **Tver Province**: Ostashkov District, Kamennoe Lake, 5.VI.1909, *Ramensky s.n.* (LE); **Perm Province**: Vishersky Nature Reserve, Lyp'ya River, 21.VI.1995, *Bezgodov #234* (MW); Vishersky Nature Reserve, Vishera River, 30.VII.2009, *Bezgodov #812* (MHA); **Bashkortostan Republic**: Beloretzk District, Malyi Iremel' Peak, 1.IX.1990, *Ignatova s.n.* (MW); Beloretzk District, Tyulyuchka River, 7.IX.1990, *Ignatova #7/45* (MW); **Sverdlovsk Province**: Visimsky Nature Reserve, 20.VIII.1979, *Dyachenko s.n.* (MW); ASIAN RUSSIA: **Yamalo-Nenetzky Autonomous District**: Yamal Peninsula, Syunyaj-Sale, 29.VII.1996, *Czernyadjeva & E.Yu. Kuzmina #34* (LE); Verkhnetazovsky Reserve, Kochepcha River, 10.VIII.1997, *Czernyadjeva #21* (LE); **Khanty-Mansijsk Autonomous District**: Middle Ob River, Lower Sabun River, 20.VII.2000, *Czernyadjeva & E.Yu. Kuzmina #118* (LE); Surgut Disrict, Tro'egan River, 8.VII.2010, *Pisarenko #op04241* (NS); eastern slope of Subpolar Ural Mts., Neroika, upper course of Kabyla-Yu Stream, 8.VIII.2013, *Lapshina #55* (Herbarium of Yugorsky State University, duplicate in MHA). **Kemerovo Province**: Kuznetsky Alatau, Tserkovnoe Lake, 27.VIII.2003, *Pisarenko #op00525* (NS); **Altai Republic**: Altajsky State Reserve, Karakem River, 16.VII.1989, *Ignatov #0/1757* (MHA); Altajsky State Reserve, Shapshal Range, 26.VI.1990, *Zolotuhin s.n.* (MHA); Altajsky State Reserve, Kurkure Range, 7.VII.1991, *Ignatov s.n.* (MHA); Altajsky State Reserve, Kolbakaya Creek, 31.VII.1993, *Ignatov #8/117* (MHA); **Taimyrsky Autonomous District**: Khatanga, 21.VII. 2011, *Fedosov #11-653, 11-619, 11-715* (MW); Anabarskoe Plateau, Kotujkan River, 22.VII.2007, *Fedosov #07-197* (MW); **Krasnoyarsk Territory**: Kharutta River, 13.VII.1913, *Pole s.n.* (LE); **Yakutia**: Tomponsky District, Khatuma River, 19.V.1934, *Rabotnov s.n.* (LE); Olekminsky District, Kebekte River basin, 14.VII.1994, *Ivanova #0033* (LE); Mirninsky District, Ulakhan-Botuobuja River, 16.VII.2006, *Ivanova #17* (MW); **Zabaikal'sky Territory**: Durdul'ginsky District, "Alkhanaj" Nature Reserve, 21.VII.2005, *Afonina #3905* (LE); Sokhondinsky Biosphere Reserve, Bukukun River, 21.VII.2008, *Afonina #06508* (LE); Tungir River, 17.VII.1996, *Golyakov s.n.* (LE); **Kamchatsky Territory**: Middle Range, Esso, 4.VIII.2003, *Czernyadjeva #81* (LE); Petropavlovsk-Kamchatsky, Savoiko, 1.IX.1928, *Malaise s.n.* (LE); **Chukotsky Autonomous District**: Beringijsky District, Getlyanen River, 31.VII.1976, *Afonina s.n.* (LE); Anadyrsko-Koryaksky District, Onemen bay, 1.IX.1977, *Afonina s.n.* (LE); Anadyrsko-Koryaksky District, Belaya River, 1.VIII.1980, *Afonina s.n.* (LE); Anadyrsky District, Anadyr' River basin, Baran'e Lake, 4.VIII.1980, *Afonina s.n.* (LE); Anadyrsky District, Anadyr' River basin, Nanyuner River, 29.VII.1981, *Afonina s.n.* (LE); Anadysrsky District, Markovo, 8.VII.1933, *Vasil'ev #1125* (LE).

Dichelyma japonicum Cardot, Bull. Soc. Bot. Genève sér. 2, 1: 132. 1909. — *Dichelyma hatakeyamae* Okam., Bot. Mag. Tokyo 25:137. 1911.

Fig. 5. Illustrations: Cherdantseva, 2010; *http://arctoa.ru/Flora/taxonomy-ru/Dichelyma-ill.pdf*.

Plants moderate in size, irregularly and sparsely branched, yellowish, greenish, yellowish-brown to dark greyish-brown at base, glossy when dry. Stems to 5-10 cm, yellowish brown, brown to blackish, stem and branch tips erect-ascending to weakly falcate-secund**.** Leaves rather dense, making stem stem invisible, 3-ranked, erect-spreading, keeled, ovate to lanceolate, gradually narrowed, obtuse or acute, not or weakly decurrent, 2.5-3.5×0.7-1.0 mm, length/width ratio 3-5: 1; margin plane or narrowly recurved, entire in proximal part, serrulate to serrate distally; costa 40-60 μm wide at base, subpercurrent, percurrent or, rarely, ending well below leaf apex; median laminal cells 80-150×7-10 μm, linear, slightly flexuose, thin-walled, smooth, eporose, upper laminal cells shorter, basal laminal cells shorter and wider, incrassate and porose, alar cells not differentiated. Perichaetial leaves to 8 mm long, sheathing the setae, not covering the capsule. Seta to 8 mm. Capsule 2-3.5 mm long, oblong-cylindrical, exserted; operculum high conic; exostome teeth spiculose-papillose; endostome segments longer than exostome teeth, spiculose-papillose, trellis perfect. Spores 13-18 μm, minutely papillose.

Differentiation. Densely foliate shoots, 3-ranked, strongly keeled leaves with blunt apices and percurrent to subpercurrent costa are diagnostic characters of *D. japonicum.* The two latter characters, as well as shorter leaves (see Table 1), separate the species from *D. falcatum*.

Distribution. Higuchi (2011) referred the species to endemics of Japan, where it grows on Hokkaido and Honshu, on tree trunk bases near water courses and lakes. It was recently found on Middle Kuril Islands, Iturup Island (Bakalin *et al.*, 2009; Cherdantseva, 2010).

Ecology. *D. japonicum* was collected on *Salix* trunk at lake bank, submerged in water.

Specimens examined: **RUSSIA**: Sakhalinskaya Province, Kuril'sky District, Iturup Island, 21.IX.2005, *Bakalin #64-5-05* (VLA).

JAPAN: Honshu Island, Gifu Prefecture, 19.VII.1973, *Ando s.n.* (LE); Honshu Island, Shiga Prefecture, 28.VIII.1972, *Nakajima #1216* (LE); Honshu Island, Niifata Prefecture, VIII.1949, *Ikegami #172* (LE).

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LITERATURE CITED

AFONINA, O.M. 2006. New moss records from Chukotskij Autonomous District. 1. – *Arctoa* **15**: *270*.

BAKALIN, V.A., V.YA. CHERDANTSEVA, M.S. IGNATOV, E.A. IGNATOVA & T.I. NYUSHKO 2009. Bryophyte flora of the South Kuril Islands (East Asia). – *Arctoa* **18**: *69-114*.

BROTHERUS, V. F. 1923. Die Laubmoose Fennoskandia. – *Fl. Fennica* **1**. *xiii + 635 pp.*

CRUM, H. & L. E. ANDERSON 1981. Mosses of Eastern North America. Vol. 2. – *Columbia University Press, New York. Pp. 665-1328*.

[CHERDANTSEVA, V.Ya.] ЧЕРДАНЦЕВА, В.Я. 2010. Новые и редкие для России виды мхов с острова Медный (Командорские острова). – [Moss species new and rare to Russia from Medny Island (Commander Islands)] *Бот.журн*. [*Bot. Zhurn.*] **95**(1): *85-92*.

CZERNYADJEVA, I.V. 2002. *Dichelyma capillaceum* (Dicks.) Myr. (Musci) in Russia. – *Arctoa* **11**: *87-89*.

FEDOSOV, V.E. 2010. New moss records from Kamchatskaya Province 5. – *Arctoa* **19**: *279-280*.

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

FEDOSOV, V.E., E.A. IGNATOVA, M.S. IGNATOV, A.I. MAKSIMOV & V.I. ZOLOTOV 2012. The moss flora of Bering Island (Commander Islands, North Pacific). – *Arctoa* **21**: *133-164*.

HEDENÄS, L, S. GODOW & K. HYLANDER 1996. Bryophyte Profiles. 1. *Dichelyma capillaceum* (Dicks.) Myr. (Bryopsida: Fontinalaceae). – *J. Bryol.* **19**: *157-179.*

HIGUCHI, M. 2011. Endemic Species of Bryophytes in Japan. – *Bull. Natl. Mus. Nat. Sci., Ser. B*, **37**(3): *117-126*.

HYLANDER, K. 1999. Intermediates between the pleurocarpous mosses *Dichelyma falcatum* (Hedw.) Myr. and *D. capillaceum* (Dicks.) Myr., possible of hybrid origin. – *Lindbergia* **24:** *59-64.*

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

[IGNATOV, M. S. & E. A. IGNATOVA] ИГНАТОВ, М.С., Е.А. ИГНАТОВА 1990. Материалы к познанию бриофлоры Московской области. – [Contribution to bryophyte flora of Moscow Province] *В кн.: Флористические исследования в Москвоской области (ред. А. К. Скворцов), М. Наука* [*In: A. K. Skvortsov (ed.) Floristicheskie issledovaniya v Moskovskoj oblasti, Moscow, Nauka*]: *121-179.*

INGERPUU, N. & K. VELLAK 1998. Eesti sammalde määraja. – *Tartu. 239 pp*.

IRELAND R.R., G.R. BRASSARD, W.B. SCHOFIELD & D.H. VITT 1987. Checklist of the mosses of Canada II. – *Lindbergia* **13**(1-2): *1-62*.

RED DATA BOOK OF EUROPEAN BRYOPHYTES. 1995. – *Trondheim, European Commitee for the Conservation of Bryophytes (ECCB). 291 pp.*

RED DATA BOOK OF EAST FENNOSCANDIA. 1998. – *Helsinki. 351 pp.*

SPIRINA, U.N. & M.S. IGNATOV 2011. On the branch development in Fontinalaceae (Bryophyta). – *Arctoa* **20**: *119-136.*

TOIVONEN, H. 1972. Distribution of *Dichelyma capillaceum* (With.) Myr. emend. Br. & Schimp. (Bryophyta), especially in northwestern Europe. – *Ann. Bot. Fennici* **9**: *102-106.*

VOLOSNOVA, L.F., M.S. IGNATOV & E.A. IGNATOVA 2012. New records of rare mosses in Ryazan Province (European Russia). – *Arctoa* **21**: *81-84*.

WELCH, W. H. 1960. Monogr. Fontinalaceae. – *Martinus Nijhoff, The Hague,* [*vii*] *+ 357 pp.*