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TWO *SCAPANIA* SPECIES (SCAPANIACEAE) NEWLY RECORDED FROM KAMCHATKA

ДВА ВИДА *SCAPANIA* (SCAPANIACEAE) НОВЫХ ДЛЯ ФЛОРЫ КАМЧАТКИ

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Abstract

Two species of *Scapania* (*S. magadanica* and *S. spitsbergensis*) are newly reported for the Kamchatka Peninsula from the Alney-Chashakondzha Massif (Central Kamchatka). New records of the recently described *S. magadanica* are the first outside the Magadan Province and expand its known distribution. Both species occur on Kamchatka Peninsula in areas of current glaciations or areas where periglacial processes were common in relatively recent past. These species were found in Kamchata without sporophytes, and in general produce sporophytes quite rarely.

Резюме

Scapania magadanica и *S. spitsbergensis* впервые приводятся для полуострова Камчатка из вулканического массива Алней-Чашаконджа (Центральная Камчатка). Находки недавно описанного *S. magadanica* являются первыми вне Магаданской области и изменяют представление о его ареале. Оба вида встречаются на Камчатке, в районах современного оледенения или там где перигляциальные процессы были широко распространены в прошлом. Все их находки, сделанные на Камчатке, были без спорофитов, которые вообще у этих видов встречаются редко.

KEYWORDS: *Scapania*, new records, Central Kamchatka, Russian Far East

INTRODUCTION

Although Kamchatka liverwort flora has been recently actively studied and summarized by Bakalin (2003, 2005, 2009), the extended territory of the peninsula is still incompletely known, thus new records from there continue to arrive (Bakalin & Klimova, 2016 a,b). The especially diverse liverwort flora was found in Central Kamchatka, the Sredinnyi Range that stretches for ca. 1200 km from north to south. Central Kamchatka is a sparsely populated area mostly intact from anthropogenic disturbance; moreover it is protected by the Nature Park "Bystrinsky". Part of the park adjacent to Esso Settlement is relatively easily accessible, whereas other areas are difficult to access, so only a few studies have been conducted there. Despite the obvious incompleteness of the data, the liverwort diversity of the park is outstanding, and it was designated as one of four 'hot spots' of liverwort diversity in the Russian Far East (Bakalin, 2013). In 2016, the first author visited the least known areas in this park, and among others, the Alney-Chashakondzha Mountain Massif. This area has extensive glaciers and periglacial areas, whereas the ridge line of the massif is ice-free. It remains unresolved whether large outliers along the ridge can serve as unglaciated nunataks in the Pleistocene glaciations, and the topic is little discussed (Ogorodov, 1972). Regardless of the answer, the species composition in such habitats is very interesting. The overall species diversity is low in these severe conditions, but two species of *Scapania* appeared different from other species known in the area. Later, they were identified as *S. magadanica* S.S. Choi, Bakalin & B.-Y Sun and *S. spitsbergensis* (Lindb.) Müll. Frib., both being new for Kamchatka (Fig. 1). The paper describes habitats of these species and discusses their distribution.

STUDY AREA

The Alney-Chashakondzha is a highly dissected orographic formation within the Sredinnyi Range (the largest mountainous system on the Kamchatka Peninsula), stretching for 30 km from north to south with a total area of 600 km^2. The surrounding lowland elevation is from 700 to 900 m, which is high enough in this area to become decisive for the wide distribution of mountain tundra and the absence of forest vegetation. The highest points of the massif are peaks of Alney (2598 m) and Chashakondzha (2526 m). Both peaks are the result of volcanic activity and represent a complex formation whose original landscapes were strongly modified by subsequent processes of erosion and denudation. The elevations above 1800 m are characterized by alpine relief with steep slopes, narrow peaks, numerous outliers, sharp ridges and glacial circuses (Figs. 2, 3). The massif is mostly composed of andesite, basalt and andesite-basalt rocks, presumably including higher elevations.

The volcanic activity has been evidenced for the period from the late Pliocene to Holocene (Ogorodov, 1972; Pevzner, 2015; Markovsky *et al.*, 1989).

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At present the Alney-Chashakondzha massif is one of the largest modern glaciation centers on the Kamchatka Peninsula. However, in the time of Pleistocene glaciations this land was covered by 'mountain-valley' glaciers which allow the existence of nunataks and widespread occurence of periglacial landscapes. Over the past 60 years, glaciers have been progressively degrading and reduced by ca. 20% due to increased summer temperatures and decrease in the amount of solid precipitation. This pattern is somewhat similar to the processes observed in the glaciers of the Altai, Tyan-Shan' and the Caucasus (Muravyev, 2014).

OBSERVATIONS

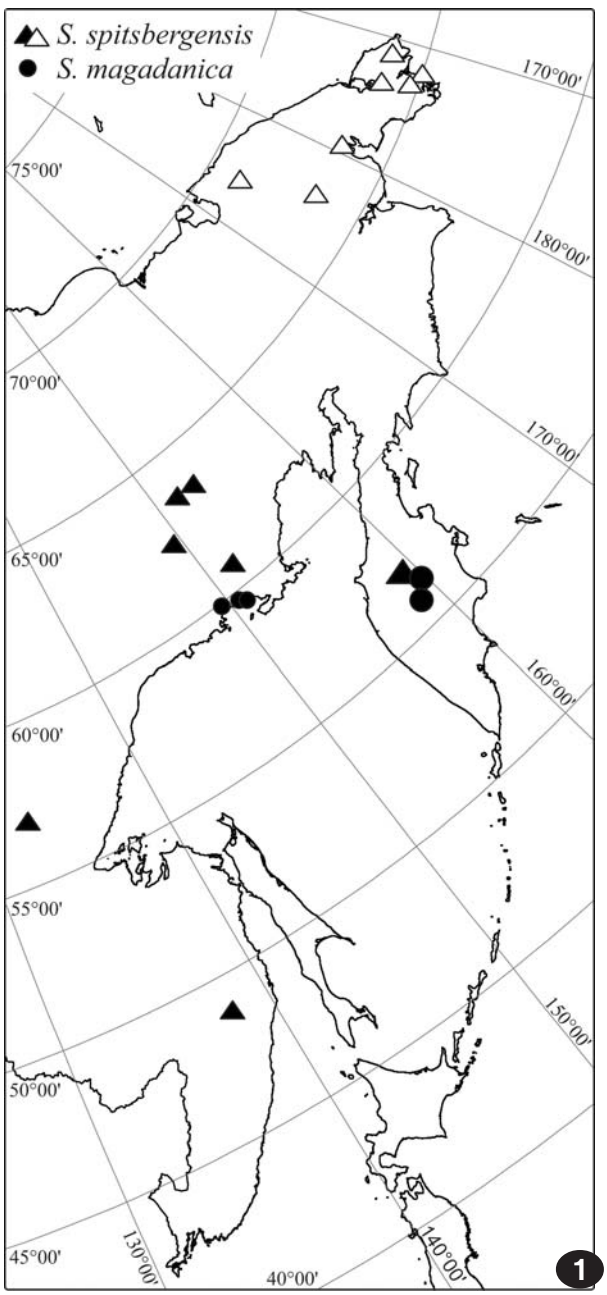
Scapania spitsbergensis (Lindb.) Müll. Frib., Bull. Herb. Boissier, sér. 2, 1(6): 607. 1901.

Scapania spitsbergensis was originally placed to the sect. *Nemorosae* (Müll. Frib.) H. Buch (Müller, 1915; Buch, 1928), then the species was referred in turns to the following sections: *Rufidulae* R.M. Schust. ex Grolle (Schuster, 1974), *Ciliatae* Grolle (Potemkin, 1998), *Scapania* (Choi et al., 2012), and, at last, *Compactae* (Müll. Frib.) H. Buch (Váňa et al., 2012). The last transfer was carried out on the basis of the analysis of nucleotide sequences and is not obvious from the morphological point of view. The species is somewhat superficially similar to *S. paludosa* (Müll. Frib.) Müll. Frib. and *S. paludicola* Loeske & Müll. Frib. (Schuster, 1974) and differs from these species in: 1) teeth become noticeable larger (in extreme variant antleroid and even branched) to ventral lobe base, 2) evident leaf keel wing that is commonly dentate, 3) monoicous inflorescence (versus dioicous) and 4) habitat (mainly merely mesic cliff crevices, versus the banks of streams in the case of *S. paludosa* and oligotrophic swamps in the case of *S. paludicola*). In our opinion, it is more troublesome to distinguish *S. spitsbergensis* from *S. rufidula* Warnst. The latter differs in dioicous inflorescence, larger dorsal lobe and less developed teeth in both the ventral lobe base and keel wing. The descriptions, illustrations and identification keys of *S. spitsbergensis* and related taxa can be found in Choi et al. (2012).

Scapania spitsbergensis has an arctic-alpine nearly circumpolar distribution with several gaps which can be explained by poor research in the respective regions. The species is known from Scandinavia (Norway, including Svalbard, Sweden and Finland) (Damsholt, 2002), eastwards it sporadically occurs in the North-West European Russia and then throughout the Russian Arctic, Siberia and the Russian Far East. In New World the species is distributed in North America (Alaska, Northwest Territories, Yukon, Ontario, Maine and west Greenland) (Damsholt, 2013; Hong, 1980; Schuster, 1974). In the Russian Far East, *S. spitsbergensis* is known from Chukotka (Afonina, Duda, 1993), the Magadan Province (see specimens examined) and the Khabarovsk Territory (see specimens examined) (Fig. 1). Tardoki-Yani Mt. (Sikhote-Alin Range) in the Khabarovsk Territory is the southernmost location (48°N 138°E) of the species in Eurasia (Bakalin, 2015). Many reports of *S. spitsbergensis* refer to the north of 62°N, where the species can be locally abundant. However, the species can be common in some areas of South Siberia southward of the aforementioned latitude (Konstantinova, 2000; Konstantinova & Bakalin, 2009; Schuster & Konstantinova, 1996).

Within Russian Asia the species occurs from almost the sea level (arctic environments) (Afonina, Duda, 1993) to mountain tundras at 2330 m a.s.l. in the Kodar Range in East Siberia (Mamontov, 2013). Basing on specimens examined, in Russian Asia the species occurs in cliff or gravelly barrens crevices where moisture conditions are varied from moist (where *Aneura pinguis* (L.) Dumort., *Diplophyllum taxifolium* (Wahlenb.) Dumort., *Scapania crassiretis* Bryhn occur) to mesic (where it is associated with *Barbilophozia hatcheri* (A. Evans) Loeske, *Cephalozia bicuspidata* (L.) Dumort., *Diplophyllum albicans* (L.) Dumort., *Gymnomitrion concinnatum* (Lightf.) Corda, *Lophozia wenzelii* (Nees) Steph., *Marsupella emarginata* (Ehrh.) Dumort., *Tetralophozia setiformis* (Ehrh.) Schljakov). Commonly the species avoids fine soils, although in several cases it was found on clay-filled crevices between stones, where it was associated with *Pellia neesiana* (Gottsche) Limpr., *Tritomaria quinquedentata* (Huds.) H. Buch. Rarely *Scapania spitsbergensis* grows over rocky outcrops along streams (although aside from direct exposure to running water), where it can be associated with *Diplophyllum albicans* and *Pseudolophozia sudetica* (Nees ex Huebener) Konstant. & Vilnet. The current report on the species comes from gravelly barrens (alpine belt) at the watershed of the Alney-Chashakondzha Massif (2102 m alt.), where the species was found intermixed with mosses on mineral soil in a niche under a boulder and on a fine-grained soil covering stones (Figs. 2–4).

Specimens examined: ASIAN RUSSIA: **Kamchatka Territory:** Central Kamchatka, Bystrinsky District, Sredinnyi Range, watershed of Alney-Chashakondzha Massif, (56°38'11"N 159°37'37"E), 2102 m alt., 3.VIII.2016, Klimova, Kam-62-9-16, Kam-62-28-16, c. gemm. (VBGI). **Khabarovsk Territory:** Ayano-Maisky District, Lurikan Range, Stlanikovaya Mt. (56°58'N 132°15'E) 9.VII.1989, Barkalov, Bezdeleva (VBGI); Nanaisky District, Sikhote-Alin Range, N-facing slope of Tardoki-Yani Mt. (48°53'49"N 138°03'14"E), 2090 m alt., 23.VIII.2013, Bakalin, Kh-37-5-13, c. gemm., per., ant. (VBGI); (48°54'06"N 138°02'55"E), 1687 m alt., 23.VIII.2013, Bakalin, Kh-38-6-13 (VBGI). **Magadan Province:** Srednekansky District, Seimchan River Basin, ca. 60 km upstream of Seimchan Settl., right bank of the valley, knolls (63°12'57"N 152°07'35"E), 500 m alt., 13.VI.2010, Bakalin, Mag-14-6-10 (VBGI); Srednekansky District, Kolyma Upland, Bolshoy Tuonnakh Mts., upper course of Verina River (63°16'41"N 151°03'44"E), 1312 m alt., 25.VII.2011, Bakalin, Mag-35-14-11, c. ant., arch., Mag-35-23-11, c. per., ant., Mag-35-32-11 (VBGI); (63°16'26"N



Figs. 1–5. Distribution of *S. spitsbergensis* (triangles: solid – studied specimens; open – literature data) and *S. magadanica* (circles) in the Russian Far East, and their habitats in Alney-Chashakondzha Massif, Chashakondzha Mt. **1**: map; **2**: ridge; **3**: glacier, where *Scapania magadanica* (1) and *S. spitsbergensis* (2) were collected; **4**: collecting place of *S. spitsbergensis;* **5**: collecting place of *S. magadanica.*

151°03’22"E), 1244 m alt., 23.VII.2011, Bakalin, Mag-27-5-11 (VBGI); south spoors of Ezop Mt. (63°17’12"N 151°04’58"E), 1734 m alt., 24.VII.2011, Bakalin, Mag-32-9-11 (VBGI); area near the top of Ezop Mt. (63°17’36"N 151°06’04"E), 1960 m alt., 24.VII.2011, Bakalin, Mag-33-3-11 (VBGI); W-facing slope of Ezop Mt. (63°17’54"N 151°05’01"E), 1554 m alt., 24.VII.2011, Bakalin, Mag-30-8-11, Mag-30-10-11, Mag-30-12-11, c. ant., arch., per., (VBGI);

Yagodinsky District, upper course of Koroviy Stream (the middle course of Snezhnyy Stream), (62°10’01"N 149°18’17"E), 1600 m alt., 29.VII.2014, Bakalin, Mag-26-20-14, c. per., ant. (VBGI); mountain circus in upper course

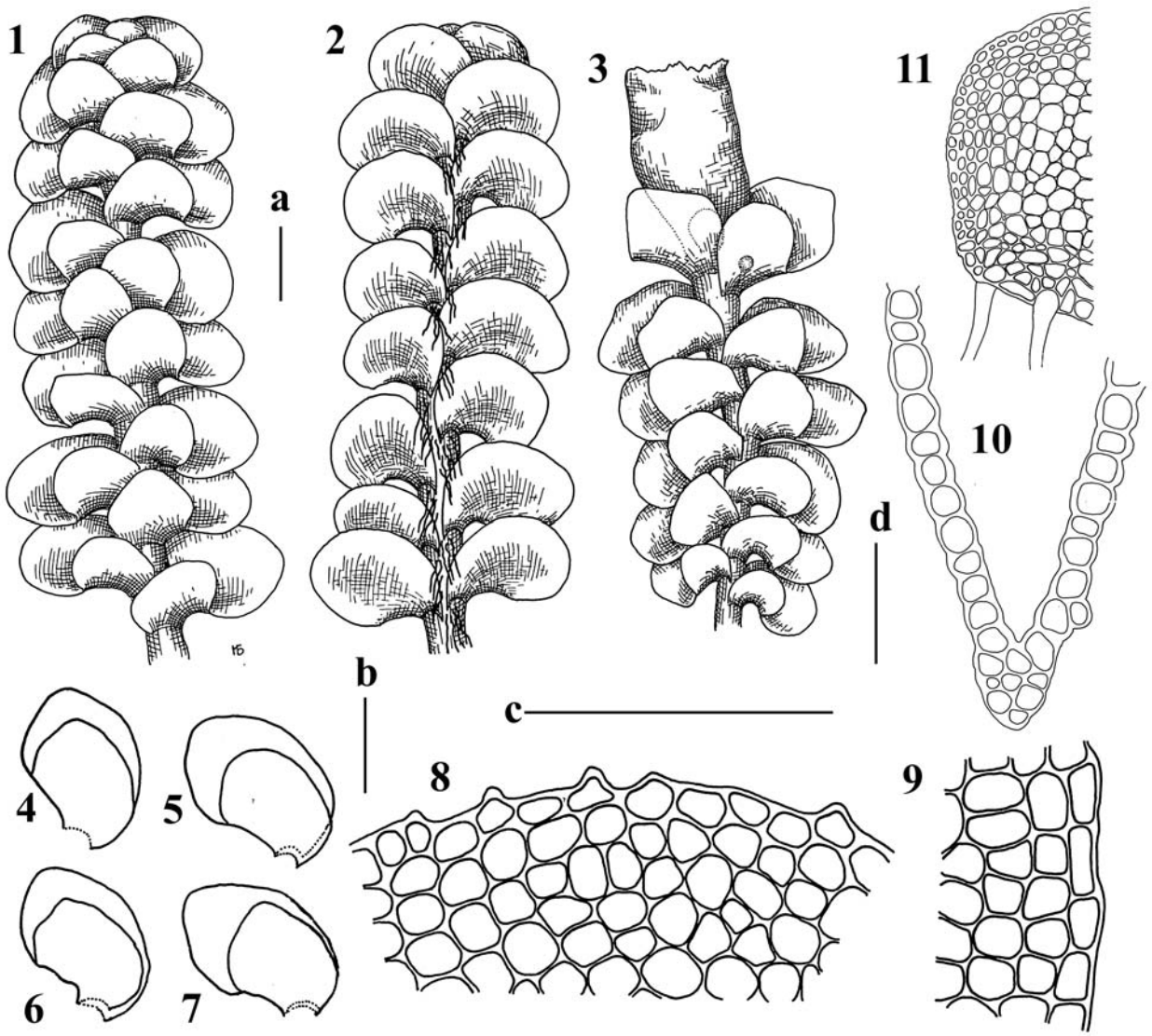


Fig. 6. *Scapania magadanica* S.S. Choi, Bakalin & B.-Y Sun (from Kam-62-4-16, VBGI): 1 – habit, dorsal view, 2 – habit, ventral view, 3 – perianthous plant, dorsal view; 4–7 – leaves; 8 – leaf apex; 9 – leaf margin; 10 – keel cross section; 11 – stem cross section, fragment. Scales: a – 1 mm, for 1-3; b – 1 mm; c – 500 μm, for 8, 9; d – 50 μm, for 10, 11.

of Koroviy Stream (the middle course of Snezhnyy Stream), (62°10’23"N 149°20’21"E), 1300 m alt., 29.VII.2014, Bakalin, Mag-25-24-14, c. per., ant., Mag-25-25-14, Mag-25-28-14, Mag-25-38-14, c. per., ant. (VBGI); Khasynsky District, Ol’skoye Plateau, upper course of Maltan River (60°39’01"N 151°24’59"E), 1200 m alt., 9.VIII.2011, Bakalin, Mag-55-2-11, c. per., ant., arch., Mag-55-8-11, (VBGI); 8.VIII.2011, Bakalin, Mag-50-28-11, c. per., ant., arch., Mag-50-30-11, c. per., ant., arch. (VBGI). **Republic of Buryatia:** Khamar-Daban Range, Pereemnaya River Basin, Chyornoe Lake (57°14’N 119°44’E), 9.VIII.2001, Konstantinova, 64-2-01 (KPABG-102495 duplicate in VBGI). **Republic of Yakutia:** Olyokminsky District, Udokan Range, Sigikan Stream (57°14’N 119°44’E), 1300 m alt., 2.VIII.2000, Bakalin, 28-5-00 (KPABG-101652, duplicate in VBGI); Neryungrinsky District, Stanovoy Range, Tokinsky Stanovik Range (the label is also designated by the Yablonevyy Range that, as a term, was treated very widely in the early twentieth century; by now Yablonevyy Range is treated in a narrower sense and is quite far from the place where the specimen was probably collected), a pass between Malaya Tuksani River and Bol’shaya Tuksani River to Maloe Toko Lake and Bol‘shoe Toko Lake, 1500 m alt., 24.VIII.1911, Prokhorov, Kuzeneva (two specimens from one location) (VBGI). EUROPEAN RUSSIA: **Murmansk Province:** Kutsa Reserve, middle part of Pyukhyakuru Creek (68°24’N 29°07’E), 2.VIII.1986, Konstantinova, 64-2-01 (KPABG-102495 duplicate in VBGI). NORWAY: Svalbard Archipelago, North-Eastern Land, Prince Oskar Land, west slope of Sanfordkhyogdene Mt. (80°12’59"N 22°35’06"E), 144 m. alt., 5.VIII.2006, Konstantinova, K91-2a-06 (KPABG-111838 duplicate in VBGI); lake westward of Sanfordkhyogdene Mt., Maferdeja plain (80°12’40"N 22°27’39"E), 56 m. alt., 5.VIII.2006, Konstantinova, K104-06, K103-06, c. gemm. (KPABG-111854, KPABG-111853 duplicates in VBGI).

Scapania magadanica S.S. Choi, Bakalin & B.Y. Sun, Bot. Pacif. 1(1): 46. 2012. Fig. 6.

Description based on specimens from Kamchatka. **Plants** 10.0–30.0×2.6–3.2 mm, prostrate, pale green to brownish-greenish and brown in well exposed parts, in loose mats. **Stems** sparsely branched, blackish-brown to brownish and green in apical part, deep brown below, **cross section** 0.30×0.35 mm, external wall smooth to papillose, **cortex cells** thick-walled in 2–3 layers, 10.0–17.0×9.0–13.0 μm, with rusty brown walls; **inner cells** larger, thin-walled, 18–28 μm in diameter with colorless walls. **Rhizoids** numerous, fasciculate, obliquely spreading or forming loose mat under stem, colorless. **Leaves** contiguous to subimbricate; **keel** 0.4–0.5 of ventral lobe length, straight to slightly arched, ca. 80–90 (120)° with stem axis, usually with wing 2–3 cells wide. Lobes obliquely ovate, rounded to obtuse rounded; **dorsal lobe** transversely to arcuately inserted, not or barely decurrent, obliquely obovate, slightly convex, 1.10–1.30×1.00 mm, 0.80–0.85 of ventral lobe in size, axis ca. 15–50° with stem axis, margin entire, apex rounded to obtuse; **ventral lobe** arcuately inserted, insertion line arched, not or barely decurrent, slightly convex, obliquely oblong-ovate, 1.40–1.70×1.20–1.30 mm, (0.75–0.80: 1), axis ca. 75–90° with stem axis, margin entire to sometimes distantly denticulate, apex rounded. **Cells in the midleaf** oblong to polygonal, (22.5–)25.0–35.0×(20.0–)22.5–25.0 μm with concave to triangular trigones; **cells in the leaf margin** 15.0–25.0 (–40.0) μm along margin, thin-walled; **near apex** (20.0–)22.5–32.5×(15.0–)20.0–22.5 μm, thin-walled; **at the base** 30.0–57.5 (–62.5)×17.5–35.0 μm with concave trigones; cuticle smooth throughout. **Oil bodies** (3–)4–6(8) per cell, spherical to shortly elliptic, granulate, 4–8×4–7 μm. [Specialized asexual reproduction by **gemmae** in masses at apices of leaf-lobes, elliptical, 19.6–25.2×14.0–16.8 μm, 2-celled, green (Choi *et al.*, 2012).] Sexual condition **paroicous**. Androecia just below female bracts, with 1–2 pairs of bracts, similar to leaves but loosely inflated in the base, 3–5-androus, body ca. 100×80 μm, antheridial stalk 1-seriate, ca. 80.0–140.0 μm long. **Perianth** oblong, strongly dorsiventrally compressed, truncate, ca. 3×1.7 mm, mouth coarsely dentate with teeth 2-3 cells long, apical part of the perianth turned to ventral side. [Sporophytes unknown in Kamchatkan plants; according to Choi *et al*. (2012): **Seta** ca. 4.0–6.0 mm long. **Capsule** elliptic, ca. 1250.0×800.0–900.0 μm, 4-layered, inner cells 42.0–70.0×22.4–33.6 μm, with annular thickenings, outer cells ca. 56.0–84.0×28.0–42.0 μm with 14–16 nodular thickenings in vertical wall. **Elaters** 2-spiral, ca. 140.0–160.0×6.0–8.4 μm. **Spores** ca. 14.0–19.6 μm in diameter, papillose, brown.]

Scapania magadanica is superficially similar to East Asian *S. diplophylloides* Amakawa & S. Hatt. due to rounded leaf lobes. However, *S. magadanica* strikingly differs from the latter in: 1) monoicous inflorescence, 2) thin-walled marginal cells of the ventral lobe versus equally thick-walled, 3) usually the entire ventral lobe margin versus a denticulate one, 4) brownish-green to olive-green pigmentation versus bright to deep green or yellowish (Choi *et al.*, 2012).

Scapania magadanica is a recently described taxon, reported from *locus classicus* near Magadan (Fig. 1). In 2013, it was collected in two places ca. 70 km westward from the type locality, in mesic crevices of granitic rock outcrops, cliffs or gravelly barrens (Bakalin, unpublished). Later it was also identified from the Kozyrevsky Range in Central Kamchatka, but has never been published from there either.

In the Magadan Province, the species grows at low altitude, from 350 to 650 m, in rock fields and rock crevices in moss-dwarf shrub tundra and *Pinus pumila* thickets. The species forms small pure loose patches or is associated with *Diplophyllum albicans* (L.) Dumort., *Marsupella emarginata* (Ehrh.) Dumort., and *Pseudolophozia sudetica* (Nees ex Huebener) Konstant. & Vilnet. Its range in the province is confined to granitic rocks near the Sea of Okhotsk (not more than 20 km inland). This pattern can also be associated with the moisturizing effect of air masses traveling in summer from the Sea of Okhotsk. This influence suddenly decreases at a short distance from the coast, where the climate is already much more continental. Both localities were probably free of ice during the Pleistocene glaciations (Bakalin *et al.,* 2012).

Kamchatka localities of *S. magadanica* in both cases refer to the ridge line with apparently higher humidity due to interception of water from eastern winds of summer cyclones. Therefore, the environment of the newly revealed localities from Kamchatka is consistent with that in the Magadan Province, despite the difference in altitude.

The first locality on the Kamchatka Peninsula is in the tundra on the watershed of the Kozyrevsky Range (1361 m a.s.l.) where the species was collected on fine soil among rocks in the rock field, in pure mat. The second locality is from the rocky ridge bordering Chashakondzha Mt. glacier (Fig. 3, 5) in the alpine belt (1938 m alt.), where the species was found on fine grained soil in a crevice, in pure mat.

Specimens examined: ASIAN RUSSIA: **Kamchatka Territory** (Central Kamchatka): Kozyrevsky Range, Esso Settl. area, (55°53’56"N 158°48’05"E), 1361 m alt., 13.VII.2006, Bakalin, K-11-5-06, c. per., ant. (VBGI); Sredinnyi Range, west slope of Alney-Chashakondzha Massif, rocky ridge along Chashakondzha Mt. glacier, (56°37’55"N 159°36’16"E), 1968 m alt., 3.VIII.2016, Klimova, Kam-62-4-16, c. per., ant. (VBGI). **Magadan Province**: Magadan City area, ca. 4 km NWW from Morgorodok Microdistrict (59°33’60"N 150°40’21"E), 171 m alt., 16.VI.2010, Bakalin, Mag-19-4-10, Mag-19-6-10 (paratypes, VBGI); Marchakanskaya Sopka Mt., Chasha Stream valley (59°31’19"N 150°49’23"E), 350 m alt., 11.VIII.2011, Bakalin, Mag-61-30-11, Mag-61-35-11, c. per., ant., Mag-61-40-11, Mag-61-42-11, c. per., ant. (VBGI); central part of Ka-

mennyi Range, upper course of Levaya Lankovaya River (59°49'06"N 149°40'35"E), 511 m alt., 8.VIII.2013, Bakalin, Mag-22-7-13, c. per., ant. (VBGI).

DISCUSSION

The presence of the two species considered above could hardly be expected on the Kamchatka Peninsula. For *Scapania spitsbergensis,* the "relict ranges" (Konstantinova, 2000: 29) or "a limited range which apparently centers in a South Siberian region peripheral to unglaciated terrain" (Schuster & Konstantinova, 1996: 35) have been estimated. The similar ranges can be expected in North-East Asia for such taxa as *Herbertus arcticus* (Inoue & Steere) Schljakov, *Lejeunea alaskana* (R.M. Schust. & Steere) Inoue & Steere, *Frullania subarctica* Vilnet, Borovich. & Bakalin, *Anastrophyllum assimile* (Mitt.) Steph., *Cryptocolea imbricata*, *Apotreubia nana* (S. Hatt. & Inoue) S. Hatt. & Mizut., and *Scapania magadanica*. Taking into account the rarity of sexual reproduction in both *S. magadanica* and *S. spitsbergensis*, the probability of their occurrence in Kamchatka should be relatively low due to very active geomorphological processes accompanied with heavy volcanic eruptions in Quaternary period. This circumstance tentatively should prevent the survival of all mentioned taxa, where sporophytes occurs as rarity, due to disturbance of suitable habitats and necessity of permanent spreading to suitable habitats for a long distances to re-establish the populations. However, recent studies have shown several inconsistencies with this expectation, e.g. *Frullania subarctica* was found in the ridge line of the Avachinskaya volcano group (Bakalin & Klimova, 2017), *Cryptocolea imbricata* is quite common in East Kamchatka (authors unpublished data). Thus, these findings can be considered as evidence of common overestimation of volcanic impact on small organisms such as hepatics. On the other hand, these records may indicate larger potentials for spore productivity of the aforementioned taxa in a relatively recent past, contrary to currently observed low ability for generative propagation.

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