



Flora of lichens, mosses and liverworts of Wrangel Island: New records

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Abstract: New records to lichen flora and bryoflora of Wrangel Island are presented. The additions to the island cryptogam flora include 32 lichens and one lichenicolous fungus, 26 mosses and eleven liverwort species. *Acarospora sinopica*, *Alectoria gowardii*, *Austroplaca sibirica*, *Calogaya bryochryson*, *Hymenelia ceracea*, *Porpidia ochrolemma*, and *Sagiolechia protuberans* are new to the island and to the Russian Far East. Two lichen species (*Lecideia lithophila* and *Rinodina terrestris*), as well as two liverwort taxa (*Clelea hyaline*, *Lophozioipsis excisa* var. *elegans* and *Pseudolophozia debiliformis*), are new to the Chukotka Autonomous Area. Two of the reported moss species (*Funaria arctica* and *Schistidium umbrosum*) are extremely rare. Location data and ecological descriptions for the newly reported species are included.

Keywords: Arctic, biodiversity, checklist, new records, cryptogams.



Introduction

So far, Arctic lichens have been intensively studied only in a few relatively accessible regions. In some regions lichens were thoroughly recorded. Lichens are represented by 760 species in Svalbard (Øvstedal *et al.* 2009; Zhurbenko and Brackel 2013; Melechin 2015; Breuss 2017; Konoreva *et al.* 2019b; Czernyadjeva *et al.* 2020) and about a thousand species in Greenland (Kristinsson *et al.* 2010). The Russian Arctic, which is by its nature less accessible, remains poorly studied in this aspect. For example, only 229 species were recorded in Franz Josef Land (Konoreva *et al.* 2019a), about 400 species in Severnaya Zemlya (Kristinsson *et al.* 2010), and some 50 species from Vaigach Island (Blytt 1872; Heuglin 1874; Elenkin 1901; Zhurbenko and Vechov 2001). Main continental areas such as the Kola Peninsula, Taimyr and Chukotka are well studied, with about 700 species recorded in each of these regions (Kristinsson *et al.* 2010).

The first inventory of lichens of Wrangel Island was made by Gorodkov (1943, 1958) and Petrovsky (1967) who listed a total of 77 species. Those studies were later supplemented with 27 new species (Makarova 1981). A major advance in knowledge in this area is through several works by Dobrysh (Dobrysh 1988, 1994, 1995; Dobrysh and Makarova 1998) who summarized the knowledge of lichens at that time in the form of an annotated list, and compiled a list of 309 taxa (Dobrysh 2000). Kholod and Zhurbenko (2005) added another 25 species to the list. The most recent summary on lichens was published by Kholod (2014), although no new species were reported for Wrangel Island. A total of 334 lichen species were known for the island at the outset of that study.

Arctic mosses and liverworts were the focus of several studies (*e.g.*, Lindenberg and Arnell 1889), but the flora of relatively inaccessible regions of Alaska, Ellesmere Island, Greenland, Yamal, Severnaya Zemlya, Taimyr, the lower Lena River, and Chukotka were reported for the most part only within the last few decades (Schuster *et al.* 1959; Steere and Inoue 1978; Schuster 1988; Afonina 1993, 2004; Potemkin 1993; Konstantinova and Filin 1998; Zhukova and Matveeva 2000; Czernyadjeva 2001; Söderström *et al.* 2015). For Wrangel Island, the first data on the diversity of these plants were published by Gorodkov (1958) who reported 27 liverwort and 100 moss species. The most complete list of liverworts for the region, including 86 species, was published by Afonina and Duda (1993). Afonina (2000) compiled the records published by Gorodkov (1958), Pulyaev and Afonina (1989) and Afonina and Sekretareva (1994) presenting a list of 237 bryophyte species in total.

Our study aims to further characterize the diversity of cryptogams, as lichens, liverworts, and mosses on Wrangel Island. Most of the lichens and lichenicolous fungi we report were collected by G.S. Evdokimov, whereas the bryophytes were collected by R.P. Obabko during an expedition in June–August 2020 (Fig. 1).

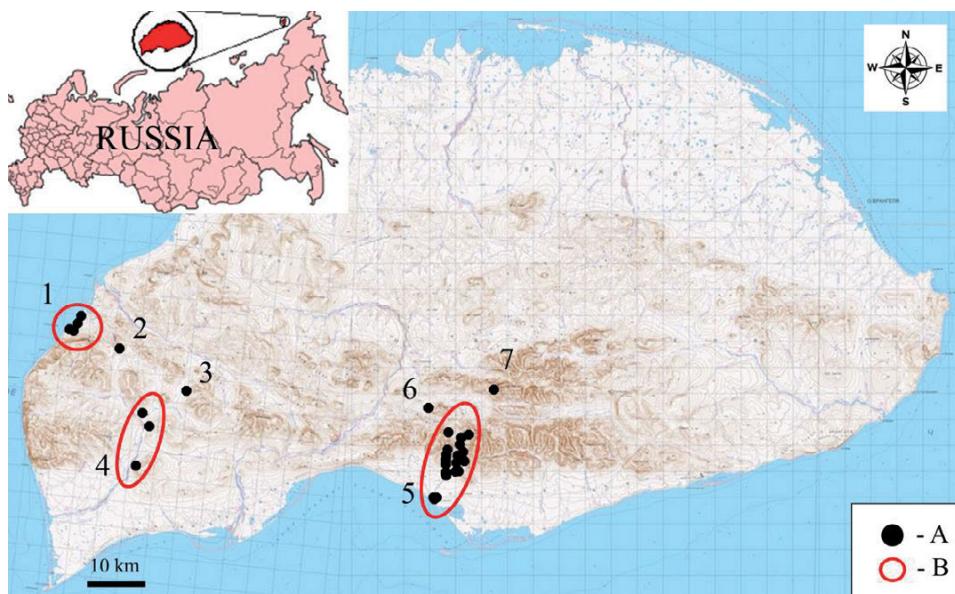


Fig. 1. Bryophyte, liverworts and lichen collection sites (A) and areas (B) on Wrangel Island (NE Russia): **1** – Ptichiy Bazar Cape (71°08' N, 178°49' E); **2** – Sovetskaya River (71°07' N, 179°01' E); **3** – area between Kamnesharka and Gusinaya Rivers (71°03' N, 179°22' E); **4** – Neozhidannaya River area (71°00' N, 179°09' E); **5** – Somnitel'nyj Creek area (70°58' N, 179°33' W); **6** – Dvuglavaya Mountain (71°03' N, 179°38' W); **7** – Sovetskaya Mountain (71°05' N, 179°22' W).

Our collections included plants from diverse substrates but focused mainly on saxicolous and terricolous lichen habitats. Collections made on iron items, fabrics, bones, and driftwood were also included.

Study area

Wrangel Island (70°40'–71°40' N 178°30' E–177°00' W) is located in northeastern Russia, between the East Siberian and Chukchi Seas, separated from the mainland by the Long Strait. Administratively, it belongs to the Iultinsky District of the Chukotka Autonomous Area and is part of the Wrangel Island State Nature Reserve. The island is 144 km long from Zapadny Cape to Waring Cape and 78 km wide, from Evans Cape to Somnitel'naya barrier beach. The central part is occupied by mountains, with the highest point being Sovetskaya Mt. at 1096 m a.s.l. The Tundra Akademii Plain dominates the northern part of the island.

Wrangel Island is in the area of continuous permafrost (Kachurin 1952), the thickness of which, reaches 400–600 m along the shore, and 1000 m in the central regions (because of the higher thermal conductivity of rocks).

The average annual air temperature is –11.3°C and the average annual relative humidity is 88%. The amount of annual precipitation on the island is 162 mm.

Thunderstorms are uncommon, occurring in July and August. The number of foggy days reaches 80–86 at the coast of the island. Snow cover usually lasts for 240–250 days, with an uneven snowpack surface and frequent sastrugi (firm ridges of wind-eroded snow). The polar day lasts from May 12th to July 26th, while the night extends from November 18th to January 25th (Kester 1980).

Methods

The collected material was carried out according to standard techniques (Schuster 1966; Ignatov and Ignatova 2003; Smith *et al.* 2009; Andreev and Himelbrant 2014) in the Laboratory of Lichenology and Bryology of the Komarov Botanical Institute of the Russian Academy of Sciences (BIN RAS) using a binocular stereoscopic microscope MSP 1 var. 2, transmitted light microscope Micromed 6 var. 3, long-wave ultraviolet radiation (UV cabinet, wavelength 254/365 nm), and standard chemical reagents for spot test reactions to indicate the presence of certain lichen substances in thalli. Lichens were identified by us according to widely used indicator of flora condition: Foucard (2001), Øvstedal *et al.* (2009), Smith *et al.* (2009) and McCune (2017). Mosses were identified using mainly the keys in *Moss Flora of Russia* (Ignatov 2017, 2020). Liverworts were identified according to Schljakov (1980), Schuster (1988), Damsholt (2002) and Bakalin (2005). The collected and identified specimens are stored at the herbaria of the Komarov Botanical Institute RAS (LE) and the Main Botanical Garden (MHA).

The topographic base map used to represent the collection sites (Fig. 1) was obtained from: <https://www.skyecooley.com/single-post/2016/03/25/map-of-wrangel-island-russia>. Geographical ranges of species follow Kristinsson *et al.* (2010) for the Arctic (including Chukotka) and Tchabanenko (2002), Urbanavichus (2010), Cherdantseva *et al.* (2013), Yakovchenko *et al.* (2013), Himelbrant *et al.* (2014, 2019), and Skirina (2015a, b) for the Russian Far East.

Lichen nomenclature mainly follows: Lumbsch and Huhndorf (2010), Kondratyuk *et al.* (2020), Søchting and Arup (2021) and Westberg *et al.* (2021). The nomenclature of mosses follows Ignatov *et al.* (2016) with additions and changes as in Hodgetts *et al.* (2020). The nomenclature of liverworts follows Konstantinova *et al.* (2009) for the most part, with some changes based on Hodgetts *et al.* (2020).

Results and interpretation

Our work revealed 32 new lichen and one lichenicolous fungus species (Appendix, marked by asterisk) that had never been previously reported for Wrangel Island. These additions bring the total number of lichen species on

Wrangel Island up to 367 and that of lichenicolous fungi to 28 (Dobrysh 2000; Kholod and Zhurbenko 2005; Kristinsson *et al.* 2010). Nevertheless, the diversity of lichen biota of the island, with its wide variety of biotopes and substrates, is expected to be even higher. The large number of new records discovered in our study suggests that many species remain to be discovered. Although some of the species we report as new are common and widespread in other arctic-alpine regions (Makryi 2002; Urbanavichus and Urbanavichene 2004; Sedelnikova 2013; Chesnokov and Konoreva 2015), eight lichen species are new to the Russian Far East, including *Acarospora sinopica*, *Alectoria gowardii*, *Austroplaca sibirica*, *Calogaya bryochryson*, *Hymenelia ceracea*, *Porpidia ochrolemma*, and *Sagirolechia protuberans* (marked by “●”). In addition, two lichen species, *Lecidea lithophila* and *Rinodina terrestris*, are new to the Chukotka Autonomous Area (marked by “◆”).

We identified eleven liverworts and 26 moss species that are new findings for Wrangel Island. With these results, the total number of moss and bryophyte species on the island increased to 238 (11% increase) and 87 (13% increase), respectively (Afonina 2000). Several newly discovered bryophyte species, namely *Arctoa fulvella*, *Barbilophozia lycopodioides*, *Fissidens bryoides*, *Mesoptychia badensis*, *M. gillmanii*, *Pseudoleskeella rupestris*, and *Schistidium pulchrum*, are widely distributed (Ignatov *et al.* 2006; Konstantinova *et al.* 2009), thus their presence on Wrangel Island was anticipated. Most of the newly revealed species are rather widespread in the Arctic and Subarctic, but they usually occur sporadically (Afonina and Czernyadjeva 1995; Konstantinova and Potemkin 1996). However, some species of mosses and liverworts, like *Funaria arctica*, *Lophozia uncinata*, *Lophozia excisa* var. *elegans*, *Mielichhoferia mielichhoferiana*, and *Schistidium umbrosum* are rare, so the expansion of their known distributions is especially significant. As with the new finds of lichens and lichenicolous fungi, the discovery of such a large number of new records for mosses and liverworts underlines the need for further bryophyte research on Wrangel Island.

Species such as *Amandinea punctata*, *Lecidella euphorea*, and *Rinodina exigua* are widespread in the boreal zone, but rare in the Arctic, thus probably they were often overlooked. Although widespread, those species cannot be used as indicators for the assessment of climate change due to the lack of baseline data on their distribution and abundance. Effects of climate change can presumably be traced by observed or projected changes in species distributions among monitoring plots and transects. Many of liverwort specimens recorded by us are endangered taxa, particularly from the genera as *Lophozia*, *Lophozia excisa* var. *elegans*, *Lophozia uncinata* or possible conspecificity of *Lophozia silvicola* and *L. ventricosa*. Numerous specimens, including some in *Lophozia excisa*, *Marsupella* and *Solenostoma*, remain undetermined due to their ambiguous morphology.

These species will be the focus of further studies using molecular methods to test their phylogenetic relationships and possibly revealing further new additions to the Wrangel Island flora and/or novel taxa. The distribution of numerous bryophytes in the island has also yet to be explored, as many taxa widely distributed in the Arctic, *e.g.*, *Frullania subarctica* (sub *F. nisquallensis* in the previous publications) and *Radula prolifera* were discovered here in only one or few localities (Afonina 2000).

A compiled floristic analysis provides a baseline for long-term observations of climate change. Information on the distribution of bryophytes is of particular importance for monitoring dynamic changes in the Arctic, where temperature changes are pronounced, and effects are directly observable. Providing as complete a list as possible summarizing the results of the current state of knowledge is therefore needed and provides a good reference for future research.

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Appendix

LICHENS

Acarospora molybdina (Wahlenb.) Trevis. — Vicinity of Ptichiy Bazar Cordon, 71°09'27.2" N, 178°50'52.0" E, alt. 28 m, dry tundra with small stones, 10 July 2020, leg. and det. G. S. Evdokimov 12 (LE-L15488).

- *Acarospora sinopica* (Wahlenb.) Körb. — Headwaters of Sovetskaya River, 71°07'07.0" N, 179°01'06.9" E, alt. 107 m, rocky slope, 13 July 2020, leg. and det. G. S. Evdokimov 18 (LE-L15495). A rare species in the Arctic. The closest locations are Novaya Zemlya (Lynge 1928) and the Transbaikal Territory (Makryi 2002).

- *Alectoria gowardii* Lumbsch — Between Kamnesharka and Gusinaya Rivers, near hill with an altitude of 597 m, 71°03'33.1" N, 179°21'56.1" E, alt. 219 m, rocky slope, on soil, 15 July 2020, leg. G. S. Evdokimov 22, det. S.V. Chesnokov (LE-L15499); Somnitel'nye Gory Mountains, right bank of Somnitel'nyj Creek, 70°59'24.8" N, 179°34'15.3" W, alt. 306 m, tundra, 24 July 2020, leg. G. S. Evdokimov Pl. 18, det. S.V. Chesnokov (LE-L15522); estuary of Somnitel'nyj Creek, vicinity of Somnitel'nyj Cordon, 70°56'35.2" N, 179°35'59.8" W, alt. 12 m, coastal tundra, 31 July 2020, leg. G. S. Evdokimov Pl. 24, det. S.V. Chesnokov (LE-L15524). The nearest location is on the Novosibirskie Islands (Zhokhov Island) (Halonen *et al.* 2009).

Amandinea punctata (Hoffm.) Coppins *et* Scheid. — Estuary of Somnitel'nyj Creek, vicinity of Somnitel'nyj Cordon, 70°56'13.5" N, 179°36'51.0" W, alt. 4 m, coastal tundra with anthropogenically disturbed areas, 19 July 2020, leg. and det. G. S. Evdokimov 27 (LE-L15503).

Athallia holocarpa (Hoffm.) Arup *et al.* — Vicinity of Ptichiy Bazar Cordon, 71°09'27.2" N, 178°50'52.0" E, alt. 28 m, dry tundra with small stones, 10 July 2020, leg. G. S. Evdokimov 12, det. I. Frolov (LE-L15489); *ibidem*, 71°09'05.6" N, 178°49'48.3" E, alt. 24 m, saxicolous on rocky marine shore, 11 July 2020, leg. and det. G. S. Evdokimov 15 (LE-L15494); *ibidem*, Ptichiy Bazar Cape, 71°08'31.7" N, 178°48'59.6" E, alt. 67 m, tundra near stream, rock outcrops, 11 July 2020, leg. and det. G. S. Evdokimov 14 (LE-L15492); estuary of Somnitel'nyj Creek, vicinity of Somnitel'nyj Cordon, 70°56'13.5" N, 179°36'51.0" W, alt. 4 m, coastal tundra with anthropogenically disturbed areas, on stones and iron, 19 July 2020, leg. G. S. Evdokimov 27, det. I. Frolov (LE-L15504). A widespread lichen preferring siliceous outcrops.

- *Austroplaca sibirica* (H. Magn.) *Søchting et Arup* — Valley of Neozhidannaya River, near Neozhidannaya Cordon, 71°01'25.2" N, 179°09'54.4" E, alt. 122 m, shale mountain slope, 9 July 2020, leg. G. S. Evdokimov 8, det. I. Frolov (LE-L15519); estuary of Somnitel'nyj Creek, vicinity of Somnitel'nyj Cordon, 70°56'13.5" N, 179°36'51.0" W, alt. 4 m,

coastal tundra with anthropogenically disturbed areas, 19 July 2020, leg. G. S. Evdokimov 27, det. S.V. Chesnokov (LE-L15506). The nearest location is on the Novosibirskie Islands (Kristinsson *et al.* 2010). This species is quite rare or merely overlooked due to its small size. Recently Söchting and Arup (2021) demonstrated that *A. sibirica* has a bipolar distribution.

• ***Calogaya bryochryson*** (Poelt) Vondrák — Estuary of Somnitel'nyj Creek, vicinity of Somnitel'nyj Cordon, 70°56'13.5" N, 179°36'51.0" W, alt. 4 m, coastal tundra with anthropogenically disturbed areas, on iron and cloth, 19 July 2020, leg. G. S. Evdokimov 27, det. I. Frolov (LE-L15505); Somnitel'nye Gory Mountains, headwaters of Somnitel'nyj Creek, 71°00'56.5" N, 179°30'55.0" W, alt. 233 m, rocks and stone rubble, on stone, 26 July 2020, leg. G. S. Evdokimov 30, det. I. Frolov (LE-L15512). The closest locations are Novaya Zemlya and the Transbaikal Territory (Vondrak *et al.* 2016). The species seems to be circumpolar and it is also known from high mountains at lower latitudes.

Caloplaca spitsbergensis H. Magn. — Estuary of Somnitel'nyj Creek, vicinity of Somnitel'nyj Cordon, 70°56'13.5" N, 179°36'51.0" W, alt. 4 m, coastal tundra with anthropogenically disturbed areas, on bark, 19 July 2020, leg. G. S. Evdokimov 27, det. L.A. Konoreva, G. S. Evdokimov (LE-L15507). *Caloplaca spitsbergensis* is probably conspecific with *C. caesiorufella* (Nyl.) Zahlbr. (Söchting *et al.* 2008). Here we formally distinguish these two taxa based on apothecial size according to data provided by Söchting *et al.* (2008).

Candelariella xanthostigma (Pers. ex Ach.) Lettau — Valley of Neozhidannaya River, near Neozhidannaya Cordon, 71°01'25.2" N, 179°09'54.4" E, alt. 122 m, shale mountain slope, on bone, 9 July 2020, leg. and det. G. S. Evdokimov 8 (LE-L15520); estuary of Somnitel'nyj Creek, vicinity of Somnitel'nyj Cordon, 70°56'13.5" N, 179°36'51.0" W, alt. 4 m, coastal tundra with anthropogenically disturbed areas, on bark, 19 July 2020, leg. and det. G. S. Evdokimov 27 (LE-L15508).

Cetraria muricata (Ach.) Eckfeldt — Somnitel'nye Gory Mountains, left bank of Somnitel'nyj Creek, 70°59'39.0" N, 179°29'23.1" W, alt. 362 m, gorge between rocks with a stream and stone rubble, on soil, 28 July 2020, leg. and det. G. S. Evdokimov 31 (LE-L15513).

Cetraria odontella (Ach.) Ach. — Somnitel'nye Gory Mountains, headwaters of Somnitel'nyj Creek, left bank, 71°01'08.5" N, 179°24'47.8" W, alt. 325 m, stone rubble with areas of *Salix* sp.-herbaceous tundra, 1 August 2020, leg. and det. G. S. Evdokimov 33 (LE-L15515).

Cladonia alinii Trass — Left bank of Neozhidannaya River, near Neozhidannaya Cordon, 71°00'52.3" N, 179°09'47.9" E, alt. 124 m, tundra, 14 July 2020, leg. G. S. Evdokimov *Pl. I*, det. S.V. Chesnokov (LE-L15521).

• ***Hymenelia ceracea*** (Arnold) Poelt *et* Vězda — Left bank of Neozhidannaya River, near hill with an altitude of 378 m, 70°57'37.9" N, 179°08'41.5" E, alt. 362 m, stone rubble, on rock, 17 July 2020, leg. G. S. Evdokimov 26, det. L.A. Konoreva (LE-L15501). The nearest locations are in the Republic of Altai,

Kemerovo region (Sedelnikova 2013) and the Republic of Tyva (Sedelnikova and Sedelnikov 2018). Rare in the Arctic.

Lecanora marginata (Schaer.) Hertel *et* Rambold — Vicinity of Ptichiy Bazar Cordon, 71°09'27.2" N, 178°50'52.0" E, alt. 28 m, dry tundra with small stones, 10 July 2020, leg. and det. G. S. Evdokimov 12 (LE-L15490).

Lecidea atrobrunnea (Raymond ex Lam. *et* DC.) Schaer. — Somnitel'nye Gory Mountains, headwaters of Somnitel'nyj Creek, left bank, 71°01'08.5" N, 179°24'47.8" W, alt. 325 m, stone rubble with areas of *Salix* sp. — herbaceous tundra, on rock, 1 August 2020, leg. and det. G. S. Evdokimov 33 (LE-L15516); vicinity of "Ptichiy Bazar" Cordon, 71°09'27.2" N, 178°50'52.0" E, alt. 28 m, dry tundra with small stones, 10 July 2020, leg. and det. G. S. Evdokimov 12 (LE-L15491).

♦ ***Lecidea lithophila*** (Ach.) Ach. — Left bank of Neozhidannaya River, near hill with an altitude of 378 m, 70°57'37.9" N, 179°08'41.5" E, alt. 362 m, stone rubble, 17 July 2020, on rock, leg. G. S. Evdokimov 26, det. L.A. Konoreva, G. S. Evdokimov (LE-L15502). The nearest localities are in the Khabarovsk Territory (Tchabanenko 2002), the Jewish Autonomous Region (Skirina 2015) and the Taimyr Peninsula (Kristinsson *et al.* 2010).

Lecidea silacea (Hoffm.) Ach. — Headwaters of Sovetskaya River, 71°07'07.0" N, 179°01'06.9" E, alt. 107 m, rocky slope, 13 July 2020, leg. and det. G. S. Evdokimov 18 (LE-L15496).

Lecidella euphorea (Flörke) Hertel — Estuary of Somnitel'nyj Creek, vicinity of Somnitel'nyj Cordon, 70°56'13.5" N, 179°36'51.0" W, alt. 4 m, coastal tundra with anthropogenically disturbed areas, on bark, 19 July 2020, leg. G. S. Evdokimov 27, det. L.A. Konoreva, G. S. Evdokimov (LE-L15509).

Lendemerella borealis (Vain.) S. Y. Kondr. — Somnitel'nye Gory Mountains, left bank of Somnitel'nyj Creek, 70°59'39.0" N, 179°29'23.1" W, alt. 361 m, gorge between rocks with a stream and stone rubble, on branch, 28 July 2020, leg. G. S. Evdokimov 31, det. I. Frolov (LE-L15514).

Lichenomphalia hudsoniana (H. S. Jenn.) Redhead *et al.* — Valley of Neozhidannaya River, near Neozhidannaya Cordon, 71°01'23.8" N, 179°09'17.3" E, alt. 34 m, *Salix* sp. — herb tundra, 10 July 2020, leg. G.S. Evdokimov 11, R.P. Obabko, det. L.A. Konoreva (LE-L15486); vicinity of Dvuglavaya Mountain, 71°03'21.7" N, 179°38'48.8" W, alt. 312 m, swampy tundra at the foot of the mountain, 2 August 2020, leg. R.P. Obabko D25 P4 №1, det. S.V. Chesnokov (LE).

Multiclavula corynoides (Peck) R.H. Petersen — Somnitel'nye Gory Mountains, right bank of Somnitel'nyj Creek, 70°58'32.8" N, 179°34'13.5" W, alt. 89 m, tundra on slope, 24 July 2020, leg. R.P. Obabko D15, det. S.V. Chesnokov (LE).

Polyblastia bryophila Lönnr. — Estuary of Somnitel'nyj Creek, vicinity of Somnitel'nyj Cordon, 70°56'35.2" N, 179°35'59.8" W, alt. 12 m, coastal tundra, 31 July 2020, leg. and det. G. S. Evdokimov Pl. 24 (LE-L15525); *ibidem*,

70°56'26.1" N, 179°37'02.9" W, alt. 32 m, coastal tundra, 5 August 2020, leg. and det. G. S. Evdokimov *Pl.* 28 (LE-L15527).

Porpidia melinodes (Körb.) Gowan *et* Ahti — Headwaters of Sovetskaya River, 71°07'07.0" N, 179°01'06.9" E, alt. 107 m, rocky slope, 13 July 2020, leg. and det. G. S. Evdokimov *l8* (LE-L15497).

• ***Porpidia ochrolemma*** (Vain.) Brodo *et* R. Sant. — Headwaters of Sovetskaya River, 71°07'07.0" N, 179°01'06.9" E, alt. 107 m, rocky slope, 13 July 2020, leg. and det. G. S. Evdokimov *l8* (LE-L15498). The nearest localities are in the Trans-Baikal Territory (Makryi 2002) and the Republic of Buryatia (Urbanavichene and Urbanavichus 1998).

Psoroma tenue var. ***boreale*** Henssen — Tsentral'nye Mountains, Sovetskaya Mountain, 71°05'49.7" N, 179°21'15.5" W, alt. 1056 m, stone rubble with large boulders, 4 August 2020, leg. and det. G. S. Evdokimov *36* (LE-L15518); valley of Neozhidannaya River, near Neozhidannaya Cordon, 71°01'19.9" N, 179°08'21.8" E, alt. 122 m, tundra, 6 August 2020, leg. and det. G. S. Evdokimov *Pl.* 26 (LE-L15526).

Ramalina scoparia Vain. — Vicinity of Dvuglavaya Mountain, 71°03'41.1" N, 179°38'54.6" W, alt. 375 m, tundra with stone rubble, on rock, 2 August 2020, leg. G. S. Evdokimov *34*, det. O.A. Kataeva (LE-L15517).

Rhizocarpon effiguratum (Anzi) Th. Fr. — Somnitel'nye Gory Mountains, right bank of Somnitel'nyj Creek, 70°59'21.2" N, 179°34'17.5" W, alt. 277 m, swampy gentle slope with a stream, on rock, 22 July 2020, leg. and det. G. S. Evdokimov *28* (LE-L15510).

Rinodina exigua (Ach.) Gray. — Valley of Neozhidannaya River, near Neozhidannaya Cordon, 71°01'23.8" N, 179°09'17.3" E, alt. 34 m, *Salix* sp. — herb tundra, on bark, 10 July 2020, leg. and det. G. S. Evdokimov *l1* (LE-L15487).

Rinodina milvina (Wahlenb.) Th. Fr. — Somnitel'nye Gory Mountains, right bank of Somnitel'nyj Creek, 70°59'21.2" N, 179°34'17.5" W, alt. 277 m, gentle boggy slope with a stream, on rock, 22 July 2020, leg. and det. G. S. Evdokimov *28* (LE-L15511).

♦ ***Rinodina terrestris*** Tomin — Estuary of Somnitel'nyj Creek, vicinity of Somnitel'nyj Cordon, 70°56'35.2" N, 179°35'58.2" W, alt. 27 m, coastal tundra, 31 July 2020, leg. G. S. Evdokimov *Pl.* 22, det. L.A. Konoreva (LE-L15523). The nearest localities are in the Republic of Sakha (Yakutia) (Poryadina 2020) and the Jewish Autonomous Region (Skirina 2015).

• ***Sagiolechia protuberans*** (Ach.) A. Massal. — Left bank of Neozhidannaya River, near hill with an altitude of 378 m, 70°58'08.1" N, 179°09'40.4" E, alt. 151 m, hummock swampy tundra with *Eriophorum* sp., 17 July 2020, leg. G. S. Evdokimov *25*, det. L. A. Konoreva (LE-L15500). The nearest localities are in the Nenets Autonomous Area (Dolgy Island) (Urbanavichus *et al.* 2009) and the Krasnoyarsk Territory (Zhdanov 2013).

* *Stigmidium conspurcans* (Th. Fr.) Triebel *et* R. Sant. — Vicinity of Ptichiy Bazar Cordon, Ptichiy Bazar Cape, 71°08'31.7" N, 178°48'59.6" E, alt. 67 m, tundra near stream, rocky outcrops, on thallus of *Psora rubiformis* (Wahlenb. ex Ach.) Hook., 11 July 2020, leg. G. S. Evdokimov 14, det. S.V. Chesnokov (LE-L15493).

MOSSES

Arctoa fulvella Bruch *et* Schimp. — Headwaters of Neozhidannaya River, 71°07'06.8" N, 179°01'06.7" E, alt. 91 m., shale rocks on riverbank, in crack, 13 July 2020, leg. R. P. Obabko D5 P4, det. O.M. Afonina (LE).

Brachytheciastrum collinum (Schleich. ex Müll. Hal.) Ignatov *et* Huttunen — Somnitel'nye Gory Mountains, middle course of Somnitel'nyj Creek, 70°58'43.6" N, 179°30'36.1" W, alt. 290 m, rock outcrops, 29 July 2020, leg. R. P. Obabko D21 P1, det. M. S. Ignatov (LE).

Coscinodon hartzii C.E.O. Jensen — Tsentral'nye Mountains, Sovetskaya Mountain, 71°05'07.3" N, 179°30'54.6" W, alt. 464 m, rock outcrops, 4 August 2020, with sporophytes, leg. R. P. Obabko D27, det. E.A. Ignatova (LE).

Encalypta brevipes Schljakov — Somnitel'nye Gory Mountains, middle course of Somnitel'nyj Creek, 70°59'05.4" N, 179°34'17.7" W, alt. 230 m, disturbed vegetation, 24 July 2020, with sporophytes, leg. R. P. Obabko D15, det. O.M. Afonina (LE); *ibidem*, 70°58'34.8" N, 179°31'39.9" W, alt. 162 m, rock outcrops at base of slope, 29 July 2020, with sporophytes, leg. R. P. Obabko D12 P1, det. O.M. Afonina (LE). Rather rare arctic-montane species, included in the Red Book of the Russian Federation (Bardunov and Novikov 2008). This species was previously reported for Wrangel Island in Afonina (2004), but the specimens were reidentified by V. E. Fedosov as *Encalypta pilifera* Funck (Ignatov 2017).

Fissidens bryoides Hedw. — Somnitel'nye Gory Mountains, middle course of Somnitel'nyj Creek, 70°59'02.3" N, 179°30'54.6" W, alt. 208 m, on soil near stream, 28 July 2020, with sporophytes, leg. R. P. Obabko D20 P2, det. O.M. Afonina (LE).

Funaria arctica (Berggr.) Kindb. — Somnitel'nye Gory Mountains, middle course of Somnitel'nyj Creek, 70°56'37.4" N, 179°36'37.1" W, alt. 458 m, willow-moss tundra, 22 July 2020, with sporophytes, leg. R. P. Obabko D13 P2, det. O.M. Afonina (LE). This species occurs in North America from Alaska to Greenland; in Russia it is rare species known from several localities in the Asian Arctic in areas with distribution of carbonate rock types (Anabar Plateau, Wrangel Island, Chukotka Peninsula) (Ignatov 2017).

Grimmia donniana Sm. — Lower course of Neozhidannaya River, 70°57'58.7" N, 179°09'06.3" E, alt. 156 m, talus, on stones, 17 July 2020, leg. R. P. Obabko D9, det. O.M. Afonina (LE).

Grimmia incurva Schwägr. — Dvukhglavaya Mountain, 71°03'51.0" N, 179°38'29.4" W, alt. 458 m, rock outcrops, in cracks, 2 August 2020, leg. R. P. Obabko D25 P1, det. O.M. Afonina (LE).

Isopterygiella alpicola (Lindb.) Ignatov *et* Ignatova — Somnitel'nye Gory Mountains, middle course of Somnitel'nyj Creek, 71°00'54.8" N, 179°31'02.1" W, alt. 229 m, rock outcrops, 26 July 2020, leg. R. P. Obabko *D18 P3*, det. O.M. Afonina (LE).

Mielichhoferia mielichhoferiana (Funck) Loeske — Ptichiy Bazar Cape, 71°09'05.9" N, 178°49'50.7" E, alt. 7 m, metalliferous rock types, 11 July 2020, leg. R. P. Obabko *D3 P1*, det. O.M. Afonina (LE). In Russia rather rare species, two nearest locations known in Chukotka – Anyui highlands and Crest Bay (Afonina 2004).

Oligotrichum falcatum Steere — Headwaters of Neozhidannaya River, 71°07'06.8" N, 179°01'06.7" E, alt. 91 m, slate rocks on riverbank, in cracks, 13 July 2020, leg. R. P. Obabko *D5 P4*, det. O.M. Afonina (LE).

Oncophorus elongatus (I. Hagen) Hedenäs — Neozhidannaya River, near cordon, 71°03'00.3" N, 179°07'38.9" E, alt. 348 m, wet moss tundra at basen of slope, 10 July 2020, leg. R. P. Obabko *D2 P1*, det. O.M. Afonina (LE).

Oncophorus integerrimus Hedenäs — Somnitel'nye Gory Mountains, middle course of Somnitel'nyj Creek, 70°58'10.0" N, 179°34'23.6" W, alt. 78 m, willow-dryad tundra, 25 July 2020, leg. R. P. Obabko *D17 P1*, det. O.M. Afonina (LE).

Orthothecium retroflexum Ignatov *et* Ignatova — Low course of Neozhidannaya River, 70°58'08.9" N, 179°09'51.4" E, alt. 225 m, wet moss-herb tundra, 17 July 2020, leg. R. P. Obabko *D9 P1*, det. O.M. Afonina (LE). This species was recently described from Yakutia and is known to be widespread in arctic regions (Ignatov *et al.* 2020; Ignatov 2020). *Orthothecium retroflexum* is similar to *O. chryseon* Bruch, Schimp *et* W. Gümbel, from which it differs by broadly oblong-ovate leaves ending in a strongly revolute apiculus. It is likely that *Orthothecium retroflexum* was previously often reported from Russia misidentified as *O. chryseon*.

Orthotrichum anomalum Hedw. — Somnitel'nye Gory Mountains, middle course of Somnitel'nyj Creek, 70°59'05.4" N, 179°34'17.7" W, alt. 230 m, stony slope, on stone with *Lewinskya iwatsukii* (Ignatov) F. Lara, Garilleti *et* Goffinet, 24 July 2020, leg. R. P. Obabko *D15*, det. O.M. Afonina (LE); Neozhidannaya River, near cordon, 71°00'56.8" N, 179°10'13.8" E, alt. 159 m, stony moss-herb tundra, 17 July 2020, with sporophytes, leg. R. P. Obabko *D6 P1*, det. O.M. Afonina (LE).

Orthotrichum hyperboreum Fedosov *et* Ignatova — Somnitel'nye Gory Mountains, middle course of Somnitel'nyj Creek, 70°59'21.1" N, 179°34'17.5" W, alt. 248 m, stony slope on stone, 22 July 2020, with sporophytes and gemmae, leg. R. P. Obabko *D14 P1*, det. O.M. Afonina (LE). This species was recently described from the Anabar Plateau (Fedosov *et al.* 2017), and presently known to be rather widespread in the mountains of the Siberian Arctic and Subarctic.

Plagiothecium cavifolium (Brid.) Z. Iwats. — Somnitel'nye Gory Mountains, middle course of Somnitel'nyj Creek, 70°59'43.5" N, 179°33'53.0" W, alt. 436 m, on bank of stream, 24 July 2020, leg. R. P. Obabko *D16 P2*, det.

O.M. Afonina (LE); *ibidem*, on fine earth in scree, 29 July 2020, leg. R. P. Obabko D21 P2, det. O.M. Afonina (LE).

Polytrichastrum septentrionale (Brid.) E. I. Ivanova *et al.* — Neozhidannaya River, near cordon, 71°01'25.7" N, 179°07'56.9" E, alt. 94 m, riverbank, 14 July 2020, leg. R. P. Obabko D6 P3, det. O.M. Afonina (LE).

Pseudoleskeella rupestris (Berggr.) Hedenäs — Neozhidannaya River, near cordon, 71°04'14.6" N, 179°21'05.1" E, alt. 341 m, 17 July 2020, top of calcareous hill (Sopka), leg. R. P. Obabko D7 P4, det. O.M. Afonina (LE).

Schistidium agassizii Sull. *et* Lesq. in Sull. — Neozhidannaya River, near cordon, 71°01'57.0" N, 179°07'10.0" E, alt. 20 m, moss community along riverbank, 17 July 2020, with sporophytes, leg. R. P. Obabko D8 P1, det. O.M. Afonina (LE); *ibidem*, moss-herb tundra, 17 July 2020, leg. R. P. Obabko D9 P3, det. O.M. Afonina (LE).

Schistidium boreale Poelt — Somnitel'nye Gory Mountains, middle course of Somnitel'nyj Creek, 71°01'45.7" N, 179°34'11.8" W, alt. 490 m, calcareous slope, in cave, 3 August 2020, leg. R. P. Obabko D26 P1, det. O.M. Afonina (LE).

Schistidium flexipile (Lindb. *ex* Broth.) G. Roth — Somnitel'nye Gory Mountains, middle course of Somnitel'nyj Creek, 70°59'02.3" N, 179°30'54.6" W, alt. 208 m, disturbed vegetation on bank of stream, on stone, 28 July 2020, with sporophytes, leg. R. P. Obabko D20 P3, det. O.M. Afonina (LE). Dvukhglavaya Mountain, 71°03'51.0" N, 179°38'29.4" W, alt. 458 m, rock outcrops, in cracks, 2 August 2020, leg. R. P. Obabko D25 P1, det. E.A. Ignatova (LE).

Schistidium* cf. *pulchrum H. H. Blom — Neozhidannaya River, near cordon, 71°01'24.5" N, 179°09'49.9" E, alt. 107 m, scree on slope, in niche on fine earth, 9 July 2020, with sporophytes, leg. R. P. Obabko D6, det. O.M. Afonina (LE); Somnitel'nye Gory Mountains, headwaters of Somnitel'nyj Creek, 71°01'45.7" N, 179°34'11.8" W, alt. 490 m, calcareous slope, in cave, 3 August 2020, with sporophytes, leg. R. P. Obabko D26 P1, det. O.M. Afonina (LE).

Schistidium sordidum I. Hagen — Somnitel'nye Gory Mountains, middle course of Somnitel'nyj Creek, 70°59'05.4" N, 179°34'17.7" W, alt. 230 m, stony slope, on stone, 24 July 2020, leg. R. P. Obabko D15, det. O.M. Afonina (LE); *ibidem*, 71°00'54.9" N, 179°31'02.1" W, alt. 229 m, moss community along stream, 28 July 2020, leg. R. P. Obabko D18 P1, det. O.M. Afonina (LE).

Schistidium umbrosum (J. E. Zetters.) H. H. Blom — Somnitel'nye Gory Mountains, middle course of Somnitel'nyj Creek, 70°58'43.6" N, 179°30'36.2" W, alt. 290 m, rock outcrops, 29 July, 2020, with sporophytes, leg. R. P. Obabko D21 P1, det. E.A. Ignatova (LE). Though widespread, this arctic species is very rare observed, known from few records in the Murmansk Region, in Taimyr, Severnaya Zemlya Archipelago, arctic Yakutia, and Chukotka (Ignatov 2017).

Splachnum sphaericum Hedw. — Somnitel'nye Gory Mountains, middle course of Somnitel'nyj Creek, 70°59'02.3" N, 179°30'55" W, alt. 208 m, disturbed vegetation on bank of stream, 28 July 2020, with sporophytes, leg. R. P. Obabko D20 P3, det. O.M. Afonina (LE).

LIVERWORTS

Barbilophozia lycopodioides (Wallr.) Loeske — Headwaters of Neozhidannaya River, near Neozhidannaya Cordon, 71°01'24.5" N, 179°09'49.9" E, alt. 103 m, boggy tundra with *Salix* spp., *Eriophorum* sp., *Sphagnum* spp., *Aulacomnium* sp., 9 July 2020, leg. R. P. Obabko D1, det. Yu. S. Mamontov (MHA). *Barbilophozia lycopodioides* is a rather common Holarctic species.

Clevea hyalina (Sommerf.) Lindb. — Cape Ptichiy Bazar, near Ptichiy Bazar Cordon, 71°08'42.3" N, 178°47'43.6" E, alt. 77 m, willow tundra, 12 July 2020, leg. R. P. Obabko D4 P1 №2, det. Yu. S. Mamontov (MHA). *Clevea hyalina* is a rather uncommon Holarctic species having a sporadic circumboreal arctic-alpine distribution.

Lophozia silvicola H. Buch — Neozhidannaya River, near Neozhidannaya Cordon, 71°03'00.3" N, 179°07'38.9" E, alt. 348 m, screes on mountain slope, 10 July 2020, leg. R. P. Obabko D2 P1 №1, det. Yu. S. Mamontov (MHA); headwaters of Sovetskaya River, 71°07'06.8" N, 179°01'06.7" E, alt. 91 m, crevices in block of schist, 13 July 2020, leg. R. P. Obabko D5 P4 №3, det. Yu. S. Mamontov (MHA); watershed between Kamnesharka and Gusinaya Rivers, 71°03'33.7" N, 179°21'35.4" E, alt. 320 m, moist mossy tundra, 15 July 2020, leg. R. P. Obabko D7 P5 №1, det. Yu. S. Mamontov (MHA); *ibidem*, scree near late-lying snow patch, 15 July 2020, leg. R. P. Obabko D7 P5 №5, det. Yu. S. Mamontov (MHA). This species is widely distributed and rather common in the Holarctic. Its distinction from *L. ventricosa*, which is known on Wrangel Island (Afonina 2000), remains problematic in the context of possible conspecificity of these taxa.

Lophozia uncinata Schljakov — Headwaters of Neozhidannaya River, near Neozhidannaya Cordon, 71°01'24.5" N, 179°09'49.9" E, alt. 103 m, boggy tundra with *Salix* spp., *Eriophorum* sp., *Sphagnum* spp., *Aulacomnium* sp., 9 July 2020, leg. R. P. Obabko D1, det. Yu. S. Mamontov (MHA). This is a rare arctic species may be endemic to the Chukotka-Beringia region. Schljakov (1979) described this species as dioicous, and was later synonymized with the also dioecious *L. polaris* (Bakalin 2005). However, the discovery of paroecous inflorescences in our material supports the recognition of this species.

Lophozipsis excisa var. *elegans* (R.M. Schust.) Konstant. et Vilnet — Watershed between Kamnesharka and Gusinaya Rivers, 71°03'33.7" N, 179°21'35.4" E, alt. 320 m, screes near the late-lying snow patch, 15 July 2020, leg. R. P. Obabko D7 P5 №3, det. Yu. S. Mamontov (MHA). This is a rare arctic-montane taxon possibly deserving specific rank due to distinctions from *L. excisa* var. *excisa* in ecology and distribution, as well as by the shape of shoots and the shape and color of the gemmae.

Lophozipsis polaris (R.M. Schust.) Konstant. et Vilnet — Cape Ptichiy Bazar, near Ptichiy Bazar Cordon, 71°08'42.3" N, 178°47'43.6" E, alt. 77 m, willow tundra, 12 July 2020, leg. R. P. Obabko D4 P1 №2, det. Yu. S. Mamontov (MHA);

Somnitel'nye Gory Mountains, right bank of Somnitel'nyj Creek, 70°59'05.4" N, 179°34'17.7" W, alt. 231 m, tundra on the mountain slope, 24 July 2020, leg. R. P. Obabko *Pl. 15*, det. Yu. S. Mamontov (MHA); estuary Somnitel'nyj Creek, near Somnitel'nyj Cordon, 70°59'04.6" N, 179°31'47.7" W, alt. 199 m, 28 July 2020, leg. R. P. Obabko *D20 Pl №2*, det. Yu. S. Mamontov (MHA); middle course of Somnitel'nyj Creek, the abandoned military base, 70°56'37.4" N, 179°36'37.1" W, willow tundra, bank of channel, 30 July 2020, leg. R. P. Obabko *D22 Pl*, det. Yu. S. Mamontov (MHA). *Lophozipsis polaris* is a Holarctic species having a sporadic circumboreal arctic-alpine distribution.

Mesoptychia badensis (Gottsche *ex* Rabenh.) L. Söderstr. *et* Váňa — Headwaters of Neozhidannaya River, near Neozhidannaya Cordon, 71°01'24.5" N, 179°09'49.9" E, alt. 103 m, boggy tundra with *Salix* spp., *Eriophorum* sp., *Sphagnum* spp., *Aulacomnium* sp., 9 July 2020, leg. R. P. Obabko *D1*, det. Yu. S. Mamontov (MHA); middle course of Somnitel'nyj Creek, the abandoned military base, 70°56'37.4" N, 179°36'37.1" W, crevices between tundra polygons, near the river, 30 July 2020, leg. R. P. Obabko *D22 P3*, det. Yu. S. Mamontov (MHA). *Mesoptychia badensis* is a rather uncommon Holarctic species having a sporadic circumboreal arctic-alpine distribution.

Mesoptychia gillmanii (Austin) L. Söderstr. *et* Váňa — Somnitel'nye Gory Mountains, left bank of Somnitel'nyj Creek, 70°59'04.6" N, 179°31'47.7" W, alt. 199 m, bare soil on bank of brook, 28 July 2020, leg. R. P. Obabko *D20 Pl №2*, det. Yu. S. Mamontov (MHA). *Mesoptychia gillmanii* is a Holarctic species commonly distributed in the mountains of circumboreal latitudes but rather rare in the Arctic.

Peltolepis quadrata (Saut.) Muell. Frib. — Cape Ptichiy Bazar, near Ptichiy Bazar Cordon, 71°08'42.3" N, 178°47'43.6" E, alt. 77 m, willow tundra, 12 July 2020, leg. R. P. Obabko *D4 Pl №2*, det. Yu. S. Mamontov (MHA); Somnitel'nye Gory Mountains, left bank of Somnitel'nyj Creek, 70°59'04.6" N, 179°31'47.7" W, alt. 199 m, bare soil on brook bank, 28 July 2020, leg. R. P. Obabko *D20 Pl №2*, det. Yu. S. Mamontov (MHA). *Peltolepis quadrata* is an uncommon Holarctic species distributed in the Arctic and in mountains at lower latitudes. In North America, it is known in Alaska, Ellesmere I., Greenland I., and the Rocky Mountains, while in Eurasia it is known in Scandinavia, central Europe, Siberia and Northern Japan (Schuster 1992).

Pseudolophozia debiliformis (R. M. Schust. *et* Damsh.) Konstant. *et* Vilnet — Cape Ptichiy Bazar, near Ptichiy Bazar Cordon, 71°00'56.8" N, 179°10'13.9" E, alt. 159 m, shist cliffs above late-lying snow patch, 14 July 2020, leg. R. P. Obabko *D6 Pl*, det. Yu. S. Mamontov (MHA); Neozhidannaya River, near Neozhidannaya Cordon, 71°01'38.4" N, 179°07'51.1" E, alt. 94 m, herb tundra, 14 July 2020, leg. R. P. Obabko *D6 P5 №1*, det. Yu. S. Mamontov (MHA); lower course of Somnitel'nyj Creek, near Somnitel'nyj Cordon, 70°56'37.4" N, 179°36'37.1" W, 20 July 2020, leg. R. P. Obabko *D12 Pl*, det. Yu. S. Mamontov (MHA). This is rare species was recently described from Greenland and was later found in arctic parts of the European Russia and Western

Siberia. Also present in the Caucasus, Kamchatka, Sakhalin, and the Kuriles (Konstantinova *et al.* 2009).

Scapania praetervisa Meyl. — Somnitel'nye Gory Mountains, right bank of Somnitel'nyj Creek, 70°59'05.4" N, 179°34'17.7" W, alt. 231 m, tundra on mountain slope, 24 July 2020, leg. R. P. Obabko *Pl. 15*, det. Yu. S. Mamontov (MHA); *ibidem*, 70°58'10" N, 179°34'23.6" W, alt. 78 m, *Salix-Dryas* tundra in foothills, 25 July 2020, leg. R. P. Obabko *D17 Pl №1*, det. Yu. S. Mamontov (MHA); *ibidem*, 70°58'30.2" N, 179°34'11" W, alt. 90 m, mountain stream, 25 July 2020, leg. R. P. Obabko *D17 Pl №2*, det. Yu. S. Mamontov (MHA). *Scapania praetervisa* is an uncommon Holarctic species having a sporadic circumboreal arctic-alpine distribution.