

CONTRIBUTION TO THE MOSS FLORA OF THE KARAGINSKII ISLAND
(SOUTH KORYAKIA, THE RUSSIAN FAR EAST)

К ФЛОРЕ МХОВ ОСТРОВА КАРАГИНСКИЙ
(ЮЖНАЯ КОРЯКИЯ, ДАЛЬНИЙ ВОСТОК РОССИИ)

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Abstract

Despite ongoing moss flora research in the Russian Far East, the bryoflora of Koryakia remains relatively poorly studied. A brief excursion to Karaginskii Island in August 2023 revealed 112 bryophyte species. With the previously published data and our additions, the total number of moss species on the island is 141. We identified 36 species that are new to the “Southern Koryakia” region of the northern Russian Far East. The most interesting findings are *Brachythecium frigidum*, *Bucklandiella macounii* subsp. *alpina*, and *Ditrichum zonatum*, previously known in the north of the Far East only from the Commander Islands, as well as a rare and little-studied species *Tortella pseudofragilis*. Our record of *Bryoerythrophyllum rubrum* is the first for Kamchatka.

Резюме

Несмотря на продолжающиеся активные исследования флоры мхов Дальнего Востока России, бриофлора Корякии остается слабо изученной. Краткосрочная экскурсия на остров Карагинский позволила выявить 112 видов мхов. С учетом наших дополнений к списку 2012-го года на острове произрастает 141 вида мхов. Среди выявленных мхов 36 видов являются новыми для района «южная Корякия» севера Дальнего Востока России. Наиболее интересные находки – это ранее известные на севере Дальнего Востока только с Командорских островов *Brachythecium frigidum*, *Bucklandiella macounii* subsp. *alpina* и *Ditrichum zonatum*, а также редкий и малоизученный вид *Tortella pseudofragilis*. Наша находка *Bryoerythrophyllum rubrum* – первая для Камчатского края.

KEYWORDS: moss, Karaginskii Island, Russian Far East, biodiversity conservation

INTRODUCTION

Despite the ongoing moss flora research in the Russian Far East, the bryoflora of Koryakia remains relatively poorly studied: for the “Southern Koryakia” the smallest number of species (152) among all floristic regions of the northern part of Russian Far East is reported (Afonina *et al.*, 2022).

The hard-to-reach subarctic Karaginskii Island has been visited by botanists many times since the 19th century (Barkalov *et al.*, 1986). The flora of vascular plants on the island was studied in sufficient detail (Barkalov *et al.*, 1986; Ivanova *et al.*, 2023), and an outline of the island’s vegetation is provided by Barkalov *et al.* (1986). In the early 2000s, V.Yu. Neshataeva studied the diversity of vegetation of the island with the focus on the dwarf pine communities (Neshataeva, 2009, 2011).

Mosses and liverworts of the island for first time were examined in 2005 during a short excursion by V.A. Baka-

lin. The compiled list (Bakalin *et al.*, 2012) included 85 species of liverworts and 66 species of mosses. Several moss specimens collected in the course of the other botanical expeditions were also cited. The authors showed that the bryoflora of Karaginskii Island is represented mainly by widespread in northeast Asia species. Taking into account the diversity of habitats on the island, the authors suggested that the moss flora of the island remained insufficiently studied.

In 2023, SD visited Karaginskii Island from August 13 to 18. During short field excursions with landing on the shore of the island from the vessel, it was possible to explore five areas (Fig. 1): on the southern tip of the island, in the valley of the Gnumvayam river, in the valley of the river Markelovskaya, in the valley of the river Akonvayam, and on the east coast of the island near the Ptichii Island. During the work, whenever possible, we tried to cover the maximum possible range of habitats

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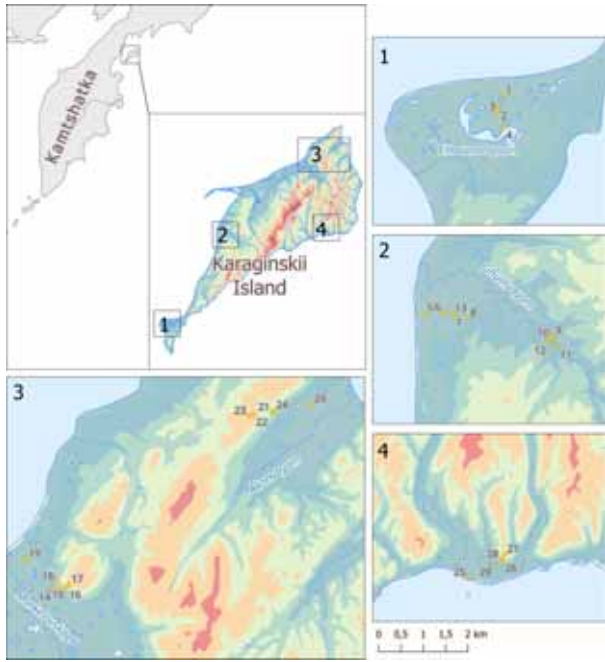


Fig. 1. Study key areas. List of collecting localities is given in Table 1.

and examine the diversity of geological and moisture conditions. A total of 188 specimens were collected and identified by VF, AS and SD.

STUDY AREA

Karaginskii Island is located in the southwestern part of the Bering Sea, off the northeastern coast of the Kamchatka Peninsula. The length of the island, stretching from southwest to northeast, is 110 km; in width it narrows to 1–9 km to the southwest and expands to 32 km to the northeast. The maximum height of the island is 920 m a. s. l. (Vysokaya Mountain). The area of the island is 1.9 thousand km².

Karaginskii Island can be divided into two orographic parts – a flat northwestern and a mountainous southeastern, extending almost along its longitudinal axis (Melnikova, 1987). The narrow strip stretching along the northwestern coast to the southern tip of the island is distinguished by its flat and hilly character. The central part of the island is occupied by the most extensive and elevated mountain range with peak elevations of 600–900 m a. s. l. The eastern part of the island is a highly dissected middle mountains with sharp peaks and steep slopes.

The Island is composed of a complex of rocks of Proterozoic, Upper Cretaceous, Paleogene and Neogene ages, as well as loose Quaternary deposits (Melnikova, 1987). Cretaceous and Paleogene complexes of tuffs of acidic and basic composition, siltstones, basaltic porphyrites and limestones are widespread. Neogene siltstones, marls, conglomerates, sandstones, and shell rocks are found mainly in the north-west of the island. The coastal lowlands in the west and north-west of the island are com-

Table 1. List of collecting localities.

- 1 – Southern tip of the island, 58°33'32" N, 163°29'52" E, modern marine terrace, seasonally watered depression, community of shrubs (*Salix pulchra*, *Dasiphora fruticosa*) and pioneer plants, 13.VIII.2023;
- 2 – *ibid.*, 58°33'14" N, 163°29'39" E, marine terrace, hummock tundra with flooded depressions, 13.VIII.2023;
- 3 – *ibid.*, 58°33'9" N, 163°29'36" E, elongated depressions on the inner margin of modern marine terrace, dwarf-shrub moss mire, 13.VIII.2023;
- 4 – *ibid.*, 58°33'46" N, 163°29'54" E, the depression of the Elnavan Lagoon, moss-willow-dwarf shrub mire, 13.VIII.2023;
- 5 – Lower reaches of the Gnumvayam River, 58°51'58" N, 163°46'37" E, subhorizontal surface of marine terrace, siberian dwarf pine communities and moss-lichen bog, 14.VIII.2023;
- 6 – *ibid.*, 58°51'59" N, 163°47'27" E, subhorizontal surface of marine terrace, communities of dwarf alder in the stream valley, 14.VIII.2023;
- 7 – *ibid.*, 58°51'56" N, 163°47'57" E, subhorizontal surface of marine terrace, complex of dwarf-shrub-moss and sedge-moss mires, 14.VIII.2023;
- 8 – *ibid.*, 58°51'52" N, 163°48'38" E, subhorizontal surface of marine terrace, Tall-grass alder woodland, 14.VIII.2023;
- 9 – The valley of the Gnumvayam River 6.5 km above the mouth, 58°51'28" N, 163°52'37" E, floodplain, tall-grass alder woodland, 14.VIII.2023;
- 10 – *ibid.*, 58°51'25" N, 163°52'32" E, subhorizontal surface of marine terrace, reed-sedge-cranberry sphagnum bog, 14.VIII.2023;
- 11 – *ibid.*, 58°51'13" N, 163°52'50" E, left side of the valley, gentle N slope, patch of dwarf-shrub tundra among siberian dwarf pine thickets, 14.VIII.2023;
- 12 – The valley of the left tributary of the Gnumvayam River 6.5 km above the mouth of the latter, 58°51'19" N, 163°52'24" E, steep slope near the stream, wet sandstone outcrops, 14.VIII.2023;
- 13 – The valley of the Gnumvayam River 1.5 km above the mouth, 58°51'58" N, 163°47'55" E, left side of the valley, mire complex, lake with sphagnum floating mat, 15.VIII.2023;
- 14 – The valley of the Markelovskaya River 1.5 km from the mouth, 59°6'37" N, 164°22'25" E, right side of the valley, southern slope, patch of scree among dwarf alder thickets, 16.VIII.2023;
- 15 – *ibid.*, 59°6'40" N, 164°22'46" E, W slope, steepness 15°, sparse thickets of siberian dwarf pine, 16.VIII.2023;
- 16 – The valley of the Markelovskaya River 2.7 km from the mouth, 59°6'40" N, 164°23'2" E, The valley of the small stream, snowbed, rock outcrops, 16.VIII.2023;
- 17 – *ibid.*, 59°6'44" N, 164°23'8" E, W slope, steepness 10°, patch of dwarf-shrub tundra among siberian stone pine thickets, 16.VIII.2023;
- 18 – *ibid.*, 59°6'48" N, 164°22'34" E, the valley of the small stream, rock outcrops near the stream, 16.VIII.2023;
- 19 – The valley of the Markelovskaya River 1.5 km from the mouth, 59°7'19" N, 164°21'13" E, the lake in the river's valley, sedge-sphagnum mire, 16.VIII.2023;
- 20 – Akonvayam River Valley 1.9 km above the mouth, 59°10'55" N, 164°33'52" E, subhorizontal surface of marine terrace, crowberry tundra, 16.VIII.20233;
- 21 – Akonvayam River Valley 3.5 km above the mouth, 59°10'43" N, 164°32'6" E, Rocky slope, sparse tundra on gravel of ultramafic rocks, 17.VIII.2023;
- 22 – *ibid.*, 59°10'40" N, 164°31'16" E, medium steep slope E exposure, sparse dwarf pine thickets, 17.VIII.20233;
- 23 – *ibid.*, 59°10'38" N, 164°31'2" E, the summit surface of the ridge, gently undulating plateau, spotty prostrate dwarf-shrub tundra, 17.VIII.2023;
- 24 – *ibid.*, 59°10'46" N, 164°32'10" E, rock pillar on the slope, 0, 17.VIII.2023 2023;
- 25 – The shore of the island opposite the Ptichiy island, 58°51'49" N, 164°29'52" E, rocky slope of marine terrace, rock outcrops, 17.VIII.2023;
- 26 – *ibid.*, 58°52'14" N, 164°31'29" E, southern slope, rock pillar on the slope, 18.VIII.2023;
- 27 – *ibid.*, 58°52'23" N, 164°31'34" E, The summit surface of the ridge, rock pillars with dwarf-shrub tundra, 18.VIII.2023;
- 28 – *ibid.*, 58°52'16" N, 164°31'24" E, SW slope 20° steepness, tall-grass meadow in the snowbed, 18.VIII.2023;
- 29 – *ibid.*, 58°52'8" N, 164°31'3" E, the surface of marine terrace, the shore of the lake, sand patches, 18.VIII.2023.



Fig. 2. Habitats of Karaginskii Island. A: Siberian dwarf pine communities; B: dwarf alder communities occupy large areas in lower mountain belt. C: Dwarf shrub tundras with *Empetrum nigrum* s.l. are common on the coastal plains. D: Dwarf shrub lichen tundras on the southern tip of the island. E: Mire complex on the western part of the island: dwarf shrub-moss, dwarf shrub-moss-lichen and cloudberry-moss peat bogs. F: Sedge and sedge-moss bogs. G: Moss-dwarf shrub-forb mountain tundras. H: Snowbeds are widespread on all altitudes.

posed of lower and middle Quaternary marine sediments: sands, loams, clays, pebbles, and boulders. Intrusive rocks play a significant role in the geological structure of the island. In the central, northeastern parts and in the extreme south of the island there are Late Cretaceous intrusions of ultrabasic rocks – peridotites, dunites and

pyroxenites. Gabbro and gabbro-diorite are widely distributed in the central, elevated part of the island.

In accordance with the Köppen-Geiger classification (Beck *et al.*, 2018), the area of Karaginskii Island has a moderately cold climate with uniform moisture. According to the CHELSA climate model (Karger *et al.*, 2017),

the average annual air temperature on the island at an absolute altitude of 50 m above sea level is -0.2°C , annual precipitation is ca. 720 mm. Summer is cool and short: on average it lasts less than 2 months from the second half of June to August. The island is located in the zone of sporadic permafrost (Ermakov, 1974). Permafrost occurs only within the coastal plain and its thickness does not exceed 20–30 m (Vas'kovsky, 1973).

In the lower altitudinal vegetation belt, up to altitudes of 350–400 m a. s. l. communities of siberian dwarf pine (*Pinus pumila*) and dwarf alder (*Alnus alnobetula* subsp. *fruticosa*) occupy large areas (Fig. 2). Lichen and dwarf shrub tundras and bogs are common on the coastal plains. Sedge and sedge-moss bogs (*Carex cryptocarpa*, *C. aquatilis* var. *minor*, *C. rariflora*, *Eriophorum russeolum*, *Trichophorum alpinum*) with dwarf shrubs (*Vaccinium uliginosum*, *Empetrum nigrum* s.l., *Salix fuscescens*), sometimes with lakes or flooded depressions (*Menyanthes trifoliata*) are confined to low river terraces. The moss layer is dominated by *Sphagnum fallax* s.l.; *Helodium blandowii*, *Paludella squarrosa*, and *Aulacomnium palustre* are also widespread. In the valleys of large rivers there are dwarf shrub-moss bogs (*Betula glandulosa*, *Rhododendron tomentosum*, *Vaccinium uliginosum*), dwarf shrub-moss-lichen and cloudberry-moss peat bogs in combination with sparse thickets of siberian dwarf pine. The moss-lichen layer on hummocks includes *Cetraria islandica*, *Cladonia gracilis*, *C. mitis*, *C. rangiferina*, and *Pleurozium schreberi*. In the depressions between hummocks, *Aulacomnium palustre*, *Sphagnum compactum*, *S. fuscum*, *S. lindbergii*, and *S. russowii* occur.

For the southern part of the island, small groves of stone birch (*Betula ermanii*) up to 12 m high are reported (Barkalov *et al.*, 1986). Mostly in the river valleys of the island, shrubby willow communities (*Salix pulchra*, *S. hastata*, *S. alaxensis*, *S. lanata*) are common.

Meadows occur on sea terraces and along stream valleys. Floodplain reed grass (*Calamagrostis purpurea*) and reed grass-forb meadows are developed here, typically with the admixture of tall herbs – *Angelica gmelinii*, *Parasenecio hastatus*, *Cirsium kamtschaticum*, *Veratrum oxysepalum*, etc., often with colorful spots of *Delphinium brachycentrum*, *Chamaenerion angustifolium*, *Jacobaea cannabifolia*, etc. (Barkalov *et al.*, 1986).

At altitudes from 400 to 700 m, a mountain-tundra belt is developed. The most widespread are forb-dwarf shrub-lichen tundras with lichens from the genus *Cladonia* s.l. (Barkalov *et al.*, 1986). Prostrate dwarf shrubs (*Empetrum nigrum* s.l., *Phyllodoce caerulea*, *Kalmia procumbens*, *Cassiope lycopodioides*, *Harrimanella stelleriana*) are common. The most common herb species are *Parrya nudicaulis*, *Claytonia acutifolia*, *Artemisia arctica*, *Polygonum viviparum*, etc. Moss-dwarf shrub-forb tundras with prostrate willow species (*Salix arctica*, *S. sphenophylla*, *S. reticulata*), and sedges *Carex fuscicula*, *C. rotundata*, *C. bigelowii* subsp. *lugens*) are com-

mon along saddles, poorly drained slopes and banks of brooks.

At altitudes of 700–900 m, the vegetation cover is sparse among rocky ridges, screes and rock fields (Barkalov *et al.*, 1986). In a cold oceanic climate, thick snow cover forms in the concave slopes and closed depressions, which slowly melt in summer and can persist until the next winter. In these conditions snowbed meadow communities (*Carex podocarpa*, *Veronica grandiflora*, *Juncus beringensis*, *Anemonastrum sibiricum*, *Gagea serotina*, *Ranunculus nivalis*, *Poa paucispicula*) occur.

RESULTS

In total, we identified 112 species of mosses in the collection. Taking into account our additions and the 2012 list, 141 species of mosses are known for the Karaginskii Island. The annotated checklist below contains only 75 new species records for the island, not previously listed by Bakalin *et al.* (2012). Symbol “!” indicates the new species to the “Southern Koryakia” floristic region of the northern part of Russian Far East in the recent checklist (Afonina *et al.*, 2022). The species are annotated by their sampling locations, habitat and substrates. Specimens are stored in the Moscow University Herbarium (MW).

ANNOTATED CHECKLIST

- Abietinella abietina* (Hedw.) M. Fleisch. – 24: rock pillar on the slope, on rock cliff.
 !*Aquilonium adscendens* (Lindb.) Hedenäs, Schlesak & D. Quandt – 24: rock pillar on the slope, on rock cliff.
 !*Brachythecium frigidum* (Müll. Hal.) Besch. – 6: communities of dwarf alder in the stream valley, on *Alnus kamtschatica* bark.
 !*Bryoerythrophyllum recurvirostrum* (Hedw.) P.C. Chen – 16, 21: rock pillar on the slope, in rock crevices.
 !*B. rubrum* (Jur.) P.C. Chen – 21: rock pillar on the slope, in rock crevices.
Bryum argenteum Hedw. – 26: rock pillar on the slope, in crevices.
B. pseudotriquetrum (Hedw.) P. Gaertn., B. Mey. & Scherb. 2 – 21: on wet soil near the stream.
 !*Bucklandiella macounii* subsp. *alpina* (E. Lawton) Bedn.-Ochyra & Ochyra – 25: rock outcrops.
Calliargon cordifolium (Hedw.) Kindb. – 9: tall-grass alder woodland in floodplain, on floating mat in the pool.
Cinclidium stygium Sw. – 19: sedge-sphagnum mire, in moss cover.
C. subrotundum Lindb. – 19: sedge-sphagnum mire, in moss cover.
 !*Dilutineuron fasciculare* (Hedw.) Bedn.-Ochyra, Sawicki, Ochyra, Szczecińska & Plášek – 18: rock outcrops near the stream.
 !*Coscinodon hartzii* C.E.O. Jensen – 25: rock outcrops, in crevices.
 !*Cynodontium tenellum* (Schimp.) Limpr. – 27: rock pillars with dwarf-shrub, on rock outcrops.
Dicranellopsis subulata (Hedw.) Bonfim Santos, Siebel & Fedosov – 30: on wet sandstone outcrops.
 !*Dicranum angustum* Lindb. – 2, 4, 15: siberian dwarf pine thickets, moss-dwarf-shrub tundras, dwarf-shrub-moss mires, in moss cover.

- D. bonjeanii* De Not. – 6, 27, 28: communities of dwarf alder in floodplains, tall-grass meadows in snowbeds, moss-dwarf-shrub tundra; in moss cover, on turf covered rocks.
- !*D. brevifolium* (Lindb.) Lindb. – 22: sparse dwarf pine thickets, on soil.
- D. elongatum* Schleich. ex Schwägr. – 11: patch of dwarf-shrub tundra among siberian dwarf pine thickets, in moss cover.
- !*D. schljakovii* Ignatova & Tubanova – 22: sparse dwarf pine thickets, on soil.
- D. scoparium* Hedw. – 17: patch of dwarf-shrub tundra among siberian dwarf pine thickets, on soil.
- !*Ditrichum zonatum* (Brid.) Kindb. – 25: rock outcrops, on cliff.
- !*Drepanium fastigiatum* (Hampe) Lange & Jensen – 24: rock pillar on the slope, on cliff.
- !*Encalypta trachymitria* Ripart – 26: rock pillar on the slope, in shaded niche, in rock crevices.
- Fissidens osmundoides* Hedw. – 1: seasonally watered depression, community of shrubs (*Salix pulchra*, *Dasiphora fruticosa*) and pioneer plants, on fine soil.
- !*Grimmia alpestris* (F. Weber & D. Mohr) Schleich. – 21: rock pillar on the slope, in rock crevices.
- !*G. reflexidens* Müll. Hal. – 21, 24: on rock outcrops.
- !*Gymnostomum aeruginosum* Sm. – 27: the summit surface of the ridge, rock pillars with dwarf-shrub tundra, on rock outcrops.
- Helodium blandowii* (F. Weber & D. Mohr) Warnst. – 10: reed-sedge-cranberry sphagnum bog in floodplain, in moss cover.
- Hygrohypnella bestii* (Renauld & Bryhn) Ignatov & Ignatova – 18: wet rock outcrops near the stream, on boulders in the brook.
- !*Hymenoloma mulahaceni* (Höhn.) Ochyra – 24: rock pillar on the slope, on rock outcrops.
- Hypnum cupressiforme* Hedw. – 24: rock pillars, on rock outcrops.
- !*Isopterygiella alpicola* (Lindb.) Ignatov & Ignatova – 27: rock pillars with dwarf-shrub, on rock outcrops, in shaded niche.
- !*Isopterygiopsis catagonioides* (Broth.) Ignatov & Ignatova – 27: rock pillars with dwarf-shrub, on rock outcrops, in rock crevices.
- !*Arctoa blyttii* (Bruch & Schimp.) Loeske – 23, 25: rock outcrops; spotty prostrate dwarf-shrub tundra, on soil.
- !*A. starkei* (F. Weber & D. Mohr) Loeske – 16, 18: on fine soil on snowbed, on wet rock outcrops.
- Leptobryum pyriforme* (Hedw.) Wilson – 29: sand patches on the shore of the lake, on fine soil.
- !*Lewinskya pylaisii* (Brid.) F. Lara, Garilleti & Goffinet – 24: rock pillar on the slope, on cliff.
- !*Meesia triquetra* (L. ex Lolycl.) Ångstr. – 19: sedge-sphagnum mire.
- !*Niphotrichum panshii* (Müll. Hal.) Bedn.-Ochyra & Ochyra – 14: rock outcrops.
- !*Oncophorus integerrimus* Hedenäs – 2: hummock tundra with watered depressions, on wet soil.
- Plagiomnium ellipticum* (Brid.) T.J. Kop. – 8: tall-grass alder woodland, on wet soil.
- Plagiothecium cavifolium* (Brid.) Z. Iwats. – 25, 27: in turf covered rocks, on rock outcrops.
- Pleurozium schreberi* (Brid.) Mitt. – 11: patch of dwarf-shrub tundra among siberian dwarf pine thickets.
- Pogonatum urnigerum* (Hedw.) P. Beauv. – 25: on rock outcrops.
- !*Pohlia proligera* (Lindb. ex Breidl.) Lindb. ex H. Arnell – 30: on wet sandstone outcrops.
- P. nutans* (Hedw.) Lindb. – 22: sparse dwarf pine thickets, on soil.
- Polytrichastrum alpinum* (Hedw.) G.L. Sm. – 20, 24: dwarf-shrub tundra, turf covered rocks.
- Polytrichum hyperboreum* R. Br. – 16: snowbed, on gravel soil.
- P. longisetum* Sw. ex Brid. – 29: on temporary flooding soil on the lake shore.
- Pseudobryum cinclidioides* (Huebener) T.J. Kop. – 3: dwarf-shrub moss mire.
- !*Pseudoleskeella rupestris* (Berggr.) Hedenäs & L. Söderstr. – 16, 27: rock pillars with dwarf-shrub tundra, rock outcrops in snowbed, in rock crevices.
- Rhizomnium magnifolium* (Horik.) T.J. Kop. – 18: rock outcrops near the stream, on wet rock outcrops.
- Rhytidium rugosum* (Hedw.) Kindb. – 27: rock pillars with dwarf-shrub tundra, turf covered rocks.
- Rhytidadelphus squarrosus* (Hedw.) Warnst. – 25: rocky slope of marine terrace, on boulders.
- !*Roaldia revoluta* (Mitt.) P.E.A.S. Câmara & Carv.-Silva – 27: rock pillars with dwarf-shrub tundra, rock outcrops.
- Sarmentypnum exannulatum* (Schimp.) Hedenäs – 2: hummock tundra with watered depressions, in pools.
- S. sarmentosum* (Wahlenb.) Tuom. & T.J. Kop. – 19: sedge-sphagnum mire.
- !*S. trichophyllum* (Warnst.) Hedenäs – 2, 13: in pools in hummock tundra, lake with sphagnum floating mat, on the lake bottom.
- !*Schistidium rivulare* (Brid.) Podp. – 21: rocky slope, on cliffs.
- Scorpidium scorpidioides* (Hedw.) Limpr. – 19: sedge-sphagnum mire.
- Sphagnum compactum* DC. – 1, 2, 7: on seasonally watered depressions in hummock tundra, in dwarf-shrub mire.
- S. fuscum* (Schimp.) H. Klinggr. – 6, 7: dwarf-shrub-moss mires.
- S. lindbergii* Schimp. ex Lindb. – 2, 5, 7: in pools in mires, in sedge-moss mires.
- !*S. riparium* Lngstr. – 13: mire complex, lake with sphagnum floating mat.
- !*S. russowii* Warnst. – 2, 3: mire complex, on hummocks.
- S. teres* (Schimp.) Ångstr. – 10, 19: sedge-sphagnum mires.
- !*S. tescorum* Flatberg – 11: patch of dwarf-shrub tundra among siberian dwarf pine thickets.
- Syntrichia ruralis* (Hedw.) F. Weber & D. Mohr – 24: rock pillar on the slope, on cliff.
- Tomentypnum nitens* (Hedw.) Loeske – 29: sedge-sphagnum mire.
- !*Tortella fragilis* (Hook. & Wilson) Limpr – 16, 21, 27: rock outcrops, in crevices and cliffs.
- !*T. tortuosa* (Hedw.) Limpr. – 21, 27: rock pillars, on cliffs, in rock crevices.
- Tortella pseudofragilis* (Thér.) Köckinger & Hedenäs – 24: rock pillar on the slope, in rock crevices.
- Tortula hoppeana* (Schultz) Ochyra – 25: rock outcrops.
- !*Weissia controversa* Hedw. – 21: on rock field, between stones.

DISCUSSION

Among the list of mosses, we identified 37 species new to the “southern Koryakia” region of the north of the Russian Far East (Afonina *et al.*, 2022). Among them: *Arctoa blyttii*, *A. starkei*, *Aquilonium adscendens*, *Brachythecium frigidum*, *Bryoerythrophyllum recurvirostrum*, *B. rubrum*, *Bucklandiella macounii* subsp. *alpina*, *Coscinodon hartzii*, *Cynodontium tenellum*, *Dicranum angustum*, *D. brevifolium*, *D. schljakovii*, *Dilutineuron*

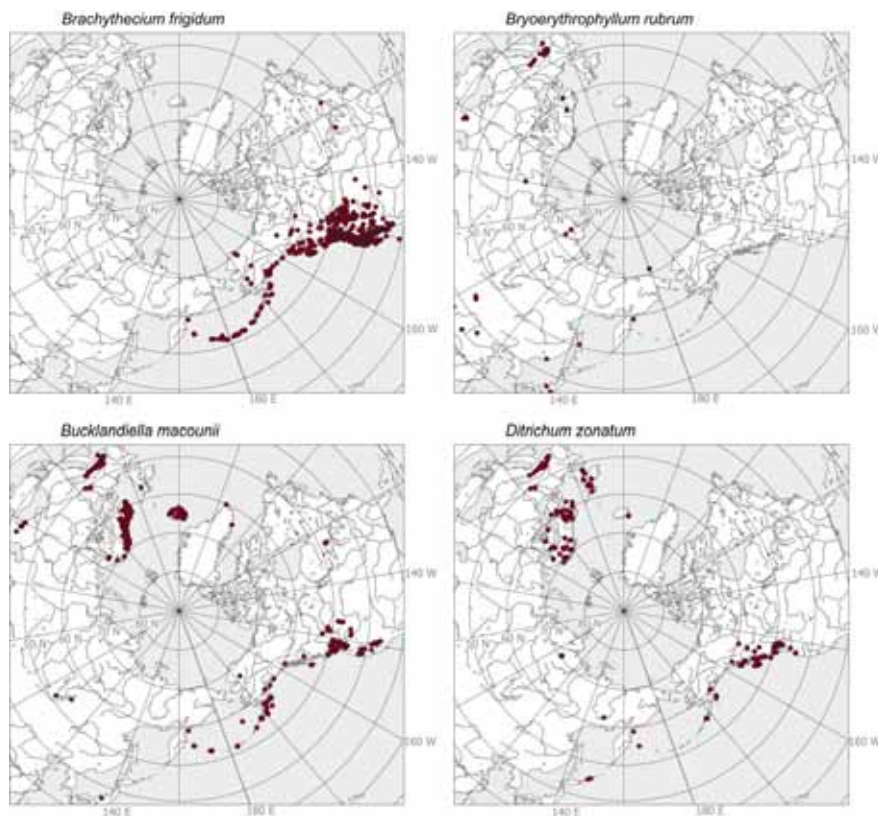


Fig. 3. Maps of the ranges of moss species - the most interesting floristic records

fasciculare, *Ditrichum zonatum*, *Drepanium fastigiatum*, *Encalypta trachymitria*, *Grimmia alpestris*, *G. reflexidens*, *Gymnostomum aeruginosum*, *Hymenoloma mulahaceni*, *Isopterygiopsis catagonioides*, *Isopterygiella alpicola*, *Lewinskya pylaisii*, *Meesia triquetra*, *Niphotrichum panschii*, *Oncophorus integerrimus*, *Pohlia prolifera*, *Pseudoleskeella rupestris*, *Roaldia revoluta*, *Sphagnum riparium*, *S. russowii*, *S. tescorum*, *Sarmetypnum trichophyllum*, *Schistidium rivulare*, *Tortella fragilis*, *T. pseudofragilis*, *T. tortuosa*, *Weissia controversa*.

Distribution maps of the most interesting findings are presented in Fig. 3. Predominantly distributed in North America, *Brachythecium frigidum* was previously known in Russia only from the Commander Islands (Afonina *et al.*, 2022). Our record of *Bryoerythrophyllum rubrum* is the first for Kamchatka (Czernyadjeva, 2012). Previously, in the north of the Far East, this species was reported from Wrangel Island (Afonina *et al.*, 2022), this rare species is known from a few localities in the Arctic and the mountains of Eurasia. *Bucklandiella macounii* subsp. *alpina* is widespread in the mountains of western North America and in the oceanic regions of Europe (Ignatov *et al.*, 2017). In Russia, it was previously known from the Commander Islands, the Kola Peninsula, the Northwestern Caucasus, as well as from relict habitats in the Baikal region (Fedosov *et al.*, 2022). *Ditrichum zonatum* has a similar distribution; for Kamchatka, it was also previously reported only from Bering Island (Fedosov *et al.*, 2012). Probably the least expected record, however, proved with molecular data is *Tortella pseudofra-*

gilis (Kuznetsova *et al.*, 2023), which until recently was thought to have European range; the closest locality of this insufficiently known species is in the Middle Ural Mts.

On the other hand, several widespread mosses were not collected in the island neither by V.A. Bakalin, nor in course of the present study. For instance, *Andreaea rupestris* and *Hymenoloma crispulum* are very typical saxicolous mosses in rockfields of upper mountain belt, in Kamchatka Peninsula, Koryakia and Bering Island. Also, the present list includes the single species of the genus *Schistidium*, whereas the bryophyte flora of Bering Island includes at least eight species of the genus, and, taking into account high bedrock diversity, we expect that in Karaginskii Island even more *Schistidium* species may occur. Among other groups underrepresented in the present list, large and taxonomically difficult groups challenging in identification, *Bryum* and *Sphagnum* worth mentioning; their representation in Karaginskii Island probably is comparable to those in the Bering Island (19 and 23 species). Thus, during expeditionary research in 2023, information about the diversity of mosses on Karaginskii Island was significantly supplemented. At the same time, the bryoflora of the island still remains poorly studied. Nevertheless, among the identified species, three are listed in the Red Book of the Kamchatka Territory (Bakalin *et al.*, 2018), with category 3 – “rare species”: *Hymenoloma mulahaceni*, *Brachythecium frigidum*, and *Hygrohypnella bestii*; *Bucklandiella macounii* subsp. *alpina* is included in the Red Data Book of the Kamchatka Territory as a species that requires spe-

cial attention to its state in the natural environment and monitoring (Bakalin *et al.*, 2018).

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