

CONTRIBUTION TO THE MOSS FLORA OF AYAN  
(WEST COAST OF THE SEA OF OKHOTSK, THE RUSSIAN FAR EAST)

К ФЛОРЕ МХОВ ОКРЕСТНОСТЕЙ ПОСЕЛКА АЯН  
(ЗАПАДНОЕ ПОБЕРЕЖЬЕ ОХОТСКОГО МОРЯ, РОССИЙСКИЙ ДАЛЬНИЙ ВОСТОК)

ELENA A. IGNATOVA<sup>1</sup>, MICHAEL S. IGNATOV<sup>1,2</sup>, KSENIA G. KLIMOVA<sup>3\*</sup> & VADIM A. BAKALIN<sup>3</sup>  
ЕЛЕНА А. ИГНАТОВА<sup>1</sup>, МИХАИЛ С. ИГНАТОВ<sup>1,2</sup>, КСЕНИЯ Г. КЛИМОВА<sup>3\*</sup>, ВАДИМ А. БАКАЛИН<sup>3</sup>

Abstract

The exploration of the area near Ayan Settlement and adjacent part of Dzhugdzhur Range on the Western coast of the Sea of Okhotsk revealed 164 species and 1 variety of mosses; their annotated list is provided. The cold and humid climate restricts the occurrence of the East Asian species that are more numerous in a few hundred kilometers to the south, and xerophytic plants that are characteristic to continental areas, at less than 300 km from the seacoast. Species with the North Pacific distribution are well represented in the area: *Coscinodon yukonensis*, *Trachycystis ussuriensis*, *Myuroclada maximowiczii*, *Echinophyllum sachalinense*, *Sciuro-hypnum uncinifolium*, *Bartramiopsis lescurii*, *Oligotrichum falcatum*, *O. parallelum*, and *Rhizomnium nudum*. The frequent occurrence of *Aquilonium plicatulum*, *Brachythecium baicalense*, *Echinophyllum sachalinense*, and *Dicranum majus*, and finding of *Oedipodium griffithianum* are other features of oceanic environment here.

Резюме

По итогам изучения флоры мохообразных в окрестностях поселка Аян и прилегающей части хребта Джугдзур на западном побережье Охотского моря выявлено 164 вида и 1 разновидность мхов; приводится аннотированный список. Распространение южных восточноазиатских видов, более многочисленных в нескольких сотнях километров к югу, а также ксерофитных видов, характерных для континентальных районов, расположенных не менее чем в 300 км от морского побережья, ограничено холодным и влажным климатом района исследований. Хорошо представлены виды, распространенные в северной части побережья Тихого океана: *Coscinodon yukonensis*, *Trachycystis ussuriensis*, *Myuroclada maximowiczii*, *Echinophyllum sachalinense*, *Sciuro-hypnum uncinifolium*, *Bartramiopsis lescurii*, *Oligotrichum falcatum*, *O. parallelum* и *Rhizomnium nudum*. Океаничность климата подчеркивается частой встречаемостью *Aquilonium plicatulum*, *Brachythecium baicalense*, *Echinophyllum sachalinense*, *Dicranum majus*, а также обнаружением *Oedipodium griffithianum*.

KEYWORDS: biodiversity, phytogeography, bryophytes, Khabarovsk Territory, Dzhugdzhur Range

INTRODUCTION

The flora of the Russian Far East was in a focus of extensive studies in the recent decades, and numerous discoveries in this area continue (Cherdansteva *et al.*, 2018). At the same time, the coverage of exploration remains fairly uneven. Pisarenko & Bakalin (2017) summarized all published materials for the regional moss diversity of the Russian Far East by 39 spatial units of 5×5 degrees latitude/longitude. Most of such units include records for more than 200 moss species, with maximal diversity of 416 species in the Primorsky Territory.

Eight regions are least known, with less than 100 moss species reported, and the region of the present study on the western coast of the Sea of Okhotsk is one of these: the total number of known species is 52 cf. Pisarenko & Bakalin (2017). This number is based only on Lazarenko (1940, 1941a, b, 1945) catalogue that refers to the unpublished data of Victor N. Vassiliev, who studied vegetation in Ayan region in 1936. These records include mostly common species of the main type of vegetation, and lack exact locality data.

<sup>1</sup> – Lomonosov Moscow State University, Faculty of Biology, Plant Ecology and Geography Dept., Leninskie Gory Str. 1–12, Moscow 119234 Russia; ORCID (EA): 0000-0001-6287-5660, (MI): 0000-0001-6096-6315

<sup>2</sup> – Tsitsin Main Botanical Garden, Russian Academy of Sciences, Botanicheskaya Str., 4, Moscow 127276 Russia

<sup>3</sup> – Botanical Garden-Institute, Far Eastern Branch of the Russian Academy of Sciences, Makovskogo Street, 142, Vladivostok, 690024, Russia ORCID (KK): 0000-0002-3229-1880; (VB): 0000-0001-7897-4305

\* – Author for correspondence: ksenia.g.klimova@mail.ru

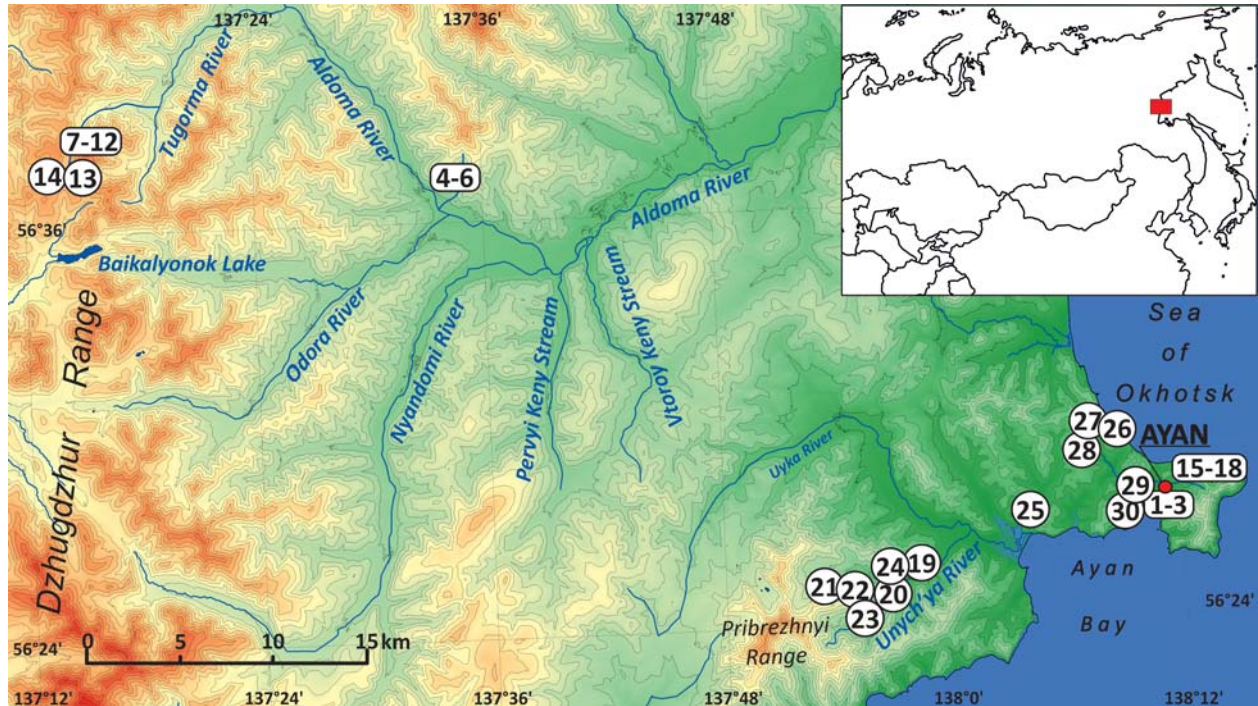


Fig. 1. Collecting localities. See also Table 1. More precise locality data are shown in the map in supplementary material.

Table 1. Collecting localities, with brief notes on vegetation and substrates

#	Locality	Latitude, longitude, altitude
1	Southward of Ayan Settl., Sarafanovka River valley, <i>Betula lanata</i> and <i>Duschekia fruticosa</i> crooked forest communities on the edge with <i>Pinus pumila</i> thickets at the bottom of NW-facing slope.	56°27'24"N, 138°10'16"E, 11 m
2	Small hill southward of Ayan Settl., dwarf-shrub-lichen tundra intermingled with spots of bare ground and <i>Pinus pumila</i> clumps on S-SW-facing slope.	56°27'13"–56°27'10"N, 138°10'27"–138°10'25"E, 140 m
3	Small hill southward of Ayan Settl., edge of dwarf-shrub-lichen tundra bordered with <i>Pinus pumila</i> thickets and <i>Betula lanata</i> and <i>Duschekia fruticosa</i> crooked forest communities.	56°27'08"N, 138°11'01"E, 65 m
4	Eastern spur of Dzhugdzhur Range, left tributary of Aldoma River, wide valley of small stream with flood plain vegetation ( <i>Populus suaveolens</i> , <i>Salix udensis</i> ), surrounded by <i>Larix forest</i> with some clumps of <i>Pinus pumila</i> in understory.	56°36'39" – 56°36'48"N, 137°34'15"–137°34'31"E, 294–330 m
5	Eastern spur of Dzhugdzhur Range, left tributary of Aldoma River, <i>Larix forest</i> with <i>Picea</i> and <i>Betula</i> admixture in stream valley with some clumps of <i>Pinus pumila</i> in understory.	56°36'53"N, 137°34'46"E, 377 m
6	Eastern spur of Dzhugdzhur Range, left tributary of Aldoma River, rock field on steep slope to stream valley surrounded by <i>Larix forest</i> with <i>Picea</i> and <i>Betula</i> admixture and <i>Pinus pumila</i> thickets.	56°36'58"N, 137°34'52"E, 418 m
7	Upper reaches of Tugorma River near the main ridge of Dzhugdzhur Range, stream valley in subalpine belt with many rocks and rocky outcrops along streambed and thickets of subalpine vegetation ( <i>Duschekia fruticosa</i> , <i>Pinus pumila</i> , <i>Betula lanata</i> s.l.) with dwarf-shrub-moss-lichen tundra spots on slope to stream.	56°39'18"–56°39'06"N, 137°15'34"–137°15'37"E, 904–935 m
8	Upper reaches of Tugorma River near the main ridge of Dzhugdzhur Range, NE-facing slope of stream valley in alpine belt: mostly dwarf-shrub-moss-lichen tundra with rocky outcrops, spots of bare ground and clumps of dwarf subalpine shrubs ( <i>Pinus pumila</i> , <i>Duschekia fruticosa</i> ).	56°38'52"N, 137°15'47"E, 1066 m
9	Upper reaches of Tugorma River near the main ridge of Dzhugdzhur Range, rock fields with small spots covered by tundra vegetation and sparse rocky outliers on NE-facing slope to stream valley and ridgeline in alpine belt.	56°38'44"–56°38'48"N, 137°15'26"–137°15'31"E, 1261–1328 m
10	Upper reaches of Tugorma River near the main ridge of Dzhugdzhur Range, rocky ridge.	56°38'35"–56°38'39"N, 137°15'20"–137°15'19"E, 1393–1436 m
11	Upper reaches of Tugorma River near the main ridge of Dzhugdzhur Range, alpine vegetation moistened by neutral to basic reaction percolate water with many rocky outcrops and rock fields on steep N-NW-facing slopes.	56°38'29"–56°38'24"N, 137°15'24"–137°15'10"E, 1473–1484 m

- 12 Upper reaches of Tugorma River near the main ridge of Dzhugdzhur Range, small rock field at the bottom of a slope. 56°38'31"N, 137°14'33"E, 1119 m
- 13 Area near the pass over main ridge of Dzhugdzhur Range, its western macro-slope (Arctic Ocean Basin), upper reaches of Birandya River, alpine belt with sparse vegetation represented by dwarf shrub-lichen tundra and *Sphagnum lenense* mats over percolate water openings, surrounded by rock fields. 56°37'47"N, 137°14'26"E, 1148 m
- 14 Area near the pass over main ridge of Dzhugdzhur Range, its western macro-slope (Arctic Ocean Basin), upper reaches of Birandya River, moist mossy tundra near stream. 56°37'48"N, 137°14'03"E, 1109 m
- 15 Upper reaches of Sarafanovka River northward of Ayan Settl., mostly *Picea ajanensis* forest with admixture of *Betula lanata* and grass cover in river valley with some *Salix udensis* near watercourse turned into crooked *Betula lanata*-*Duschekia fruticosa*-*Pinus pumila* forest along river. 56°27'44"-56°27'33"N, 138°12'04"-138°13'02"E, 54–143 m
- 16 Upper reaches of Sarafanovka River northward of Ayan Settl., *Picea* forest on SW-facing slope to the river valley and on a ridge. 56°27'35.7"-56°27'40"N, 138°13'06"-138°13'10"E, 182–273 m
- 17 Upper reaches of Sarafanovka River northward of Ayan Settl., *Betula lanata* forest on W-facing slope. 56°27'51"N, 138°12'07"E, 125 m
- 18 Saddle in the hilly landscape near sea coast northward of Ayan Settl., windy community with low grasses and shrubs. 56°27'59"N, 138°12'01"E, 105 m
- 19 Pribrezhnyi Range, Unych'ya River valley, large riverside SE-S-facing cliffs. 56°25'26"-56°25'21"N, 137°58'16"-137°57'56"E, 82–93 m
- 20 Pribrezhnyi Range, its northern part, Unych'ya River middle course, large N-facing conglomerate cliffs with scattered *Betula lanata* along riverside. 56°25'07"N, 137°56'55", 129–154 m
- 21 Pribrezhnyi Range, its northern part, eastern spur of Unych'ya Mt., small mountain with many rocky outcrops, rock fields and *Pinus pumila* clumps (virtually crooked forest belt). 56°24'36"N, 137°54'34"E, 780 m
- 22 Pribrezhnyi Range, its northern part, eastern spur of Unych'ya Mt., SE-facing slope to Unych'ya River valley, crooked *Betula* forest. 56°24'25"N, 137°54'57"E, 517 m
- 23 Pribrezhnyi Range, its northern part, upper course of Unych'ya River, small waterfall in deep canyon and rocks along river bank in mixed forest. 56°24'15"-56°23'44"N, 137°55'19"-137°55'50"E, 179–235 m
- 24 Pribrezhnyi Range, its northern part, middle course of Unych'ya River, *Picea* forest with some *Betula lanata* trees in the valley. 56°25'10"N, 137°56'59"E, 117 m
- 25 Westward of Ayan Settl., Sivakchan River valley, boggy community covered in winter by aufeis glade not far from slightly salted estuary occasionally filling with salted water. 56°26'49"N, 138°03'40"E, -2 m
- 26 Northwestward of Ayan Settl., steep N-NE-facing slope to sea with many limestone outcrops surrounded by tundra-like communities (developed mostly due to severe wind conditions). 56°29'37"N, 138°07'59"E, 34 m
- 27 Northwestward of Ayan Settl., lighted *Larix* forest in small stream valley with many limestone boulders in the streambed. 56°29'38"N, 138°07'53"E, 22 m
- 28 Northwestward of Ayan Settl., Ayanka River valley, eutrophic hypnaceous swamp developed over limestone subbase with sluggishly flowing waters. 56°29'26"N, 138°07'24"E, 91 m
- 29 Ayan Settl. surroundings, northern coast of Ayanskaya Bay, basic sedimentary N-facing rock outcrops along seacoast. 56°27'33"N, 138°09'49"E, 5 m
- 30 Ayan Settl. surroundings, western coast of Ayanskaya Bay, basic sedimentary N-facing rock outcrops along seacoast. 56°27'07"N, 138°09'09"E, 5 m

Deficiency of data is mainly because the area is very difficult to access. In 19th Century the Ayan Settlement was founded in 1843 on the main road for the Russian-American Company trade. The road connected Europe to Pacific seas via Yakutsk Town and Ayan (Lightfoot, 2003), but severe climate and possible usage only in winter resulted in that after 30 years of the road exploitation it was abandoned.

In the Soviet Union period few botanical explorations were conducted in the area, but publications included only vascular plants of this land (Khokhrjakov & Berkutenko, 1979; Kharkevich *et al.*, 1983; Schlothgauer, 1990; Schlothgauer & Kryukova, 2005). Therefore, present account is a first step to fill this 'blank spot' on the map of exploration of the moss flora of the Russian Far East.

Fieldworks were conducted by KK and VB over a total of three weeks in late June – early July of 2019,

addressed specifically to liverwort exploration (Bakalin *et al.*, 2021); however, mosses were gathered wherever possible, and 350 moss specimens were collected.

#### STUDY AREA

Liverwort flora analysis for the area was recently published (Bakailn *et al.*, 2021), with the expanded overview of the area climate and vegetation. Thus here only a brief data are provided.

The Ayan mean annual temperature at sea level is  $-3.3^{\circ}\text{C}$ , with  $+13.0$  in August and  $-19.6^{\circ}\text{C}$  in January. The mean annual precipitation is 856 mm, with a vast majority of them in July to September, and quite scanty precipitation in winter (<https://en.climate-data.org/asia/russian-federation/khabarovsk-krai/ayan-718644/>).

The vegetation in the study area is highly intermingled mosaic of *Picea ajanensis* and *Larix cajanderi* forest, *Pinus pumila* thickets, crooked forests (krummholz)

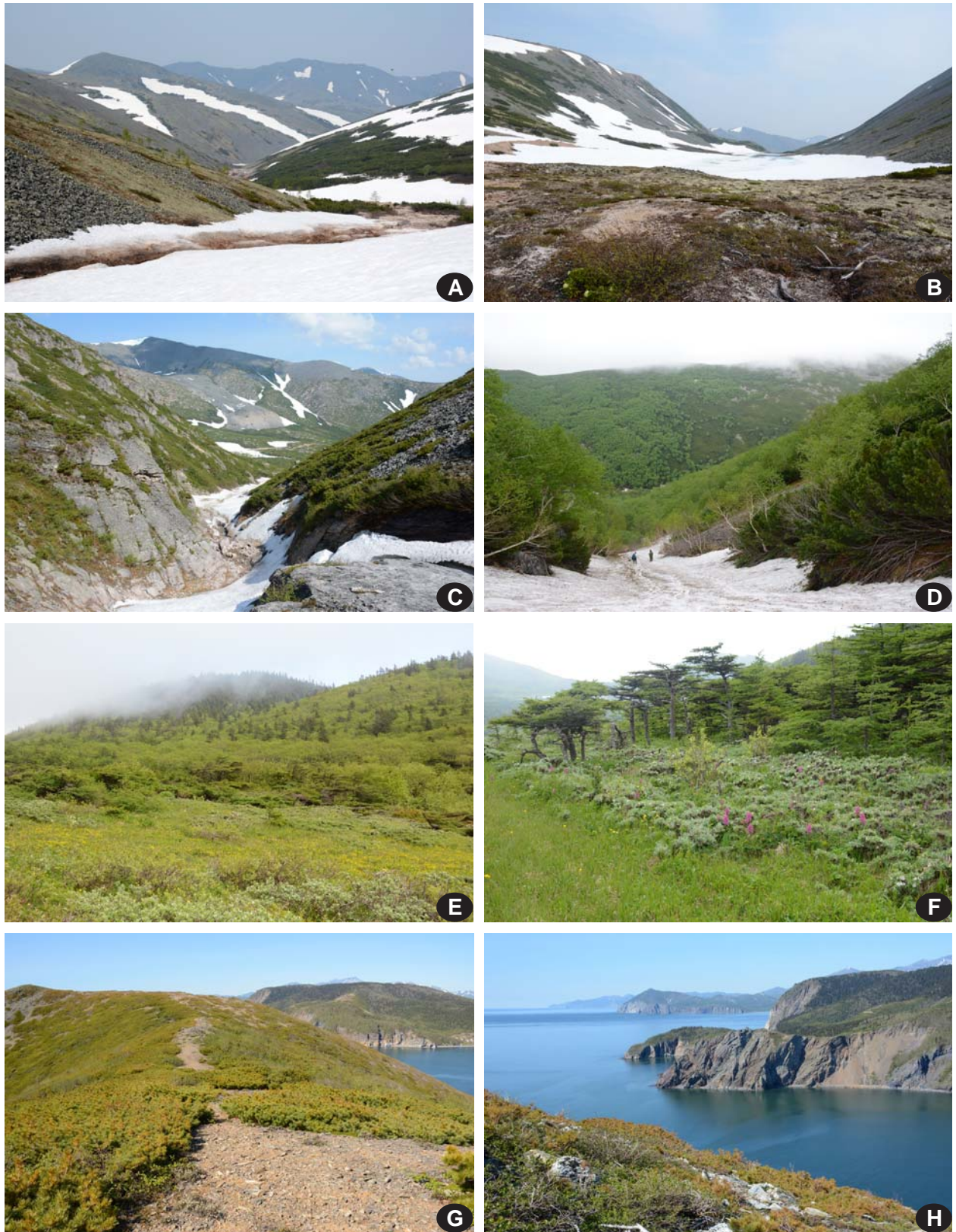


Fig. 2. Vegetation types in the studied area. **A, B:** Dzhugdzhur Range vegetation (loc. 14). **C:** Dzhugdzhur Range, stream valley (loc. 7). **D:** SE-facing slope to Unych'ya River, *Betula lanata* crooked forest and *Pinus pumila* thickets (loc. 22). **E:** Seacoast area, wind-faced vegetation with *Picea ajanensis* and *Betula lanata* (loc. 18). **F:** 'Flag formed' trees of *Larix cajanderi* among tundra-like community with grasses and *Caragana jubata* in the seacoast area (loc. 18). **G:** Dwarf *Pinus pumila* and tundra vegetation on coastal hills along Ayanskaya Bay (loc. 2). **H:** Cliffy shore of the Sea of Okhotsk, with lighted *Picea ajanensis* stands in 'wind shade' and *Pinus pumila* in wind exposed places (loc. 2).



Fig. 3. Vegetation types in the studied area and habitats of rare moss species. **A:** *Larix cajanderi* forest in the stream valley, eastern spurs of Dzhugdzhur Range, 300 m alt., habitats of *Rhizomnium nudum* and *Sphagnum tundrae*. **B:** Rock field on a slope to stream valley surrounded by *Larix* forest with *Picea*, *Betula* and *Pinus pumila*, eastern spurs of Dzhugdzhur Range, 400 m alt., habitat of *Grimmia jacutica*. **C:** Ridgeline in alpine belt with rock fields, small spots covered by tundra vegetation and sparse rocky outliers, axial part of Dzhugdzhur Range, 1300 m alt., habitat of *Grimmia jacutica*. **D:** Large N-facing conglomerate cliffs, Pribrezhnyi Range, Unych'ya River valley, 129–154 m alt., with scattered *Betula lanata* along riverside, habitat of *Hedwigia kuzenevae*. **E:** Riverside SE-S-facing cliffs, Pribrezhnyi Range, Unych'ya River valley, 80 m alt., habitats of *Coscinodon yukonensis*, *Echinophyllum sachalinense* and *Oedipodium griffithianum*. **F:** *Oedipodium griffithianum* from 'E'. **G:** Boggy community covered in winter by aufeis glade not far from slightly salted estuary occasionally filling with salted water, -2 m alt. (sic!), westward of Ayan Settl., Sivakchan River valley, habitat of *Cinclidium stygium*, *Distichium inclinatum*, *Meesia triquetra*. **H:** Rich fen over limestone subbase, with sluggishly flowing waters, NW of Ayan Settlement, 90 m alt., habitats of *Catoscopium nigratum*, *Cinclidium arcticum*, *Paludella squarrosa*, and *Tortella spitsbergensis*.

of *Alnus fruticosa*, and mountain tundra. Rock fields are numerous. Late snow beds have willow dominated or mossy communities. Mires are few, and one with thick peat deposit was seen only once. Rock types are many, ranging from acid, e.g. granites, to presumable alkaline metamorphic rocks and limestone.

Specimens were collected in the three main areas: 1) Ayan Settlement surroundings within a radius of 3–7 km from the settlement, 2) northernmost part of Pribrezhnyi Range (low and middle altitudinal belts) and Unych'ya River valley, 3) sources of Tugorma and Birandya Rivers in the axial part of Dzhugdzhur Range (the watershed of Pacific and Arctic Oceans). All collected localities are shown in Table 1 and Fig. 1.

#### SPECIES LIST

The names of taxa are arranged alphabetically, with nomenclature following Cherdantseva *et al.* (2018), with some recent taxonomic changes. Species is annotated by: 1) altitudinal range, in meters (given in square brackets); 2) collection localities according Table 1 and Fig. 1.; 3) accompanying moss species, if available; 4) description of habitats.

- Abietinella abietina* (Hedw.) M. Fleisch. – [1066–1484 m], 8, 11, 13. Humus and plant debris and those covering rocks in mountain tundra communities with clumps of dwarf subalpine shrubs.
- Amphidium cf. lapponicum* (Hedw.) Schimp. – [54–935 m], 7, 15, 19, 21. Covering rocks and fine soil covering rocks in niches in subalpine belt, fine soil filling crevice in riverside SE-S-facing cliffs in forest belt, fallen decaying barked branch in *Picea ajanensis-Betula lanata* forest in stream valley.
- Andreaea alpina* Hedw. (= *A. obovata* Thed.) – [1066 m], 8. Covering rocks on NE-facing slope to stream valley in alpine belt.
- A. rupestris* Hedw. – [101–1328 m], 4, 7, 9, 15, 21. Covering rocks and boulders in subalpine and alpine belts and in stream and river valleys in forest belts.
- Anoetangium thomsonii* Mitt. – [129–154 m], 20. Covering rocks in a big crevice of N-facing conglomerate cliffs with scattered *Betula lanata* along riverside.
- Anomobryum concinnatum* (Spruce) Lindb. – [82 m], 19. Soil covering rocks in niche in SE-S-facing riverside cliffs in forest belt.
- Aquilonium plicatulum* (Lindb.) Hedenäs, Schlesak & D. Quandt – [54–1148 m], 4, 5, 7, 13, 14, 15, 21, 24. In pure mats or with *Sanionia uncinata*, *Sciuro-hypnum reflexum*. *Picea* and *Betula* trunk bases and decaying wood in *Picea ajanensis-Betula lanata* forests, covering boulders in stream valley with flood plain vegetation surrounded by *Larix* forest and in *Duschekia fruticosa* thickets in subalpine belt, soil in tundra community in alpine belt.
- Arctoa fulvella* (Dicks.) Bruch, Schimp. & W. GümbeL – [935–1328 m], 7, 9. Sandy soil covering rocks in crevice in subalpine belt, humus in niche under rock in alpine belt.
- Aulacomnium palustre* (Hedw.) Schwägr. – [91–1109 m], 4, 14, 28. Plant debris covering soil in stream valley with flood plain vegetation surrounded by *Larix* forest, soil in eutrophic hypnaceous swamp developed over limestone subbase, soil in moist mossy tundra in alpine belt.
- A. turgidum* (Wahlenb.) Schwägr. – [129–1148 m], 7, 13, 20. Ground cover in thickets of subalpine vegetation in subalpine belt and in tundra communities in alpine belt, soil covering N-facing conglomerate cliffs with scattered *Betula lanata* along riverside.
- Bartramia decidueafolia* Broth. & Yasuda – [54 m], 15. Soil covering vertical surface of rocks in *Picea ajanensis-Betula lanata* forest in the valley.
- Bartramiopsis lescurii* (James) Kindb. – [101 m], 15. Soil covering rocks in *Picea ajanensis* dominating forest with admixture of *Betula lanata* in river valley.
- Brachythecium baicalense* Ignatov – [54 m], 15. Fallen decaying barked branch in *Picea ajanensis-Betula lanata* forest in the valley.
- B. cirrosum* (Schwägr.) Schimp. – [34–200 m], 20, 23, 26. Humus covering rocks along river bank in mixed forest, humus on steep N-NE-facing slope to sea with many limestone outcrops surrounded by tundra-like communities, covering bottom of N-facing conglomerate cliffs with scattered *Betula lanata* along riverside.
- B. erythrorrhizon* Bruch, Schimp. & W. GümbeL – [129–154 m], 20. Humus covering vertical surface of N-facing conglomerate cliffs with scattered *Betula lanata* along riverside.
- B. rotaeanum* De Not. – [117–330 m], 4, 24. Decaying stump in stream valley with flood plain vegetation surrounded by *Larix* forest, *Populus suaveolens* trunk in *Picea* forest with some *Betula lanata* trees in the valley.
- Bryoerythrophyllum recurvirostrum* (Hedw.) P.C. Chen – [5 m], 29. Soil in crevice in basic sedimentary N-facing rock outcrops along seacoast.
- Bryum amblyodon* Müll. Hal. – [-2–140 m], 2, 25. Humus in dwarf shrub-lichen tundra intermingled with spots of bare ground and *Pinus pumila* clumps on a ridge near seacoast, humus and plant debris in boggy community covered in winter by aufeis glade not far from slightly salted estuary occasionally filling with salted water.
- B. argenteum* Hedw. – [140 m], 2. Humus in dwarf shrub-lichen tundra intermingled with spots of bare ground and *Pinus pumila* clumps on a ridge near seacoast.
- B. caespiticium* Hedw. – [93 m], 19. Humus covering riverside S-facing cliffs in wide river valley in forest belt.
- B. creberrimum* Taylor – [11 m], 1. Clayish soil covering rocks near road surrounded by *Betula lanata* and *Duschekia fruticosa* crooked forest on NW-facing slope in settlement area.
- B. pseudotriquetrum* (Hedw.) P. Gaertn., B. Mey. & Scherb. – [11–1109 m], 1, 4, 14, 18, 26, 27. Soil and plant debris covering boulders in *Betula lanata* and *Duschekia fruticosa* crooked forest communities, soil and soil covering rocks on a stream banks in forest, tundra belt and in tundra-like communities on slopes to sea.
- Buckia vaucheri* (Lesq.) D. Ríos, M.T. Gallego & J. Guerra – [140–1478 m], 2, 11. Clayish soil covering boulder in dwarf shrub-lichen tundra intermingled with spots of bare ground and *Pinus pumila* clumps on a ridge near seacoast, fine soil covering rocks in niche on steep slope with scattered alpine vegetation moistened by neutral to basic reaction percolate water and many rocky outcrops and talus.
- Bucklandiella microcarpa* (Hedw.) Bedn.-Ochyra & Ochyra – [904–1066 m], 7, 8. Covering rocks in stream valley in subalpine belt, humus and granitic sediments covering rocks in alpine belt.

- B. sudetica* (Funck) Bedn.-Ochyra & Ochyra – [904 m], 7. Covering rocks on N-facing slope to stream in subalpine belt.
- Calliergonella lindbergii* (Mitt.) Hedenäs – [129–154 m], 20. Clayish soil covering vertical surface of N-facing conglomerate cliffs with scattered *Betula lanata* along riverside.
- Campylium stellatum* (Hedw.) C.E.O. Jensen – [1478 m], 11. Clayish soil moistened by neutral to basic reaction percolate water on steep W-NW-facing slope with scattered alpine vegetation with many rocky outcrops and talus.
- Catoscopium nigratum* (Hedw.) Brid. – [91 m], 28. Soil in eutrophic hypnaceous swamp developed over limestone subbase with sluggishly flowing waters.
- Ceratodon purpureus* (Hedw.) Brid. – [65–780 m], 2, 3, 19, 21. Humus in open sites in alpine and subalpine belts, on rocks along river in forest belt, clayish soil on a roadside in settlement area, old animal excrements in dwarf shrub-lichen tundra on a ridge near seacoast.
- Cinclidium arcticum* (Bruch & Schimp.) Schimp. – [91 m], 28. Soil in eutrophic hypnaceous swamp developed over limestone subbase, with sluggishly flowing waters.
- C. stygium* Sw. – [-2 m], 25. Soil in boggy community covered in winter by aufeis glade not far from slightly salted estuary occasionally filling with salted water.
- Climacium dendroides* (Hedw.) F. Weber & D. Mohr – [54–200 m], 3, 15, 23. Humus in *Picea ajanensis*-*Betula lanata* forests in the valley and in *Betula lanata* crooked forest.
- Cnestrum alpestre* (Wahlenb.) Nyholm – [1478 m], 11. Humus covering rocks on steep W-NW-facing slope with scattered alpine vegetation moistened by neutral to basic reaction percolate water with many rocky outcrops and talus.
- Conostomum tetragonum* (Hedw.) Lindb. – [935 m], 7. Sandy-humus soil covering rocks in crevice in stream valley in subalpine belt.
- Coscinodon yukonensis* Hastings – [82–780 m], 19, 21. Covering rocks in subalpine belt, covering vertical surface of SE-S-facing riverside cliffs in wide river valley in forest belt.
- Cratoneuron filicinum* (Hedw.) Spruce – [22–105 m], 18, 27. Soil in windy community with low grasses and shrubs close to the seacoast, clayish soil covering rocks on a stream bank in lighted *Larix* forest.
- Cynodontium asperifolium* (Lindb. & Arnell) Paris – [140 m], 2. Humus and that covering rocks in dwarf shrub-lichen tundra intermingled with spots of bare ground and *Pinus pumila* clumps on a ridge near seacoast.
- C. strumiferum* (Hedw.) Lindb. – [418–1484 m], 6, 7, 11, 13, 21. Humus covering boulder and fine soil in niche in alpine belt, humus with granitic sediments in subalpine belt, humus covering boulder in niche on a rock field on steep slope to stream valley surrounded by *Larix* forest.
- Cyrtomnium hymenophylloides* (Huebener) T.J. Kop. – [82 m], 19. Sandy-clayish soil in deep niche at the bottom of SE-S-facing riverside cliffs in wide river valley in forest belt.
- Dicranella curvipes* (Lindb.) Ignatov – [935 m], 7. Humus filling crevice in rocky outcrops along streambed in subalpine belt.
- D. subulata* (Hedw.) Schimp. – [11 m], 1. With *Ditrichum heteromallum*. Clayish alluvial soil near road surrounded by *Betula lanata* and *Duscheckia fruticosa* crooked forest communities on NW-facing slope in settlement area.
- Dicranum elongatum* Schleich. ex Schwägr. – [294–1393 m], 4, 7, 9, 10, 13. Soil in subalpine and alpine belts, rotten wood in stream valley in forest belt.
- D. flexicaule* Brid. – [904 m], 7. Soil in *Duscheckia fruticosa* thickets in stream valley in subalpine belt.
- D. fuscescens* Turner – [101–294 m], 4, 15, 24. Humus, rotten wood in *Picea* forest with some admixture of *Betula lanata* in river valley, humus with plant debris covering boulder in stream valley with flood plain vegetation surrounded by *Larix* forest.
- D. laevidens* R.S. Williams – [140–1148 m], 2, 13. In pure mats or with *Dicranum majus*. Soil in alpine belt with dwarf shrub-lichen tundra and *Sphagnum* mats over percolate water openings surrounded by rock fields, soil shaded by *Pinus pumila* in dwarf shrub-lichen tundra intermingled with spots of bare ground and *Pinus pumila* clumps on S-SW-facing slope near seacoast.
- D. majus* Turner – [11–294 m], 1, 2, 4, 7, 15, 23, 24. Humus, plant debris and those covering rocks in alpine and subalpine belts, *Picea ajanensis*-*Betula lanata* forest, decaying wood in *Picea* forest with some admixture of *Betula lanata*.
- D. montanum* Hedw. – [418 m], 6. Humus covering boulder in niche between tree roots on rock field on steep slope surrounded by *Larix* forest with *Picea* and *Betula* admixture and *Pinus pumila* thickets.
- D. schljakovii* Ignatova & Tubanova – [935 m], 7. Sandy-clayish soil covering rocks in stream valley in subalpine belt.
- Didymodon ferrugineus* (Schimp. ex Besch.) M.O. Hill – [5 m], 29. Soil filling crevice in basic sedimentary N-facing rock outcrops along seacoast.
- D. rigidulus* Hedw. – [179 m], 23. Covering boulder on a stream bank in mostly inundated forest along river.
- D. cf. validus* Limpr. – [34 m], 26. Fine soil covering rocks on steep N-NE-facing slope to sea with many limestone outcrops surrounded by tundra-like communities.
- Distichium capillaceum* (Hedw.) Bruch, Schimp. & W. Güm- bel – [34–154 m], 18, 20, 26. Soil in tundra-like communities on slopes and saddle adjacent to the seacoast, humus covering N-facing conglomerate cliffs with scattered *Betula lanata* along riverside.
- D. inclinatum* (Hedw.) Bruch, Schimp. & W. Güm- bel – [-2 m], 25. Soil in boggy community covered in winter by aufeis glade not far from slightly salted estuary occasionally filling with salted water.
- Ditrichum heteromallum* (Hedw.) E. Britton – [11 m], 1. With *Dicranella subulata*. Clayish alluvial soil near road surrounded by *Betula lanata* and *Duscheckia fruticosa* crooked forest communities on NW-facing slope in settlement area.
- Echinophyllum sachalinense* (Lindb.) O'Brien – [54–179 m], 15, 23, 24. *Picea* trunk bases in *Picea ajanensis*-*Betula lanata* valley forests, forest litter in mostly inundated forest along river bank.
- Encalypta brevicollis* (Bruch & Schimp.) Ångstr. – [1436 m], 10. Humus covering rocks on rocky ridge in alpine belt.
- E. ciliata* Hedw. – [93–1478 m], 11, 19. Humus covering rocks on steep W-NW-facing slope with scattered alpine vegetation with many rocky outcrops, on large riverside S-facing cliffs in wide river valley in forest belt.
- E. pilifera* Funck – [5 m], 29. Soil filling crevice in basic sedimentary N-facing rock outcrops along seacoast.
- Fissidens dubius* P. Beauv. – [34–154 m], 20, 26. Soil covering rocks in crevice in N-facing conglomerate cliffs with scattered *Betula lanata* along riverside and on steep N-NE-facing slope to sea with many limestone outcrops surrounded by tundra-like communities.
- Flexitrichum flexicaule* (Schwägr.) Ignatov & Fedosov – [235 m], 23. Cliff crevice near small waterfall in deep canyon in *Duscheckia* crooked forest in subalpine belt.

- F. gracile* (Mitt.) Ignatov & Fedosov – [34 m], 26. Soil covering rocks on steep N-NE-facing slope to sea with many limestone outcrops surrounded by tundra-like communities.
- Funaria hygrometrica* Hedw. – [5 m], 29. Soil filling crevice in basic sedimentary N-facing rock outcrops along seacoast.
- Grimmia donniana* Sm. – [935 m], 7. Crevice in upper surface of rocks in stream valley in subalpine belt.
- G. jacutica* Ignatova, Bedn.-Ochyra, Afonina & J. Muñoz – [418–1328 m], 6, 9. Soil with admixture of sand covering rocks in alpine belt, humus covering boulder in niche on rock field on steep slope surrounded by *Larix* forest and *Pinus pumila* thickets.
- G. longirostris* Hook. – [780 m], 21. Humus covering rocks in subalpine belt.
- G. reflexidens* Müll. Hal. – [1478 m], 11. Covering rocks on steep W-NW-facing slope with scattered alpine vegetation with many rocky outcrops.
- Hedwigia kuzenevae* Ignatova & Ignatov – [129–154 m], 20. Covering vertical surface of N-facing conglomerate cliffs with scattered *Betula lanata* along riverside.
- Herzogiella turfacea* (Lindb.) Z. Iwats. – [82 m], 19. Rotten log near riverside in wide river valley in forest belt.
- Hygrohypnella ochracea* (Turner ex Wilson) Ignatov & Ignatova – [54–179 m], 15, 23. Covering boulders and sand over boulders submerged in running water in stream and river valleys in forest belt.
- Hylocomiadelphus triquetrus* (Hedw.) Ochyra & Stebel – [101–154 m], 15, 20. Forest litter in *Picea ajanensis* dominating forest with admixture of *Betula lanata* in river valley, soil covering N-facing conglomerate cliffs with scattered *Betula lanata* along riverside.
- Hylocomiastrum pyrenaicum* (Spruce) M. Fleisch. – [101 m], 15. Soil in *Picea ajanensis* dominating forest with admixture of *Betula lanata* in river valley.
- Hylocomium splendens* (Hedw.) Bruch, Schimp. & W. Gümbel – [54–904 m], 2, 5, 7, 13, 15, 24. Soil in alpine and subalpine belts and *Picea ajanensis*-*Betula lanata* forests, covering boulder in *Larix* forest with *Picea* and *Betula* admixture in stream valley.
- Hymenostylium recurvirostrum* (Hedw.) Dixon – [129–154 m], 20. Covering N-facing conglomerate cliffs with scattered *Betula lanata* along riverside.
- Hypnum cupressiforme* Hedw. – [117 m], 24. *Populus* trunk in *Picea* forest with some *Betula lanata* trees in the valley.
- H. cupressiforme* var. *subjulaceum* Molendo – [780 m], 21. Fine soil covering rock in niche in subalpine belt.
- Isopterygiella alpicola* (Lindb.) Ignatov & Ignatova – [93 m], 19. Humus covering riverside S-facing cliffs in forest belt.
- I. pulchella* (Hedw.) Ignatov & Ignatova – [1484 m], 11. With *Pohlia beringiensis*. Humus covering boulder on steep N-facing slope in alpine belt.
- Isopterygiopsis catagonioides* (Broth.) Ignatov & Ignatova – [129–935 m], 7, 20, 21. Soil covering rocks in niche and soil between boulders in subalpine belt, covering N-facing conglomerate cliffs with scattered *Betula lanata* along riverside.
- Iwatsukiella leucotricha* (Mitt.) W.R. Buck & H.A. Crum – [101–780 m], 5, 15, 16, 17, 20, 21, 24. *Betula* trunks in *Picea* forests and in subalpine belt, *Picea* trunk in *Larix* forest with *Picea* and *Betula* admixture, decaying barked *Betula* and *Pinus pumila* branches in *Picea* forest, covering vertical surface of N-facing conglomerate cliffs with scattered *Betula lanata* along riverside.
- Lewinskya sordida* (Sull. & Lesq.) F. Lara, Garilleti & Goffinet – [54–330 m], 4, 15, 23. *Salix udensis* and *Populus suaveolens* trunks near streams in different type forests.
- Loeskypnum badium* (Hartm.) H.K.G. Paul – [91 m], 28. With *Paludella squarrosa*, *Tomentypnum nitens*. Soil in eutrophic hypnaceous swamp developed over limestone subbase with sluggishly flowing waters.
- Meesia triquetra* (Jolycl.) Ångstr. – [-2 m], 25. Soil partly submerged in water in boggy community covered in winter by aufeis glade not far from slightly salted estuary occasionally filling with salted water.
- Mnium lycopodioides* Schwägr. – [101–1484 m], 4, 7, 11, 15. Small soil niche in tundra in alpine belt, humus covering rocks in niche in subalpine belt, *Larix* needles stratum covering soil in stream valley with flood plain vegetation surrounded by *Larix* forest, *Salix udensis* trunk base in *Picea ajanensis* dominating forest in stream valley.
- M. marginatum* (Dicks.) P. Beauv. – [330 m], 4. Tree trunk in stream valley with flood plain vegetation surrounded by *Larix* forest.
- M. spinosum* (Voit) Schwägr. – [117 m], 24. *Populus* trunk base in *Picea* forest with some *Betula lanata* trees in the valley.
- M. thomsonii* Schimp. – [780 m], 21. Humus covering rock in crevice in subalpine belt.
- Myurella julacea* (Schwägr.) Bruch, Schimp. & W. Gümbel – [5–1478 m], 11, 19, 26, 29. Clayish soil covering rocks in alpine belt, humus covering riverside S-facing cliffs in wide river valley in forest belt, soil and that covering coastal basic sedimentary N-facing rock outcrops and in tundra-like communities near seacoast.
- Myuroclada maximowiczii* (G.G. Borshch.) Steere & W.B. Schofield – [5 m], 29. Soil covering basic sedimentary N-facing rock outcrops along seacoast.
- Niphotrichum canescens* (Hedw.) Bedn.-Ochyra & Ochyra – [1119–1478 m], 11, 12. Sandy-clayish and sandy soil moistened by neutral to basic reaction percolate water on steep N-facing slope with alpine vegetation, many rocky outcrops and rock fields.
- Oedipodium griffithianum* (Dicks.) Schwägr. – [82 m], 19. Soil covering riverside SE-S-facing cliffs in wide river valley in forest belt.
- Oligotrichum falcatum* Steere – [935–1066 m], 7, 8. Sandy-humus soil between boulders in alpine belt, humus filling rock crevice in stream valley in subalpine belt.
- O. parallelum* (Mitt.) Kindb. – [101 m], 15. Soil wall on a stream bank and covering vertical surface of rocks in narrow crevice in *Picea ajanensis* dominating forest with admixture of *Betula lanata* in river valley.
- Oncophorus virens* (Hedw.) Brid. – [54–154 m], 15, 20. Clayish-sandy soil covering boulder on a stream bank in *Picea ajanensis*-*Betula lanata* forest, sandy soil covering boulder partly submerged in water on a riverbank near large N-facing conglomerate cliffs with scattered *Betula lanata*.
- Paludella squarrosa* (Hedw.) Brid. – [91 m], 28. With *Loeskypnum badium*, *Tomentypnum nitens*. Soil in eutrophic hypnaceous swamp developed over limestone subbase with sluggishly flowing waters.
- Plagiomnium ellipticum* (Brid.) T.J. Kop. – [54 m], 15. Humus and plant debris in wet hollow in *Picea ajanensis*-*Betula lanata* forest in stream valley.
- Plagiopus oederianus* (Sw.) H.A. Crum & L.E. Anderson – [93–154 m], 19, 20. Humus covering rocks in niche in riverside S-facing cliffs, covering vertical surface of rocks N-fa-



- cing conglomerate cliffs with scattered *Betula lanata* along riverside.
- Plagiothecium cavifolium* (Brid.) Z. Iwats. – [82 m], 19. Soil covering riverside SE-S-facing in wide river valley cliffs.
- P. denticulatum* (Hedw.) Bruch, Schimp. & W. Gümbel – [101–418 m], 6, 15, 23. Soil near small pool and covering rocks in *Picea ajanensis* dominating forest in river valley, clayish soil on a stream bank in *Larix* forest, humus covering rocks along river bank in mixed forest.
- P. svalbardense* Frisvoll – [377 m], 5. *Picea* trunk base in *Larix* forest with *Picea* and *Betula* admixture in stream valley.
- Platyhypnum alpestre* (Hedw.) Ochyra – [235 m], 23. Sandy soil covering boulder in streambed near small waterfall in deep canyon.
- P. duriusculum* (De Not.) Ochyra – [179–330 m], 4, 23. Sandy soil covering boulder on a stream bank near water's edge and covering boulder in a streambed in *Larix* forest with flood plain vegetation along stream, sand covering boulder submerged in water in mostly inundated forest along river bank.
- P. norvegicum* (Bruch, Schimp. & W. Gümbel) Ochyra – [182 m], 16. Covering boulder in small temporary watercourse in *Picea* forest on SW-facing slope of the river valley.
- Pleurozium schreberi* (Brid.) Mitt. – [11–904 m], 1, 4, 7, 15, 21, 24. Soil in subalpine vegetation thickets in subalpine belt, in *Picea ajanensis* forests with *Betula lanata* admixture and in *Larix* forest with flood plain vegetation along stream.
- Pogonatum dentatum* (Brid.) Brid. – [1148 m], 13. Humus filling crevice between boulders in alpine belt with sparse vegetation surrounded by rock fields.
- P. urnigerum* (Hedw.) P. Beauv. – [11–1066 m], 1, 2, 8. Clayish soil and sandy-clayish soil along streambed in alpine belt, clayish alluvial soil on a roadside surrounded by *Betula lanata* and *Duschekia fruticosa* crooked forest communities on NW-facing slope in settlement area.
- Pohlia beringiensis* A.J. Shaw – [1484 m], 11. With *Isopterygiella pulchella*. Humus covering boulder on steep N-facing slope in alpine belt.
- P. cruda* (Hedw.) Lindb. – [54–294 m], 4, 15. Humus covering rocks in small niche, soil wall in stream valley with flood plain vegetation surrounded by *Larix* forest, humus covering vertical surface of rocks in *Picea ajanensis*-*Betula lanata* forest in the valley.
- P. crudoides* (Sull. & Lesq.) Broth. – [101–1261 m], 9, 15. Coarse grained sand with small admixture of humus in niche on NE-facing slope in alpine belt, covering vertical surface of rocks in *Picea ajanensis* dominating forest with admixture of *Betula lanata* in river valley.
- P. drummondii* (Müll. Hal.) A.L. Andrews – [1484 m], 11. Sandy-clayish soil on steep N-facing slope in alpine belt.
- P. longicolla* (Hedw.) Lindb. – [82 m], 19. Soil covering riverside SE-S-facing cliffs in wide river valley in forest belt.
- P. ludwigii* (Spreng. ex Schwägr.) Broth. – [1109 m], 14. Sandy soil near stream in moist mossy tundra.
- P. nutans* (Hedw.) Lindb. – [117–1066 m], 4, 7, 8, 24. Sandy-humus soil covering rocks in alpine belt, humus and granitic sediments covering rocks in stream valley in subalpine belt, humus covering vertical surface of rocks in stream valley with flood plain vegetation surrounded by *Larix* forest, rotten wood in *Picea* forest with some *Betula lanata* trees in the valley.
- Polytrichastrum alpinum* (Hedw.) G.L. Sm. – [54–1109 m], 14, 15. Soil partly submerged in water near stream in moist mossy tundra, humus in *Picea ajanensis*-*Betula lanata* forest in the valley.
- Polytrichum commune* Hedw. – [294 m], 4. *Larix* needles stratum covering soil in stream valley with flood plain vegetation surrounded by *Larix* forest.
- P. juniperinum* Hedw. – [11–780 m], 1, 21. Clayish soil covering rocks along road in *Betula lanata* and *Duschekia fruticosa* crooked forest communities in settlement area, humus covering rocks in subalpine belt.
- P. piliferum* Hedw. – [140–1393 m], 2, 4, 10, 21. Humus and that filling crevice in alpine belt, clayish-sandy soil covering rock in subalpine belt, humus covering decaying wood in stream valley with flood plain vegetation surrounded by *Larix* forest.
- P. strictum* Brid. – [1109 m], 14. Soil in moist mossy tundra near stream.
- Pseudohygrohypnum fauriei* (Cardot) Jan Kučera & Ignatov – [54 m], 15. *Picea* trunk base in *Picea ajanensis*-*Betula lanata* forest in the valley.
- Ptilium crista-castrensis* (Hedw.) De Not. – [117–904 m], 7, 24. Soil in *Duschekia fruticosa* thickets in subalpine belt, decaying wood in *Picea* forest with some *Betula lanata* trees in the valley.
- Pylaisia polyantha* (Hedw.) Bruch, Schimp. & W. Gümbel – [101–330 m], 4, 15, 24. *Salix udensis* and *Populus suaveolens* trunks in *Picea ajanensis* forests with admixture of *Betula lanata* in valleys, in stream valley with flood plain vegetation surrounded by *Larix* forest.
- P. condensata* (Mitt.) A. Jaeger (*P. selwynii* auct. non Kindb.) – [117 m], 24. *Populus suaveolens* trunk in *Picea* forest with some *Betula lanata* trees in the valley.
- Racomitrium lanuginosum* (Hedw.) Brid. – [780–1148 m], 7, 13, 21. Humus covering boulder in alpine belt with sparse vegetation surrounded by rock fields, covering rocks and sandy-humus soil covering rocks in stream valley in subalpine belt.
- Rhabdoweisia crispata* (Dicks. ex With.) Lindb. – [82 m], 19. Soil covering riverside SE-S-facing cliffs in wide river valley in forest belt.
- Rhizomnium andrewsianum* (Steere) T.J. Kop. – [1484 m], 11. Humus and plant debris moistened by neutral to basic reaction percolate water on steep N-facing slope with alpine vegetation with many rocky outcrops and rock fields.
- R. magnifolium* (Horik.) T.J. Kop. – [179 m], 23. Humus in moist hollow in mostly inundated forest along river bank.
- R. nudum* (E. Britton & R.S. Williams) T.J. Kop. – [294 m], 4. Sandy-clayish soil in stream valley with flood plain vegetation surrounded by *Larix* forest.
- Rhytidium rugosum* (Hedw.) Kindb. – [140–1066 m], 2, 8, 20, 21. Soil and plant debris covering rocks in alpine belt, covering upper surface of N-facing conglomerate cliffs with scattered *Betula lanata* along riverside.
- Saelania glaucescens* (Hedw.) Broth. – [1478 m], 11. Clayish soil covering rocks moistened by neutral to basic reaction percolate water on steep W-NW-facing slope with scattered alpine vegetation with many rocky outcrops and talus.
- Santonina uncinata* (Hedw.) Loeske – [11–1148 m], 1, 4, 7, 8, 13, 15, 20, 23, 24. Soil, humus and plant debris covering rocks in alpine belt, covering rocks and soil covering boulders in crooked *Betula lanata*, *Duschekia fruticosa* forests, decaying wood and soil with plant debris in *Picea ajanensis*

- sis-Betula lanata* valley forests, *Larix* needles stratum covering boulder in stream valley with flood plain vegetation surrounded by *Larix* forest.
- Sarmentypnum exannulatum* (Bruch, Schimp. & W. Gümbe) Hedenäs – [904–1109 m], 7, 14. Soil, submerged in water in moist mossy tundra near stream in alpine belt, covering rocks on N-facing slope of stream valley in subalpine belt.
- Schistidium agassizii* Sull. & Lesq. – [129–154 m], 20. Covering big boulder in riverbed, near large N-facing conglomerate cliffs with scattered *Betula lanata* along riverside.
- S. papillosum* Culm. – [93–1478 m], 11, 19. Humus covering rocks on steep W-NW-facing slope in alpine belt, covering riverside S-facing cliffs in wide river valley in forest belt.
- S. pulchrum* H.H. Blom – [82 m], 19. Covering vertical surface of riverside SE-S-facing cliffs in wide river valley in forest belt.
- S. rivulare* (Brid.) Podp. – [101–330 m], 4, 15. Covering boulders in streambeds in stream valley with flood plain vegetation surrounded by *Larix* forest and in *Picea ajanensis* dominating forest with admixture of *Betula lanata* in river valley.
- S. sibiricum* Ignatova & H.H. Blom – [179 m], 23. Fine soil covering boulder in a stream bank in mostly inundated forest along river bank.
- Sciuro-hypnum latifolium* (Kindb.) Ignatov & Huttunen – [65–101 m], 3, 15. Humus near stream with sluggishly flowing water in *Betula lanata* crooked forest in settlement area, partly submerged in small stream in *Picea ajanensis* dominating forest with admixture of *Betula lanata* in river valley.
- S. plumosum* (Hedw.) Ignatov & Huttunen – [129–154 m], 20. Covering N-facing conglomerate cliffs with scattered *Betula lanata* along riverside.
- S. reflexum* (Starke) Ignatov & Huttunen – [11–517 m], 1, 15, 22, 24. Soil and soil covering boulder in crooked *Betula lanata* forest, decaying wood and humus covering boulder in *Picea ajanensis*-*Betula lanata* forests in valleys.
- S. uncinifolium* (Broth. & Paris) Ochyra & Żarnowiec – [54 m], 15. Humus in *Picea ajanensis*-*Betula lanata* forest in the valley.
- Scorpidium cossonii* (Schimp.) Hedenäs – [91 m], 28. Soil in eutrophic hypnaceous swamp developed over limestone subbase with sluggishly flowing waters.
- S. revolvens* (Sw. ex anon.) Rubers – [91 m], 28. Submerged and partly submerged in water in hollows in eutrophic hypnaceous swamp developed over limestone subbase with sluggishly flowing waters.
- S. scorpioides* (Hedw.) Limpr. – [-2 m], 25. Soil on the bottom of hollows and pools in boggy community covered in winter by aufeis glade not far from slightly salted estuary occasionally filling with salted water.
- Seligeria diversifolia* Lindb. – [129–154 m], 20. Covering N-facing conglomerate cliffs with scattered *Betula lanata* along riverside.
- Sphagnum alaskense* R.E. Andrus & Janssens – [904 m], 7. Soil on N-facing slope to stream with dwarf shrub-moss-lichen tundra spots to stream in subalpine belt.
- S. angustifolium* (C.E.O. Jensen ex Russow) C.E.O. Jensen – [904 m], 7. Soil on N-facing slope to stream with dwarf shrub-moss-lichen tundra spots to stream in subalpine belt.
- S. aongstroemii* C. Hartm. – [1148 m], 13. Soil in alpine belt with sparse vegetation represented by dwarf shrub-lichen tundra and *Sphagnum* mats over percolate water openings, surrounded by rock fields.
- S. balticum* (Russow) C.E.O. Jensen – [1148 m], 13. Soil in alpine belt with sparse vegetation represented by dwarf shrub-lichen tundra and *Sphagnum* mats over percolate water openings, surrounded by rock fields.
- S. capillifolium* (Ehrh.) Hedw. – [91 m], 28. Soil in eutrophic hypnaceous swamp developed over limestone subbase with sluggishly flowing waters.
- S. compactum* DC. – [1109 m], 14. Soil in moist mossy tundra near stream.
- S. girgensohnii* Russow – [11–294 m], 1, 4, 15. Soil in *Duschekia fruticosa* thickets, in *Picea ajanensis* dominating forest with admixture of *Betula lanata* in river valley and in stream valley with flood plain vegetation surrounded by *Larix* forest.
- S. lenense* H. Lindb. ex L.I. Savicz – [904–1148 m], 7, 13. Soil in alpine belt with sparse vegetation represented by dwarf shrub-lichen tundra and *Sphagnum* mats over percolate water openings surrounded by rock fields, in dwarf-shrub-moss-lichen tundra spots on N-facing slope to stream in subalpine belt.
- S. tundrae* Flatberg – [294 m], 4. Soil in stream valley with flood plain vegetation surrounded by *Larix* forest.
- S. warnstorffii* Russow – [1148 m], 13. In pure mats or with *Sphagnum lenense*. Soil in alpine belt with sparse vegetation represented by dwarf shrub-lichen tundra and *Sphagnum* mats over percolate water openings, surrounded by rock fields.
- Tetraphis pellucida* Hedw. – [101 m], 15. Rotten stump in *Picea ajanensis* dominating forest with admixture of *Betula lanata* in river valley.
- Tetraplodon angustatus* (Hedw.) Bruch, Schimp. & W. Gümbe – [140 m], 2. Old animal excrements in dwarf shrub-lichen tundra intermingled with spots of bare ground and *Pinus pumila* clumps on a ridge near seacoast.
- T. mnioides* (Hedw.) Bruch, Schimp. & W. Gümbe – [140 m], 2. In pure mats or with *Tetraplodon angustatus*. Old animal excrements in dwarf shrub-lichen tundra intermingled with spots of bare ground and *Pinus pumila* clumps on a ridge near seacoast.
- Tomentypnum nitens* (Hedw.) Loeske – [91 m], 28. In pure mats or with *Loeskypnum badium*, *Paludella squarrosa*. Soil in eutrophic hypnaceous swamp developed over limestone subbase with sluggishly flowing waters.
- Tortella fragilis* (Hook. & Wilson) Limpr. – [5 m], 30. Soil on basic sedimentary N-facing rock outcrops along seacoast.
- T. spitsbergensis* (Bizot & Thér.) O. Werner, Köckinger & Ros – [91 m], 28. Soil in eutrophic hypnaceous swamp developed over limestone subbase with sluggishly flowing waters.
- T. tortuosa* (Hedw.) Limpr. – [34–105m], 18, 26. Humus and plant debris shaded by *Caragana jubata*, soil covering rocks in tundra-like communities near seacoast.
- Tortula hoppeana* (Schultz) Ochyra – [93 m], 19. Humus covering riverside S-facing cliffs in forest belt.
- Trachycystis ussuriensis* (Maack & Regel) T.J. Kop. – [129–154 m], 20. Humus covering conglomerate cliffs with scattered *Betula lanata* along riverside.
- Ulota rehmannii* Jur. – [54 m], 15. *Picea* trunk in *Picea ajanensis*-*Betula lanata* forest in the valley.
- Warnstorfia pseudostraminea* (Müll. Hal.) Tuom. & T.J. Kop. – [-2 m], 25. Soil partly submerged in water in boggy community covered in winter by aufeis glade not far from slightly salted estuary occasionally filling with salted water.
- Zygodon sibiricus* Ignatov, Ignatova, Z. Iwats. & B.C. Tan – [117 m], 24. *Populus suaveolens* trunk in *Picea* forest with some *Betula lanata* trees in the valley.

## DISCUSSION

The short time of field work revealed 164 species and one variety, which indicates a rather high moss diversity for this area with such harsh environments. Of course, the revealed diversity is far from comprehensive, and its features can be discussed only preliminarily. Nevertheless, some of them are interesting and worthy mentioning. The closest for comparison are: (1) the local floras of Yudoma River (tributary of Maya River, which is a tributary of Aldan) (Ignatov *et al.*, 2001), ca. 350 km NNW; and (2) the Upper Bureya River (Ignatov *et al.*, 2000), ca. 550 km SSW.

1. Iwatsuki (1972) classified mosses that occur both in East Asia and North America in two groups. Temperate species common with North America occur in eastern North America, comprising classical 'Arcto-Tertiary' disjunction, between East Asia and eastern North America. The second group occurs in North-Pacific regions of North America. There is only one species with 'Arcto-Tertiary' disjunction among Ayan mosses, *Pseudohygrohypnum fauriei*, while North Pacific flora elements (or Beringian *sensu lato*) are rather many: *Coscidon yukonensis*, *Trachycystis ussuriensis*, *Myuroclada maximowiczii*, *Echinophyllum sachalinense*, *Sciurohypnum uncinifolium*, *Bartramiopsis lescurii*, *Oligotrichum falcatum*, *O. parallelum*, and *Rhizomnium nudum*. All of them were found in the studied area at lower elevations. In Upper Bureya moss flora about the same number of North-Pacific species (9) are known (Ignatov *et al.*, 2000), but species with 'Arcto-Tertiary' disjunction are also many (8).

Second flora taken for comparison, from Yudoma River in South Yakutia lacks species of both aforementioned groups, except of North-Pacific *Pylaisia steerei*.

Here we can find a contrast in distribution patterns between mosses and hepatics. The analysis of Bakalin *et al.* (2021) found Ayan liverwort flora to be especially similar to Northern Sikhote-Alin, then Southern Sikhote-Alin, and then Northern Hokkaido. For mosses, the Northern Sikhote-Alin is enriched by temperate elements (Fedosov *et al.*, 2016) even more than the Upper Bureya moss flora, and in Southern Sikhote-Alin and then Northern Hokkaido 'Arcto-Tertiary disjuncts' their number still increased.

2. The moss species composition characterizes the area as cold and humid. The abundance of *Sciurohypnum reflexum* and *Sanionia uncinata* at most elevations is similar to Kola Peninsula (NW Europe), Kamchatka, and also Botchi State Nature Reserve in the south of Khabarovsk Territory, also a very humid territory (Ignatova *et al.*, 2013). In the latter area *Aquilonium plicatum*, *Brachythecium baicalense*, *Echinophyllum sachalinense*, *Dicranum majus*, *Hylocomiadelphus triquetrus*, and *Tetraphis pellucida* are common, and *Herzogiella turfacea* also is not rare. One of the most interesting mosses in Ayan is *Oedipodium griffithianum*. This species was only recently found in Russia (Ignatov *et al.*, 2006) at about a

timberline in Middle Sikhote-Alin. In Ayan this species occurs at about sea level, similar to the that in other regions with hyperoceanic climate (Størmer, 1969). The Yudoma moss flora, being only 200 km from the Sea of Okhotsk, includes such strict xerophytic species as *Indusiella thisnschanica*, *Grimmia poecilostoma*, and *Entosthodon pulchellus*. Ayan moss flora has no such elements. However, a somewhat more xeric flora in the studied area exists at upper elevation, in high mountains, above 1000 m alt. Such species as *Abietinella abietina* seems absent or at least very rare at lower elevations: all its collections were done in the interval 1066–1484 m. Only or mostly at the same level occur *Pogonatum dentatum*, *Niphotrichum canescens*, *Racomitrium lanuginosum*, *Buckia vaucheri*, and *Conostomum tetragonum*. Some species from these elevations represent northern flora element, close to the southern limit of general distribution: *Cnestrum alpestre*, *Encalypta brevicollis*, *Sphagnum aongstroemii*, *S. lenense*, *Rhizomnium andrewsianum*.

3. Wetland and peat land moss composition is unusual. There is no *Calliergon* and *Drepanocladus*, and *Campylium* was found just once at ca. 1500 m. *Sarmenotypnum exannulatum* was found only twice, and *Wanstorfia pseudostraminea* – once. Rich fen species were collected in two places, one calcareous (*Catoscopium nigratum*, *Cinclidium arcticum*, *Loeskypnum badium*, *Paludella squarrosa*, *Scorpidium cossonii*, *S. revolvens*, *Tomentypnum nitens*), and one salty (*Cinclidium stygium*, *Meesia triquetra*, *Scorpidium scorpioides*). Interestingly, there were no one species in common in these places. *Campylium stellatum*, that commonly co-occurs with these species, was found in third place.

Although the short field trip conditions makes exploration fairly uneven, the following data on species diversity may show at least roughly a pattern of moss distribution along the altitude:

Altitude, m	studied locs.	Species
0–400	20	125
400–800	3	20
800–1200	5	44
1200–1484	3	22

As expected, low elevations comprise the maximal diversity in this area.

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