

# The diversity of mosses of the coastal areas of the Koryak Upland (Far East, Russia)

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**Abstract:** Data on the mosses found at 16 sites on the Koryak Upland territory on the coastland of Bering Sea are presented. Totally 76 moss species were documented. It has been discovered that among all the mosses detected there are no typical halophytes, but all the species are more or less resistant to saline soils. We outlined four groups of species that are mostly adapted to halophilic conditions. It has been discovered that the bryoflora of the coastal territories is considerably rich and diverse and represents 25,9% of the total amount of mosses of the upland.

**Key words:** bryoflora, rare species, halophilic species, Bering Sea

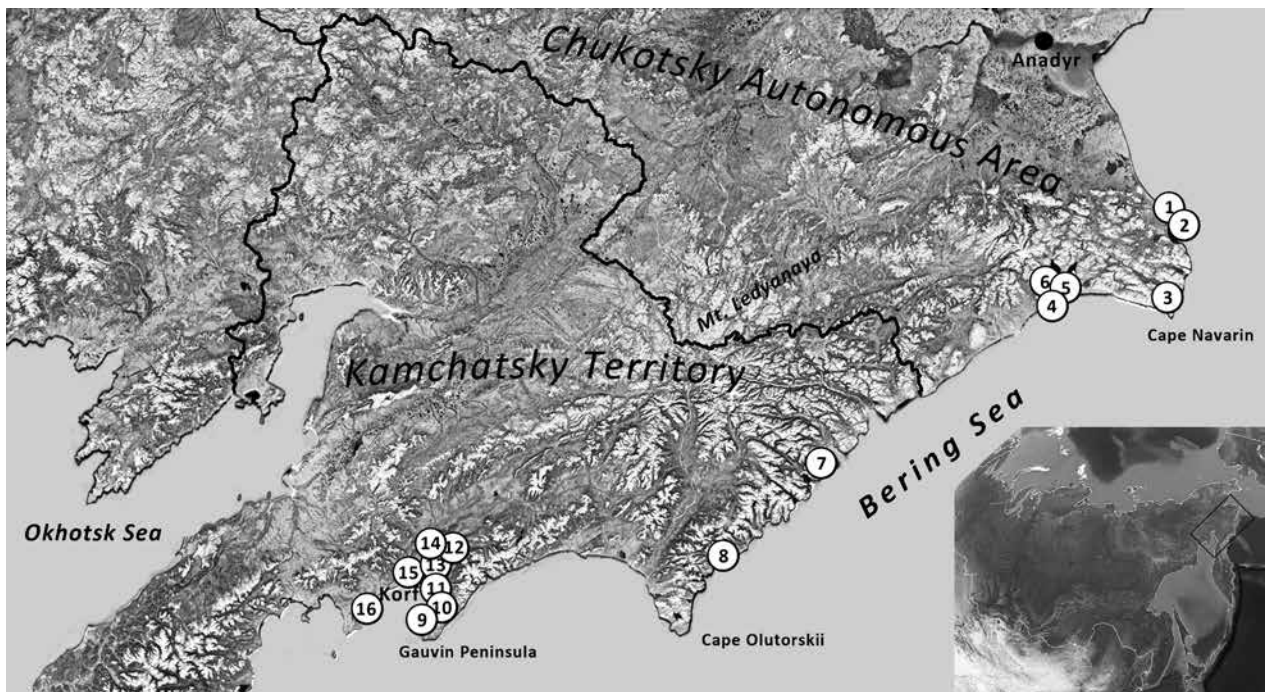
## Introduction

The Koryak Upland bryoflora has become an area of study relatively recently. The first data regarding the Koryak Upland mosses, including those of coastal areas, were published by CHERDANTSEVA (1978). The first list of the Koryak Upland mosses with 275 species was published by KUZMINA (2003). By 2012 283 species were known for the upland (KUZMINA et al. 2012). Currently, taking into account unpublished data, list of species of mosses of the Koryak Upland includes 294 species. The study of the mosses of this area continues. Therefore, the aim of the present work was to study the bryoflora of the coastal areas of the Koryak Upland.

## Material and methods

Koryak Upland is situated in the far North-East of Russia between 59°40' и 63°40' N and 163°50' and 179°40'E (Fig. 1). It borders with Kamchatka in the south and with Anadyr lowland in the north. It is a vast mountain land with absolute altitudes up to 2562 meters above the sea level (mount Ledyanaya), which is washed by the Bering Sea and by the Sea of Okhotsk in the southeast. Vegetation communities of the seacoast are being formed in specific conditions,

which are harsh subarctic climate, salinization of substrates, systematic irrigation of habitats by tides and storms. The following 16 sites on the northeast and southwest upland spurs at the Bering Sea shore were examined (Fig. 1): **I Beringovskiy** (63° 04'N, 179° 26'E) – 0.5 km to the west of the Village Beringovskiy; **II Nagorny** (63° 04'N, 179° 13'E) – 1 km to the north-east of the Village Nagorny; **III Navarin** (62° 24'N, 179° 03'E) – Cape Navarin in the Gulf of Greiga; **IV Mainypilgyno** (62° 31'N, 176° 57'E) – On the coastal pebble spit in 2-3 km to the north of the Village Mainypilgyno; **V Yanrakoim** (62° 29'N, 176° 45'E) – The pebble spit between the south-eastern shore of Pekulneiskoe Lake and the Island Yanrakoim; **VI Vaamochka** (62° 28'N, 176° 44'E) – Pebbly lakeside terrace on the southern and south-eastern shore of the Lake Vaamochka; **VII Krasnaya** (61° 14'N, 172° 33'E) – The coast of the Bering Sea, the “Krasnaya” weather station (to the North of the Bay Natalia); **VIII Topata** (60° 26'N, 170° 47'E) – The Olyutorskiy Peninsula, the surroundings of the weather station “Topata”; **IX Primetnyi** (59° 53'N, 166° 06'E) – Gauvin Peninsula, north of Cape Primetnyi; **X Chayachii** (60° 03'N, 166° 11'E) – Gauvin Peninsula, Cape Chayachiy, the mouth of the



**Fig. 1.** Collecting sites: 1 – Beringovskiy (I), 2 – Nagornyi (II), 3 – Navarin (III), 4 – Mainypilgyno (IV), 5 – Yanra-koim (V), 6 – Vaamochka (VI), 7 – Krasnaya (VII), 8 – Topata (VIII), 9 – Primetnyi (IX), 10 – Chayachii (X), 11 – Peschanyi (XI), 12 – Enilkivayam (XII), 13 – Kultushnoye (XIII), 14 – Tilichiki (XIV), 15 – Korf (XV), 16 – Geka (XVI)

Alinatuvayam River; **XI Peschanyi** ( $60^{\circ} 08'N$ ,  $166^{\circ} 16'E$ ) – Gauvin Peninsula, Cape Peschanyi, the mouth of the Asigivaym River; **XII Enilkivayam** ( $60^{\circ} 27'N$ ,  $166^{\circ} 21'E$ ) – Delta of the River Kultushnaya, at the mouth of the Stream Enilkivayam; **XIII Kultushnoye** ( $60^{\circ} 28'N$ ,  $166^{\circ} 24'E$ ) – Corf Bay, near the Village Kultushnoe; **XIV Tilichiki** ( $60^{\circ} 32'N$ ,  $166^{\circ} 17'E$ ) – Corf Bay, surroundings of Tilichiki Village; **XV Korf** ( $60^{\circ} 26'N$ ,  $166^{\circ} 05'E$ ) – Korf Bay, near of the Korf Village; **XVI Geka** ( $60^{\circ} 01'N$ ,  $165^{\circ} 09'E$ ) – South coast of Geka Bay.

The dates of sampling and investigated ecotopes, designated by Arabic numerals, for each site were as follows: **I** (5.07.1986): **1**) swampy seashore, **2**) pebble near the sea, **3**) pebbles on the sea coast, **4**) primitive plant aggregation on the shore of the sea and dwarf-shrub tundra, **5**) primitive plant aggregation on the sea coast, **II** (6.07.1986): **6**) dwarf-shrub tundra; **III** (1997): **7**) sedge-moss primitive aggregation; **IV** (7.08.1986): **8**) grassy-dwarf-willow-sedge primitive plant aggregation on the flooded shore, **9**) sedge hummock in a damp depression on the seaside pebble terrace, **10**) slightly saline dry riverbed, **11**) seaside gravels, **12**) seaside pebble spit, grassy-dwarf-willow-sedge primitive plant aggregation on the flooded shore, **13**) seaside pebble spit, **14**) stony and pebble (sometimes with a weak salinity) the banks of the ponds, **15**) herbs-dwarf-willow with *Empetrum subholarcticum* tundra on the seaside

pebble spit, **16**) hummock in the old canal with poor salinity **V** (27-28.07.1986): **17**) swampy shore of pebble beach, **18**) shingle of seaside pebble spit, **19**) seaside pebble spit, **20**) marshy depression in the gravel, **21**) dry high bank of the lake, **22**) boggy place on the shore of the lake, **23**) pebble spit, **24**) pebbly ramparts on the shore of the lake, **25**) pebble hills along the lake shore, **26**) pebble hills along the lake shore, boggy place, **27**) seaside pebble spit, **28**) pebble shaft on a gravel spit, **29**) low waterlogged place on the shore of the lake, **30**) in the thickets of *Leymus interior* around burrows gophers on the seaside pebble spit; **VI** (9.08.1986): **31**) pebbly lakeside terrace, **32**) track of all-terrain road, **33**) dwarf-shrub tundra on the pebbly lakeside terrace, **34**) hilly dwarf-shrub tundra on the pebbly lakeside terrace, **35**) dwarf-shrub tundra, dry patch of small pebbles, **36**) pebbles on the sea shore, **37**) dwarf-shrub tundra, **38**) gravel near the sea, **39**) spotty dwarf-shrub tundra, **40**) all-terrain trail in the shrub tundra; **VII** (28.06.-2.07.1976): **41**) rarefied thickets of alder-shrub, **42**) boggy shore of the bay; **VIII** (12.07.1976): **43**) thickets of dwarf pines and alder elfin woods, **44**) thickets of dwarf pine and alder-shrub, **45**) dwarf-shrub tundra, **46**) heather tundra; **IX** (2.09.1975): **47**) pebbles on the stream bank; **X** (15-21.07.2012): **48**) seaside community of *E. subholarcticum*, **49**) seaside community of *E. subholarcticum*, **50**) seaside meadow herbs-iris at seaside

high shaft, **51**) dwarf-willow community (*Salix fuscescens*); **XI** (18.07.2012): **52**) sedge-grass communities, **53**) sedge communities, **54**) grass community, **55**) sedge-moss community; **XII** (26.07.2012): **56**) sedge coastal marshes on the shore of the estuary, **57**) dwarf-willow-sedge community on the shore of the estuary, **58**) dwarf-willow-moss community; **XIII** (1960): **59**) damp thickets of alder on a cliff to the sea, **60**) boggy shore of the bay, **61**) old fire site on the seaside plain, **62**) steep bank of the lake on the coastal plain, **63**) wet shrub thickets on coastal plain, **64**) stream floodplain on the coastal plain; **XIV** (6.07.2014): **65**) wet track on the shore of the bay; **XV** (13.07.2012): **66**) seaside community of *E. subholarcticum* with grasses; **XVI** (2.07.1976): **67**) dwarf-shrubs-sphagnum bog and **68**) thickets of dwarf pines.

For the compilation of the species list we have used author's made in 1986, 2012 and 2014 and the materials gathered by A. E. KATENIN, 1960 (KUZMINA 1998); S. Y. BARKALOV and M. Y. GORSHKOV, 1975, S. S. KHARKEVICH and T. G. BUCH, 1976 (CHERDANTSEVA 1978), A. V. BELIKOVICH and A. V. GALANIN, 1997 (KUZMINA 2003). The specimens collected by the author, KATENIN, BELIKOVICH and GALANIN are kept in the bryological herbarium of Komarov Botanical Institute (LE). The nomenclature of mosses follows IGNATOV et al. (2006).

## Results

Below the list of moss species with the sites (designated by Roman numerals) and relevant ecotopes (designated by Arabic numerals in coincidence with the text above) are provided. Rare species for the upland are marked with an asterisk (\*):

*Amblystegium serpens* (Hedw.) B. S. G. – **IV**: 8.

*A. varium* (Hedw.) Lindb. – **IV**: 9; **XIII**: 59.

*Aulacomnium palustre* (Hedw.) Schwaegr. – **I**: 1; **II**: 6; **IV**: 10; **V**: 17; **XIII**: 60; **XIV**: 65.

*Bartramia ithyphylla* Brid. – **V**: 19.

*Brachythecium salebrosum* (F. Weber & D. Mohr) Bruch et al. – **IV**: 11.

\**B. udum* I. Hagen – **XIII**: 59.

\**Bryum argenteum* Hedw. – **V**: 19; **XIII**: 61.

*B. pseudotriquetrum* (Hedw.) P. Gaertn., B. Mey. & Scherb. – **II**: 6; **XI**: 52.

\**B. turbinatum* (Hedw.) Turner – **IV**: 8, 13; **V**: 25.

*Calliergon cordifolium* (Hedw.) Kindb. – **IV**: 13; **XI**: 52; **XII**: 56; **XIII**: 59.

*C. giganteum* (Schimp.) Kindb. – **XI**: 52; **XII**: 56, 58; **XIII**: 62; **XVI**: 67.

*Calliergonella lindbergii* (Mitt.) Hedenäs – **IV**: 14; **V**: 20.

*Ceratodon purpureus* (Hedw.) Brid. – **I**: 2; 4; **IV**: 13; **V**: 25;

**XV**: 66; **XVI**: 68.

*Climacium dendroides* (Hedw.) F. Weber & D. Mohr – **IV**: 13; **V**: 26.

*Cynodontium strumiferum* (Hedw.) Lindb. – **IV**: 13; **VIII**: 43.

\**C. tenellum* (Schimp.) Limpr. – **VI**: 31.

\**Dicranella cerviculata* (Hedw.) Schimp. – **I**: 3.

\**D. subulata* (Hedw.) Schimp. – **VI**: 32.

*Dicranoweisia crispula* (Hedw.) Milde – **IV**: 13; **VII**: 41.

*Dicranum angustum* Lindb. – **V**: 26.

\**D. drummondii* Müll. Hal. – **V**: 27.

*D. elongatum* Schleich. ex Schwägr. – **V**: 27.

*D. groenlandicum* Brid. – **III**: 7.

*D. majus* Turner – **I**: 4; **IV**: 13; **V**: 26; **X**: 48.

*D. spadiceum* J. E. Zetterst. – **I**: 5; **II**: 6; **IV**: 15; **V**: 26; **VI**: 33.

*Distichium capillaceum* (Hedw.) Bruch et al. – **V**: 27.

*Drepanocladus aduncus* (Hedw.) Warnst. – **IV**: 15; **V**: 26; **XI**: 52.

*D. polygamus* (Bruch et al.) Hedenäs – **IV**: 15; **V**: 26; **XI**: 53; **XII**: 56; 58.

\**D. sendtneri* (Schimp. ex H. Müll.) Warnst. – **IV**: 16.

*Hylocomium splendens* var. *obtusifolium* (Geh.) Paris – **II**: 6; **IV**: 15.

*Leptodictyum riparium* (Hedw.) Warnst. – **IV**: 8; **V**: 21.

*Niphotrichum canescens* (Hedw.) Bednarek-Ochyra & Ochyra – **IX**: 47.

*Oncophorus compactus* (Bruch et al.) Kindb. – **V**: 22.

\**O. virens* (Hedw.) Brid. – **V**: 22.

*O. wahlenbergii* Brid. – **IV**: 15; **V**: 22; **VII**: 41.

*Philonotis fontana* (Hedw.) Brid. – **IX**: 47; **XI**: 54.

*P. tomentella* Molendo – **IV**: 16.

*Plagiomnium ellipticum* (Brid.) T. J. Kop. – **IV**: 16; **VII**: 41; **XI**: 53; **XIII**: 63.

*Plagiothecium denticulatum* (Hedw.) Bruch et al. – **X**: 49.

*Pleurozium schreberi* (Brid.) Mitt. – **V**: 23; **VI**: 34.

*Pogonatum urnigerum* (Hedw.) P. Beauv. – **II**: 6; **IV**: 15; **V**: 28; **VI**: 35.

\**Pohlia bulbifera* (Warnst.) Warnst. – **IV**: 8.

*P. cruda* (Hedw.) Lindb. – **I**: 5; **V**: 28; **VI**: 36.

*P. drummondii* (Müll. Hal.) A. L. Andrews – **IV**: 8.

\**P. filum* (Schimp.) Mårtensson – **IV**: 8.

*P. nutans* (Hedw.) Lindb. – **V**: 28; **VI**: 33; **VII**: 41.

*P. wahlenbergii* (F. Weber & D. Mohr) A. L. Andrews – **XI**: 52.

*Polytrichastrum alpinum* (Hedw.) G. L. Sm. – **IV**: 15; **V**: 28.

*P. fragile* (Bryhn) Schljakov – **IV**: 15; **V**: 28; **VI**: 37.

*P. septentrionale* (Brid.) E. I. Ivanova – **IV**: 13; **IX**: 47.

*Polytrichum commune* Hedw. – **VI**: 33.

*P. hyperboreum* R.Br. – **IV**: 13; **VI**: 38.

*P. jensenii* I. Hagen – **IV**: 13.

*P. juniperinum* Hedw. – **I**: 5; **II**: 6; **IV**: 15; **V**: 24; **VI**: 37; **X**: 49; **XVI**: 68.

\**P. longisetum* (Sw. ex Brid.) G. L. Sm. – **IV**: 9.

*P. piliferum* Hedw. – **I**: 5; **II**: 6; **V**: 25; **VI**: 39; **VII**: 41; **VIII**: 44.

*P. strictum* Brid. – **VI**: 33; **VIII**: 45; **XVI**: 67.

*Pseudobryum cinclidioides* (Huebener) T.J.Kop. – **XIII**: 64.

\**Psilopilum laevigatum* (Wahlenb.) Lindb. – **V**: 30; **VI**: 40.

*Racomitrium lanuginosum* (Hedw.) Brid. – **V**: 25; **IX**: 47.

*Rhytidium rugosum* (Hedw.) Kindb. – **IV**: 15; **VIII**: 46.

\**Sanionia orthothecioides* (Lindb.) Loeske – **X**: 50.

- S. uncinata* (Hedw.) Loeske – I: 5; II: 6; IV: 11; V: 25; VI: 31; VII: 41; IX: 47; X: 51; XII: 57; XV: 66.  
*Sciuro-hypnum reflexum* (Starke) Ignatov & Huttunen – IV: 11; V: 25.  
*Scorpidium revolvens* (Sw. ex anon.) Rubers – V: 22.  
*Sphagnum lenense* H. Lindb. ex L. I. Savicz – XIII: 60.  
*S. squarrosum* Crome – XII: 58; XIII: 60.  
*Sphagnum teres* (Schimp.) Åongstr. – VII: 42.  
*Stereodon revolutus* Mitt. – IV: 15.  
*Straminergon stramineum* (Dicks. ex Brid.) Hedenäs – XIII: 60.  
*Syntrichia norvegica* F. Weber – IV: 15.  
*S. ruralis* (Hedw.) F. Weber & D. Mohr – V: 25.  
*Tetraplodon mnioides* (Hedw.) Bruch et al. – VII: 41.  
*Tomentypnum nitens* (Hedw.) Loeske – II: 6; V: 26.  
*Warnstorfia exannulata* (Bruch et al.) Loeske – V: 29; IX: 47; XI: 55; XII: 56, 58.  
*W. sarmentosa* (Wahlenb.) Hedenäs – IV: 12.

## Discussion

Among the detected 76 moss species from 40 genera and 23 families, the most common are the genera *Pohlia*, *Polytrichum* and *Dicranum* (6 species each) and the families *Polytrichaceae* (12 species) and *Amblystegiaceae* (7 species). Bryoflora of the coastal territories is rich and diverse, and comprises 25,9% of the total amount mosses of the upland. Among the detected mosses there are no typical halophytes, but all the species are more or less resistant to saline soils. Four groups of species are mostly adapted to the halophilic conditions: **a)** species on disturbed habitats – representatives of the genera *Pohlia*, *Polytrichum*, *Polytrichastrum* and *Bryum*, and also *Ceratodon purpureus*, *Dicranella subulata*, *Psilopilum laevigatum*, etc. that prefer pebble areas, beaches and

habitats with no dense vegetation. Several mosses have been found on the seashore areas that are constantly being flooded by the seawater: *Bryum turbinatum*, *Leptodictyum riparium*, *Pohlia bulbifera*, *P. drummondii*, *P. filum*; **b)** species on rocky substrates – *Bartramia ithyphylla*, *Cynodontium strumiferum*, *C. tenellum*, *Dicranoweisia crispula*, etc.; **c)** hygrophytes of coastal marshes – *Bryum pseudotriquetrum*, *Calliergon cordifolium*, *C. giganteum*, *Calliergonella lindbergii*, *Warnstorfia exannulata*, *Sphagnum* spp., etc.; **d)** tundra species related to low-shrub tundras of seaside plains and sea cliff shrubberies – *Dicranum* spp., *Hylocomium splendens* var. *obtusifolium*, *Oncophorus wahlenbergii*, *Pleurozium schreberi*, etc.

Fourteen species that are rare for the overall upland moss flora were outlined during the study. This reflects the specific conditions of this territory. The considerable diversity of mosses on the coastland indicates their good adaptiveness to halophilic conditions, which, by far, demands further study.

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