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MOSSES OF KANDALAKSHA CITY (MURMANSK PROVINCE, NORTH-WEST RUSSIA)

МХИ ГОРОДА КАНДАЛАКША (МУРМАНСКАЯ ОБЛАСТЬ, СЕВЕРО-ЗАПАД РОССИИ)

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Abstract

A catalogue of 128 mosses revealed in Kandalaksha City is provided, with the annotations of their frequency, habitats and distribution in different zones of the city. Diversity for each city zone, including specific species, common species and mosses well tolerated to anthropogenic habitats, are discussed. Nine species found in the city are rare for the Murmansk Province.

Резюме

Составлен аннотированный список листостебельных мхов города Кандалакша, который включает 128 видов. В списке приводятся данные о распространении и частота встречаемости видов. Рассмотрены особенности флористического разнообразия мхов в отдельных городских зонах. Для каждой из зон указываются специфичные и наиболее часто встречаемые мхи, а также виды, произрастающие на антропогенных местообитаниях; 9 видов являются редкими для Мурманской области.

INTRODUCTION

Kandalaksha City (67°10'N, 32°25'W) is located in south-west of Kola Peninsula on the coast of Kandalakshskiy Bay of the White Sea (Fig. 1). It covers 30.6 km^2. The city is a large railway station and sea harbor. Aluminum plant has the leading role in industry. Machine-building and machine-repairing plants and locomotive depot also operate. Most buildings in the city are small houses with small gardens.

STUDY AREA AND VEGETATION

Kandalaksha is located on maritime plain. South and south-west parts of the city are located at the shore of Kandalakshskiy Bay. Niva River flows in eastern part of the city. It runs from Imandra Lake to the White Sea. The river is about 20 meters wide, its valley is stony, and part of river bed is dry due to water power stations upstream from the Kandalaksha. The effluenting water of one of them is flowing through underground channel and then through Nivskiy Channel, which banks are partly cliffy and partly build with concrete blocks. Proximity of the White Sea causes the high relative humidity in the city territory. The average annual precipitation is 500–600 mm. The annual mean temperature is near 0°C. The average number of frost-free days is about 100-110 days (Yakovlev, 1961). Kandalaksha is located within the northern taiga zone. The coastal part of the city has a large number of cliffs with tundra communities and seaside meadows. The inland areas of the city have preserved xeric to mesic and quite rarely moist *Pinus sylvestris* s.l.forests, often mixed with *Betula alba* s.l., with *Salix* spp. and *Juniperus sibirica* Burgsd. are most common in shrub layer. The dwarf shrub layer consists of *Vaccinium myrtillus* and *V. vitis-idaea*, and in places where these dwarf shrub are not dense, the moss layer is formed by *Pleurozium schreberi, Hylocomium splendens, Dicranum scoparium, Sanionia uncinata*. *Populus* plantings along the roads and around houses are common

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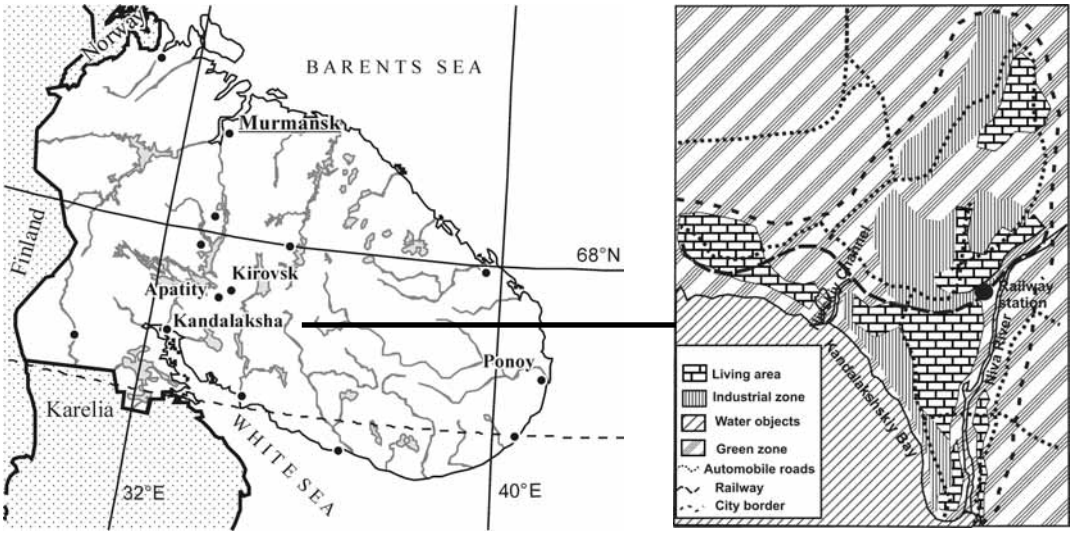

Fig. 1. The study area.

in the city. There are no boggy or swampy forests within the city territory.

METHODS

We studied mosses in Kandalaksha during summer 2006; about 400 specimens were collected, representing mostly species difficult for identification, while species recognizable in the field were recorded without sampling. The city has been subdivided into 6 zones: (1) Living zone (L) comprises built-up area and adjacent territories (yards, gardens, lawns, roads, abandoned grounds); (2) Industrial zone (IZ) includes territories of enterprises and sea harbor; (3) Forest and park zone (FP) includes parks and surrounding forests; (4) Niva River (NR) comprises banks and river bed; (5) Nivskiy Channel (NC) includes mainly channel banks and also rock outcrops in proximity to the channel; (6) Kandalakshskiy Bay (KB) includes coastal area (Fig. 1). Within each zone all types of habitats and substrates were examined several times. No less than 60% of area of L, IZ and FP zones were studied, while KB, NR and NC were investigated throughout. All collected specimens are deposited in KPABG.

ANNOTATED LIST OF MOSSES

The list includes 128 species with distributional data (including city zones and habitats) and frequency of occurrence. The nomenclature follows Ignatov, Afonina, Ignatova et al. (2006). Species names are followed by the indication of sporophyte presence (S+). Collecting numbers of Drugova are cited in brackets (all numbers for rare species and selected ones for common mosses). Frequency of occurrence: Com (10-15 localities), Com-Sp (8-10), Sp (6-7), Sp-Rr (4-5), Rr (2-3) and Un (1).

Abietinella abietina – **KB**: small hill with *Juniperus sibirica* and dwarf shrubs at the sea shore, on soil-covered rock outcrops [2-1, 2-203]; Rr.

Amblystegium serpens S+ – **NR**: wooden bridge near the river, on decaying planking; building ruins, concrete pipes and blocks. **FP**: decaying wood. **L**: buildings, trunks of trees, grass-plots, road flanks. **IZ**: waste ground, on moist soil with *Eriophorum* sp.; willow stands near railway, on tree trunks; walls of buildings [2-17, 2-26, 2-41, 2-53, 2-108]; Com.

Andreaea rupestris S+ – Stones and rock outcrops, artificial substrates in different parts of the city [2-96, 2-115, 2-127]; **KB**, **FP** – Com; **NC**, **NR** – Sp; **L**, **IZ** – Sp-Rr.

Aulacomnium palustre – **KB**: on dry soil-covered rock outcrops and sea meadows near the shore. **NR**: on soil in temporary flooded part of river-bed [2-3, 2-6, 2-9, 2-25, 2-75]; Sp.

Barbula convoluta S+ – **NR**: building ruins on river bank, stones. **FP**: wet willow stand, on stone; concrete construction in pine forest. **L**: buildings and building materials, road flanks, waste grounds, exposed soil. **IZ**: exposed soil, road flanks, debris, gravel embankments [2-58, 2-70, 2-78, 2-97, 2-138, 2-145]; **L**, **IZ** – Com, **NR**, **FP** – Rr.

Brachythecium albicans – **NR**: willow stand, on stone. **FP**: tree bases and soil. **L**: walls of buildings near ground-level, exposed soil, concrete. **IZ**: walls of buildings [2-33, 2-58, 2-62, 2-83, 2-185]; Com.

B. campestre – **NR**: temporary flooded part of river-

bed, on sandy soil between boulders [2-74]; Un.

B. mildeanum – **NR**: temporary flooded part of river-bed, on sandy soil between boulders and in shady cavity under the stone. **FP**: on trunk base of *Populus tremula* **L**. **IZ**: wet willow stand, on root interweaving [2-21, 2-45, 2-91, 2-131]; Sp-Rr.

B. rivulare – **NR**: on humid soil near the edge of watercourse, on boulder submerged in water [2-176, 2-230]; Rr.

B. salebrosum S+ – On soil, stones, rotten logs, stumps, tree bases, on building materials in different habitats [2-17, 2-20, 2-45]; Com.

B. turgidum – sea meadow, on soil with *Trifolium pratense* **L**. in a few meters from water [2-181]; Un.

Bryoerythrophyllum recurvirostrum S+ – **NC**: concrete blocks and debris, exposed soil, shaded moist caverns between boulders [2-12, 2-13, 2-104, 2-214]; Sp-Rr.

Bryum argenteum – Buildings, building materials, roadsides, exposed soil in different parts of the city [2-50, 2-76, 2-85, 2-108]; Com.

B. bimum – **NR**: moist ditch in willow stand, on sandy soil; wet and submerged soil in temporary flooded part of river bed; horizontal surface of soil-covered boulder [2-36, 2-42, 2-86]; Sp-Rr.

B. caespiticium – **NR**: temporary flooded part of river-bed, on sandy soil between boulders [2-21]; Un.

B. capillare – **KB**: on soil-covered rock outcrops. **NR**: willow stand, on decaying log. **FP**: pine forest, on soil with *Vaccinium vitis-idaea* [2-24, 2-89, 2-196]; Rr.

B. creberrimum S+ – **NR**: concrete pipe. **FP**: concrete blocks in pine forest. **IZ**: wet willow stand near railway, on base trunk; knoll with weeds, on disturbed soil; building ruins [2-121, 2-148, 2-163, 2-180]; Sp.

B. elegans – **KB**: rock outcrops, in cracks with soil. **NR**: willow along the stream, on shaded moist soil and soil-covered stone. **L**: lawn, on soil overgrown with herbs; bark of *Populus* x *berolinensis* (C. Koch.) Dipp [2-94, 2-165, 2-189, 2-219]; Sp-Rr.

B. intermedium S+ – **KB**: soil-covered wet cliffs near the sea shore. **NR**: moist hummock in temporary flooded part of river bed. **IZ**: stony exposed soil near the railway [2-30, 2-70, 2-195, 2-247]; Sp-Rr.

B. lonchocaulon S+ – **NR**: recreation lawn near the river bank, on exposed soil. **FP**: decaying plank. **L**: road flanks, building materials, disturbed soil. **IZ**: eroded soil at the slope of ravine; waste ground, on soil-covered building materials; road flanks; exposed fine soil between rails [2-51, 2-52, 2-53, 2-84, 2-159, 2-180]; Sp.

B. pallens – **NR**: exposed moist soil at trails and near the river bed. **NC**: stony exposed soil near the water stream [2-16, 2-104, 2-134, 2-147]; Sp-Rr.

B. pallescens S+ – Exposed soil and buildings in different parts of the city [2-18, 2-300, 2-301]; Sp.

B. pseudotriquetrum S+ – Wet soil and rotten wood in different parts of the city [2-25, 2-44, 2-53, 2-75, 2-97]; **KB**, **NR** – Sp-Com; **FP**, **IZ** – Rr.

B. purpurascens S+ – **NR**: in shady crevice between boulders on clayey soil; exposed soil at the edge of small pool. **IZ**: waste ground, exposed clayey soil near pool with *Eriophorum* sp. [2-69, 2-112]; Rr.

B. salinum S+ – **KB**: soil-covered rock outcrops at the shore, drained by sea water [2-291, 2-294]; Rr.

B. weigelii – **NR**: temporary flooded part of river bed, on moist exposed soil [2-292, 2-300]; Rr.

Bucklandiella microcarpa S+ – Rock outcrops, boulders and stones [2-14, 2-28, 2-48, 2-96, 2-115, 2-127]; Com-Sp.

Calliergon cordifolium S+ – In different wet habitats: river banks, pools, willow stands, sea meadows, ditches, hummocks, roots; once on ceramic remnants in ditch filled with water [2-19, 2-27, 2-35, 2-38, 2-66]; **NR** – Com; **NC**, **KB**, **FP**, **L**, **IZ** – Rr.

C. giganteum – **KB**: sea meadow, under canopy of herbs. **NR**: temporary flooded part of river bed, on moist shady soil between boulders. **NC**: moist soil with *Carex* species near channel bank. **L**: in water of pool with domestic waste. **IZ**: wet willow stand near railway, on moist soil [2-55, 2-86, 2-144, 2-149, 2-151]; Sp.

C. richardsonii – **KB**: on sea meadow under canopy of *Carex* sp. [2-3]; Un.

Calliergonella lindbergii – **KB**: sea meadow, under herb canopy; flooded base of hill, on moist soil. **NR**: wet soil, decaying logs, ditches, submerged boulders and hummocks. **NC**: stones submerged in fast stream; moist soil at small pools [2-3, 2-24, 2-42]; Com-Sp.

Campyliadelphus chrysophyllus – **KB**: sea meadow, on soil drained with sea water. **L**: waste ground, dry clayey soil [2-136, 2-303]; Rr.

Campylium stellatum – **NC**: channel bank, in moist rock cavity; on stones and concrete blocks with fine soil [2-13, 2-234, 2-302]; Rr.

Ceratodon purpureus S+ – Common in disturbed places: exposed soil on waste grounds and road flanks, in ravines, in cracks of building materials, on soil-covered stones and outcrops, sometimes on tree bases and decaying wood [2-17, 2-24, 2-25, 2-32, 2-52, 2-70]; Com.

Cinclidium stygium – **NR**: temporary flooded part of river bed, on moist soil in willow stand [2-226]; Un.

Climacium dendroides – **KB**: soil-covered rock outcrops and cracks in cliffs; flooded sea meadows. **NR**: very common on soil along river. **L**: on soil-covered concrete road [2-1, 2-3, 2-9, 2-27]; Sp.

Conostomum tetragonum – **KB**: dry cliffs at the sea shore [2-5, 2-14, 2-63]; Rr.

Cynodontium tenellum S+ – **KB**: rock outcrops, boulders and stones. **FP**: recreation lawn in pine forest, on disturbed stony soil [2-82, 2-140]; Sp-Rr.

C. strumiferum S+ – **KB**: dry rock outcrops and stones

[2-14, 2-48, 2-191, 2-265]; Sp-Rr.

Dicranella crispa S+ – **KB**: shady rock cavity between boulders, on soil [2-46]; Un.

D. grevilleana S+ – Exposed soil in disturbed places [2-70, 2-307, 2-310, 2-311]; **L**, **IZ** – Com.

Dicranum brevifolium – **KB**: soil-covered rock outcrops [2-196]; Un.

D. flexicaule – **FP**: rotten stumps and logs in pine forests [2-59, 2-304]; Rr.

D. elongatum – **KB**: on soil-covered rock outcrops at the hill with *Juniperus sibirica* and dwarf shrubs at the sea shore [2-224]; Un.

D. fuscescens – **FP**: wet pine forest, on soil-covered stone; on rotten logs [2-107, 2-305]; Rr.

D. majus – **KB**: soil-covered cliffs and sea meadows. **FP**: trunk bases [2-99, 2-169]; Sp-Rr.

D. scoparium S+ – **KB**: dry rock outcrops on the hill near the sea shore. **FP**: on trunk bases, soil and soil-covered stones. **NC**: on rock outcrops near the channel bank. **L**: decaying planks and stumps [2-40, 2-48, 2-62, 2-93, 2-107]; Com.

Didymodon fallax S+ – Exposed soil, buildings, concrete, asphalt, brick, cement in different parts of the city [2-64, 2-152, 2-298]; **L**, **IZ** – Com; **KB**, **NR**, **NC** – Rr.

Ditrichum flexicaule S+ – **KB**: concrete foundation of garage; soil-covered rock outcrops. **NR**: concrete blocks at the bank. **NC**: dry rock outcrops and soil-covered concrete. **IZ**: exposed soil and building materials. **L**: hillock with *Trifolium pratense*, on disturbed soil [2-123, 2-145, 2-163, 2-193, 2-243, 2-244]; Com.

Distichum inclinatum S+ – **NC**: soil-covered stones and concrete blocks. **L**: waste ground, on exposed tuberous soil [2-152, 2-208, 2-234]; Sp-Rr.

Drepanocladus aduncus – Soil, stones, outcrops, pools, ditches, tree trunks and rotten logs, concrete, walls of buildings [2-16, 2-25, 2-43, 2-64, 2-66, 2-109]; Com.

D. polygamus S+ – **KB**: sea meadow, under canopy of *Carex* sp. **NR**: flooded soil between boulders; building ruins at the bank. **NC**: moist stony soil near the channel bed. **FP**: wet willow stand, on soil-covered stone. **L**: waste ground, in small depression with *Carex* sp [2-3, 2-97, 2-104, 2-108]; Sp.

Fissidens adianthoides – **NR**: willow stand, on shady moist soil [2-207]; Un.

Fontinalis antipyretica – **NR**: stones submerged in stream [2-9, 2-65]; Rr.

Funaria hygrometrica S+ – Different disturbed places, exposed soil, buildings, building materials, road flanks, once on boulder in river bed [2-50, 2-69, 2-71, 2-87, 2-137]; **L**, **IZ** – Com; **KB**, **NR**, **NC**, **FP** – Rr.

Grimmia longirostris S+ – **KB**: hill with *Juniperus sibirica* and dwarf shrubs at the sea shore, on exposed outcrops and cliffs [2-275, 2-285]; Rr.

G. muehlenbeckii – **KB**: exposed rock outcrops at sea shore, in cracks [G16611]; Un.

G. reflexidens S+ – **KB**: hill with *Juniperus sibirica* and dwarf shrubs at the sea shore, on exposed cliffs in cracks [2-5]; Un.

Hedwigia ciliata – **KB**: on dry boulders and rock outcrops at the sea shore [2-5, 2-98, 2-248]; Rr.

Hygroamblystegium varium – **KB**: shady cavity under boulders, on wet soil [2-46]; Un.

Hygrohypnella ochracea – **NR**: stone submerged in stream [2-293]; Un.

Hygrohypnum luridum – **NC**: shady rock cavity with water near the bank; stone submerged in stream [2-100, 2-263]; Rr.

Hylocomium splendens – **KB**: on soil-covered outcrops. **NR**: waste ground near the river bank, on soil-covered clothes remains. **FP**: soil in pine forests, trunk bases and stumps [2-20, 2-33, 2-59, 2-88]; Com-Sp.

Hymenoloma crispulum S+ – **KB**: rock outcrops and stones. **FP**: on stones. **L**: stones, buildings and building materials [2-15, 2-39, 2-203, 2-290]; **KB**, **FP** – Sp-Com, **L** – Sp-Rr.

Kiaeria starkei – **KB**: rock outcrops and stones. **FP**: stones in pine forests [2-315, 2-316]; Sp.

Leptobryum pyriforme S+ – Common in disturbed places, on exposed soil, buildings, road flanks, embankments; sometimes on trunk bases and decaying wood [2-23, 2-32, 2-53, 2-70, 2-87]; **L**, **IZ** – Com; **KB**, **NR**, **NC**, **FP** – Sp-Rr.

Meesia uliginosa S+ – **KB**: on moist soil-covered rock outcrops [2-237]; Un.

Niphotrichum canescens – Exposed soil in disturbed places, road flanks and concrete [2-72, 2-158, 2-168, 2-282]; Com-Sp.

Ochyraea duriuscula – **NR**: stone submerged in stream [2-90]; Un.

O. mollis – **NR**: boulder submerged in stream [2-320]; Un.

O. smithii – **NC**: stone submerged in stream [2-263]; Un.

Orthotrichum obtusifolium S+ – **L**: *Populus* plantings, on bark of *Populus* x *berolinensis* [G16610]; Un.

O. speciosum S+ – **L**: *Populus* planting, on bark of *Populus* x *berolinensis* [G16610]; Un.

Philonotis fontana S+ – **KB**: sea meadows, exposed soil drained with sea splashes; flooded base of hill, on soil-covered stones. **NR**: on moist soil in willow stands, river banks, ditches, small pools. **NC**: moist soil and concrete blocks [2-6, 2-16, 2-27, 2-47, 2-66]; Com.

Plagiomnium affine – **KB**: shady cavity between boulders, on soil. **FP**: shady flooded ditch at the edge of mixed pine-birch forest, on soil [2-2, 2-46]; Rr.

P. cuspidatum – **L**: on soil-covered concrete at the base of building [2-124]; Un.

P. ellipticum – **KB**: grassy sea meadow. **NR**: flooded

soil with *Carex* sp. in small pool; temporary flooded part of river-bed, on exposed soil and in small depressions. **FP**: soil, rotten planks, trunk bases, herb hummocks. **L**: in moist willow stands, on trails and lawns overgrown with herbs and mosses. **IZ**: small wet depression nearby railway [2-27, 2-42, 2-49, 2-53, 2-79]; Com.

P. medium – **KB**: meadow at the sea shore flooded with pool. **NR**: temporary flooded part of river bed, on soil at the boulder base [2-67, 2-225]; Rr.

Plagiothecium denticulatum S+ – **FP**: trunk bases in pine forests [2-185, 2-194]; Sp-Rr.

Pleurozium schreberi – Common on soil in pine forests, willow stands, sea meadows; on rotten wood; sometimes on exposed and disturbed soil, on forest trails [2-20, 2-24, 2-62, 2-73, 2-88]; **NR**, **FP** – Com; **KB**, **NC** – Sp-Rr; **L** – Rr.

Pogonatum urnigerum S+ – Soil-covered cliffs, cracks in rock outcrops, exposed disturbed soil on waste grounds, embankments, trails, roads, building materials [2-37, 2-60, 2-73, 2-141, 2-158]; Com.

Pohlia andrewsii – **NR**: shady cavity under boulder, on moist sandy soil; wet willow stand, on soil in pit [2-91, 2-215]; Rr.

P. cruda – **KB**: on soil in shady rock cavity. **NC**: soil covered forested outcrops on the hill nearby channel bank. **FP**: in shady places on soil and trunk bases [2-46, 2-235]; Sp-Rr.

P. bulbifera – **NR**: flooded exposed soil between boulders; in small cavity between stones; in willow stand on shady wet soil [2-110, 2-134, 2-207]; Rr.

P. camtotrachela – **NR**: moist shady soil between boulders in temporary flooded part of river bed [2-227]; Un.

P. drummondii – **NR**: moist sandy soil in willow stand. **L**: waste ground and road flanks, exposed clayey soil [2-111, 2-308, 2-309]; Sp.

P. filum – **NR**: exposed moist soil in temporary flooded part of river bed. **L**, **IZ**: exposed soil in different disturbed places [2-308, 2-318, 2-328]; Sp.

P. longicollis S+ – **KB**: rock outcrops with *Juniperus sibirica* on the hill at the sea shore [2-187]; Un.

P. nutans S+ – Pine forests, sea meadows, lawns, disturbed places; on soil, trunk bases, stumps, rotten wood, stones, rock outcrops, cliffs, building materials [2-14, 2-20, 2-24, 2-25, 2-59, 2-158]; Com.

P. proligera – **NR**: exposed soil on recreation lawn near river bank; moist shady soil in temporary flooded part of river bed [2-321, 2-324, 2-325]; Sp-Rr.

P. wahlenbergii – **NR**: wet willow stands, river banks, pools, on moist and flooded soil, herb hummocks. **NC**: in shady cavity on sandy soil [2-38, 2-175, 2-223]; Sp.

Polytrichastrum alpinum – **KB**: soil-covered cliffs at the shore, in cracks. **NR**: temporary flooded part of river bed, on soil [2-189, 2-222, 2-225]; Rr.

P. longisetum – **NR**: soil-covered stone in flooded part of river bed [2-197]; Un.

Polytrichum commune S+ – Wet forests, soil-covered rock outcrops, exposed soil in disturbed places, forest roads and trails [2-265, 2-303]; **KB**, **NR**, **FP** – Sp-Rr; **L**, **IZ**, **NC** – Rr.

P. juniperinum – **KB**: dry soil-covered rock outcrops. **NR**: soil and decaying logs. **FP**: trunk bases and soil in pine forests. **L**: exposed soil on road flanks and waste grounds [2-14, 2-74, 2-102, 2-135, 2-163]; Com-Sp.

P. piliferum S+ – **KB**: exposed rock outcrops at the sea shore. **NR**: recreation lawn, on exposed soil. **L**: lawns and road flanks, on disturbed dry soil. **IZ**: embankments, ravines, road flanks, on exposed dry soil [2-14, 2-48, 2-60, 2-73]; Com.

Pseudobryum cinclidioides – **NR**: flooded *Carex* hummock; flooded soil in willow stand. **L**: soil-covered roots in wet willow stand [2-29, 2-44, 2-45]; Rr.

Pylaisia polyantha S+ – **IZ**: bark of *Populus* x *berolinensis* in *Populus* plantings near railway station [2-156]; Un.

Racomitrium lanuginosum – **KB**: exposed dry outcrops at the hill base near the sea shore [2-327]; Rr.

Rhizomnium magnifolium – **NR**: flooded soil, wet depressions and herb hummocks [2-178, 2-257, 2-257]; Sp-Rr.

R. pseudopunctatum – **FP**: wet willow stand, on stone partly submerged in soil [2-97]; Un.

R. punctatum – **NR**: temporary flooded part of river bed, on shady soil at the base of boulder [2-225]; Un.

Rhytidium rugosum – **KB**: hill with *Juniperus sibirica* and dwarf shrubs at the sea shore, on soil-covered outcrops [2-1, 2-220, 2-248]; Rr.

Saelania glaucescens – **KB**: exposed dry outcrops, in cracks with soil [2-295]; Un.

Sanionia orthothecioides – **KB**: in coastal area, on exposed soil-covered cliffs drained with sea splashes [G16614, G16615]; Rr.

S. uncinata S+ – Soil, outcrops, stones and boulders, trunk bases and bark, stumps, decaying wood, concrete, asphalt, planks, leather clothes remnants [2-6, 2-16, 2-24, 2-35]; Com.

Schistidium agassizii S+ – **KB**: exposed dry outcrops at the sea shore. **NR**: temporary flooded part of river bed, on horizontal surfaces of boulders, in cracks. **NC**: exposed cliffs, in cracks [2-34, 2-71, 2-201, 2-280]; Sp-Rr.

S. apocarpum S+ – **NR**: concrete blocks. **NC**: exposed cliffs, in cracks. **L**: concrete covering at the base of building [G16609, G16612, G16613, G16617]; Sp-Rr.

S. crenatum – **NC**: exposed cliffs, in cracks [G16608]; Un.

S. papillosum S+ – **NR**: concrete blocks. **NC**: forested hill near channel bank, on rock outcrops; on boul-

ders and cliffs, in cracks [2-235, 2-274, 2-284, 2-288]; Sp-Rr.

S. platyphyllum – **NR**: concrete blocks [G16609]; Un.

S. pulchrum – **KB**: exposed cliffs, in cracks [2-285]; Un.

S. submuticum – **NR**: temporary flooded part of river bed, on horizontal surfaces of boulders; concrete blocks [2-34, 2-71, 2-284, 2-287]; Sp-Rr.

Sciuro-hypnum latifolium – **NR**: moist soil in temporary flooded part of river bed [2-75, 2-257]; Rr.

S. oedipodium – **FP**: on soil and stones in pine forests. **L**: on soil and soil-covered roots in willow stand. **IZ**: on asphalt at the base of building; on soil in *Populus* plantings [2-22, 2-89, 2-116, 2-129]; Com-Sp.

S. reflexum S+ – Stones, tree bases, rotten wood, stumps, soil, building materials in different habitats [2-15, 2-129, 2-130]; Com.

S. starkei S+ – Soil, stones, trunk bases, rotten wood in different habitats [2-33, 2-129, 2-161]; **NR**, **FP** – Sp; **NC**, **KB** – Sp-Rr; **L**, **IZ** – Rr.

Scorpidium revolvens S+ – **KB**: flooded sea meadows, on moist soil and stones, in water of pools. **NR**: flooded soil [2-47, 2-86, 2-104]; Sp-Rr.

Serpoleskea subtilis – **NR**: moist willow stand, on stone [2-146]; Un.

Sphagnum flexuosum – **KB**: flooded sea meadow, on moist soil at the small pool [2-160]; Un.

S. russowii – **KB**: flooded sea meadow, on moist soil at the small pool. **FP**: wet pine forest with dwarf shrubs, in small depression [2-160, 2-265]; Rr.

S. sqarrosum – **KB**: flooded herb meadow at the hill base [2-67]; Un.

Stereodon callichrous – **KB**: soil-covered exposed cliffs. **NR**: moist exposed soil of trail at the river bank; soil-covered stone; concrete blocks. **NC**: boulders and concrete blocks [2-16, 2-132, 2-214, 2-219, 2-282]; Sp-Rr.

Straminergon stramineum – **KB**: exposed soil-covered outcrops and flooded sea meadows. **NR**: flooded soil among boulders. **NC**: on moist soil with *Carex* species. **FP**: rotten stump in pine forest [2-48, 2-59, 2-67, 2-81, 2-110]; Sp.

Syntrichia ruralis – **NR**: building materials and stony soil near building ruins; eroded soil at the edge of ravine. **NC**: exposed cliffs, in cracks [2-85, 2-108, 2-183, 2-199, 2-277]; Sp-Rr.

Tortella tortuosa – **KB**: soil-covered cliffs at the sea shore [2-296]; Un.

Warnstorfia exannulata – **KB**: flooded sea meadows, moist stones and cliffs. **NC**: in small pool at the channel bank. **L**: waste ground, on exposed clayey soil in depression. **IZ**: wet ditch near railway embankment [2-67, 2-125, 2-133, 2-202, 2-222]; Sp.

W. sarmentosa – **KB**: exposed cliffs and outcrops; wet stones on flooded meadow. **NC**: concrete and stones [2-63, 2-202, 2-214, 2-276, 2-286]; Sp-Rr.

DISCUSSION

The compiled list of mosses of Kandalaksha City includes 128 species. This is only slightly less than in Murmansk City (139 species), despite the latter city is much larger, 150 km^2 vs. 30.6 km^2 for Kandalaksha. The moss diversity of other cities in Murmansk Province is somewhat smaller: 105 species in Kirovsk City (20.4 km^2) and 108 species in Apatity City (30.4 km^2). The abundance of dry and moist rocks in Kandalaksha City is a characteristic feature. In such habitats many mosses were found which are missing in other cities of Murmansk Province. We registered 36 species in Kandalaksha City only. Among them, 15 species are epilithic (*Abietinella abietina, Bryoerythrophyllum recurvirostrum, Conostomum tetragonum, Hedwigia ciliata, Saelania glaucescens, Grimmia* spp., *Schistidium* spp., and others). They are restricted to numerous exposed rocky habitats at Niva River Valley, Nivskiy Channel bank and shore of Kandalakshskiy Bay. Submerged stones and boulders in Niva River and Nivskiy Channel are other characteristic habitats in this city. Some aquatic mosses (*Fontinalis antipyretica*, *Hygrohypnum luridum*, *Ochyraea* spp.) occur here. *Cinclidium stygium*, *Fissidens adianthoides* and *Polytrichastrum longisetum* prefer moist soil in periodically flooded parts of river bed. Three epiphytes, *Orthotrichum obtusifolium*, *O. speciosum*, *Pylaisia polyantha,* were found only in Kandalaksha among the cities of Murmansk Province; all three of them were found only one time each, on planted *Populus* trees, despite *Populus* plantings are rather abundant, and a special search of these species was undertaken.

Among mosses of disturbed habitats 4 species occur in Kandalaksha City only. Three of them, *Bryum lonchocaulon*, *Distichum inclinatum* and *Ditrichum flexicaule,* are not rare on exposed soil and construction waste in different parts of the city. *Bryum purpurascens* was registered only in 3 points on exposed moist soil.

Niva River

The highest diversity of mosses (77 species) were registered in Niva River Zone.

Twenty one species were found in this zone only. Five of these mosses are restricted to submerged stones (*Fontinalis antipyretica, Hygrohypnella ochracea, Ochyraea duriuscula, O.*

mollis, and *Brachythecium rivulare*) and 13 species were collected on temporary flooded clayey and sandy soil (*Brachythecium campestre*, *Cinclidium stygium, Bryum bimum, B. weigelii, Fissidens adianthoides, Pohlia andrewsii, P. bulbifera, P. camtotrachela, P. proligera, Polytrichum longisetum, Rhizomnium magnifolium, R. punctatum,* and *Sciuro-hypnum latifolium*). Most of these species are rare or sparse in Niva River Zone. Two species grow on exposed dry boulders and concrete blocks: *Schistidium platyphyllum* (1 locality) and *S. submuticum* (3 localities).

Among most common and abundant species of Niva River area are *Climacium dendroides*, *Calliergon cordifolium*, *Calliergonella lindbergii*, *Drepanocladus aduncus, Pohlia wahlenbergii,* and *Philonotis fontana*. These species occupy moist soil and soil-covered stones along the river bed.

Common species of disturbed places in Niva River Valley include species known as ruderal ones, like *Ceratodon purpureus*, *Niphotrichum canescens*, *Pogonatum urnigerum, Pohlia nutans*, *Sciuro-hypnum* spp., *Leptobryum pyriforme*, *Sanionia uncinata*, *Bryum* spp., as well as mosses more characteristic for natural communities (*Drepanocladus aduncus, Pohlia wahlenbergii, Philonotis fontana*). Mosses of the former group occupy a wide range of disturbed places: exposed soil, construction waste, ditches, building ruins, whereas species of latter group are registered at wet trails and disturbed soil in moist places.

Tortula ruralis, Stereodon callichrous, Schistidium agassizii, S. apocarpum, and *S. papillosum* were collected several times on concrete blocks and building ruins. Most species of *Schistidium* in Kandalaksha City are restricted to rocky and artificial substrates in Niva Valley, at Nivskiy Channel and Kandalakshskiy Bay.

Kandalakshskiy Bay

The bryophytes of cliffs, outcrops and meadows at the shore of Kandalakshskiy Bay include 74 mosses, 25 species being restricted to this zone only.

Most of specific species of this zone were found on exposed cliffs (*Grimmia* spp., *Conostomum tetragonum*, *Hedwigia ciliata*, *Schistidium pulchrum*, *Racomitrium lanuginosum*, *Saelania glaucescens*) and soil-covered rock outcrops (*Abietinella abietina*, *Bryum salinum*, *Dicranum* spp., *Meesia uliginosa, Rhytidium rugosum*, *Sanionia orthothecioides, Tortella tortuosa*) along the sea shore. The most interesting finding in this zone is a little-known *Sanionia orthothecioides* that usually grows in coastal areas in north-west Europe (Hedenäs, 1989). A number of hygrophytes (*Calliergon richardsonii, Sphagnum flexuosum* and *S. sqarrosum*) were found only in this zone of Kandalaksha City, occurring in two or three localities in open moist sea meadows.

Rocky habitats of Kandalakshskiy Bay are occupied mainly by cushions of *Cynodontium* spp., *Bucklandiella microcarpa*, *Andreaea rupestris,* and *Hymenoloma crispulum*. *Dicranum* spp., *Aulacomnium palustre*, *Calliergon cordifolium, Scorpidium revolvens,* and *Philonotis fontana* are common on wet and moist soil along the sea coast. *Climacium dendroides*, *Sanionia uncinata* and *Pohlia nutans* are abundant on soil and rocks.

On slightly disturbed places (wet trails, recreation meadows) *Calliergon cordifolium, Aulacomnium palustre, Climacium dendroides, Straminergon stramineum,* and *Calliergonella lindbergii* are abundant. *Bryum argenteum*, *Leptobryum pyriforme*, *Ceratodon purpureus*, *Ditrichum flexicaule*, *Pogonatum urnigerum*, *Brachythecium salebrosum,* and *Sanionia uncinata* are common in places with strong anthropogenic pressure (garage settlements and wastelands).

Nivskiy Channel

On moist and dry cliffs and outcrops of Nivskiy Channel we found 42 species.

Five species were registered in this zone only. *Bryoerythrophyllum recurvirostrum, Campylium stellatum* and *Schistidium crenatum* grow on concrete blocks and cliffs of channel bank. *Schistidium crenatum* is a rare species, known in Murmansk Province in Ponoj only. Two other specific species of this zone were gathered on submerged stones: *Hygrohypnum luridum* and *Ochyraea smithii*. Among all specific mosses of Nivskiy Channel only *Bryoerythrophyllum recurvirostrum* is abundant.

Besides *Bryoerythrophyllum recurvirostrum,* only a few species are abundant at Nivskiy Channel: *Calliergonella lindbergii, Drepanocladus aduncus, Philonotis fontana, Pohlia cruda, P. nutans, and Sanionia uncinata.*

Among mosses of anthropogenic habitats of Nivskiy Channel a great number of species were

restricted to concrete: *Bryoerythrophyllum recurvirostrum, Drepanocladus aduncus, Stereodon callichrous, Scorpidium revolvens, Warnstorfia sarmentosa, Campyllium stellatum, Schistidium* spp.*, Didymodon fallax, and Philonotis fontana.* Several species occur also on disturbed soil: *Niphotrichum canescens, Leptobryum pyriforme, Ceratodon purpureus, Pogonatum urnigerum,* and *Brachythecium salebrosum*.

Forest and park zone

43 mosses were found in forest and park zone.

Four species were found in this zone only. Among them 3 species are restricted to rotten wood and tree trunks: *Plagiothecium denticulatum* (common in this zone), *Dicranum flexicaule*, *D. fuscescens,* two latter species being found in tree localities each. Forth species, *Rhizomnium pseudopunctatum* was found once in willow stand.

Several mosses are abundant in plots of pine forests on sandy soil: *Brachythecium salebrosum*, *Dicranum scoparium*, *Hylocomium splendens*, *Pleurozium schreberi*, *Sciuro-hypnum oedipodium, Sanionia uncinata,* and *Polytrichum juniperinum*. A few hygrophylous species were found in northern part of the city in moist mixed forest (*Sphagnum russowii*, *Plagiomnium ellipticum, Calliergon cordifolium*). *Hymenoloma crispulum, Kiaeria starkei, Bucklandiella microcarpa,* and *Andreaea rupestris* are common on rocks in forest.

Majority of species of disturbed places in forest and park zone are restricted to forest trails and roads: *Brachythecium albicans, Sciuro-hypnum oedipidium, Dicranum scoparium, Pleurosium schreberi* and others. *Barbula convoluta, Pohlia nutans, Brachythecium salebrosum, Sanionia uncinata* were found on concrete also.

Build-up areas

In build-up areas species diversity ranges from 47 in living zone to 36 in industrial zone.

Five species were found in build-up areas only. *Orthotrichum obtusifolium*, *O. speciosum* and *Pylaisia polyantha* were found on bark of *Populus* x *berolinensis* in *Populus* plantings; these mosses are rare in the Murmansk Province, and *O. speciosum* is included in its Red Data Book (2003). Two other species specific for this zone are *Plagiomnium cuspidatum* and *Distichum capillaceum.* They are common in Murmansk Province, but found in Kandalaksha only once, on concrete blocks and exposed soil.

Majority of mosses of build-up areas are characteristic species of anthropogenic habitats. Most frequent and abundant taxa are: *Funaria hygrometrica, Brachythecium salebrosum, Bryum argenteum, Drepanocladus aduncus, Leptobryum pyriforme, Amblystegium serpens, Dicranella grevilleana, Didymodon fallax, Barbula convoluta, Niphotrichum canescens, Pogonatum urnigerum,* and *Sanionia uncinata*. Some of these species occur in most Russian cities. *Funaria hygrometrica, Bryum argenteum, Amblystegium serpens* are also common in European towns (Pokorny et al., 2006).

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