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MOSS FLORA OF THE SUNTAR-KHAYATA RESERVE, YAKUTIA

ФЛОРА МХОВ РЕСУРСНОГО РЕЗЕРВАТА "СУНТАР-ХАЯТА" (ЯКУТИЯ)

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Abstract

Moss flora of the area Suntar-Khayata Reserve is studied. This area is situated in the Verkhoyansk Mountain Range, at 800–1895 m elev. The annotated list includes 208 species. Inspite the coldest climate in Northern Hemisphere, the flora of the area combines some temperate taxa, *e.g.*, *Hydrogonium amplexifolium, H. gregarium, Philonotis falcata, Plagiomnium acutum, Syntrichia pagorum, S. sinensis* and *Zygodon sibiricus,* with such mainly Arctic species, as *Lyellia aspera, Plagiothecium berggrenianum, Psilopilum cavifolium, Sphagnum beringiense* and *S. tundrae*. Among the most remarkable records are *Coscinodon hartzii, Dicranum bardunovii, Haplodontium macrocarpum*, *Indusiella thianschanica, Leptopterigynandrum piliferum, Schistidium relictum, Sphagnum subfulvum*, *Platydictya acuminata, Pseudohygrohypnum subeugyrium*, and *Pylaisia steerei.*

Резюме

Изучена флора мхов ресурсного резервата "Сунтар-Хаята", расположенного на Верхоянском хребте в интервале высот 800–1895 м над ур. м. Аннотированный список включает 208 видов. Несмотря на то, что климат данной территории самый холодный в Северном полушарии, его бриофлора представляет собой комбинацию видов с неморальным распространением, таких как *Hydrogonium amplexifolium, H. gregarium, Philonotis falcata, Plagiomnium acutum, Syntrichia pagorum, Tortula sinensis, Zygodon sibiricus,* и преимущественно северных видов, включая *Lyellia aspera, Plagiothecium berggrenianum, Psilopilum cavifolium, Sphagnum beringiense* и *S. tundrae*. Наибольший интерес представляют находки *Coscinodon hartzii, Dicranum bardunovii, Haplodontium macrocarpum*, *Indusiella thianschanica, Leptopterigynandrum piliferum, Schistidium relictum, Sphagnum subfulvum*, *Platydictya acuminata, Pseudohygrohypnum subeugyrium* и *Pylaisia steerei.*

KEYWORDS: mosses, rare species, metallophytes, Russia

INTRODUCTION

Yakutia is the largest administrative unit of Russia, with the territory over 3 million sq. km, though low populated due to a very severe climate. Thus, despite the recent advances in moss flora exploration, resulted in the regional checklist (Ivanova *et al*., 2005), there still are many white spots.

The Nature Resourse Reserve "Suntar-Khayata" is situated in the central part of the Suntar-Khayata Range in the upper course of the East Khandyga River, a tributaty of Aldan, Lena River Basin, at the watershed of Lena and Indigirka Rivers.

The reserve was founded in 1996, covering 6310 sq. km. The vascular plant flora and vegetation of this area was studied by Yurtsev (1968), with additional more complete data of Nikolin (2013), lichens by Poryadina (2001) and hepatics by Sofronova (2000). The latter study resulted in finding of *Apotreubia* cf. *hortoniae,* which remains the only known Yakutian locality of this relic genus of the basalmost hepatics, and known in Asia so far from three localities (Zhukova, 1986; Sofronova, 2005; Bakalin, 2015).

Moss flora studies were conducted in the reserve since 1999, but mostly in the course of short visits, and were not summarized yet.

A number of moss floras in several nearby areas were published recently: Ust-Maya District (Ignatov *et al*., 2001), Yana-Adycha Plateau (Isakova, 2010), Mus-Khaya Peak suppoundings (Ignatova *et al.*, 2011), and Orulgan Range (Ignatov *et al*., 2014). Although all of them belong to the Verkhoyansk Mountain System, their moss species composition differ considerably from one place to another, presumably depending on bedrock composition and differences in local climate.

Suntar-Khayata mountain ridges mainly reach 1400 to 2200 m alt., maximally to 2959 m in Mus-Khaya Peak,

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Table 1. Collecting localities

	Locality	Altitude, m	Latitude	Longitude
1	Right bank of the East Khandyga River, mouth of At-Moole (Atmoole) Creek, the Nature Reserve Station	800	63°07’	138°49’
2	Left bank of the East Khandyga River, mouth of Svetly Creek, opposite #1	1085	63°03’	138°48’
3	At-Moole (Atmoole) Creek, lower course	770–800	63°07’	138°49’
4	Sukhaya Creek, lower course	890	63°07’	139°00’
5	Right bank of the East Khandyga River, mouth of Kyurbelyakh Creek, Station of the faculty of Geology	895	63°06’	139°03’
6	Right bank of Kyurbelyakh Creek, lower course, southern slope of Baran’ya Mountain	950–1240	63°06’	139°00’
7	Right bank of Kyurbelyakh Creek, lower course, eastern slope of Baran’ya Mountain	885–1490	63°07’	139°02’
8	Right bank of Kyurbelyakh Creek, lower course, northern slope of Baran’ya Mountain	900–1490	63°08’	139°02’
9	Right bank of Kyurbelyakh Creek, lower course, western slope of Baran’ya Mountain	890–960	63°06’	139°03’
10	Left bank of Kyurbelyakh Creek, lower course, foothill of Strelka Mountain	950	63°07’	139°03’
11	Left bank of Setorym River, Nekyulyakh Creek, slopes and cliffs along Yakutsk-Magadan Hwy, ‘Zayach’ya Petlya’	1010–1100	63°12’	139°27’
12	Left bank of Setorym River, Dol Creek near semipermanent ice field	1120	63°10’	139°20’
13	Left bank of Setorym River, Nekyulyakh Creek	1280–1895	63°12’	139°27’

with the valley being 880–1100 m deep in relation to nearby mountains. Permafrost is 700 m thick, due to a very cold climate.

The reserve territory is only 350–250 km from Oimyakon, an area with the coldest temperature in the Northern Hemisphere (among lowland regions), –67.7°C. Climate is ultracontinental, with the mean temperature in January –36.2°C, in July +12.6°C. Creeks are numerous, and many of them are interrupted with semi-permanent valley’ ice-beds.

The vegatation of the forest belt is composed by *Larix cajanderi* Mayr stands that reach 1400 m on southern and western slopes and 1000 m on north- and east-faced ones. Mountain tundra above timber-line is represented by a varieties of communities with the dominance of *Dryas octopetala* s.l., *Cassiope tetragona*, *Cladonia stellaris*, *etc*. Slopes often have expanded rock fields. Tickets of shrubby *Pinus pumila* (Pall.) Regel do not form a belt, as in more southern regions of Siberia, but its individual groups are scatteed at all altitudes. A succession of vegetation in river valleys starts with *Chosenia arbutifolia* and then *Populus suaveolens,* which are later substituted by *Larix*. Meadows, bogs, and *Betula nana* and *Salix* spp. shrubs form a mozaic in valleys and foothills. *Betula lanata* (Regel) V.N. Vassil., or stone birch, and *Alnus fruticosa* Rupr. occur along brooks on slopes and in stream canyons (Yurtsev, 1968; Sofronova, 2000; Meteo..., 1987–1990).

Bedrocks include Upper Permian and Lower Triassic sandstones (with occasional calcareous layers), aleurolites, argillites, and schists (Sofronova *et al*., 2015).

SPECIES LIST

The list is based on specimens collected in 1999 by E.I. Ivanova and K.K. Krivoshapkin, in 2003 by Ivanova and V.I. Zolotov, and by the authors of the paper in 2011 and 2015. Altogether 1500 specimens were studied from 13 localities. Collections are in MHA, MW and SASY.

Nomenclature follows Ignatov, Afonina, Ignatova *et al*. (2006). The species name is followed by collecting point(s), according to Table 1 – altitudinal range – and habitats.

Abietinella abietina – 1, 3, 4, 12, 13 – 750–1280 m – on soil in flood valley larch forests with poplar and *Chosenia,* and in *Alnus fruticosa* stands; on rotten wood in open poplar stand; on rock outcrops and rocks along streams.

Aloina rigida – 6, 11 – 970–1010 m – on wet rubbly soil on mountain slope; on bare soil in a quarry.

Amblystegium serpens – 1, 4, 5, 12 – 800–1120 m – on rotten wood and poplar trunk bases in larch forests with poplar and *Chosenia* and in poplar stands; on rock outcrops.

Amphidium lapponicum – 1, 11, 12 – 800–1120 m – on cliffs with seeping water; on brook banks; near icefields in creek valleys.

Andreaea rupestris – 7, 13 – 980–1300 m – on rock-fields; on rocks along streams.

Anoectangium stracheyanum – 4 – 890 m – in crevices of rock outcrops at the base of slope to the stream valley.

Anomobryum concinnatum – 1, 4, 7 – 800–1140 m – in crevices of north-faced wet cliffs; on moist rock outcrops along streams; in crevices of dry rocks on rocky slopes.

Aulacomnium palustre – 4, 9, 12 – 890–1100 m – on soil in larch forests on slopes and in flood valley larch forests with poplar and *Chosenia*; on mossy rock outcrops with seeping water.

A. turgidum – 9, 13 – 950–1280 m – in moderately wet larch forests and in open larch forests with *Sphagnum* on slopes.

Bartramia ithyphylla – 8 – 1125 m – on cliffs near waterfall.

B. ithyphylla var. *deciduaefolia* – 8 – 1125 m – on wet cliffs in *Alnus fruticosa* stand.

B. pomiformis – 7 – 970 m – on rock in stream.

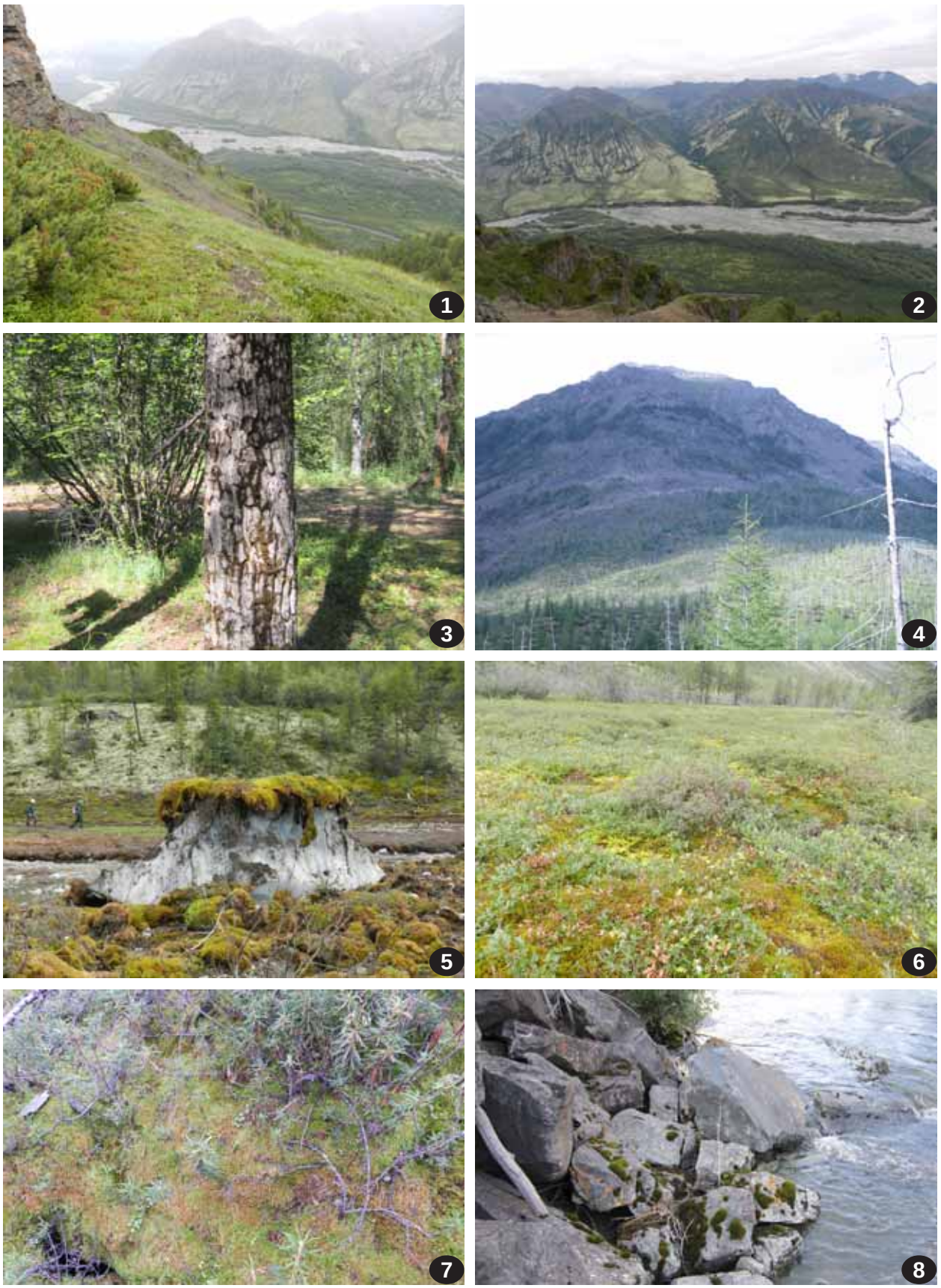
Blindia acuta – 11 – 1010 m – on cliffs with seeping water.

Brachytheciastrum trachypodium – 4, 8, 12 – 890–1490 m – in crevices of rock outcrops.

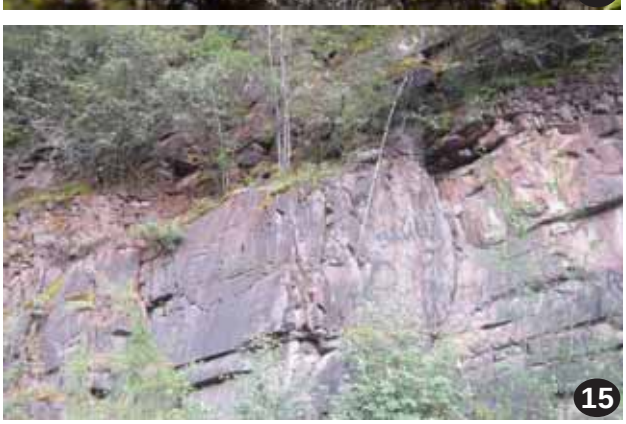
Brachythecium boreale – 1, 3, 11, 13 – 775–1280 m – on rocky slope at creek bank, in niches between rocks; on rock outcrops in *Alnus fruticosa* stands; in cliff niches near creek.

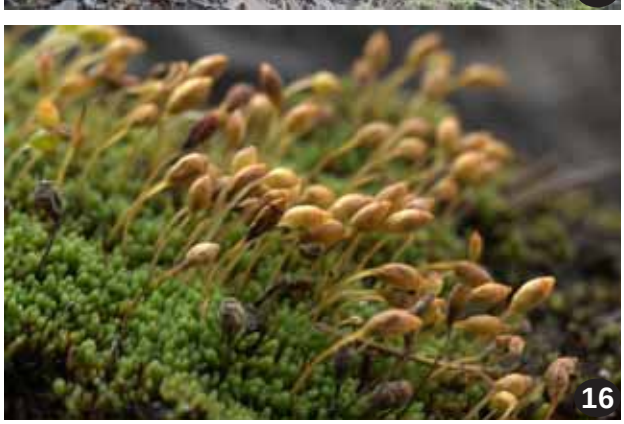
B. erythrorrhizon – 1, 4, 5 – 800–895 m – at poplar trunk bases in poplar stands; on litter, upturned roots of trees covered with soil and rotten wood in larch forests.

B. jacuticum – 1, 4, 13 – 800–1300 m – at poplar trunk bases in poplar stands; on soil at cliff base in *Chosenia* stand; on rock outcrops and soil at stream banks.



Figs. 1–8. Suntar-Khayata Reserve area. 1–2: Vostochnaya Khandyga River; 3: flood plain *Populus* forest, *Orthotrichum obtusifolium* habitat; 4: Baran'ya Mt.; 5: semipermanen ice field, at almost melted state; 6: valley: *Aulacomnium*+*Polytrichum*; 7: slope, *Sphagnum* cf. *girgensohnii*; 8: creek bank, rocks with epilithic mosses (Grimmiaceae, Dicranaceae).





Figs. 9–16. Suntar-Khayata Reserve area. 9–10: mountain tundra at the top of Baran'ya Mt., locality of *Apotreubia hortoniae* and *Lyellia aspera* (see 10); 11–13: slope with dripping cliffs, habitat of *Haplodontium macrocarpum*; 14: rock outcrops with *Indusiella thianschanica* in the valley bottom, in *Larix* forest; 15–16: cliffs with *Mielichhoferia mielichhoferiana*.

B. rotaeanum – 1 – 800 m – at poplar trunk bases in poplar stands.
B. salebrosum – 1 – 800 m – on rotten wood in poplar stands.
B. udum – 12 – 1120 m – on bare soil near stream in larch forest.
Bryoerythrophyllum ferrufinascens – 13 – 1280 m – on soil at brook bank.
B. recurvirostrum – 1, 3–6, 11–13 – 775–1280 m – at bases of poplar trunks, on upturned root of trees covered with soil and on bare soil in pure poplar stands and mixed with *Chosenia*, in larch forests; in crevices of rock outcrops; on bluffs at stream banks.
Bryum algovicum – 11 – 1010 m – on ledges of rock outcrops.
B. amblyodon – 12 – 1120 m – on soil with scattered gravel near flood valley icefield.
B. archangelicum – 7 – 1490 m, on soil at cliff base.
B. argenteum – 4, 7, 13 – 890–1490 m – on cliffs at the base of slope to the flood-valley; on soil at brook bank.
B. caespiticium – 4, 6 – 890–970 m – on rubbly soil in a quarry; on soil in dry stream bed.
B. capillare – 4, 7 – 890–1000 m – on soil between rocks in larch forest; on rubbly soil at roadside.
B. creberrimum – 4, 11, 12 – 890–1120 m – on rotten log in larch forest with poplar and *Chosenia*; in *Salix* marsh; on slope under *Alnus fruticosa* stand; on rubbly soil at roadside.
B. cryophilum – 1, 13 – 800–1280 m – in damp hollow in larch forest.
B. longisetum – 8 – 1450 m – on soil in mountain tundra.
B. pseudotriquetrum – 4, 7, 11 – 890–1490 m – on rock outcrops covered with soil in mixed larch and *Chosenia* forests; on cliffs with seeping water; on rocks in a brook; in deep cliff niche at the ridge top.
B. sibiricum – 11 – 1010 m – on soil under *Alnus fruticosa* stand on slope to the road.
Campylidium sommerfeltii – 5 – 895 m – on rotten wood in larch and poplar forest.
Ceratodon purpureus – 1, 4, 6, 11 – 800–1010 m – on soil in poplar stand; on rock outcrops at the base of slope to the forested flood-valley; on soil in a quarry; on rubbly soil at roadside; in dry creek bed.
Cinclidium latifolium – 1 – 1010 m – on damp soil at brook bank.
Cnestrum schistii – 1, 13 – 800–1280 m – in cliff niche at stream bank; in mossy *Alnus fruticosa* stand.
Cnestrum sp. – 13 – 1445 m – в расщелинах по берегу ручья.
Conostomum tetragonum – 8 – 1445 m – in deep niche of rock outcrops; between rocks of a rock-field.
Coscinodon hartzii – 4, 7, 8, 11 – 890–1490 m – on cliffs at the base of slope to the forested flood-valley; on dry rock outcrops in larch forest; in cliff crevices at stream bank; on small rock among boulder fields; on rocks at cliff base at the ridge top.
Cratoneuron filicinum – 4 – 890 m – on soil in dry stream bed.
Cynodontium asperifolium – 1, 4, 5, 7 – 800–960 m – on cliffs at the base of slope to the forested flood-valley; on stump in larch forest; at base of birch trunk in stone-birch forest.
C. strumiferum – 6–8 – 970–1450 m – on mossy rocks in larch forest; on rubbly soil in a quarry; on ledges of rock outcrops on ridge top.
C. tenellum – 1, 2, 12 – 1085–1120 m – on rock outcrops in stream valleys.
Cyrtomnium hymenophylloides – 1, 4 – 800–890 m – in deep niches of cliffs at the base of slope to the forested flood-valley; in niche between rocks in stream valley.
Dichodontium pellucidum – 11–13 – 1010–1280 m – on north-faced wet cliffs.
Dicranella cerviculata – 12 – 1120 m – on rocks with soil layer near flood-valley icefield.
D. subulata – 12 – 1120 m – in niche between tree roots in larch forest.
D. varia – 13 – 1285 m – on soil at brook bank.
Dicranodontium denudatum – 3 – 775 m – on rock outcrops at stream bank.
Dicranum bardunovii – 1, 3-6, 13 – 775–1450 m – on soil and rotten wood in larch forests, *Alnus fruticosa* and poplar stands; among rocks in rocky mountain tundra; on rock outcrops alog streams.
D. elongatum – 1, 5, 6, 13 – 800–1280 m – on soil and rotten wood in dwarf birch thickets, poplar and *Alnus fruticosa* stands; on wet cliffs along streams; on rubbly soil in a quarry.
D. flexicaule – 5 – 895 m – on shingle along stream.
D. laevidens – 2, 8, 12 – 1085–1125 m – on soil in larch forest; on wet rock outcrops in *Alnus fruticosa* stand; on the lake bank.
D. majus – 7, 8, 13 – 970–1445 m – on wet rock outcrops in *Alnus fruticosa* stand; on wet rocks along streams; on nival meadow.
D. schljakovii – 1, 8, 12, 13 – 800–1895 m – on soil in larch forest; on rocks with soil layer at stream bank; on shingle at river bank; on rock outcrops at ridge top.
D. spadiceum – 7, 13 – 970–1280 m – on soil at brook bank below snow-field; in niche between lumps of boulder-stream.
Didymodon ferrugineus – 4, 7 – 890–1140 m – in cliff crevices; on rocks with soil layer.
D. hedysariformis – 4 – 890 m – on cliffs at the base of slope to the forested flood-valley.
D. icmadophilus – 1, 4, 7, 8, 11 – 800–1490 m – on cliffs at the base of slope to the forested flood-valley; in crevices and cracks of dry cliffs at stream bank; on rubbly slope; on rocks with soil layer; in the cavity of cliff at ridge top.
D. johansenii – 4, 6, 7, 12 – 890–1490 m – in cliff crevices in the upper part of xeric slope; on cliffs at the base of slope to the forested flood-valley.
D. rigidulus – 1 – 800 m – in damp niche of mossy cliffs in stream valley.
D. validus – 4, 6, 7, 11 – 890–1240 m – on cliffs at the base of slope to the forested flood-valley; on soil between rocks in larch forest; in crevices of north-faced cliffs; on rubbly soil at roadside.
D. vinealis – 4, 6, 11 – 890–1240 m – in crevices of north-faced cliffs; on soil at cliff base near stream.
Distichium capillaceum – 1, 3, 7, 8, 13 – 800–1490 m – on damp mossy cliffs along streams; on soil at cliff bases; in crevices and niches of cliffs on ridge top.
D. inclinatum – 8 – 1490 m – on soil at cliff base on ridge top.
Ditrichum cylindricum – 6, 8 – 970–1125 m – on rubbly soil in a quarry; on cliffs near waterfall.
D. flexicaule – 4, 11, 13 – 890–1280 m – on soil in dwarf birch thickets and *Chosenia* stands; on north-faced cliffs; at cliff bases along streams.
Drepanium recurvatum – 13 – 1300 m – on rock outcrops at stream bank.
Drepanocladus aduncus – 1 – 800 m – on soil in mixed *Chosenia* and poplar forest.
Encalypta brevicollis – 6, 7 – 900–1150 m – in cliff and rock crevices, on mossy rocks in stone-birch and aspen forests; in larch forest; on wet rocks at strean bank.

E. ciliata – 4 – 890 m – in crevices of cliffs at the base of slope to the forested flood-valley.
E. pilifera – 4, 6–8 – 890–1490 m – on dry cliffs in larch forest; on cliffs at the base of slope to the forested flood-valley; on soil, in cliff crevice and deep cavity at cliff base on ridge top.
E. procera – 4, 5, 11, 12 – 890–1120 m – on north-faced cliffs; on cliffs at the base of slope to the forested flood-valley.
E. rhaptocarpa – 2, 4, 7, 8 – 890–1490 m – on cliffs at the base of slope to the forested flood-valley; on soil at cliff base and on cliff ledges on ridge top.
E. trachymitria – 4, 11 – 890–1010 m – on rock outcrops; in niche of rock-field.
Entodon concinnus – 1, 4, 5 – 800–895 m – on soil in larch and mixed with poplar and *Chosenia* forests.
Funaria hygrometrica – 6 – 970 m – on rubbly soil in a quarry.
Grimmia anodon – 7, 8 – 1150–1490 m – on dry cliffs in larch forest on steep slope; in cliff crevices on ridge top.
G. donniana – 13 – 1280 m – on rocks in *Alnus fruticosa* stand.
G. jacutica – 7, 8 – 870–1500 m – on rocks in larch forests; on rocks and boulders of rock-fields; on rock outcrops on ridge top.
G. longirostris – 1, 4–6, 8, 13 – 800–1490 m – on rocks and rock outcrops in aspen, larch and mixed poplar and *Chosenia* forests, in *Alnus fruticosa* stands; on bare soil on bluffs at stream banks; on boulder streams; on cliffs on ridge top.
G. tergestina – 4, 6 – 890–1240 m – in crevices of large rock outcrops; on dry cliffs at the base of slope to the forested flood valley.
Gymnostomum aeruginosum – 1, 4, 7, 8, 12 – 800–1490 m – on damp mossy rock outcrops; on cliffs at the base of slope to the forested flood-valley; on soil at cliff base on ridge top.
Haplodontium macrocarpum – 3, 11 – 775–1010 m – on north-faced cliffs with seeping water; on cliffs at stream bank.
Hedwigia ciliata – 1, 6, 7 – 800–1050 m – on rocks and rock outcrops in aspen and larch forests.
Hydrogonium amplexifolium – 11 – 1010 m – on vertical wall of north-faced cliff.
H. gregarium – 7, 11 – 1010–1140 m – on north-faced cliffs with seeping water; in crevices of cliffs on steep slope.
Hygrohypnella polaris – 1, 7, 12, 13 – 800–1445 m – on soil, rocks and rock outcrops on stream banks; on rocks in streams and brooks; on moist rocks near flood-valley icefield; in damp niche of boulder-stream.
Hygrohypnum luridum – 4, 13 – 890–1280 m – on soil and rocks along streams; on boulders in dry bed of stream; at cliff base on stream bank.
Hylocomium splendens – 4, 5, 13 – 890–1280 m – on soil and litter in larch and mixed with poplar and *Chosenia* forests; in mossy *Alnus fruticosa* stand.
Hylocomium splendens var. *obtusifolium* – 12, 13 – 1120–1280 m – in larch forest and open larch stands with *Sphagnum*; in marsh with *Salix*; on rock outcrops.
Hymenoloma crispulum – 13 – 1145–1280 m – in crevices of cliffs at stream bank; between rocks of rock-fields.
Hymenostylium recurvirostrum – 1, 3, 7, 10 – 775–1160 m – on dry cliffs in larch forest; on damp mossy cliffs along stream.
Hypnum cupressiforme – 1, 3, 7, 11, 12 – 800–1490 m – on rocks and rock outcrops in larch forests on slopes; in niches of rock outcrops in *Alnus fruticosa* and *Pinus pumila* stands; on cliffs on stream banks.
Indusiella thianschanica – 3, 4 – 775–890 m – in cracks and on cliff walls at the base of slope to the forested flood-valley; on cliffs at creek banks.
Isopterigyopsis muelleriana – 1, 8, 13 – 800–1450 m – in niches between boulders on boulder-streams; in niches and cracks of cliffs at stream banks.
I. pulchella – 1, 4, 5, 7, 11, 13 – 800–1490 m – on rotten wood in mixed poplar and *Chosenia* forest; in cracks of cliff walls at the base of slope to the forested flood-valley; on rock outcrops under *Alnus fruticosa* stands; in deep niche of cliffs on ridge top; on rocks in brook on nival meadow; in niches of cliffs on stream banks.
Leptobryum pyriforme – 6 – 970 m – on bare soil in a quarry.
Leptodictyum riparium – 1, 5 – 800–895 m – on rotten wood in flood-valley poplar and larch forests.
Leptopterigynandrum piliferum – 1, 4, 6 – 800–1050 m – on cliff walls at the base of slope to the forested flood-valley, often on overhanging surfaces; on strongly weathered rock in aspen forest; on damp mossy cliffs.
Limprichtia revolvens – 10, 13 – 955–1280 m – in *Sphagnum* bog; on stream bank, in water.
Loeskypnum badium – 12, 13 – 1120–1280 m – in open larch forest with *Sphagnum*; лиственничник; in *Salix* marsh.
Lyellia aspera – 9, 8, 13 – 920–1445 m – in sphagnous *Alnus fruticosa* stands and in dwarf birch thickets.
Meesia uliginosa – 12, 13 – 1120-1400 m – in *Salix* marsh; in damp niche of boulder-stream.
Mielichhoferia mielichhoferiana – 4, 8, 11 – 890–1125 m – on north-faced cliffs with seeping water; on soil and rocks under overhanging cliffs at the base of slope to the forested flood valley.
Mnium marginatum – 5 – 895 m – on damp soil in mixed poplar and *Chosenia* forest.
M. spinosum – 8 – 1450 m – in niche of rock outcrops on ridge top.
M. thomsonii – 1, 3, 5, 12 – 800–1120 m – on soil and on trunk bases in *Alnus fruticosa* stands; in niches of rock outcrops.
Molendoa sendtneriana – 1, 4, 7, 11 – 800–1490 m – in niches and cracks of cliffs at the base of slope to the forested flood-valley; on dry cliffs in larch forest on steep slope; on mossy cliffs along stream; in crevices of cliffs on ridge top.
Myurella julacea – 1, 4, 7, 8, 11 – 800–1490 m – on soil in a deep cavity at the base of cliffs on ridge top; on north-faced cliffs with seeping water; in crack of cliffs at the base of slope to the forested flood valley; on rock outcrops in larch forest; in crevices of cliffs on stream bank.
M. tenerrima – 4, 13 – 890–1445 m – in niche of rock outcrop in *Alnus fruticosa* stand; in crevices of cliffs at the base of slope to the forested flood-valley; on cliffs on stream bank.
Neckera pennata – 8, 11 – 1010–1490 m – in deep crack of cliff on ridge top; between rocks in rock-field.
Niphotrichum canescens – 5, 12, 13 – 895–1280 m – between rocks in larch forests on slopes; on pebbly bars on river banks; on soil-covered rocks of rock-fields and boulder-streams; occasionally in marshes.
N. canescens subsp. *latifolium* – 5 – 895 m – on pebbly bar on river bank; on rocky soil in flood-valley larch forest.
N. panschii – 4, 5, 12, 13 – 890–1285 m – on rocks along stream; between rocks near flood-valley icefield; on pebbly bar on creek bank; in a hollow in open larch stand; on wet rocks in *Chosenia* stand at creek bank.
Oligotrichum hercynicum – 11 – 1010 m – on damp rubbly soil on slope to the road.
Oncophorus virens – 3, 9, 12, 13 – 775–1445 m – on soil in larch forest and in *Alnus fruticosa* stand; on shingly soil near flood-valley icefield; on nival meadow; on bluffy slope; on rock outcrops on stream bank.

O. wahlenbergii – 1, 4, 5, 12 – 800–1120 m – on soil in larch forest; on rotten wood in poplar stands and in mixed larch forest with poplar and *Chosenia*; on marsh with *Salix*; on stream bank.

Orthothecium strictum – 4, 11 – 890–1010 m – on north-faced cliffs with seeping water; in crevices of rock outcrops on creek bank.

Orthotrichum iwatsukii – 3, 4, 7, 8, 12 – 800–1490 m – on rocks in larch forest on slope; on poplar trunk in mixed larch and poplar forest; on rock outcrops and rotten wood in larch forest with *Chosenia*; on rocks in *Alnus fruticosa* stand; in cliff crack on ridge top; on cliffs along stream bank.

O. obtusifolium – 1, 3–5, 8 – 775–1125 m – on poplar trunks in mixed larch forests with poplar and *Chosenia* and in pure poplar stands.

O. sordidum – 5, 7 – 895–960 m – at base of poplar trunk in mixed larch and poplar forest; on birch trunk in larch and stone-birch forest.

O. speciosum – 3, 4, 13 – 800–1280 m – on poplar trunk in mixed larch forests with poplar and *Chosenia*; on rottenwood in *Alnus fruticosa* stand; on rocks in rock-fields.

Oxystegus tenuirostris – 13 – 1280 m – in crevices of inclined cliff surfaces on SE-faced slope.

Philonotis capillaris – 13 – 1285 m – on soil on brook bank.

P. falcata – 4 – 890 m – on rubbly soil at roadside.

P. tomentella – 4, 7, 8, 11, 13 – 890–1280 m – on soil between rocks in *Alnus fruticosa* stand; in niches under rocks on stream banks; on moist rocks in stream; on north-faced cliffs with seeping water; on ledge at cliff base on stream bank.

Plagiomnium acutum – 5 – 895 m – at base of poplar trunk in mixed larch and poplar forest.

P. elatum – 13 – 1280 m – open sphagnous larch stand with shrublets.

P. ellipticum – 11, 13 – 1010–1280 m – on soil in *Alnus fruticosa* stand; near the water on creek bank.

P. medium – 1, 3–5, 13 – 800–1280 m – on soil in larch forest and mixed larch and poplar forests with *Chosenia*, in *Alnus fruticosa* stands; in niche under tree roots in open larch stand; on damp mossy cliffs.

P. rostratum – 1, 12 – 800–1120 m – on damp rock outcrops with soil layer on stream banks.

Plagiothecium berggrenianum – 7, 8 – 900–1125 m – on rotten wood in *Alnus fruticosa* stands; on moist cliffs in sphagnous *Alnus fruticosa* stand.

P. cavifolium – 12 – 1120 m – on cliffs on creek bank.

P. laetum – 1, 3, 12 – 800–1120 m – in niche under tree roots in *Alnus fruticosa* stand; on rotten wood on creek bank; in niches of damp mossy cliffs.

Platydictya acuminata – 1, 13 – 800–1280 m – on soil in mossy *Alnus fruticosa* stand; in niche of rock outcrops on stream bank.

Pleurozium schreberi – 7, 9, 12 – 800–1120 m – on litter in moderately wet larch forests.

Pogonatum dentatum – 6, 13 – 970–1300 m – on cliffs on creek bank; on soil in a quarry.

P. urnigerum – 5, 8, 12, 13 – 895–1825 m – on soil covering upturned roots of fallen trees, on soil bank in a ditch in larch forest; on mossy rocks and in niches between rocks in *Alnus fruticosa* stands; on rocks on brook bank; on cliffs near waterfall; in niches under rocks on ridge top.

Pohlia andalusica – 13 – 1280 m – on soil on brook bank.

P. andrewsii – 8, 13 – 1125–1280 m – in sphagnous *Alnus fruticosa* stand; on stream bank.

P. bulbifera – 11 – 1010 m – on damp rubbly soil on slope.

P. cruda – 1, 4, 7, 11, 12, 13 – 800–1490 m – on rock outcrops in larch forests; on cliffs at the base of slope to the forested flood-valley; on cliffs on stream bank; in damp niches under tree roots on steep slope; on north-faced cliffs; in deep cavity at cliff base on ridge top; in deep niche of rock outcrops in a cirque at creek sources.

P. crudoides – 8 – 1450 m – in deep niche of rock outcrops in a cirque at creek sources.

P. drummondii – 12, 13 – 1120–1280 m – on loamy soil on stream bank; on pebbly bar near flood-valley icefield.

P. filum – 13 – 1280–1285 m – on loamy soil on stream bank.

P. longicollis – 4, 7, 8 – 890–1125 m – on moist cliffs in sphagnous *Alnus fruticosa* stand; on cliffs on stream bank; on cliffs at the base of slope to the forested flood-valley; at base of birch trunk in stone-birch forest; on moist rocks in stream.

P. nutans – 5, 8, 12 – 895–1450 m – on stump in larch forest; on damp soil between rocks near flood-valley icefield; on rock outcrops on ridge top.

Polytrichastrum alpinum – 1, 8, 12, 13 – 800–1450 m – in deep niche at cliff base on ridge top; under tree root on bluffy stream bank; in sphagnous *Alnus fruticosa* stand; in niches of cliffs on stream banks; on mossy rocks under cliffs with seeping water.

P. septentrionale – 8, 12, 13 – 1120–1400 m – on moist cliffs in sphagnous *Alnus fruticosa* stand; on rocks in water on nival meadow; on cliffs on creek banks.

Polytrichum hyperboreum – 12, 13 – 1120–1280 m – on soil in dwarf birch thickets and in larch forest.

P. juniperinum – 1, 7, 13 – 800–1280 m – on soil in poplar stands, larch forests and sphagnous lopen larch stands.

P. piliferum – 11 – 1100 m – on mossy rocks in *Alnus fruticosa* stand.

Pseudohygrohypnum subeugyrium – 3, 13 – 775–1280 m – on pebbly soil near flood-valley icefield; in damp niches of boulder-stream; on moist cliffs on stream bank.

Pseudoleskeella rupestris – 7 – 1490 m – on rock at cliff base on ridge top.

Psilopilum cavifolium – 11, 13 – 1010–1445 m – on mossy rocks in *Alnus fruticosa* stands; on damp rubbly soil on roadside; on bluffy slope; on stream bank.

Pterygoneurum ovatum – 7 – 1140 m – in crevices of cliffs on cteep east-faced slope.

Ptilium crista-castrensis – 4, 12 – 890–1120 m – on litter in mixed larch and poplar forest with *Chosenia*.

Pylaisia polyantha – 1, 4, 5 – 800–895 m – on poplar trunk and its base in mixed larch forest with poplar and *Chosenia*; on rotten wood in poplar stand.

P. steerei – 5, 7 – 895–900 m – on rotten wood *in Alnus fruticosa* stand; on base of larch trunk in mixed larch and poplar forest.

Racomitrium lanuginosum – 8, 13 – 1280–1450 m – on rocks with soil layer and in niches od boulder-streams and rock-fields.

Rhizomnium andrewsianum – 8, 12 – 1120–1450 m – on soil between rocks near flood-valley icefield; in niches of boulder-streams.

Rhytidium rugosum – 1, 4, 5, 12, 13 – 800–1280 m – on soil in poplar stands; on litter and rock outcrops in mixed larch for-

ests with poplar and *Chosenia*; on rubbly soil near flood-valley icefield.

Saelania glaucescens – 7, 11 – 1010–1100 m – in niches and on ledges og north-faced cliffs with seeping water; on rock outcrops in larch forest on slope.

Sanionia uncinata – 1, 4, 5, 12, 13 – 800–1280 m – on litter and on soil bank in larch forest; on rotten wood in poplar stand; on soil and rocks in *Alnus fruticosa* stands; on cliffs at the base of slope to the forested flood-valley; in marsh with *Salix*; on rubbly soil near flood-valley icefield.

Schistidium boreale – 1 – 800 m – on rocks on river bank.

S. crenatum – 11 – 1010 m – on north-faced cliffs.

S. liliputanum – 4 – 890 m – on cliffs at the base of slope to the forested flood-valley.

S. marginale – 7 – 1100 m – on rock under larch.

S. papillosum – 1, 6, 10, 12, 13 – 800–1280 – on rocks in larch and poplar forests; on rubbly slope in aspen stand; on north-faced cliffs; on rocks with soil layer in boulder-stream.

S. plathyphyllum – 1, 3, 13 – 770–1280 m – on damp and moist rocks in *Alnus fruticosa* stands, along streams and on rocks in streams, below snow-beds.

Schistidium pulchrum – 1, 2–4, 6, 7, 11, 12 – 800–1150 m – on mossy rocks in larch forests; on cliffs at the base of slope to the forested flood-valley; on strongly decayed wood in poplar stand; on rocks in *Alnus fruticosa* and aspen stands; on rubbly soil in *Pinus pumila* thickets; on rocks in rock-fields; on north-faced cliffs with seeping water; on mossy cliffs an stream banks; on rocks on bluffy stream bank.

S. relictum – 6 – 970 m – on rubbly soil in a quarry.

Scorpidium scorpioides – 10 – 955 m – in lake near the shore.

S. diversifolia – 7–8, 13 – 950–1450 m – on rocks and in walls of lamps of boulder-streams; on rocks in stream bank and in mountain tundra.

Sphagnum angustifolium – 7, 10 – 955 m – in *Sphagnum* mire.

S. aongstroemii – 7, 8, 11–13 – 900–1445 m – sphagnous larch forest with *Ledum*; in sphagnous *Alnus fruticosa* stands; on soil near flood-valley icefield; on rocks along stream; on cliffs near waterfall.

S. balticum – 9, 10, 12, 13 – 955–1280 m – in moderately moistened larch forest; in sphagnous larch forests and open larch stands; in *Sphagnum* mire.

S. beringiense – 2, 10 – 955–1090 m – in stream near lake bank; in *Sphagnum* mire.

S. capillifolium – 2, 8, 10, 12 – 950–1400 m – in moderately moistened larch forests; in sphagnous larch forests; in wet mossy tundra; on sphagnous slope to the stream; on boggy lake shore.

S. compactum – 13 – 1280 m – in dwarf birch thickets.

S. fuscum – 9, 10, 13 – 955–1450 m – in moderately moistened larch forests; in sphagnous open larch stands; in dwarf birch thickets; in *Sphagnum* mire; in shrublet-moss-lichen tundras.

S. girgensohnii – 7–9, 11 – 900–1450 m – in moderately moistened larch forests; in sphagnous larch forests and open larch stands.

S. lenense – 2, 8, 10, 13 – 955–1090 m – in moderately moistened larch forests; in sphagnous larch forests and opel larch stands; in *Sphagnum* mires; on boggy lake shore.

S. subfulvum – 9, 10, 13 – 890–1280 m – in moderately moistened larch forests; in sphagnous larch forests and opel larch stands; in *Sphagnum* mires.

S. teres – 8, 9 – 950–955 m – in moderately moistened larch forest.

S. tundrae – 8, 9 – 780–950 m – in moderately moistened larch forest.

Stereodon revolutus – 8 – 1490 m – at cliff base on ridge top;

S. vaucheri – 1, 4, 6–8 – 800–1490 m – on dry cliffs in larch forest on steep slope; on soil in poplar stands; on soil on rocky slope; on cliffs at the base of slope to the forested flood-valley; in crevices of cliffs on ridge top.

Straminergon stramineum – 12 – 1120 m – in larch forest on slope to the stream; in a hollow near flood-valley icefield.

Syntrichia pagorum – 4 – 890 m – in niches and crevices of cliffs at the base of slope to the forested flood-valley.

S. ruralis – 1, 3–5, 7, 8, 11–13 – 800–1490 m – on ledges of cliffs at the base of slope to the forested flood-valley; at base poplar trunks in mixed poplar and *Chosenia* forest; on rotten wood in mixed larch forest with poplar and *Chosenia*; on soil and rock outcrops in *Alnus fruticosa* stands; between rocks of rock-fields; in cliff crevices on stream bank and on ridge top.

S. submontana – 4 – 890 m – in niche of cliffs at the base of slope to the forested flood-valley.

Tetraplodon angustatus – 13 – 1280 m – on bones of reindeer in larch forest.

T. mnioides – 4, 5, 12, 13 – 890–1280 m – on organic substrate in *Chosenia* stand; on stump and animal remnants in larch forests and open larch stands.

Thuidium assimile – 1, 3, 4, 7, 8 – 775–1125 m – on trunk and base of poplar in mixed poplar and *Chosenia* stand; on mossy rocks in larch forest with poplar and *Chosenia*; on rotten wood in Alnus fruticosa stand; in niche of cliff on stream bank; on cliffs near waterfall.

Timmia comata – 11 – 1010 m – in crevice of moist north-faced cliff.

T. sibirica – 4 – 890 m – on ledge at cliff base close to the stream.

Tomentypnum nitens – 9, 12 – 1120 m – in moderately moistened larch forests.

Tortella alpicola – 7, 11 – 1010–1490 m – in crevices of cliff wall on ridge top; on ledges of north-faced cliffs.

T. fragilis – 4, 11–13 – 890–1300 m – in crevices of cliffs at the base of slope to the forested flood-valley; on soil and rock outcrops under *Alnus fruticosa* thickets on slope; on cliffs on stream bank; on tree roots at creek bank.

T. inclinata – 1, 5, 13 – 800–1280 m – on bare soil in mixed poplar and *Chosenia* forest; on soil banks on bluffy river bank; in crevices of inclined rock surfaces.

T. tortuosa – 1, 4 – 800–890 m – on damp mossy cliffs; on soil at cliff base in *Chosenia* stand.

Tortula mucronifolia – 1, 3, 4, 6, 7, 11, 13 – 800–1445 m – in crevices of cliffs at the base of slope to the forested flood-valley; on rock outcrops in *Alnus fruticosa* stand; in deep niche of cliff on steep slope; in cracks of large rock outcrops; in cliff niches; on stream bank; on bluff to the river.

Ulota curvifolia – 7 – 980 m – on rocks in mossy larch forest.

Warnstorfia exannulata – 13 – 1120–1445 m – in hollow in sphagnous open forest.

Warnstorfia fluitans – 12 – 1190 m – in larch forest on slope to the creek.

W. sarmentosa – 2, 12, 13 – 1085–1445 m – in damp hollow in larch forest; in open larch stand; in water on stream bank; in a hollow near flood-valley icefield.

Zygodon sibiricus – 1, 4, 5 – 800-895 m – on trunks and bases of poplar trunks in poplar stands; in niches and crevices of cliffs and on rotten wood in mixed larch and poplar forest with *Chosenia*.

Discussion

Total diversity of mosses in the reserve, 208 species plus three infraspecific taxa, is not high for the principally mountain region. Even considering rather short trips for the area exploration, this is less than one might expect here. From the other side, the Mus-Khaya Peak area with a rather thorough exploration resulted in only 180 species (Ignatova *et al.*, 2011).

At the same time, the number of rare species in the reserve is remarkably high, and isolated populations of some of them are worthy to be discussed.

A very interesting are new findings of the xeric species of the tundra-steppe environments (Murray, 1992), with the 'flagship species' of *Indusiella thianschanica*. The latter one, being relatively common in Gobi in Mongolia (Ignatov *et al.*, 2004) and NW China, is rather rare in Siberia, though several recent records considerably expanded the range of this species in Subarctic areas of Asian Russia (Ignatov *et al*. 2014; Fedosov *et al*., 2011). The most surprizing in this finding in Suntar-Khayata was the fact that the species was found in the forest, while in all other areas we collected it on S-faced open cliffs and rock outcrops, usually in steppes and deserts. Rock outcrops in Suntar-Khayata where *Indusiella* was found, were in the bottom of a narrow valley with scattered *Larix* forest. Among other associated species, *Leptopterigynandrum piliferum* was quite abundant, and rare here, but revealing, were metallophytes *Mielichhoferia mielichhoferiana* and *Cosconodon hartzii.*

One more species growing on rocks with *Indusiella* was *Anoectangium stracheyanum*. Being not rare in the southern part of Russian Far East, it does not penetrate to the north, at least this record is the first one for the whole Yakutia.

It is also noteworthy to mention the finding of *Syntrichia submontana* in Yakutia. This xeric species, common in Mongolia and Middle Asia, was only recently detected in Russia (Afonina *et al.*, 2014) and found to be rather frequent in xeric areas of southern Siberia (from Zabaikalsky Territory and Buryatia to Altai Mts.) and the Caucasus. In Suntar-Khayata Reserve, it was collected once in niche of the same forested rock outcrops where *Indusiella* grew. The Yakutian locality is situated far to the north from the northernmost known one in Buryatia (ca. 52°N).

Another species of this xeric complex in the reserve are *Didymodon johansenii, Grimmia tergestina,* and *Pterygoneurum ovatum.*

Being widespread, *Didymodon vinealis* is in general a more southern species in Russia, and the present collection is the first one in Yakutia.

Coscinodon hartzii, a species described from Greenland and rare in northern North America, was only recently recognized in Asia (Ignatova *et al.*, 2008). Later it was found to be not rare in the Mus-Khaya Mountain surroundings: it grew with *Mielichhoferia mielichhoferiana,* which is abundantly represented there (Ignatova *et al.*, 2011). Exploration of bryophyte flora of Suntar-Khayata Range revealed that *Coscinodon hartzii* is a more widespread species than it was thought before. In most areas where we undertook an expanded search of its suitable habitats, it was sooner or later found, and even locally in abundance. Not rare, but far from always *Coscinodon hartzii* occurred together with *M. mielichhoferiana.*

Hydrogonium gregarium, a species with the main distribution in Hilalayas and Japan, has been recently found in Yakutia, ca. 250 km to the west from the reserve (Ignatova *et al.*, 2013). Two more localities were detected in 2015; the species grew on wet, 'dripping' cliffs together with a number of other interesting species. The most rare of them is *Haplodontium macrocarpum*. The main range of this species is in North America, while in Russia (and Asia as a whole) only three localities are known, one near Baikal Lake in Eastern Sayan Mountains (Bardunov, 1974), and two in the Suntar-Khayata Reserve. Among other rare species on the same 'dripping cliffs' are *Platydictya acuminata*, a rare species, confined mostly to the permafrost area in Asia, and *Barbula amplexifolia*, hitherto known in Yakutia only from south-east (Ignatov *et al.*, 2001), and being more common in southern regions in Asia. At the same time, primarily Arctic and Subarctic species, *Psilopilum cavifolium* and *Oligotrichum falcatum,* were also found on the same cliff, representing an interesting combination with the mentioned disjunctive southern species.

The similar co-occurrence also takes place in case of epixylic species: primarily Arctic species, *Plagiothecium berggrenianum,* and temperate *Plagiomnium acutum* grew if not side by side, but at the same elevation in the reserve.

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