

MOSS FLORA OF ULAKHAN-CHISTAI RANGE AND ITS SURROUNDINGS  
(MOMSKY DISTRICT, EAST YAKUTIA)

ФЛОРА МХОВ ХРЕБТА УЛАХАН-ЧИСТАЙ И ОКРЕСТНОСТЕЙ  
(МОМСКИЙ УЛУС, ВОСТОЧНАЯ ЯКУТИЯ)

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Abstract

Moss flora of the Ulakhan-Chistai Range is studied. The range is situated within Obruchev chain of mountain ranges of Chersky System, forming a watershed between Nera and Moma Rivers (Indigirka River basin, Eastern Yakutia). The studied area, mainly in the valley of Tirekhtyakh Creek, was at 64°42'–65°11.5' latitude and 145°32'–146°45' longitude. The annotated list of mosses includes 325 species, which is the highest number among the local floras of Yakutia. It is apparently caused by a great variety of habitats: calcareous and acid rocks (marble, siltstone, mudstone, sandstone, slate, granite, rhyolite, etc.), larch forests, alder and Siberian pine thickets, various tundra communities in alpine belt and on aufeis glades, mires, lake shores, willow stands in flood valleys, disturbed habitats, places of reindeer and horse grazing, etc. Wet marble cliffs, especially near waterfalls, have numerous populations of *Andreaeobryum macrosporum*. Other interesting records in the area include three species of *Mielichhoferia* and *Coscinodon hartzii*, four species of *Meesia*, five species of *Tetraplodon*, four species of *Splachnum*, two species of *Tayloria*, seven species of *Didymodon*, five species of *Tortella*, 16 species of *Schistidium*, and 23 species of *Sphagnum*. In one locality *Tetraphis pellucida* was collected, with is very rare in Yakutia, and at base of steep dry slope to Tirekhtyakh Creek *Hilpertia velenovskyi* was found.

Резюме

Представлены результаты изучения флоры мхов хребта Улахан-Чистай. Это один из хребтов цепи Обручева в системе Черского; он образует водораздел между реками Нера и Мома (бассейн р. Индигирка, Восточная Якутия). Район исследования, б. ч. в долине р. Тирехтах, расположен в пределах 64°42'–65°11.5' с.ш. и 145°32'–146°45' в.д. Аннотированный список включает 325 видов мхов; это самая богатая локальная флора мхов Якутии. Столь высокое видовое богатство обусловлено высоким разнообразием местообитаний и субстратов: это разнообразие горных пород – осадочные и магматические, основного и кислого состава (мраморы, аргиллиты, алевролиты, песчаники, сланцы, граниты, риолиты и др.), лиственничные леса и редколесья, заросли ольшаника и кедрового стланика, разнообразные тундровые сообщества в альпийском поясе и на наледных полянах, разные типы болот, берега озер, нарушенные местообитания вдоль дорог, места выпаса оленей и лошадей и т.д. На сырых скалах на г. Мраморная были найдены многочисленные популяции *Andreaeobryum macrosporum*. Среди интересных особенностей изученной флоры следует отметить находки трех видов *Mielichhoferia* и *Coscinodon hartzii*, четырех видов *Meesia*, пяти видов *Tetraplodon*, четырех видов *Splachnum*, двух видов *Tayloria*, семи видов *Didymodon*, пяти видов *Tortella*, 16 видов *Schistidium* и 23 видов *Sphagnum*. В одном местонахождении был собран редкий в Якутии *Tetraphis pellucida*, а в основании сухого крутого склона к р. Тирехтах собрана *Hilpertia velenovskyi*.

KEYWORDS: bryophytes, phytogeography, Siberia, Russia, Chersky Mountains

INTRODUCTION

Yakutia is a largest administrative unit of Russia with the territory 3 083 523 sq. km. However, its severe climate makes it very low populated: less than 1 000 000 people live there. Therefore many areas of Yakutia are

hard-to-reach due to the absence of roads, and as a consequence the bryophyte exploration of Yakutia is very uneven. In 2011 and 2015–2017 we undertook several collecting trips to Yakutia, but they were mainly confined to the areas around the Yakutsk–Magadan Hwy and

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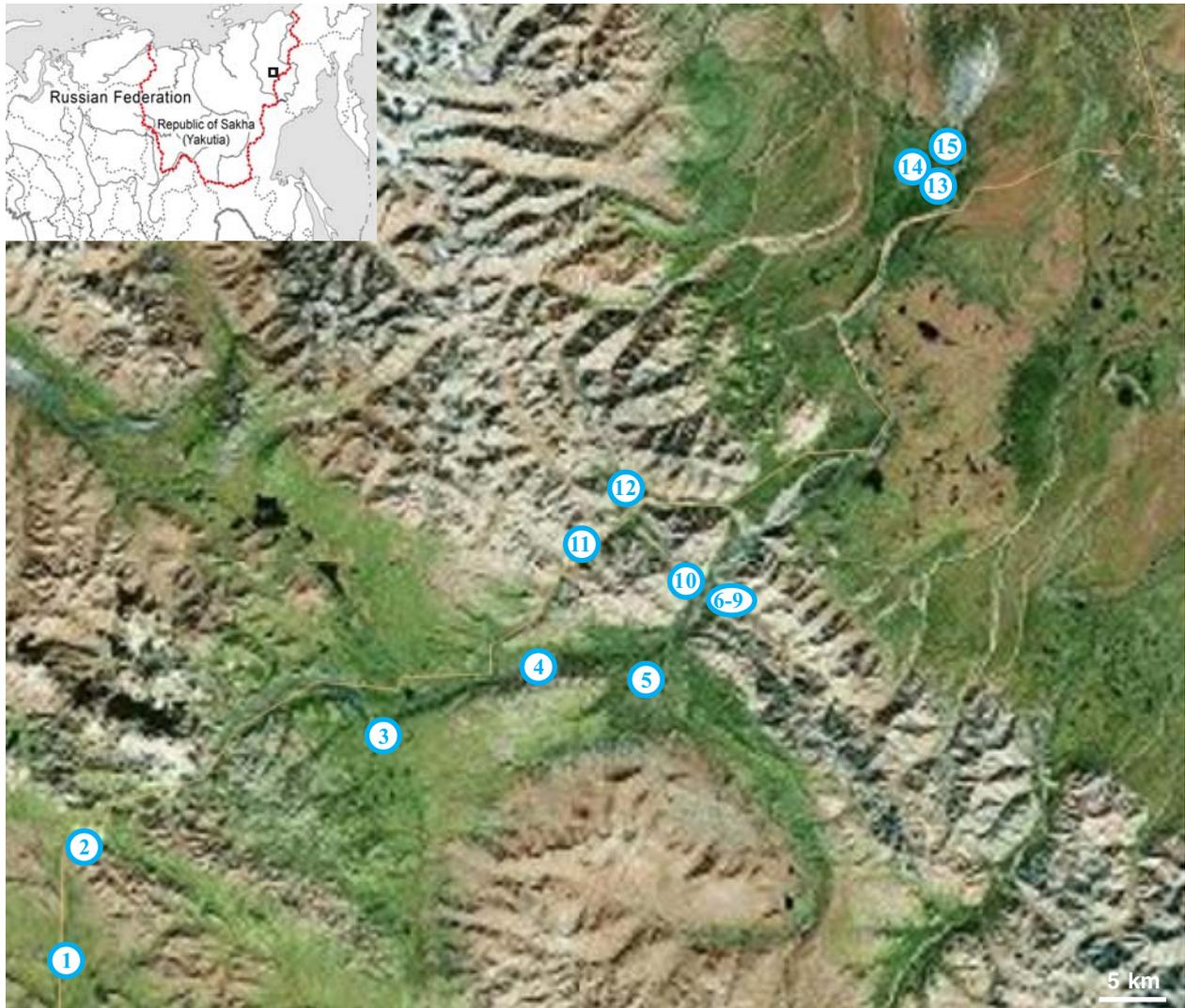


Fig. 1. Collecting localities on Ulakhan-Chistai Range and surroundings.

Locality	Altitude, m	Latitude, N	Longitude, E
1. Valley of Sakhynja Creek	1238	64°42'	145°32'
2. Lake Anton near the pass to Tirektyakh Creek upper course	1100	64°47'	145°37'
3. Valley of Tirektyakh Creek in its upper course; steppe slopes			
4. Valley of Tirektyakh Creek in its upper course	1035–1070	64°49'	145°58.5'
5. Lakes in the valley of Chugulukka-Yuryuje Creek, right tributary of Tirektyakh Creek	870–900	64°51' – 64°52'	146°19.5' – 146°20.5'
6. Right bank of Tirektyakh Creek near Mramornaya Mt.	800–840	64°52.5' – 64°55.5'	146°25' – 146°28.5'
7. Foot of the NW slope of Mramornaya Mt.	860–1300	64°53' – 64°55.5'	146°27.5' – 146°30.5'
8. Wide boggy valley between ridges of Mramornaya Mt.	1240	64°53'	146°31'
9. Valley of the brook and slopes of NW spurs of Mramornaya Mt.	925–1250	64°53.5'	146°25'–146°26.5'
10. Tas Creek, left tributary of Tirektyakh Creek	895–1050	64°55'	146°23'–146°25'
11. Surroundings of Kytyp-Kyuel Lake	1120 – 1155	64°54' – 64°55'	146°11' – 146°14'
12. Valley of Pravjy Dzhapkychan Creek near its mouth	945	64°57.5'	146°20'
13. Left side of wide valley of Tirektyakh Creek in lower course	575–602	65°10' – 65°11'	146°43' – 146°45'
14. Valley of unnamed brook	590–595	65°10.5' – 65°11'	146°41'
15. Left side of wide valley of Tirektyakh Creek in lower course	594–599	65°11.5'	146°42'

near Yakutsk City. These studies brought a number of interesting new records; among them the most remarkable was finding of *Andraeobryum macrosporum* Steere & B.M. Murray, a relic species previously known only from NW North America. It was first found in one local-

ity in Sette-Daban mountains within Verkhoyansky Mt. Range (Ignatov *et al.*, 2016). Further search of this species revealed that it sporadically occurs in Sette-Daban Range, being however strictly confined to the areas with metamorphic and rather hard calcareous rocks. Natural-

ly, it was intriguing to check if *Andreaeobryum* grows in other areas of Yakutia with similar bedrocks and climatic conditions. One of the most promising localities for this was Mramornaya (Marble) Mountain in Ulakhan-Chistai Range, ca. 1000 east of Sette-Daban. And in summer of 2018 we undertook a trip to this area, which required a transportation by heavy truck that can follow creeks frequently crossing them. The trip was combined with the Yakutian team of glaciologists, thus the places for bryophyte collecting were determined partly by other members of expedition, and partly by rains which make water in creeks too high to cross them. So, besides the exploration the Mramornaya Mt., we could collect mosses in a number of intentional and unintentional stops, mostly along the Tirekhtyakh Creek within the Ulakhan-Chistai Mountain Range (Chersky Mt. System), and also the lower course of Tirekhtyakh Creek in a broad valley of Moma River (Indigirka River tributary), opposite Sasry Settlement. Collecting localities are shown in Fig 1.

The finding of *Andreaeobryum macrosporum* in several localities on Mramornaya Mt. was already discussed by Ignatov *et al.* (2018), along with the discussion on its distribution in Asia, and the records of only four other species from this area were published earlier (Sofronova *et al.*, 2018). The subject of the present paper is the overall moss diversity revealed in this area during this field trip in the second half of July and August 2018.

#### STUDY AREA

Our studies were conducted in the valley of Tirekhtyakh Creek, a left tributary of Moma River. Most part of this territory is included in Minsky Nature Park founded in 1996 and occupying now 1 8563 sq. km.

Chersky Mt. System stretches for 1500 km from the upper course of Kolyma River north-west to the lower course of Yana River. It includes Obruchev and Bilibin chains of ranges, plateaus and depressions. Ulakhan-Chistai Range is one of the ranges of Obruchev chain; it forms a watershed between Nera and Moma Rivers, with elevations reaching 1800–2700 m. These mountains are formed of Middle Paleozoic metamorphic bedrocks, Triassic sandstone and slate, Jurassic effusive rocks and slate, and extensive intrusions of granite. This territory had been repeatedly glaciated in the past; however, contemporary glaciers occupy small area and are restricted to Pobeda Peak. Ancient glaciations resulted in extensive moraine and fluvio-glacial deposits. Mountain formation is still continuing in this area, tectonic uplifts result in earthquakes and landslides (Andreev, 2016; Igoshin *et al.*, 1988).

Rivers in the study area are of a mountain type in their upper and middle courses, though their valleys are often wide and flat as a result of ancient glaciations. They have numerous aufeis (‘‘taryn’’ in Yakutian) caused by strong water currents below thick layer of frozen ground, which are coming out through tectonic faults. Massifs of ice often do not completely melt during summer (Aleksiev, 2017). There are also numerous lakes of various

origin (thermokarst, flood valley’ and glacial). Rains are the main source of river water; they cause moderate floods in summer and autumn.

Climate of the region is severe, continental, with sharp fluctuations of temperature. Mean annual temperature is  $-14^{\circ}\text{C}$ , mean temperature of January is ca.  $-47^{\circ}\text{C}$ . Winter lasts 240–270 days; frost free period is 56–92 days, mean temperature of July is  $+16^{\circ}\text{C}$  and maximal recorded temperature in summer is  $+35^{\circ}\text{C}$ ; however, snowfalls could happen during whole summer in the mountains. Mean annual precipitation is 500–600 mm; depth of snow cover varies from 40–50 cm to 60–80 cm in the mountains; permafrost is to 700 m deep (Kryukov, 1988; Onufrieva, 1989).

Collecting localities 1–12 were in the mountain area; most collections were made at the foothills of Mramornaya Mt. (loc. 6–9). It is characterized by dissected relief with sharp ridges, deep narrow canyons and various glacial deposits. It is formed by massive white marble, as well as dark grey loamy limestone, sandstone and conglomerates (Andreev *et al.*, 1987).

Collecting localities 13–15 were in the lowland area, in a wide valley of Tirekhtyakh Creek and Moma River south-east of Pobeda Peak. This valley is situated within Moma-Selennyakh rift depression; its flat bottom with altitude ca. 600 m has many mires, lakes, watercourses and oxbows of Tirekhtyakh Creek and Moma River and their tributaries, aufeis and aufeis glades (Igoshin *et al.*, 1988). Bedrocks are represented by siltstone, mudstone, sandstone, slate, as well as granite, rhyolite and other acid igneous rocks (Surmilova *et al.*, 1985).

Vegetation in the study area is composed of larch forests, open larch stands (tree line is about 1150 m alt.) and mountain tundra communities; various types of mires (*Sphagnum*, sedge and cottongrass types) and dwarf birch thickets are also common. Rare minerotrophic mires are present in lowland downstream Tirekhtyakh Creek. *Chosenia* and willow thickets with forbs occur at places in river valleys. Above tree line, subalpine alder and Siberian pine thickets with dwarf shrubs, mosses and lichens occupy slopes to river and stream terraces. Above 950–1150 m alt. there are various tundra communities of moss, lichen (*Cladonia* ssp., *Cetraria* ssp., *Alectoria ochroleuca*) and shrublet (*Dryas octopetala*, *Cassiope ericoides*, *Rhododendron adamsii*) types. Flat river and stream terraces and shores of lakes in depressions are occupied by moss mires, willow thickets (*Salix glauca*) and dwarf birch communities (*Betula exilis*). Willow (*Salix* ssp.) and alder (*Alnaster fruticosa*) stands are situated at stream banks. Cliffs and rock outcrops of various rock composition and moisture conditions also provide a diversity of suitable habitats for mosses.

Moss flora of larch forests and open larch stands is not especially rich; such widespread species as *Hylocomium splendens*, *Aulacomnium palustre*, *A. turgidum*, *A. acuminatum*, *Rhytidium rugosum*, *Abietinella abietina*, *Sanionia uncinata*, *Pleurozium schreberi*, *Tomentypnum involutum*, *Dicranum elongatum*, and *Polytrichum juni-*



Fig. 2. A–B: valley of Tirekhtyakh Creek in its upper course, with an extensive aufeis (A) and xeric slopes, habitat of *Pterygoneuron ovatum* (B); C: valley of Tirekhtakh Creek in its middle course near Mramornaya Mt.; D: NW slopes of Mramornaya Mt.; E: stream valley with bedrocks rich in iron, habitat of *Mielichhoferia*; F: Kytyn-Kyuel Lake; G: horse pasturing place in mountain tundra, ca. 1200 m alt.; H: *Tetraplodon pallidus* and *T. paradoxus*, in the area shown in fig. G in scattered *Larix* stands.

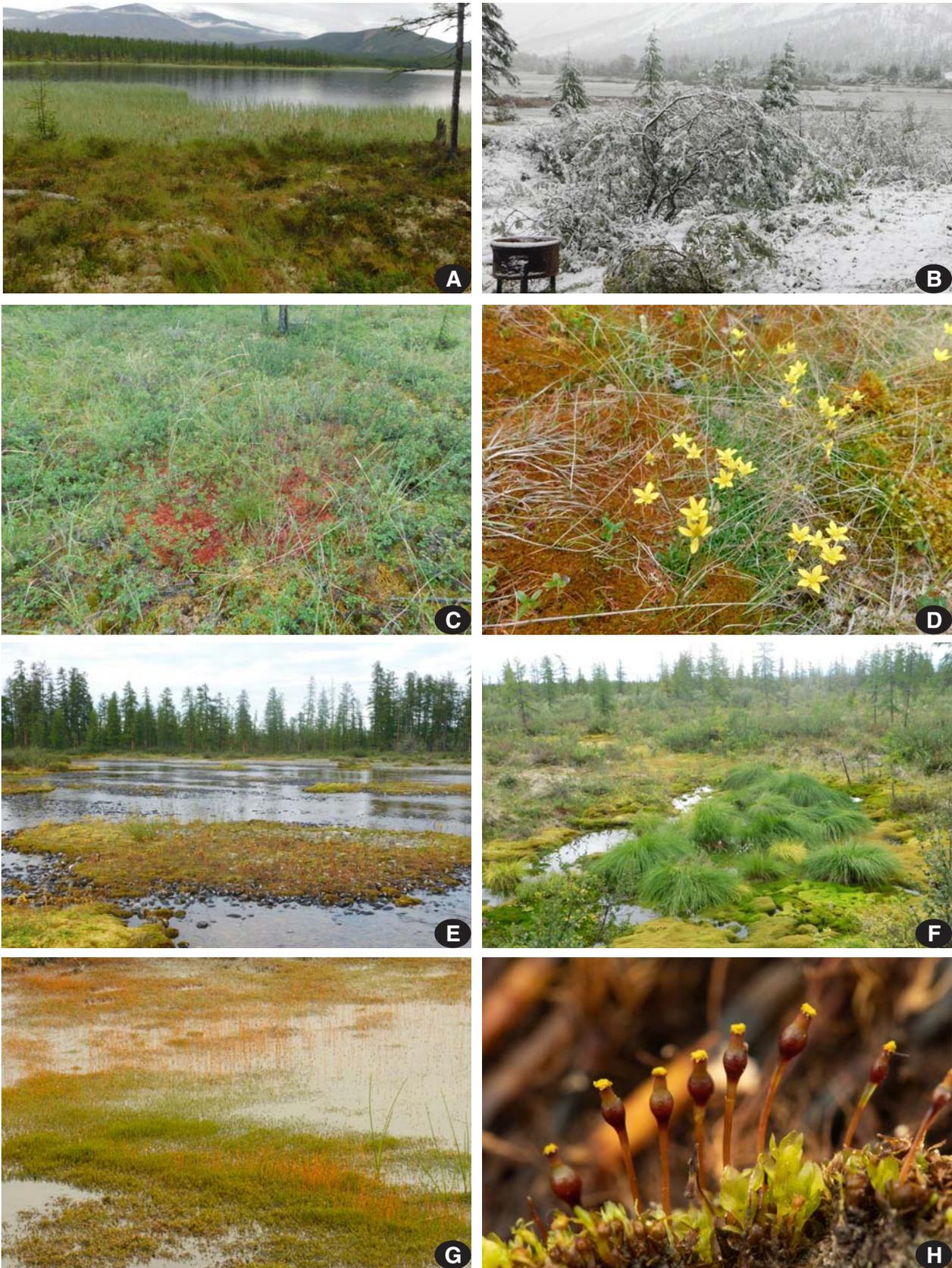


Fig. 3. A: lake in the boggy valley of Chugulukka-Yuryuje Creek (hummocks and hollows on its shore with exceptionally rich composition of *Sphagna*, 20 species); B: snowfall on 19 of July; C: *Betula nana* hummock with *Sphagnum andersonianum*, *Aulacomnium* spp. and rich fen species; D–F: moss communities along wide and shallow brook: *Sphagnum fuscum*+*Tomentypnum nitens*+*Saxifraga hirculus* (D), *Tomentypnum nitens*+*Andreaea rupestris*+*Didymodon gaochenii*+*Saxifraga hirculus* on pebble bars (E), sedge hummocks among *Tomentypnum nitens* (F); G: *Warnstordia tundrae* in a pool in stream valley; H: *Splachnum vasculosum*, small form on dung in wet mire.

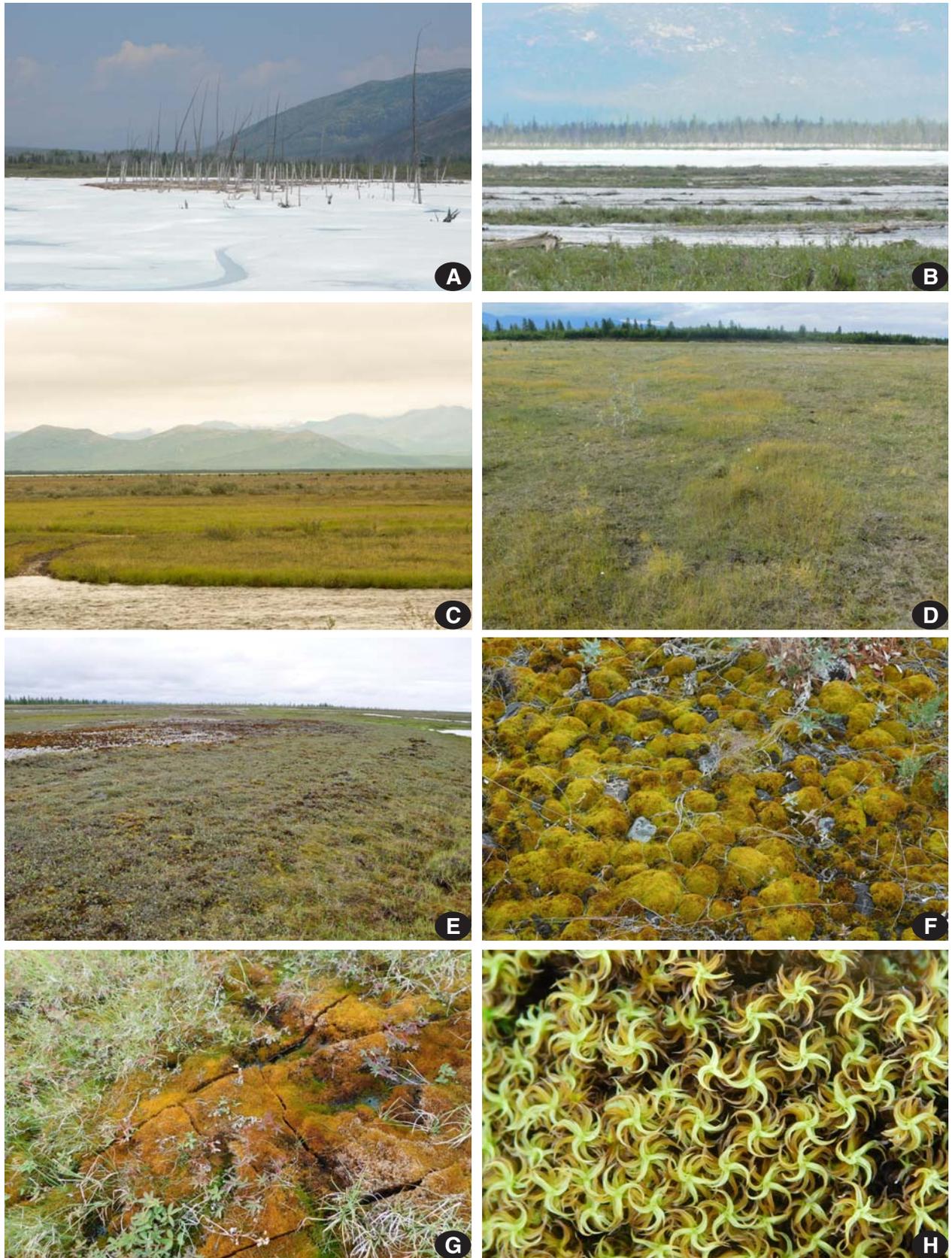


Fig. 4. Aufeis glades and their vegetation. A: late July view; B: August view; C: marginal part of aufeis glade with developed sedge vegetation; D–E: mid-summer melted parts; F: *Didymodon asperifolius* (seen in fig. E); G: permafrost cracks of *Dicranum elongatum* carpet in wet place; H: *Tortella spitsbergensis* forming an extensive cover in drier elevated places.

*perinum* occur on soil and litter under larch canopy. However, moss diversity increases on forested slopes of terraces with small soil bluffs and soil banks: *Saelania glaucescens*, *Bartramia pomiformis*, *B. ithyphylla*, *Bryoerythrophyllum recurvirostrum*, *Bryum amblyodon*, *Cnestrumschisti*, *Cynodontium tenellum*, *Distichium capillaceum*, *D. inclinatum*, *Pohlia cruda*, *P. prolifera*, *Eurhynchias-trum pulchellum*, *Platydictia jungermannioides*, *Fissidens arcticus*, *Myurella tenerrima*, *Oncophorus elongatus*, *Timmia megapolitana*, etc. were collected in this type of habitat.

In sedge and cottongrass mires on terraces of Tirekhtyakh Creek various hygrophilous mosses grow: *Tomentypnum nitens*, *T. involutum*, *Aulacomnium palustre*, *A. acuminatum*, *Hamatocaulis vernicosus*, *Cinclidium arcticum*, *C. stygium*, *C. subrotundum*, *Sphagnum capillifolium*, *Sanionia uncinata*, *Catoscopium nigratum*, *Meesia uliginosa*, *Scorpidium revolvens*. In the lower course of Tirekhtyakh Creek in minerotrophic mires such species as *Paludella squarrosa*, *Meesia triquetra*, *M. hexasticha*, and *M. longisetata* were collected.

In a flood valley of Tirekhtyakh Creek there are fragmentary *Chosenia* and willow (*Salix glauca*) thickets with forbs, where *Flexitrichum flexicaule*, *Tortella fragilis*, *T. inclinata*, *Niphotrichum panschii*, *Sanionia uncinata*, *Abietinella abietina*, *Rhytidium rugosum*, *Syntrichia ruralis*, *Didymodon asperifolius*, and *Distichium inclinatum* grow. Some propaguliferous *Pohlia* species (*Pohlia* cf. *andalusica*, *P. filum*) were found on sand and silt in a flood valley.

Above timberline, in dwarf Siberian pine and alder thickets *Rhizomnium andrewsianum* and *Lyellia aspera* were found. In dry tundra communities with *Dryas* and numerous spots of bare rocky ground such species as *Encalypta brevicollis*, *E. pilifera*, *Brachythecium tauriscorum*, *B. jacuticum*, *Didymodon asperifolius*, *Oligotrichum falcatum*, *Tortella alpicola*, etc. occur. Mosses are rather diverse on various rock outcrops on slopes and along streams, where *Ortothecium chryseon*, *O. strictum*, *O. sibiricum*, *O. retroflexum*, *Distichium capillacium*, *Cinclidium arcticum*, *Cyrtomnium hymenophylloides*, *C. hymenophyllum*, *Flexitrichum gracile*, *Philonotis tomentella*, *Encalypta procera*, *Drepanium fastigiatum*, *Mnium lycopodioides*, *Pohlia cruda*, *Myurella julacea*, and *Timmia comata* were found, and *Sanionia uncinata* and *Rhytidium rugosum* are also frequent.

On calcareous rock outcrops and cliff walls *Andreaeobryum macrosporum*, *Gymnostomum aeruginosum*, *Molendia hornschuchiana*, *Schistidium frivollianum*, *S. relictum*, *Blindiadelphus diversifolius*, and *B. subimmersus* were found. On rocks rich in iron such metallophytes as *Coscinodon hartzii*, *Mielichhoferia asiatica*, *M. mielichhoferiana* and *M. elongata* grew in abundance; *Amphidium lapponicum*, *A. mougeotii*, *Arctoa fulvella*, *A. starkei*, *Blindia acuta*, *Didymodon ferrugineus*, *D. johansenii*, *Grimmia anodon*, *G. donniana*, *G. tergestina*, *G. triformis*, *Oligotrichum hercynicum*, *Pohlia beringi-*

*ensis*, *P. crudoides*, *Pseudocrossidium obtusulum*, *Schistidium frigidum*, *S. liliputanum*, *S. scabripilum*, *Stegonia pilifera*, and *Syntrichia pagorum* were also collected in rocky habitats with high content of iron and various rock composition.

The increase of moss diversity in the area was apparently caused by the presence of anthropogenic and naturally disturbed habitats: ruts of ground roads and roadsides, soil banks on steep slopes of terraces and stream banks. In ruts of ground roads and on roadsides such species as *Aongstroemia longipes*, *Barbula unguiculata*, *Dicranella crispa*, *D. grevilleana*, *D. varia*, and *Trichodon cylindricus* were found; on disturbed turf in deep ruts of winter road on boggy shore of Kytup-Kyuel Lake *Dicranella cerviculata*, *Psilopilum cavifolium*, *Psilopilum laevigatum*, *Pogonatum dentatum*, and *Dicranella cerviculata* grew in abundance. In places of extensive reindeer and horse grazing a higher diversity of the Splachnaceae was observed: *Splachnum luteum*, *S. rubrum*, *S. sphaericum*, *S. vasculosum*, *Tetraplodon angustatus*, *T. mnioides*, *T. pallidus*, *T. paradoxus*, *T. urceolatus*, *Tayloria acuminata*, and *T. lingulata* were collected in such places.

Few fragments of relic steppes on steep slope to Tirekhtyakh Creek were also studied and brought some additional records of mosses: *Aloina brevirostris*, *A. rigida*, *Pterygoneurum ovatum*, *Tortula acaulon*, *T. systylia*, *Hilpertia velenovskiyi*.

Another specific habitat for mosses is comprised by extensive aufeis glades with patches of tundra communities dominated by *Salix pulchra*, *Dryas* ssp., *Equisetum variegatum*, *Poa* sp.; ca. 50 species were collected there, including *Aongstroemia longipes*, *Brachythecium jacuticum*, *Bryobrittonia longipes*, *Bryum algovicum*, *B. axelblyttii*, *B. wrightii*, *Calliergonella lindbergii*, *Campylium stellatum*, *Catoscopium nigratum*, *Dicranella crispa*, *D. humilis*, *D. subulata*, *D. varia*, *Dicranum bonjeanii*, *Didymodon icmadophilus*, *Drepanocladus aduncus*, *D. polygamus*, *D. turgescens*, *Funaria hygrometrica*, *Lepetobryum pyriforme*, *Oncophorus elongatus*, *Philonotis tomentella*, *Plagiomnium ellipticum*, *Pohlia wahlenbergii*, *Pseudostereodon procerrimus*, *Scorpidium cossonii*, *S. scorpioides*, *Splachnum sphaericum*, *Streblotrichum convolutum*, *Tetraplodon paradoxus*, *Tortella spitzbergensis*, *Trichodon cylindricus*, *Trichostomum crispulum*, *Warnstorfia fluitans*, *W. procera*, *W. tundrae*, etc.

On rocks in brooks *Schistidium agassizii*, *S. sordidum* and *S. subjulaceum* were found. A peculiar moss community was observed on extensive pebble bars along and in a shallow brook (locality 14 in Fig. 1, Fig. 3E–F); mosses grew in abundance on pebble and rocks in shallow water, some species were quite unexpected for such habitat: *Didymodon gaochenii*, *Schistidium frivollianum*, *Andreaea rupestris*, *Tortella fragilis*, *Ceratodon purpureus*, *Dicranum bardunovii*, *D. bonjeanii*, *D. spadiceum*, *Brachythecium mildeanum*, *Bryum bimum*, *B.*

*pseudotriquetrum*, *Cratoneuron filicinum*, *Philonotis tomentella*, *Sanionia uncinata*, *Scorpidium cossonii*, *Straminergon stramineum*, *Tomentypnum nitens*. On a wall of hummock in dwarf birch & *Sphagnum* community along this brook *Tetraphis pellucidum* was collected; this species is very rare in Yakutia.

Two interesting records were occasionally made during short stops: *Sanionia nivalis* was found on soil on dry rocky slope to the lake Anton (loc. 2 in Fig. 1) and *Disceium nudum* was collected on soil in a rut of ground road in a floodplain of Tirekhtyakh Creek (loc. 4 in Fig. 1).

Altogether ca. 1950 specimens were collected during this field trip. In the following list, species names are given in accordance with Check-list of mosses of East Europe and North Asia (Ignatov *et al.*, 2006) taking into account recent taxonomic changes. Species are listed in alphabetical order. Annotation of each species includes altitudinal range (given in brackets) followed by numbers of localities (according Fig. 1) and ecological characteristic.

#### LIST OF SPECIES

- Abietinella abietina* – [850–1343 m], 2, 3, 8, 9. On dry rocky slopes with sparse mountain tundra vegetation, occasionally in dry larch forests and willow stands; once collected on slope of permafrost heaving mound where it formed a solid cover.
- Aloina brevirostris* – [1036–1040 m], 3. On moderately dry steep slope to Tirekhtyakh River, on rocky soil and among steppe vegetation.
- A. rigida* – [1036–1040 m], 3. On moderately dry steep slope to Tirekhtyakh River, on rocky soil and screes rich in iron.
- Amblystegium serpens* – [604–840 m], 7, 13. On soil at brook bank, at base of willow tree and on rotten wood.
- Amphidium lapponicum* – [940 m], 9. Collected once on dry cliffs between screes on steep slope.
- A. mougeotii* – [895–1194 m], 3, 9, 10. In niches and on ledges of shaded cliffs and on fine soil at cliff base.
- Andreaea rupestris* – [590–1343 m], 2, 5, 7, 9, 11, 14. On dry and moist rocks and cliffs on open slopes and in open larch forests, on rock surfaces and between boulders of rock-fields, on pebbly bank of shallow brook.
- Andreaebryum macrosporum* – [875–1100 m], 7. On moist vertical surfaces of calcareous cliffs.
- Anomobryum bavaricum* – [1000 m], 10. On the ledge of eroded dry cliffs rich in iron.
- A. concinatum* – [1040 m], 3. In fissures of dry cliffs on the bank of Tirekhtyakh Creek.
- Aongstroemia longipes* – [1000 m], 6, 13. In ruts of ground roads in larch forest and various tundras on aufeis glades, and on walls of frost cracks.
- Aquilonium plicatulum* (= *Stereodon plicatulus*) – [860 m], 7. On soil in rocky tundra at foot of Mramornaya Mt.
- Arctoa fulvella* – [1125–1240 m], 9, 12. On rocky soil at cliff bases and on steep slopes, rare.
- A. starkei* – [1127 m], 9. Collected once on a scree under dry cliffs rich in iron.
- Aulacomnium acuminatum* – [595–1300 m], 1, 7, 12, 13. On litter in larch forests and in yernik (dwarf birch) thickets.
- A. palustre* – [590–1130 m], 3, 4, 6, 8, 11, 13, 14. Common in wet larch forests, bogs, willow stands, mossy tundras, on pebbly bank of shallow brook.
- A. turgidum* – [590–1240 m], 1–15. Common in larch forests and various type of tundras.
- Barbula unguiculata* – [575–700 m], 6, 13. In a rut of ground road and on soil bank in river floodplain.
- Bartramia ithyphylla* – [833–1343 m], 2, 3, 6. On dry rocky slope, in niche under rock in larch forest and on fine soil in niche of cliff at brook bank.
- B. pomiformis* – [833–1036 m], 3, 6. Mossy slope at roadside in larch forest, in niche under rock, and in niche of cliff at river bank.
- Blindia acuta* – [1127–1180 m], 9, 11. In crevices of cliff walls at brook bank and on soil in moist tundra at lake shore.
- Blindiadelphus diversifolius* – [936 m], 7. On cliff wall at brook bank.
- B. subimmersus* – [930–1300 m], 7, 9. On walls of calcareous cliffs and rocky slopes.
- Brachytheciastrum trachypodium* – [875–1225 m], 7, 11. In deep crevice of calcareous cliff and on slope with *Pinus sibirica* thickets, under rock.
- Brachythecium boreale* – [930–936 m], 7. On calcareous rock outcrops and on soil on steep mossy slope between cliffs.
- B. cirrosus* – [900–930 m], 7. On steep mossy slope between cliffs and on rock in alder thickets.
- B. erythrorrhizon* – [700–1140 m], 7, 11. On rock in alder thickets on steep slope, on litter in larch forest and on soil bank in river floodplain.
- B. jacuticum* – [575–1240 m], 7, 8, 13, 14. On rocky slope with tundra vegetation, between rocks of a scree, in a rut of ground road in wet larch forest, on mossy slope to a brook, on pebbly bank of a shallow brook, on soil bank in a willow thicket.
- B. mildeanum* – [596 m], 14. On pebbly bar in a shallow brook and on litter in larch forest at brook bank.
- B. tauriscorum* – [840 m], 7. On calcareous rocks along a stream.
- B. turgidum* – [604–1300 m], 7–9, 11–13. In boggy depression with lakes between ridges, on inclined cliff walls and ledges along a stream, on ledges of eroded granite cliffs, in a bog with *Eriophorum* on a lake shore, on litter in larch forests and willow stands.
- B. udum* – [895–930 m], 7, 10. On steep slope to a stream and at base of a slope in willow and alder thickets, on soil.
- Bryobrittonia longipes* – [575–900 m], 6, 7, 13. In ruts of ground roads in larch forest and on aufeis glades with willow tundra, on vertical walls of permafrost cracks, on soil banks along streams, once collected on soil at cliff base.
- Bryoerythrophyllum recurvirostrum* – [595–1170 m], 6, 7, 9, 13. On gravelly soil in dry tundra community on steep slope, on mossy slope in larch forest, in permafrost crack in sedge meadow on aufeis glade, on soil in grass community at brook bank.
- Bryum algovicum* – [575–875 m], 6, 7, 13. In mountain tundra on rocky slope, between rocks at brook bank, on soil in a low grass meadow near stream and willow tundra on aufeis glade, on pebbly bank of a stream.
- B. amblyodon* – [600–1150 m], 3, 6, 7, 15. On rocky soil in mountain tundra on slopes, on mossy slope of terrace with alder thickets near aufeis, on soil in willow thickets along the river.
- B. arcticum* – [900–1160 m], 7, 9. On steep mossy slope between cliffs and on rocky soil between screes.
- B. argenteum* – [594–900 m], 8, 10, 13, 15. On soil and decayed dung in *Chosenia* thickets in a floodplain, on rotten log in larch forest, on old dung in grassy tundra in a floodplain, on lichens in niche between boulders, in fissures of dry cliff.

- B. axel-blyttii* – [575 m], 13. On soil in wet dwarf willow tundra on aufeis glade.
- B. bimum* – [575–1240 m], 7, 10, 11, 13, 14. On wet rocky slope, at cliff base near brook, in wet depression in willow tundra, on gravelly bank of a shallow brook.
- B. caespiticium* – [604–1260 m], 3, 6, 7, 9, 11–13. In rocky mountain tundra with *Dryas*, on gravelly soil on slopes to a floodplain, at cliff bases and in niches, on soil in *Chosenia* thickets, in niche under roots and on litter in larch forest.
- B. capillare* – [881 m], 7. In crevice of cliff and in niche of rock outcrop.
- B. creberrimum* – [575–1343 m], 2, 3, 10, 11, 13, 15. On dry rocky slopes with sparse tundra vegetation, between rocks in dry stream bed, on wet gravelly soil of a ground road, in willow tundra on aufeis glade, in a rut of old round road.
- B. cryophilum* – [1040 m], 3. In wet place along the road at the bank of Tirektyakh Creek.
- B. cyclophyllum* – [1000–1030 m], 7, 11. At cliff base just at the stream bank and in a small brook in larch forest at the bottom of slope.
- B. cf. intermedium* – [800 m], 6. On pebble bar on the bank of oxbow in floodplain of Tirektyakh Creek.
- B. kunzei* – [945 m], 12. On dry steep slope with rock outcrops and screes, between rocks.
- B. neodamense* – [1225 m], 11. Wet lawn near small brook, on soil.
- B. pallens* – [800–1200 m], 6, 9, 10, 11. On pebbly bank of a small oxbow, on steep gravelly slope, on ledge of shaded cliff at stream bank and in on disturbed turf in a bog with *Eriophorum*.
- B. pseudotriquetrum* – [575–1300 m], 1, 3, 6–8, 11–15. On wet soil along streams and brooks, on pebbly bank of a shallow brook, in wet types of mountain tundra and on aufeis glades, in dwarf birch thickets, on rocks in brooks and in different kinds of boggy communities.
- B. rutilans* – [1000 m], 10. On rocky soil on slope to a stream.
- B. sibiricum* – [900–936 m], 7, 9. On inclined rock outcrops at brook bank and at cliff base among willow and alder thickets.
- B. turbunatum* – [1050 m], 4. In dwarf birch thickets at brook bank.
- B. weigelii* – [1194 m], 3. In wet niche of cliff at river bank.
- B. wrightii* – [575–594 m], 13, 15. In willow-sedge-horsetail community on aufeis glade and on bare gravelly spots among dwarf birch thickets.
- Buckia vaucheri* (= *Stereodon vaucheri*) – [860–1200 m], 7, 9, 10, 12. On rocky soil in *Dryas* tundra on slopes, between rocks on stream bank, on dry rock outcrops among screes and between rocks on steep slope.
- Calliergon giganteum* – [575–1240 m], 6, 8, 13. In hollows of mires on a terrace of Tirektyakh Creek and in depression between ridges of Mramornaya Mt., in a pool of *Sphagnum* bog in larch forest, in sedge mires along streams.
- C. richardsonii* – [830–1238 m], 1, 6, 11. In mire on terrace of Tirektyakh Creek, in dwarf birch thickets at brook bank, in a brook and in cottongrass mire at lake shore.
- Calliergonella lindbergii* – [575–1240 m], 3, 5, 8, 11, 13. In dwarf birch thickets, at lake shore in shallow water, in mire and between rocks, in willow thickets in a floodplain and in dwarf willow tundra on aufeis glade.
- Campylium bambergeri* (= *Stereodon bambergeri*) – [875–1240 m], 7–9, 11. On soil and rocks in mountain tundra on slopes, on rocky soil on steep slope with screes and spots of *Dryas* tundra, on lawn along small brook, on wet wall of calcareous cliff near waterfall.
- C. chrysophyllum* – [599 m], 15. On rocky soil on a slope of stream terrace.
- C. longicuspis* – [1130 m], 11. In a brook at lake shore.
- C. stellatum* – [575–1300 m], 3, 6–8, 11–13. In mires, on rocky soil banks and lawns along streams and brooks, in springs, at bases of wet cliffs and rock outcrops, on rocks in brooks, in wet places in mountain tundra and along ground roads.
- Campylophyllopsis sommerfeltii* – [604 m], 15. On rotten wood in larch forest.
- Campylophyllum halleri* – [930 m], 7. On steep mossy slope between cliffs.
- Catoscopium nigratum* – [575–1155 m], 7, 11–15. In mire with sedges and horsetail, in wet tundra, on pebbly bank of a shallow brook, on rocks in a brook.
- Ceratodon purpureus* – [575–1155 m], 3–7, 9, 11, 13, 14. In rocky tundra, on mossy slope of terrace in larch forest, on disturbed sites in mires at lake shore, on mossy pebble bar in a shallow brook, on gravelly soil between rock outcrops on steep slope, on rotten wood in larch forest and alder thickets.
- Cinclidium arcticum* – [595–1300 m], 6, 7, 9, 11–13. In various kinds of mires, wet depressions, on rocks in brooks, in wet tundra; frequent.
- C. latifolium* – [595 m], 13. Collected once in a pool at brook bank.
- C. stygium* – [594–1225 m], 6, 7, 9, 11–13, 15. In various kinds of mires, often in hollows, in wet depressions, wet tundra; frequent.
- C. subrotundum* – [575–1130 m], 6, 11, 13. In mire on terrace of Tirektyakh Creek and in mires in brook floodplains, in wet tundra community on aufeis glade.
- Climacium dendroides* – [849–1238 m], 1, 3a, 5. In dwarf birch thickets along a brook, in soil in alder stands at base of terrace slope, in a floodplain willow thickets, in tundra on slope of a hill.
- Cnestrum glaucescens* – [1225 m], 11. On soil in *Pinus sibirica* thickets on slope to a stream and on rocky bluff to a dry stream bed.
- C. schisti* – [800–1343 m], 2, 6, 7, 10, 11. In niches between rocks on dry rocky slope, on mossy slope of terrace in larch forest. In crevice and on ledge of dry rock outcrops in willow & alder thickets, between rocks in mountain tundra.
- Conostomum tetragonum* – [833–1343 m], 2, 5, 7, 9, 11. On rocky soil on dry slopes with sparse tundra vegetation, on bare soil in open larch forest, on mossy slope of terrace, at base of dry cliffs rich in iron, in dwarf birch thickets at base of slope.
- Coscinodon hartzii* – [1040–1250 m], 3, 9. In fissures and rock surfaces of dry cliffs rich in iron.
- Cratoneuron curvicaule* – [860–900 m], 7. Along springs at stream bank and in deep niche between rocks.
- C. filicinum* – [575–1118 m], 3, 6, 7, 13, 14. On wet calcareous rock outcrops, along brooks, in dwarf willow tundra communities on aufeis glade, on steep mossy slope between cliffs, on rocks in a brook, on mossy pebble bar at bank of shallow brook, on cliff wall near waterfall.
- Cynodontium strumiferum* – [602–1343 m], 2, 7, 9, 11, 13. At base of larch in larch forest, among lichens in dry larch forest with dwarf *Pinus sibirica*, in niches under rocks and on rock outcrops on steep slope.
- C. tenellum* – [602–1225 m], 3–6, 11, 13. On mossy slope, in

- niche under roots and on rotten wood in larch forests, on cliff ledges at river bank, on soil in dwarf *Pinus sibirica* thickets, in rut of ground road in dwarf birch tundra.
- Cyrtomnium hymenophylloides* – [575–950 m], 7, 10, 12, 13. In niches, fissures and on ledges on wet and moderately dry cliffs and rock outcrops, on steep mossy slope between cliffs, in niches of rock-fields.
- C. hymenophyllum* – [800–930 m], 6, 7. On soil in alder thickets on slopes and on moist fine earth at stream bank.
- Dichodontium pellucidum* – [900 m], 10. On ledge of rock outcrop.
- Dicranella cerviculata* – [1130 m], 11. On turf in a rut of winter road going through a cottongrass mire at lake shore.
- D. crispa* – [600–1155 m], 3, 6, 11, 13. On sand and wall of a bluff to the road in willow stands in a floodplain, in a rut of old ground road on aufeis glade, on ground road in larch forest.
- D. grevilleana* – [595–1130 m], 6, 11, 13. On walls of ruts of ground roads in larch forest and dwarf birch tundra at lake shore, on a bluff at brook bank.
- D. humilis* – [595 m], 13. On soil bluff at brook bank.
- D. subulata* – [595–1155 m], 6, 11, 13. On soil between rocks on slope to a stream, on soil bank in *Chosenia* thickets in a floodplain, in a rut of old ground road on aufeis glade and on soil bluff at brook bank.
- D. varia* – [575–950 m], 10, 13. On bare soil in *Dryas* tundra on steep slope and in ruts of old ground road in willow-sedge-horsetail tundra on aufeis glade.
- Dicranum acutifolium* – [595–1225 m], 6, 11, 13. On litter in larch forests, in sedge-cottongrass mire with sparse larch trees and on slope with dwarf *Pinus sibirica* thickets, infrequent.
- D. bardunovii* – [590–1225 m], 3, 5–7, 9, 11, 13, 14. Common on litter in larch forests and alder stands, growing also in dwarf Siberian pine thickets, mountain tundra and on pebbly bar along shallow brook.
- D. bonjeanii* – [590–1130 m], 7, 11, 13, 14. On mossy slope near waterfall, on wet soil at brook bank, on mossy pebble bar along a shallow brook, in wet and moderately dry tundra communities at lake shore and in a floodplain on aufeis glade; infrequent but locally abundant.
- D. elongatum* – [595–1238 m], 1, 3, 5–7, 9, 11, 13. On litter, rotten wood and rocks in larch forests, in alder stands and Siberian pine thickets, in mires and mountain tundra communities; common.
- D. flexicaule* – [880 m], 5. Between rocks in open larch forest on gentle slope to river valley.
- D. groenlandicum* – [590–1343 m], 2, 4, 11, 13, 14. On litter in larch forests, on boggy terrace of Tirekhtyakh Creek, in a small mire at base of slope, in tundra community.
- D. laevidens* – [830–969 m], 4, 6. On litter in open larch forest on gentle slope, in mires at lake shore and on terraces of Tirekhtyakh Creek, in wet place under alder thickets at base of slope.
- D. majus* – [1125 m], 11. Collected once in a small mire with dwarf birch at base of a slope.
- D. spadiceum* – [590–1225 m], 5, 6, 11, 14. On rock in open larch forest on gentle slope, in rock in Siberian pine thickets, between rocks in dry tundra communities on slopes, on wet lawn along a brook, on mossy pebble bar along a shallow brook.
- D. undulatum* – [590 m], 14. On hummocks in dwarf birch community with sparse larch trees near shallow brook.
- Didymodon asperifolius* – [575–1225 m], 6, 11, 13, 15. On soil in larch forests on slopes of terrace of Tirekhtyakh River, on soil between rocks in rocky tundra communities, at brook bank.
- D. ferrugineus* – [604–900 m], 10, 13. Between rocks of rock-field and on soil in willow thickets at brook bank.
- D. gaochenii* – [596 m], 14. On mossy pebble bar along a shallow brook.
- D. icmadophilus* – [595–1194], 3, 7, 10, 13. In niches of dry cliffs and on dry rock outcrops, between rocks in rocky tundra, on bare soil and on wall of permafrost crack at brook bank.
- D. johansenii* – [900 m], 10. At base of high dry cliff rich in iron.
- D. leskeoides* – [860 m], 7. Between rocks in rocky *Dryas* tundra on gentle slope.
- D. perobtusus* – [930–1150 m], 7, 10, 12. In fissures and on ledges of cliffs and rock outcrops.
- Didymodon cf. validus* – [600–150 m], 3, 6, 7, 10, 15. On rocks in rocky *Dryas* tundra, on rock outcrops on steep slope, on a scree and on rotten wood in willow thickets.
- Discelium nudum* – [969 m], 4. On soil in a rut of ground road in a floodplain of Tirekhtyakh Creek.
- Distichium capillaceum* – [580–1300 m], 3, 5, 7, 9–11, 13. In niches of cliffs and rock outcrops, under rocks on rocky slopes with tundra vegetation, on bare soil on bluffs.
- D. inclinatum* – [575–1155 m], 6, 7, 10–13, 15. On rocky soil and in niches under rocks on slopes with tundra vegetation, on bare soil on bluffs, on vertical walls of permafrost cracks, in dwarf willow tundra on aufeis glade, on slope of terrace with larch forest.
- Drepanium fastigiatum* – [1240 m], 8. Between rocks on slope with mountain tundra.
- Drepanocladus aduncus* – [575 m], 13. In dwarf willow tundra on aufeis glade, on soil at the edge of pool and on rotten wood.
- D. polygamus* – [575–839 m], 6, 13, 15. In mire on terrace of Tirekhtyakh Creek, on moist soil and in permafrost crack in dwarf willow tundra on aufeis glade, on litter and rotten wood in larch forest on slope of terrace.
- D. sordidus* – [830 m], 6. In wet depression in larch forest.
- D. trifarius* – [1125 m], 11. Collected once in wet depression at lake shore.
- D. turgescens* – [575–1240 m], 8, 13, 15. In shallow water in a lake, in wet depressions in floodplain of brook, dwarf willow tundra on aufeis glade and in dwarf birch tundra.
- Encalypta alpina* – [800–1000 m], 6, 7. On steep mossy slope between cliffs, in niches of cliffy bluff, on rocky soil on slope of terrace with larch forest, in *Dryas* tundra.
- E. brevicolla* – [910–1343 m], 2, 3, 9. On steep gravelly slopes, on soil between rocks.
- E. brevipes* – [895 m], 10. Collected once in a fissure of dry cliff in willow and alder thickets.
- E. longicolla* – [881–950 m], 7, 12. In crevices and on ledges of calcareous cliffs and on rocky soil on a scree.
- E. pilifera* – [595–1050 m], 3, 7, 10, 12, 13. On gravelly soil on gentle slope with tundra community, on soil bluff at brook bank, on rock outcrops, and on steep dry slope with steppe vegetation.
- E. procera* – [595–1000 m], 6, 7, 10, 13. On rocky soil in *Dryas* mountain tundra, on cliffy bluff to floodplain, in deep crevice at cliff base, on soil bluff at brook bank, in niche under rock on slope of terrace with larch forest.
- E. rhaptocarpa* – [594–1250 m], 3, 7, 9, 13, 15. Between rocks on slope with tundra vegetation and screes, at base of dry

- cliffs rich in iron, on litter and in niche under roots on slope of terrace with larch forest, on soil bluff at brook bank.
- E. trachimytria* – [1050 m], 3. On gravelly soil on steep slope at cliff base.
- Entodon concinnus* – [930–1100 m], 7. On steep mossy slopes near waterfall and between cliffs.
- Eurhynchiastrum pulchellum* – [588 m], 15. Collected once on soil on slope of terrace with larch forest.
- Fissidens arcticus* – [833–900 m], 7, 10. In niche of slope of terrace with larch forest and between rocks at cliff base.
- F. osmundoides* – [1120–1125 m], 11. On moist soil and in small mire at lake shore.
- Flexitrichum flexicaule* – [575–1160 m], 7, 10, 12–14. On rocky soil on slopes with mountain tundra vegetation, at base of dry cliffs, on rock outcrops on slopes, on boulders of rock-field, in larch forest, on mossy pebble bar of shallow brook, on steep dry slope with screes.
- F. gracile* – [860–1300 m], 7, 10, 12–14. In mountain tundra on slopes to brooks, on ledges of eroded granite cliffs, in wet sites on soil.
- Funaria arctica* – [595 m], 13. On soil bluff at brook bank.
- F. hygrometrica* – [575–833 m], 6, 13. At roadside and in a rut of ground road in larch forest, on soil bluff at brook bank and on wet soil in willow tundra on aufeis glade.
- Grimmia anodon* – [900–1150 m], 10. On walls of dry cliffs rich in iron and on rock outcrops among screes on steep slope.
- G. donniana* – [900–925 m], 9. On rocks on dry rock-field, scree on steep slope and in alder thickets at slope base.
- G. fumalis* – [1150–1300 m], 6. On rocks and rock outcrops on slopes with mountain tundra.
- G. incurva* – [890], 6. On rock in mountain tundra at the foot of Mramornaya Mt.
- G. longirostris* – [840–1343 m], 2, 3, 5, 7, 9, 10, 11. On rocks in mountain tundra and in larch forests.
- G. tergestina* – [900–1150 m], 9, 10. On dry rocks and rock outcrops rich in iron.
- G. triformis* – [1230 m], 9. Collected once on overhanging surface of niche of cliff rich in iron.
- Gymnostomum aeruginosum* – [860–1130 m], 7, 9, 11. On walls of wet cliff niches, on calcareous rock outcrops, on dry cliffs rich in iron and on rocky site at lake shore; infrequent.
- Hamatocaulis vernicosus* – [595–1238 m], 1, 4, 13. In mire on terrace of Tirekhtyakh Creek, in wet depression in boggy larch forest, and in dwarf birch thickets along a brook.
- Helodium blandowii* – [594 m], 15. Collected once in a swamp with *Calamagrostis* at low bank of a stream.
- Hilpertia velenovskiyi* – [1036–1040 m], 3. On fine earth on steep slope with screes to Tirekhtyakh Creek.
- Hygrohypnella ochracea* – [595–1050 m], 3, 15. On rocks in shallow places in brooks.
- H. polaris* – [886–1127 m], 7, 9. On rocks in small brooks.
- Hygrohypnum luridum* – [840–1000 m], 7. On wet calcareous cliffs near waterfalls and along streams and on rocks in brooks.
- Hylocomium splendens* – [590–1238 m], 1, 3–7, 11, 13, 14. On litter in larch forests, willow and alder thickets, in wet mountain tundra, occasionally in mires; common.
- Hymenostylium recurvirostrum* – [800–1050 m], 6, 7, 10, 12. On wet and dry cliffs at steam banks, on rocks of rock-field and under rock on slope to a brook.
- Hypnum cupressiforme* var. *subjulaceum* – [800–1160 m], 4, 6, 7, 9, 10. On rock outcrops and cliff walls in larch forests, willow and alder stands, and on rocky soil in mountain tundra.
- Isopterygiella pulchella* – [599–1225 m], 3, 6, 7, 10, 11, 13, 15. On soil in niches under rocks and roots, occasionally on rotten wood in larch forests, willow and alder thickets, in niches and ledges of rock outcrops.
- Isopterygiopsis catagonioides* – [604–895 m], 9, 13. In niche of rock outcrop in willow thickets at stream bank and on rotten wood in larch forest at brook bank.
- Leptobryum pyriforme* – [575–1130 m], 6, 11, 13, 15. In rut of ground roads in larch forest, on wall of permafrost crack, on soil bluff at brook bank, on soil in dwarf willow tundra on aufeis glade, on sand in willow thickets, on rotten wood in larch forest at brook bank.
- Lewinskya iwatsukii* – [833–1225 m], 6, 9–11. On rock and rock outcrops in willow and alder thickets, on roots of larch in larch forest, on rocks in mountain tundra and on scree, in dry bed of brook.
- L. sordida* – [604 m], 13. On rotten wood in larch forest.
- Loeskyinum badium* – [870–1130 m], 5, 11. On soil and rocks in brooks, in mires with cottongrass and dwarf birch thickets.
- Lyellia aspera* – [900–925 m], 9. In mountain tundra along small brook and in dwarf Siberian pine thickets with *Sphagnum* carpet.
- Meesia hexasticha* – [595–1130 m], 6, 11, 13. In hollow in mire on terrace of Tirekhtyakh Creek, along springs at lake shore and in sedge community in a floodplain of brook.
- M. longiseta* – [595 m], 13. In mire with sedges and dwarf birch in a floodplain of brook.
- M. triquetra* – [595–1155 m], 11, 13. In mires in larch forest and on lake shore, in wet mossy tundra with sedges, on boggy bank of brook, along springs on lake shore.
- M. uliginosa* – [800–1238 m], 1, 3, 6, 11, 12. In mountain tundra, between rocks on slopes with rock-fields and screes, in cottongrass mire, in dwarf birch thickets, on soil bluff on slope of terrace, on wall of ditch at roadside.
- Mielichhoferia asiatica* – [900–1230 m], 9, 10. In fissures of eroded cliffs and rock outcrops rich in iron.
- M. elongata* – [1230 m], 9. In fissures at base of cliffs and on rock outcrops rich in iron.
- M. mielichhoferiana* – [900–1230 m], 3, 9, 10. At base of cliffs rich in iron and on schist rock outcrops, under rock at base of slope with scree.
- Mnium blyttii* – [1240 m], 8. Collected once of slope of pingo (permafrost mound) in boggy depression between ridges.
- M. lycopodioides* – [895 m], 10. On rocks in brook and at base of slope with willow and alder thickets.
- M. spinosum* – [1225 m], 11. On rocks in open larch forest.
- M. thomsonii* – [936–1150 m], 6, 9. In *Dryas* tundra on slope and on rock outcrops at edge of rock-field on dry steep slope.
- Molendia hornschuchiana* – [900–1100 m], 7, 10. On wet calcareous cliffs near waterfall, in niche under boulder and at base of dry cliffs rich in iron.
- Myurella julacea* – [580–1100 m], 3, 7, 10, 12, 15. In wet niches of cliffs, inclined cliff walls, under rocks, on rocky soil in mountain tundra, on soil banks and bluffs, in niches under roots, in rut of ground road, on rotten wood.
- M. tenerrima* – [599–1225 m], 3, 6, 7, 9, 11, 13, 15. In niches of cliffs, in niche of slope of terrace with larch forest, under roots, on rotten wood, in rocky *Dryas* tundra.
- Niphotrichum canescens* – [812–1150 m], 3, 5, 6, 9. On litter and soil in larch forests and *Chosenia* thickets, on rock outcrops, rocks and soil in mountain tundra, in dwarf birch community at lake shore.

- N. ericoides* – [1140 m], 9. Collected once on dry, strongly eroded granite cliffs.
- N. panschii* – [860–1225 m], 5, 7, 9, 11. On rocks in dry *Dryas* tundra, on litter in open larch forests, on pebbly bar with sand along a stream.
- Oligotrichum falcatum* – [900–1200 m], 7, 9, 10, 11. On rocky soil in dry mountain tundra and screes, in niches, fissures and on ledges of dry cliffs rich in iron.
- O. hercynicum* – [1230 m], 9. Collected once near small aufeis in stream valley, on inclined wall of eroded rock outcrop rich in iron.
- Oncophorus elongatus* – [575–1300 m], 1, 6, 7, 11, 13. In mires with cottongrass and dwarf birch, at base of mossy slope of terrace in larch forest, on litter and rotten wood, in dry mountain tundra and on pebbly bar on aufeis glade.
- O. integerrimus* – [1125 m], 11. Collected once in dwarf birch thickets at base of slope to a stream valley.
- O. virens* – [590 m], 14. In hummocky dwarf birch thickets with *Sphagnum* along a shallow brook.
- O. wahlenbergii* – [594–1155 m], 5, 6, 11, 13, 15. In mires, wet mossy tundra, on rocks and soil at brook banks.
- Orthothecium chryseon* – [800–1300 m], 3, 6–8, 11. In wet tundra communities at brook banks, in wet depression in alder thicket, in a brook, between rocks of rock-field, in swampy depression.
- O. retroflexum* – [900 m], 7. On steep mossy slope between cliffs.
- O. sibiricum* – [860–900 m], 7. On rock in brook and in deep niche at cliff base.
- O. strictum* – [800–945 m], 7, 10, 12. In crevices and niches of low cliffs at stream bank, in niches between boulders of rock-field, on rocks in a brook. First records of this species with sporophytes were made along a stream at the foot of Mramornaya Mt.
- Orthotrichum anomalum* – [875–1240 m], 7, 8. On wall of calcareous cliff, on rocks and rock outcrops in mountain tundra.
- O. hyperboreum* – [840 m], 6. Collected once on rotten wood in larch forest on slope of terrace.
- O. pellucidum* – [875 m], 7. Collected once on a wall of a crevice in calcareous cliff.
- Paludella squarrosa* – [590–602 m], 13–15. In mires at brook banks, in larch forest on terrace, on mossy pebble bar along a shallow brook.
- Philonotis capillaris* – [884 m], 5. Collected once in a pool in floodplain *Chosenia* thickets.
- P. fontana* – [604 m], 13. Collected once on soil on a bank of oxbow.
- P. tomentella* – [590–1238 m], 3, 6, 7, 11–14. In mires on terraces and at lake shore, in tundra communities in floodplain on aufeis glade, on mossy pebble bar along a shallow brook, on rocks in brooks and on soil at brook banks, on mossy slope with alder thickets, in wet mountain tundra on slopes; frequent.
- Plagiomnium curvatulum* – [925–1036 m], 3, 4, 9. On soil in alder thickets at slope bases and on boggy terrace.
- P. ellipticum* – [575–1050 m], 5, 7, 13, 15. On soil in floodplain *Chosenia* thickets, along brooks in larch forest and willow stands, in dwarf birch thickets, in dwarf willow tundra community on aufeis glade, on steep mossy slope between cliffs.
- P. medium* – [900 m], 7. Collected once on rocks in a brook.
- Plagiopus oederianus* – [881–1200 m], 7, 9. At cliff bases, on rocky soil on steep slope with screes and spots of *Dryas* tundra, on soil in willow and alder thickets at slope base.
- Plagiothecium berggrenianum* – [925 m], 9. Collected once at base of alder trunk in willow and alder thickets on steep slope.
- P. denticulatum* – [590–900 m], 10, 14. On rocks at brook bank in willow and alder thickets, on wall of hummock in dwarf birch community at bank of shallow brook, at base of dry cliffs rich in iron; rare.
- P. svalbardense* – [604–925 m], 5, 6, 9, 10, 13. In niches under rocks and roots in open larch forest, at base of larch trunk in a mire on terrace of Tirekhtyakh Creek, at trunk bases and in niches under roots in willow and alder thickets, between hummocks in boggy larch forest, at base of dry cliffs.
- Platydictya jungermannioides* – [604–1300 m], 7, 8, 10, 13. On rock outcrops in willow and alder thickets at base of slope, in niches under rocks in larch forest on slope of terrace, in niches under and between rocks in mountain tundra, along brooks, in cliff crevices, on mossy slope to a brook, on rotten wood in willow stands on the bank of oxbow.
- Platyhypnum alpestre* – [900 m], 7. Under low cliffs at stream bank.
- P. norvegicum* – [895 m], 10. Collected once on rocks in a brook in willow and alder thickets.
- Pleurozium schreberi* – [590 m], 14. Collected once in larch forest with dwarf birch.
- Pogonatum dentatum* – [884–1140 m], 6, 7, 9, 11. In niches under rocks in larch forest, at base of cliff rich in iron, on turf in a rut of winter road at lake shore.
- P. urnigerum* – [835–1230 m], 5, 6, 9, 11. On silt and sand in floodplain willow thickets, on rocky soil in dry stream bed, on screes and between rocks of rock field, on inclined wall of eroded rock outcrop rich in iron, on soil in dwarf Siberian pine thickets.
- Pohlia* cf. *andalusica* – [825 m], 6. On sand in willow thickets in floodplain of Tirekhtyakh Creek.
- P. andrewsii* – [884–1230 m], 5, 9, 11. In fissures of eroded rock outcrops rich in iron, on moist rocks at brook bank, on soil bluff on slope of terrace with willow thickets, and on turf in a rut of winter road at the edge of cottongrass mire.
- P. atropurpurea* – [595 m], 13. Collected once on soil bluff at stream bank.
- P. beringiensis* – [950–1225 m], 9, 10, 11. At base of dry cliffs rich in iron and on a scree below, on rocky soil in *Dryas* tundra on steep slope, on rocky bluff to dry stream bed.
- P. bulbifera* – [1120–1238 m], 1, 11. On soil at brook bank, in hummocky mire and in rut of winter road at lake shore.
- P. cruda* – [590–1225 m], 5–7, 10–14. In niches under roots and rotten wood in larch forests on slopes, on soil in willow and alder stands, in niche under rock in dwarf Siberian pine thickets, between boulders on slope, on rock outcrops on dry slope, on mossy pebble bar along shallow brook.
- P. crudoides* – [900 m], 9. Collected once in niche under rock at tree line on steep slope.
- P. filum* – [825–884 m], 5, 6. On sand and silt along ground roads in floodplain willow stands and on soil at base of slope of terrace.
- P. longicollis* – [895–1225 m], 10, 11. In niche under rock in dwarf Siberian pine thickets on slope to stream and on rocks in willow and alder thickets at base of slope.
- P. nutans* – [590–1130 m], 3–6, 9–11, 13, 14. On trunk bases, rotten wood and rocks in larch forests, in niches of rock outcrops on open slopes, in rut of ground road, on mossy pebble bar along a shallow brook, at base of cliffs.

- P. sphagnicola* – [839–1125 m], 6, 11. In mires on terrace of Tirekhtyakh Creek and at lake shore, in *Sphagnum* carpet and on hummocks.
- P. wahlenbergii* – [575–900 m], 6, 7, 13. On soil and pebbles along brooks, in ruts of old ground roads and in dwarf willow and horsetail tundra communities on aufeis glade.
- Polytrichastrum alpinum* – [833–1230 m], 6, 9–11. In niche under rock in larch forest, on ledge of cliff rich in iron, on soil and rocks in willow and alder thickets.
- P. septentrionale* – [839–1343 m], 2, 6. In niche between rocks on dry rocky slope and on hummock in mire on terrace of Tirekhtyakh Creek.
- Polytrichum hyperboreum* – [600–1240 m], 6, 9, 13. On gravel in niche of cliff rich in iron, on rocky soil on dry slope, on edge of bluff of terrace, at roadside in larch forest.
- P. jensenii* – [900–1238 m], 2, 5. In *Straminergon stramineum* carpet in dwarf birch community at brook bank and among *Sphagnum* in open larch forest on gentle slope.
- P. juniperinum* – [600–1225 m], 6, 11, 13. At roadside in larch forest on river terraces, on soil in willow and alder thickets, on turf in rut of winter road at boggy lake shore, on litter in larch forest with lichen cover, on rocky soil in mountain tundra and lichen community along dry stream bed.
- P. longisetum* – [830–839 m], 6. In mires on terrace of Tirekhtyakh Creek.
- P. piliferum* – [602–1150 m], 5, 6, 9, 11, 13. On soil in larch forests on terraces of Tirekhtyakh Creek, on rock outcrops rich in iron, in niches between rocks of rock-field.
- P. strictum* – [800–1040 m], 5, 6. In boggy larch forests on gentle slopes, among *Sphagnum* and at bases of larch trees.
- P. swartzii* – [596–1130 m], 4, 5, 11, 14. In mires at lake shores and on terraces of brooks, in rut of old winter road in open larch forest, on hummock in dwarf birch community on small island in a wide and shallow brook, in dwarf birch tundra on slope.
- Pseudocrossidium obtusulum* – [900 m], 10. At base of dry cliff rich in iron.
- Pseudoleskeella catenulata* – [835 m], 6. Collected once on rotten wood in willow stand in floodplain of Tirekhtyakh Creek.
- P. tectorum* – [840–860 m], 6, 7. On soil in rocky *Dryas* tundra and on rotten log on slope of terrace with larch forest.
- Pseudostereodon procerrimus* – [594–1170 m], 6, 7, 9–11, 15. On mossy cliff wall near waterfall, on inclined wall of eroded rock outcrops at stream bank, on ledge of dry grey cliff and between rocks of scree at cliff base, on steep mossy slope between cliffs, on rock outcrop on slope and on bare gravelly soil in dwarf birch tundra.
- Psilopilum cavifolium* – [969–1130 m], 5, 11. In ruts of winter roads on boggy terrace of Tirekhtyakh Creek and on lake shore.
- P. laevigatum* – [1130 m], 11. On disturbed turf near winter road in cottongrass mire on lake shore.
- Pterygoneurum ovatum* – [1036–1100 m], 3. On scree on slope to Tirekhtyakh Creek and on bare soil near burrow of gopher on steep steppe slope.
- Ptilium crista-castrensis* – [895–925 m], 9, 10. On soil and litter in willow, alder and dwarf Siberian pine thickets on slopes.
- Pylaisia polyantha* – [604–950 m], 7, 9, 13. On rotten log and willow trunk in larch forest on stream bank; on soil in alder thickets at stream bank collected once on gravelly soil in *Dryas* mountain tundra on steep slope.
- Racomitrium lanuginosum* – [840–1343 m], 2, 5, 7, 9. On soil in mountain tundra and just above tree line, on litter in larch forests, in dwarf birch community with lichens at lake shore.
- Rhizomnium andrewsianum* – [590–1225 m], 9, 11, 14. On soil along small brook in mountain tundra, in wet depression in dwarf birch community and alder thickets at base of slope and on hummocky dwarf birch thickets along a wide and shallow brook.
- Rhytidium rugosum* – [595–1130 m], 6, 11, 13. On soil bluff near waterfall, on soil in rocky mountain tundra with *Dryas*, and on litter in larch forest.
- Saelania glaucescens* – [833–940 m], 6, 9. In niche under rock on slope of terrace with larch forest, in niches between rocks in dwarf Siberian pine thickets and in niches of rock outcrop on open slope with screes.
- Sanionia nivalis* – [1343 m], 2. Collected once on soil on dry rocky slope to the lake.
- S. uncinata* – [580–1238 m], 1, 5–7, 11, 13–15. On litter and rotten wood in larch forests, in willow thickets in floodplain, on mossy slope of terrace, in rocky mountain tundra, on steep mossy slope between cliffs, on rocks and soil along brooks, on soil bluffs, on mossy pebble bar along wide and shallow brook; frequent.
- Schistidium agassizii* – [880 m], 5. Collected once on rocks in a brook running on gentle slope with mires.
- S. boreale* – [930–945 m], 7, 12. On rock outcrops in narrow cliffy valley of a brook and on inclined walls of rock outcrops on steep dry slope with screes.
- S. flexipile* – [860 m], 7. Collected once on rock in rocky *Dryas* tundra.
- S. frigidum* – [1127–1230 m], 9, 11. On inclined wall of eroded cliffs rich in iron, at base of cliff wall on steep slope with screes and on rock in dwarf Siberian pine thickets on slope to a stream.
- S. frisvollianum* – [596–1240 m], 7, 8, 14. On calcareous rocks and rock outcrops in mountain tundra and on pebble bar along wide and shallow brook.
- S. liliputanum* – [1170 m], 9. On wet rocks along a small brook.
- S. obscurum* – [900–1230 m], 7, 9, 10. On calcareous rocks on steep slope in a narrow cliffy gorge of brook, in fissures of eroded cliffs rich in iron, on rocks of rock-field under dry grey cliffs.
- S. papillosum* – [602–1250 m], 6, 9, 10, 11, 13. On rock on mossy slope of terrace with larch forest, at base of dry wall of cliff rich in iron, in fissures of boulder at stream bank, on rocks in rocky *Dryas* tundra and in dry larch forest with lichen cover.
- S. platyphyllum* – [800–1170 m], 3, 6, 7, 9, 10. On rocks in brooks in larch forest, willow and alder thickets and in open sites with tundra vegetation, at base of cliff wall at brook bank.
- S. pulchrum* – [596–1220 m], 3, 6, 9, 10, 14. On rocks in mountain tundra, at cliff bases along streams and brooks, on cliffs in willow and alder thickets, in fissures of inclined wall of cliff rich in iron, on rocks along a brook, on rock outcrops among screes.
- S. relictum* – [875–1240 m], 7, 9. On calcareous rocks, rock outcrops and cliff walls in mountain tundra at foothills of Mramornaya Mt.
- S. scabripilum* – [895–945 m], 10, 12. On ledge of cliffs in willow and alder thickets in creek valley and on inclined surface of boulder on steep slope with screes.

- S. sordidum* – [886 m], 6. Collected once on calcareous rocks in a brook running on steep slope in a narrow cliffy gorge.
- S. subjulaceum* – [590 m], 14. Collected once on rock in a wide and shallow brook.
- S. submuticum* subsp. *arcticum* – [860–881 m], 6. At base of calcareous cliff at stream bank, on rock in rocky *Dryas* tundra and in deep crevice of cliff at base of slope.
- S. trichodon* – [930 m], 7. Collected once on wall of calcareous cliff in a narrow gorge of stream.
- Sciuro-hypnum plumosum* – [594 m], 15. Collected once on mossy pebble bar in a wide valley of stream.
- Scorpidium cossonii* – [575–1300 m], 6–8, 11–15. In mires on terrace of Tirekhtyakh River and in depression between spurs of Mramornaya Mt., in wet tundra communities in a wide floodplain on aufeis glade, in mire along springs at lake shore, on mossy pebble bar along a wide and shallow brook, in wet sites in mountain tundra; abundant.
- S. revolvens* – [830–1130 m], 3–6, 11. In mires on terraces of Tirekhtyakh Creek, in wet depressions in open larch forest, in a brook on lake shore.
- S. scorpioides* – [595–1130 m], 5, 11, 13. In shallow water on boggy banks of lakes, in hollows on terraces and floodplains of streams and brooks.
- Seligeria donniana* – [930 m], 7. Collected once on wet wall of calcareous cliff in a narrow gorge of stream.
- S. tristichoides* – [881–1100 m], 7, 12. On wall surfaces and in fissures of wet and dry calcareous cliffs.
- Sphagnum alaskense* – [890 m], 5. In mire at lake shore, on hummocks and at the edge of sedge & *Sphagnum* community in shallow water.
- S. andersonianum* – [875–1225 m], 3–6, 11, 13, 14. In boggy larch forest on gentle slope to Tirekhtyakh Creek, in mires on terraces and near lakes, in hummocky dwarf birch community along wide and shallow brook; frequent.
- S. angustifolium* – [830–1225 m], 5, 6, 9, 11. In hummocky mire with sparse larch trees on gentle slope, in larch forest on terrace of Tirekhtyakh Creek, in alder thickets at base of steep slope.
- S. aongstroemii* – [840–1130 m], 5, 6, 11. On hummocks and in flat carpet in mire near the lake, in open boggy larch forest on gentle slope, at the edge of cottongrass mire in a wide floodplain of a stream.
- S. balticum* – [890–1120 m], 3, 5, 11. In boggy larch forest on gentle slope, in hummocky mire at lake shore, in cottongrass mire near the lake.
- S. beringiense* – [575–969 m], 3, 5, 11. Between hummocks and in flat carpet in mire at lake shore, in forestless mire on terrace of Tirekhtyakh Creek, at edge of boggy larch forest.
- S. capillifolium* – [1040–1238 m], 2, 3, 11. In boggy larch forest on gentle slope, in dwarf birch thickets along a brook, in small flooded mire at base of slope.
- S. compactum* – [890 m], 5. In wet site in larch forest on slope to a lake, in dwarf birch thickets with sedges and *Sphagnum* at lake shore.
- S. fimbriatum* – [590–1040 m], 5, 6, 13. In hummocky mire at lake shore, in forestless mire on terrace of Tirekhtyakh Creek, in larch forest with hummocky dwarf birch thickets.
- S. fuscum* – [590–1040 m], 3, 13, 14. In boggy larch forest at base of slope to Tirekhtyakh Creek, in wet larch forest at brook bank, in hummocky dwarf birch thickets along a wide and shallow brook.
- S. girgensohnii* – [590–1040 m], 3, 5, 6, 9, 10, 13, 14. In wet larch forests, willow, alder and dwarf Siberian pine thickets on slopes, on hummocks and in hollows in forestless mire on terrace of Tirekhtyakh Creek.
- S. lenense* – [839–1040 m], 3–6. In hummocky mire at lake shore, in forestless mire on terrace of Tirekhtyakh Creek, in boggy larch forest at base of slope.
- S. mirum* – [880 m], 5. In boggy larch forest on gentle slope.
- S. obtusum* – [817 — 1040 m], 3–6. In boggy larch forests on gentle slope and on terrace of Tirekhtyakh Creek, in flooded sedge & *Sphagnum* community at lake shore.
- S. orientale* – [839 — 1130 m], 4–6, 11. In flooded sedge & *Sphagnum* community at lake shore, in forestless mire on terrace of Tirekhtyakh Creek, on flooded tundra at slope base, along springs at lake shore, in cottongrass mire.
- S. platyphyllum* – [900 m], 5. In boggy open larch forest on gentle slope.
- S. squarrosum* – [839–1130 m], 5, 6, 11. In flooded sedge & *Sphagnum* community at lake shore, in flooded site in forestless mire on terrace of Tirekhtyakh Creek, at edge of cottongrass mire at lake shore.
- S. steerei* – [870–880 m], 5. In boggy open larch forest on gentle slope and in hummocky mire with cottongrass.
- S. subfulvum* – [602–1125 m], 5, 11, 13. In hummocky mire with sedges and *Sphagnum* at lake shore, in cottongrass mire near lake and in boggy site in larch forest.
- S. subsecundum* – [1120–1238 m], 1, 11. In dwarf birch thickets along a brook and in flooded site in cottongrass mire near lake.
- S. teres* – [839–1238 m], 1, 3, 5, 6, 11. In boggy larch forest on gentle slope to Tirekhtyakh Creek, in forestless mire on terrace, in open larch forest, in small mires at slope base and at lake shore.
- S. tundrae* – [575–1238 m], 1, 3–6, 11, 13. In boggy larch forest on gentle slope, in forestless mire on terrace of Tirekhtyakh Creek, in larch forest, in *Sphagnum* mire on terrace of stream, in alder thickets on steep slope.
- S. warnstorffii* – [890–1120 m], 5, 11. At edge of flooded lake bank and hummocky site, on open larch forest on gentle slope, in cottongrass mire near lake.
- Splachnum luteum* – [575–1130 m], 5, 11, 13, 15. On dung of elk in open larch forest, at roadside of winter road in larch forest, on disturbed turf near winter road at lake shore, on old dung in larch forest in stream bank and in sedge-cottongrass-horsetail tundra community on aufeis glade.
- S. rubrum* – [880 m], 5. On dung of elk in rut of old winter road in larch forest on gentle slope.
- S. sphaericum* – [575–1130 m], 6, 11, 13. In flooded sites in forestless mire on terrace of Tirekhtyakh Creek, in wet rut of winter road, on disturbed turf in cottongrass mire in wide valley of a brook, on ground road in larch forest, in horse dung in dwarf willow tundra on aufeis glade, on old dung in larch forest on terrace of brook.
- S. vasculosum* – [596–1120 m], 5, 10. On old dung in mire at lake shore and along a brook.
- Stegonia pilifera* – [900 m], 10. On soil between rocks of rock-field, in wet depressions at cliff base.
- Streblotrichum convolutum* (*Barbula convoluta*) – [595–840 m], 6, 13, 15. On bare soil on slopes to forest road and a brook, in niche under tree roots, on soil covering upturned roots of fallen tree in larch forest, in frost crack.
- Stereodon holmenii* – [600–860 m], 7, 13. In hollow in cottongrass-horsetail mire at slope base, on litter in larch forests.
- Straminergon stramineum* – [590–1125 m], 5, 11, 14. Among *Sphagna* in hummocky mire at lake shore, on rocks in a brook

- in larch forest on gentle slope, in boggy dwarf birch thickets along a brook, on mossy pebble bar along wide and shallow brook.
- Syntrichia norvegica* – [590 m], 14. On mossy pebble bar along wide and shallow brook.
- S. pagorum* – [900 m], 10. Collected once on rock outcrop under dry cliffs rich in iron.
- S. ruralis* – [599–1343 m], 1–3, 7, 9, 10, 12, 15. On soil on dry rocky slope, in dwarf birch thickets, on rock outcrops and rocky soil on steep slope, on mossy slope of terrace with larch forest.
- Tayloria acuminata* – [596 m], 14. Collected once in niche of soil bluff at bank of brook in larch forest.
- T. lingulata* – [590–602 m], 13, 14. On old dung on ground road in larch forest and in dwarf birch hummocky thickets along a brook.
- Tetraphis pellucida* – [590 m], 14. Collected once in niche of hummock wall in dwarf birch thickets along wide and shallow brook.
- Tetraplodon angustatus* – [600 m], 13. On ground road in larch forest with cowberry and lichens.
- T. mnioides* – [600–1155 m], 5, 7, 11, 13. On old dung in willow thickets in floodplain, on steep mossy slope between cliffs, in niche of cliff in narrow gorge of brook, on ground roads in larch forest, in mountain tundra, on decayed dung at stream bank.
- T. pallidus* – [1155–1225 m], 11. On wet lawn along a small brook, in niche in *Dryas* & shrublet tundra on gentle slope.
- T. paradoxus* – [1155–1225 m], 3, 9, 11, 13. In boggy larch forest on gentle slope, on soil in lichen tundra, on old dung at lake shore and in open larch forest, on wet lawn along a small brook, on disturbed turf near winter road in cottongrass mire at lake shore, on wet gravelly soil on ground road, in ruts of ground roads in wet tundra communities on aufeis glade.
- T. urceolatus* – [1000–1225 m], 9, 11. In mountain tundra on steep slope, between rocks of rock-field and on wet lawn along a small brook.
- Timmia bavarica* – [930 m], 7. Collected once in niche of calcareous cliff in narrow gorge of brook.
- T. comata* – [595–1200 m], 7, 9, 10, 11, 13. In niche under boulder at stream bank, on soil at brook bank, on rocky soil in *Dryas* tundra and in wet mossy tundra on slope, on soil bluff at brook bank.
- T. megapolitana* – [800 m], 6. At base of mossy slope of terrace near aufeis.
- T. sibirica* – [800–1240 m], 7, 8, 12. In wet niche of calcareous cliff near small waterfall, on inclined cliff wall, on cliffs at stream bank, in niche between rocks of rock-field, in wet depression on mossy slope with alder thickets, in larch forest at base of steep dry slope.
- Tomentypnum involutum* – [595–1240 m], 1, 7, 8, 11–13. Among *Sphagnum* in dwarf birch thickets along a stream, on soil in willow and alder thickets on slope, in hummocky mires with sedges and dwarf willow, in cottongrass & horsetail mire at lake shore, in mossy mountain tundra, on litter in boggy larch forests.
- T. nitens* – [590–1240 m], 3, 7, 8, 12–14. In flooded dwarf birch & cottongrass mire, in boggy larch forests, in willow and alder thickets on slope, in larch forest at base of steep dry slope, on pebble bar along wide and shallow brook.
- Tortella alpicola* – [595–1225 m], 7, 10, 11, 13. At cliff base on stream bank, on rocky soil in *Dryas* tundra, in deep crevice of calcareous cliff, on dry rock outcrops on steep slope, under rock in dwarf Siberian pine thickets on slope, on lawn along a small brook.
- T. fragilis* – [590–1343 m], 2, 3, 7, 9, 12–15. On soil on dry rocky slopes, in mountain tundra with *Dryas* and lichens, on mossy pebble bar along wide and shallow brook, in hummocky dwarf birch thickets with lichens, on rotten log in larch forest, in rut of ground road in larch forest on terrace, on scree at base of dry cliffs rich in iron.
- T. inclinata* – [650–950 m], 7, 10, 12. In fissures of rock outcrops, on gravel in rocky *Dryas* tundra, on boulder in rock-field, in deep crevice of calcareous cliff.
- T. spitzbergensis* – [575–800 m], 6, 13, 15. On soil at base of slope with alder thickets, in shallow water at stream bank, in sedge and dwarf willow mires on aufeis glade, in dwarf birch and *Dryas* tundra.
- T. tortuosa* – [875–1343 m], 2, 7, 10–12. In niches between rocks on dry rocky slope, on wall of deep crevice in calcareous cliff, on ledge of cliff rich in iron, on steep slope with screes and spots of *Dryas* tundra, in niches between boulders on dry slope with screes.
- Tortula acaulon* – [1050 m], 3. On soil in tundra on moderately dry slope of hill.
- T. mucronifolia* – [884–1100 m], 3, 5, 7, 9, 10. In niche of wet calcareous cliff near waterfall, on soil in alder thickets at slope base, in niche under rock on steep slope with screes, in niche of cliff rich in iron and at cliff base.
- T. systylia* – [1050 m], 3. On soil on dry slope with steppe vegetation.
- Trichodon cylindricus* – [575–1040 m], 3, 5, 6, 13. On cliff at river bank, on sand in *Chosenia* thickets in floodplain of Tirekhtyakh Creek, in rut of ground road on terrace with larch forest, in dwarf willow-sedge-horsetail tundra on aufeis glade.
- Trichostomum crispulum* – [580–1050 m], 3, 7, 10, 12, 13. On small ledge of calcareous cliff in narrow gorge of brook, on soil at edge of rock-field, on dry rocky slope with screes and rock outcrops, in dwarf willow tundra on aufeis glade.
- Warnstorfia exannulata* – [890–1125 m], 5, 11. In flooded sedge and *Sphagnum* community at lake shore, in rut of old winter road in open larch forest on gentle slope, in a pool among dwarf birch thickets, along springs at lake shore.
- W. fluitans* – [595–890 m], 5–7, 13. In wet depression in larch forest on gentle slope to a lake, in sedge mire on terrace of Tirekhtyakh Creek, in a pool in larch forest, in wet rut of ground road in larch forest.
- W. procera* – [1194 m], 3. In a brook.
- W. sarmentosa* – [830–1130 m], 5–7, 11. In forestless mire on terrace of Tirekhtyakh Creek, in flooded sedge community at lake shore, in cottongrass mire near lake, in a brook on lake shore, in small flooded swamp at base of slope.
- W. tundrae* – [580–599 m], 13, 15. In mires along stream, in pools at brook bank and in mire with *Calamagrostis* on aufeis glade.

## DISCUSSION

The results of the exploration of this moss flora appeared unexpected at the final stage of the work after compiling the species list: the final number of 325 species revealed in the area in the course of this 2018 expedition appeared to be higher than in eight previously studied areas in different parts of Yakutia, where 162 to 294 moss species were recorded basing on a similar expedition (Ignatova *et al.*, 2018). This disagrees with the gen-

eral impression obtained during the field work, when many places looked extremely poor in moss diversity. Most rocky slopes are dry, composed of easily decomposed material forming unstable screes. In such habitats there were no mosses at all, excepting scattered more solid rock outcrops, but even those were very poor in bryophytes, being too dry. Late snow beds melt mostly in August, providing only a month for bryophyte growth, but even in this period snowfalls occasionally happen (Fig. 2H) with snow lasting for several days. *Larix* forest are also largely dominated by lichens, or if they are of mossy type, then only few species co-occur with the carpet-forming *Rhytidium* and *Hylocomium*.

The increase of species diversity can be referred to the following habitats underrepresented in other, more southern parts of Yakutia.

In addition to fen species complex of wider distribution in Yakutia that includes *Cinclidium stigium*, *Paludella*, *Catoscopium*, *Meesia uliginosa*, *Tomentypnum nitens*, *Scorpidium revolvens*, etc., similar fens in the studied area include at places abundant *Cinclidium latifolium*, *C. subrotundum*, *Loeskyppnum badium*, and *Drepanocladus turgescens*; *Meesia truquetra* is also abundant at places (rare or absent in others areas recently explored by us) and *M. longiseta* (very rare). Large pools are at places totally filled by *Warnstorfia tundrae*. *Orthothecium chryseon* is also a constant component of such mires.

*Sphagnum* diversity was generally quite moderate, except for a shore of one lake (locality 5) where we collected 20 species out of 23 found during the whole expedition. A hummocky *Sphagnum* community along its shore and shallow banks with scattered sedges (Fig 2G) provided an incredible diversity of microhabitats.

Similarly unexpected diversity was found on extensive pebble bars of a brook near the place of its origin (locality 14 in Fig. 1, Fig 3D); with a completely unexpected combination of rare species, i.e. *Schistidium sordidum*, *S. subjulaceum*, *S. frisvollianum*, and *Didymodon gaochenii*.

Aufeis glades have numerous patches of bare soil maintained by numerous brooklets, so over 50 species co-exist here.

Semi-wild horses and reindeers contribute to the Splachnaceae diversity; 11 species of this family occur there. Many grow in few places but as numerous individuals, including *S. vasculosus*, *Tetraplodon pallidus*, etc.

The huge marble mountain might be considered especially important for the increase of moss species number, but in fact solid rock is appropriate for *Andreaobryum*, which is abundant along numerous small waterfalls, but in general these rocks are too hard, and probably this is the reason why some calciphilous mosses, which are frequent in Sette-Daban, are absent here: *Hydrogonium amplexifolium*, *H. gregarium*, *Myurella sibirica*, *Gollania turgens*, and less common *Timmia austriaca*, *T. norvegica*, *Platydictya acuminata*, and *Isop-*

*terygiella alpicola* were also not found on Ulakhan-Chistai Range.

Thus, instead of rather expected records, the diversity in the study area was 'hot-spotty': a relatively few places contributed sufficiently to overall species diversity. As much as 104 species were collected only from one of 15 collecting localities (Fig. 1).

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#### LITERATURE CITED

- [ALEKSEEV V.R.] АЛЕКСЕЕВ В.Р. 2017. Проблемы инженерного освоения наледных участков речных долин. – [Problems of engineering development of aufeis sites in river valleys] *Криосфера [Cryosphere]* 21(6): 65–75.
- [ANDREEV, A.P.] АНДРЕЕВ А.П. 2016. Горы Якутии. – [Mountains of Yakutia] *Якутск, изд-во Бичик [Yakutsk, Bichik Press]*, 64 pp.
- IGNATOV M.S., O.M. AFONINA, E.A. IGNATOVA *et al.* 2006. Checklist of mosses of East Europe and North Asia. – *Arctoa* 15: 1–130.
- IGNATOV, M.S., E.A. IGNATOVA, V.E. FEDOSOV, O.V. IVANOV, E.I. IVANOVA, M.A. KOLESNIKOVA, S.V. POLEVOVA, U.N. SPIRINA & T.V. VORONKOVA. 2016. *Andreaobryum macrosporum* (*Andreaobryopsida*) in Russia, with additional data on its morphology. – *Arctoa* 25(1): 1–51.
- IGNATOV, M.S., E.A. IGNATOVA, E.I. IVANOVA, O.V. IVANOV & N.A. BYSYIN. 2018. On the distribution of *Andreaobryum* in Russia. – *Arctoa* 27(2): 112–118.
- [IGOSHIN, V.I., A.I. UGLOV, E.K. POROSYATNIKOV] ИГОШИН В.И., А.И. УГЛОВ, Е.К. ПОРОСЯТНИКОВ. 1988. Хребет Черского: Буордахский массив. – [Chersky Range: massiv Buordakh]. *Moscow*, 207 pp.
- [KRYUKOV, V.D. (ed.)] КРЮКОВ В.Д. (ред.) 1988. Метеорологический Ежегодник. – [Meteorologicheskii Ezhegodnik] Гидрометеорологический центр, Якутск [Gidrometeorologicheskii tsentr, Yakutsk].
- [ONUFRIEVA, L.I. (ed.)] ОНУФРИЕВА Л.И. (ред.) 1989. Метеорологический Ежегодник. – [Meteorologicheskii Ezhegodnik] Гидрометеорологический центр, Якутск [Gidrometeorologicheskii tsentr, Yakutsk].
- SOFRONOVA, E.V. (ED.), O.M. AFONINA, S.M. AZNABAEVA, E.Z. BAISHEVA, A.N. BERSANOVA, A.G. BEZGODOV, E.A. BOROVICHEV, M.A. BOYCHUK, E.V. CEMERIS, G.YA. DOROSHINA, M.V. DULIN, A.P. DYACHENKO, V.E. FEDOSOV, I.V. FILIPPOV, E.V. GARIN, O.G. GRISHUTKIN, M.S. IGNATOV, E.A. IGNATOVA, E.I. IVANOVA, M.A. KOLESNIKOVA, T.I. KOROTEEVA, G.M. KUKURICHKIN, S.A. KUTENKOV, E.YU. KUZMINA, E.D. LAPSHINA, O.V. LAVRINENKO, A.I. MAKSIMOV, K.O. PECHENKINA, D.A. PHILIPPOV, O.YU. PISARENKO, N.N. POPOVA, YU.M. SERGEEVA, E.A. SHCHIPANOVA, G.S. TARAN, V.V. TELEGANOVA, D.A. ZAKHARCHENKO. 2018. New bryophyte records. 10. – *Arctoa* 27: 60–86. <https://doi.org/10.15298/arctoa.27.07>
- SURMILOVA, E.P., G.A. MAXIMOV, L.M. NATAPOV. 1985. State geological map of the USSR (new series). Scale 1:1000000. Sheet Q – 54, 55 (Honuu).