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LIVERWORTS OF PUTORANA PLATEAU (EAST SIBERIA): AN UPDATED CHECKLIST

ПЕЧЕНОЧНИКИ ПЛАТО ПУТОРАНА (ВОСТОЧНАЯ СИБИРЬ): АННОТИРОВАННЫЙ СПИСОК

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Abstract

The new checklist of Putorana liverworts was compiled based on examination of recent collections and summarizing of literature data. It includes 118 species, 47 of them are new for the plateau. The most interesting records are *Odontoschisma francisci, Saccobasis polymorpha, Endogemma caespiticia* and *Marchantia romanica*. The occurrence of 26 taxa mentioned in the literature was not re-confirmed. In general terms, the flora is typical for continental Hemiarctic with very limited number of taxa showing East Asian (*Apotreubia nana*) and amphi-oceanic (*Cordaea flotoviana, Lophozia savicziae, Odontoschisma francisci, Saccobasis polymorpha*) distribution.

Резюме

Составлен новый аннотированный список печеночников плато Путорана, основанный как на недавних коллекциях, так и на обобщении литературных данных. Список включает 118 видов, в том числе 47 приводятся для плато впервые. Наиболее интересными находками являются *Odontoschisma francisci, Saccobasis polymorpha, Endogemma caespiticia* и *Marchantia romanica*. Распространение 26 видов, указанных в литературе, не подтверждено, и часть из них могла быть приведена на основании ошибочных определений. В общих чертах флора типична для континентальной Гипоарктики с ограниченным количеством видов, показывающих восточноазиатские (*Apotreubia nana*) или амфиокеанические (*Cordaea flotoviana, Lophozia savicziae, Odontoschisma francisci, Saccobasis polymorpha*) связи гепатикофлоры.

KEYWORDS: Marchantiophyta, Taimyr, phytogeography, rare species

Introduction

Putorana Plateau is large volcanogenic massif composed by Siberian traps. It is located in East Siberian subarctic zone, with the most extent lying northward of Polar Circle. Putorana Plateau was referenced in the World Heritage List by UNESCO (http://whc.unesco.org/en/list/1234) as the area of great importance for arctic and subarctic ecosystems conservation. Despite large size, high variation in ecosystems and relative accessibility, Putorana Plateau was out of particular attention of hepaticologists until recently. The Swedish expedition to Siberia in 1875 and 1876 years (that was the great advance in northern Asia bryophyte flora knowledge and the first occasion in 1876 when professional bryologist, H.W. Arnell, collected bryophytes in Asian Russia), worked near, but outside of the plateau. The plateau remained completely unexplored in the view of liverworts, until the 1970th when A.L. Zhukova conducted field works in the area. Her works (Zhukova 1986a, 1986b) founded the basis for Putorana liverwort flora recognition. Thereafter two bryologists visited Putorana and had the occasion to collect liverworts, but both never published the complete lists of their collections. T.N. Otnyukova collected some *Lophozia* those were studied twenty years later by Bakalin (2005), while E.N. Andreeva collected large collection of hepatics that remains untreated and only a few new records are published (Andreeva, 2009). Therefore it was the good chance to enrich the pool of available data on hepatics when one of us (Fedosov) has visited the plateau with the main purpose of *Musci* flora exploration. The basic purpose of the present account is to provide an updated checklist of the liverwort flora of Putorana Plateau in the light of modern taxonomy and taxa understanding.

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STUDY AREA

Putorana Plateau is a strongly dissected mountain massif of ca. 250 000 km^2. It is situated in south-western part of Taimyr Municipal District of Krasnoyarsk Territory, between 67th and 70th latitudinal parallels. The plateau is originated in north western part of the Siberian craton due to volcanic activity in early Mesozoic. The relief in Putorana Plateau is quite uniform and composed by numerous basaltic or andesite strata of clinkers that formed flat surfaced mountains with the tops of ca. 1000–1200 m alt. (the highest is ca. 1700 m). The erosion of edges of these layers caused in alternation of flat terrace-like surfaces and steep rocky slopes. Deep narrow lake depressions of tectonic origin with steep rocky slopes are mostly confined to western part of the plateau and extended latitudinally. In that western part Putorana Plateau is interrupted just before Norilsk-Rybninsk Depression by the steep slope ca. 800 m high between depression bottom and upraised plain (Parmuzin, 1964).

The area covered by our field network is situated in northern and southern shores of Glubokoe Lake and near adjacent watersheds (Fig.1). Northeastern part of study area characterized by middle-mountain landscapes with altitudinal variation of vegetation. Mountain peaks reach 800–1000 m alt., while the waterline in Glubokoe Lake is about 50 m alt. These hilly mountains composed mostly by neutral andesites, whereas basic basaltic layers and sedimentary rock outcrops occur in lower part of slopes (mostly in creek canyons). Flat terrace-like surfaces in lower belt are usually covered by forest or tundra. In upper belt (higher than 750–800 m alt.) flat surfaces are mostly occupied by rock fields, with cliffs and snowbeds common on steep slopes.

Southwestern part of studied area is occupied by alluvial boggy lowland with numerous lakes. The relief becomes more hilly (with elevations to 100 m alt.) in northeastern edge of the depression as well as southward where Paleozoic calcareous bedrock outcrops occur. Extensive ice fields developed in valleys of creeks are one of characteristics of the area.

The climate is continental, with the average of annual temperature –9.6°C and mean temperature of the warmest month (July) +14.3°C. The annual precipitation reaches 500–800 mm per year. Snow cover persists 7.5–9 months per year, and only for 3–4 summer months the average of monthly temperature exceeds zero. One of remarkable features of the studied area is severe wind regime, *e.g.* Noril'sk City situated ca. 65 km westward of the studied area is included to the top-5 windy settlements of the world (Parmuzin, 1964).

VEGETATION

The studied area is situated within northern taiga subzone, where spruce dominated communities (*Picea obovata*) reach their northern limit worldwide. These open to merely dense forests are characterized by essential admixture of *Larix sibirica* and occur in closed (*i.e.*, surrounded by mountains) lake depressions with milder microclimatic conditions, especially on exposed slopes in low elevation. Ground cover in spruce dominated communities is represented by *Betula nana*, *Salix glauca*, *Vaccinium uliginosum*, *Pyrola* spp., *Orthilia* spp., *Equisetum pratense*, *Pleurozium schreberi*, *Hylocomium splendens*, *Hylocomiastrum pyrenaicum*, *Ptilium crista-castrensis*, *Barbilophozia lycopodioides*, *etc*., along with other widespread and boreal vascular plants and mosses (nomenclature of vascular plants, mosses and liverworts follows Pospelova & Pospelov, 2007, Ignatov *et al*., 2006 and Konstantinova, Bakalin *et al*., 2009, correspondingly). The proportion between larch and spruce moves from spruce dominating to larch dominating in less warm places (*e.g*., N-facing slopes in low elevation). In the communities with larch dominating (although still with spruce participation), the proportion of hypoarctic species increases that correlate with of instead with decreasing with number and ability of boreal taxa. The areas where primary coniferous forest was disturbed by fire are occupied by open birch (*Betula tortuosa*) communities with few survived larch and spruce trees. It is characterized by well developed bush and herb ground cover (*Salix* spp., *Sorbus sibirica*, *Betula nana*, *Rosa acicularis*, *Rubus arcticus*, *Vaccinium minus*, *V. uliginosum*, *Carex arctisibirica*, *C. quasivaginata*, *Pleurozium schreberi*, *Dicranum* spp., *Hylocomium splendens*, *Ptilium crista-castrensis*, *Polytrichum commune*, *P. juniperinum*, *Sciuro-hypnum reflexum*, etc.).

Willow-sedge-moss bogs are distributed in thermokarst depressions and mostly composed by *Salix pulchra*, *Carex cespitosa*, *C. cinerea*, *C. globularis*, and mosses like *Sphagnum balticum*, *S. teres*, *Paludella squarrosa*, *Scorpidium revolvens*, *Loeskypnum badium*, *Calliergon giganteum*, *Warnstorfia sarmentosa*, *etc*. Ill-drained slopes of ridges are covered by dwarf birch (*Betula nana*) dominated communities with *Ledum decumbens*, *Vaccinium minus*, *Dicranum elongatum*, *D. undulatum*, *Sphagnum girgensohnii*, *S. capillifolium*, *S. compactum*, *S. russowii*, *Polytrichum commune*, *etc*. Willow (*Salix dasyclados*, *S. jenissejensis*) thickets near creeks have the ground cover formed by *Delphinium elatum*, *Cirsium helenioides*, *Poa palustris*, *Carex juncella*, *Sciuro-hypnum* spp., *Plagiomnium spp.*, *Brachythecium jacuticum*, *Calliergonella lindbergii*, *Cratoneuron filicinum*, *Pohlia wahlenbergii*, *Aulacomnium palustre*, *Brachythecium turgidum*, *Drepanocladus polygamus*, *Schljakovia kunzeana*, *etc*.

Wet lake shores are occupied by peat moss dominated mires with *Betula nana*, *Salix* spp., *Carex chordorrhiza*, *C. rotundata*, *Sphagnum angustifolium*, *S. fuscum*, and other peat mosses, *Aulacomnium palustre*, *Polytrichum strictum*, *Blepharostoma trichophyllum* var. *brevirete*, *Odonoschisma macounii*, *O. elongatum*, *Schistochilopsis opacifolia*, *Harpanthus flotovianus*, *Scapania hyperborea*, *S. irrigua*, *etc*. Eroded surfaces of peat hillocks provide suitable habitat for more mesophytic taxa like *Psi-*

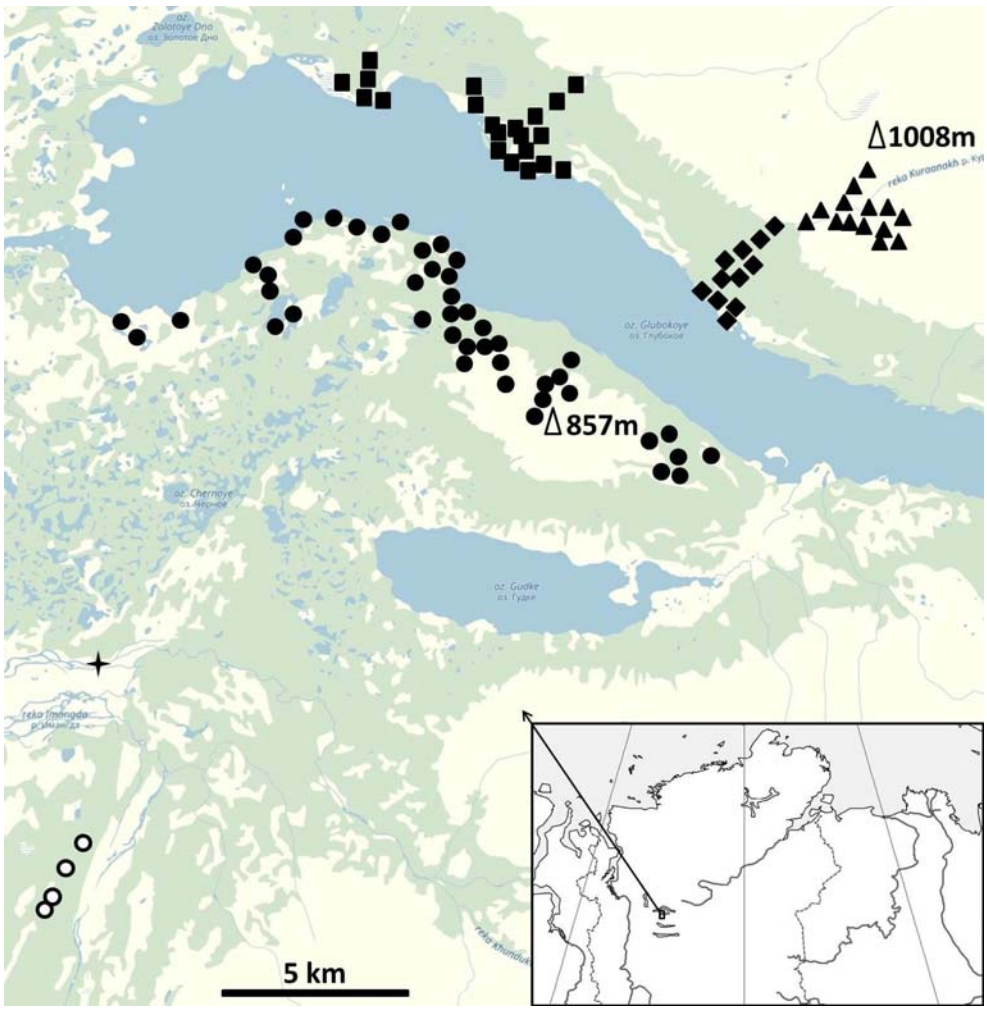

Fig. 1. Collecting localities in studied flora (see also Table 1). Filled circles – locality 1, filled rhombs – locality 2, filled triangles – locality 3, open circles – locality 4, asterisk – locality 5, filled squares – locality 6.

Table 1. Collecting localities (see also Fig. 1)

N	Coordinates	Locality	Date(s)
1	69.24719–69.31105° N; 89.28407–90.13857° E	Glubokoe Lake southern shore surroundings. 50–850 m alt.	12-15.VII, 19-24.VII, 31.VII, 4.VIII
2	69.27294–69.33057 °N; 89.94539–89.97137° E	Glubokoe Lake northern shore, Changa Stream mouth. 50–250 m alt.	16-18.VII
3	69.32219–69.35777° N; 89.81084–90.20816° E	Watershed between Glubokoe and Lama Lakes (Lamskie Mts.), creek valley eastward of Changa Creek valley. 600–950 m alt.	21.VII, 23.VII, 24.VII, 2.VIII.
4	69.15651–69.16889° N; 89.63550–89.63342° E	Imangda abandoned settlement vicinity, Kyuhta Ridge. 100–238 m alt.	27.VII
5	69.20409° N; 89.65153° E	Amdunda field with late ice melting. 60–100 m alt.	26.VII.
6	69.30131–69.30680° N;89.10136–90.08388° E	Glubokoe Lake northern shore, creek valley eastward of Changa Creek valley. Ca. 50–600 m alt.	30.VII, 3.VIII.

lopilum spp., *Dicranella* spp., *Calypogeia integristipula*, *C. muelleriana*, *Barbilophozia barbata*, *Cephaloziella divaricata*, *Endogemma caespiticia*, *Schistochilopsis grandiretis*, etc. The lakeside meadows distributed in more dry conditions than mires and composed mostly by *Equisetum arvense*, *Chamaenerion latifolium*, *Deschampsia glauca*, *Ranunculus propinquus*, *Carex eleusinoides*, *Aster sibiricus*). Willow thickets that intermingle these meadows include *Salix lanata*, *S. hastata*, *S. phylicifolia*, *Angelica decurrens*, *Ranunculus propinquus*, *Trollius asiaticus*, *Calamagrostis* spp., *Aulacomnium palustre*, *Scorpidium* spp., *Tomentypnum nitens*, *Loeskypnum badium*, *Sphagnum* cf. *teres*, *Philonotis tomentella*, *Straminergon stramineum*, *Cephaloziella varians*, *Chiloscyphus polyanthos*, *Scapania cuspiduligera* and other bryophytes.

Birch-dominated (*Betula tortuosa*) open forests are common in hilly surfaces of high terraces. They include *Duschekia friticosa*, *Salix phylicifolia*, *S. rhamnifolia*, *Poa palustris*, *P. nemoralis*, *Delphinium elatum*, *Cardamine macrophylla*, *Geranium albiflorum*, *Saxifraga aestivalis*, *Pleurozium schreberi*, *Brachythecium mildeanum*, *B.*

jacuticum, *Hylocomiastrum pyrenaicum*, *Climacium dendroides*, *Dicranum polysetum*, *D. majus*, *Sciurohypnum reflexum*, and *S. latifolium*.

Low lakeside terraces (up to 15 m above waterline) are covered by open larch forests with herbaceous cover composed mostly by *Pyrola* spp., *Orthilia* spp., *Stellaria peduncularis*, *Saxfraga spinulosa*, *S. aestivalis*, *Rubus arcticus*, *Lycopodium dubium*, as well as several mosses and lichens like *Rhytidium rugosum*, *Polytrichum juniperinum*, *P. piliferum*, *Cladonia arbuscula*, *C. rangiferina*, *C. coccifera*, and *Cetraria laevigata*. The eroded slopes of these lakeside terraces are covered by mesic meadows composed by *Calamagrostis langsdorffii*, *Trisetum agrostideum*, *Poa pratensis*, *Elymus macrourus*, *Chamaenerion angustifolium*, *Galium boreale*, *Solidago dahurica*, *Erigeron acris* and numerous pioneer bryophytes (*Nardia geoscyphus*, *Polytrichum* spp., *Pohlia* spp., *Dicranella* spp., *Bryum* spp., *Buxbaumia aphylla*, *Ceratodon purpureus*, *Trichodon cylindricus*, *etc*.).

The timberline altitude varies from 350 to 600 m a.s.l. (although single larch trees occur even up to 800 m alt.) depending on exposition and steepness of slope. Rather moist depressions in upper part of forest belt and somewhat above, in alder-dominated communities, are characterized by *Duschekia fruticosa*, *Salix glauca*, *S. reticulata*, *Ledum decumbens*, *Betula nana*, *Saxifraga nelsoniana*, *S. hieracifolia*, *Hylocomiastrum pyrenaicum*, *Sanionia uncinata*, *Polytrichastrum alpinum*, *Dicranum majus*, *Plagiomnium curvatulum*, *etc*. These communities house rare *Saccobasis polymorpha*. The alder communities alternate above with alpine meadows composed by *Potentilla nivea*, *P. stipularis*, *Papaver* spp., *Hedysarum arcticum*, *Dianthus repens*, *Phlojodicarpus villosus*, *etc*. Steep rocky slopes in gorges on the same elevation are occupied by sparse alpine meadows with *Polemonium boreale*, *Stellaria fischeriana*, *Hierochloe alpina*, *Cerastium beeringianum*, *Papaver pulvinatum*, *Potentilla nivea*, *Hedysarum arcticum* and several bryophytes (*Hylocomiastrum pyrenaicum*, *Racomitrium lanuginosum*, *Kiaeria blyttii*, *Rhytidium rugosum*, *Pogonatum urnigerum*, *Cynodontium strumiferum*, *Arctoa fulvella*, *Psilopilum cavifolium*, *Polytrichastrum alpinum*, *Pohlia* spp., *Anthelia jurartzkana*, *Calypogeia muelleriana*, *Pseudolophozia sudetica*, *Gymnomitrion concinnatum*, *etc*.).

The vegetation above timberline represents mosaic of meadows, mountain tundra and mires in snowbed habitats and rock fields. Rock fields distributed on the top of the plateau include single individuals of *Saxifraga nivalis*, *Luzula confusa*, *Potentilla hyparctica*, *Novosieversia glacialis*, *Oxytropis nigrescens* and occasional spots covered by bryophytes (*Hylocomium splendens* var. *obtusifolium*, *Rhytidium rugosum*, *Bucklandiella microcarpa*, *Racomitrium lanuginosum*, *Dicranum septentrionale*, *Ptilidium ciliare*, *Isopaches bicrenatus*, *etc*.). In more moist (and tentatively having milder micro-climate conditions) places of upper elevation (well drained terraces and steep gravely slopes) xeric *Dryas*-dominated tundra occurs. It includes *Dryas octopetala* subsp. *subincisa*, *Hierochloe alpina*, *Deschampsia borealis*, *Carex melanocarpa*, *Eritrichium villosum*, *Minuartia macrocarpa*, *Saxifraga* spp., *Hylocomium splendens* var. *obtusifolium*, *Rhytidium rugosum*, *Aulacomnium turgidum*, *Dicranum* spp., *Blepharostoma trichophyllum*, *Sphenolobus minutus*, *etc*. Less drained gentle slopes are covered by more wet tundras dominated by dwarf shrubs. They are composed by *Salix reptans*, *S. polaris*, *Dryas octopetala* subsp. *subincisa*, *Arctous alpina*, *Cassiope tetragona*, *Ledum decumbens*, *Vaccinium minus*, *V. uliginosum* subsp. *microphyllum*, *Carex arctisibirica*, *Hylocomium splendens* var. *obtusifolium*, *Rhytidium rugosum*, *Bucklandiella microcarpa*, *Dicranum spp*., *etc*. Depressions or wet rocky slopes with numerous streams below snowbeds are occupied by swampy sedge-moss tundra with *Salix reptans*, *S. pulchra Eriophorum vaginatum*, *Carex concolor*, *C. misandra*, *Arctagrostis latifolia*, *Stellaria ciliatosepala*, *Castrolychnis apetala*, *Lagotis minor*, *Valeriana capitata*, *Bryum cyclophyllum*, *Scorpidium revolvens*, *Campylium stellatum*, *Loeskypnum badium*, *Meesia uliginosa*, *Dicranum elongatum*, *Tomentypnum nitens*, *Aulacomnium palustre*, *Brachythecium cirrosum*, *B. udum*, *Orthothecium chryseon*, *Blindia acuta*, *Cinclidium* spp., *Schistidium papillosum*, *Cinclidium* spp., *Sphagnum girgensohnii*, *S. warnstorfii*, *Warnstorfia sarmentosa*, *Cephalozia bicuspidata*, *Fuscocephaloziopsis albescens*, *Lophozia savicziae*, *Marchantia quadrata*, *Tritomaria quinquedentata*, *Odontoschisma francisci*, and *Pellia neesiana*.

Moist rocky ground just below snowbeds is occupied by close communities of saxicolous bryophytes (*Sanionia uncinata*, *Niphotrichum canescens*, *Racomitrium lanuginosum*, *Bucklandiella sudetica*, *Bryum* spp., *Pogonatum dentatum*, *P. urnigerum*, *Cnestrum alpestre*, *Andreaea* spp., *Grimmia* spp., *Hymenoloma crispulum*, *Lescuraea saxicola*, *Brachythecium turgidum*, *Kiaeria starkei*, *Arctoa fulvella*, *Hygrohypnella polaris*, *Ochyraea alpestris*) and sparse vascular plants (*Festuca brachyphylla*, *Deschampsia borealis*, *Luzula confusa*, *Minuartia rubella*, *Arabis petraea* subsp. *septentrionalis*, *Saxifraga nivalis*, *Novosiever-sia glacialis*, *Eritrichium villosum*, *Endocellion glaciale*, *etc*.).

Limestone rocky outcrops occurring in lower belt are covered by open larch forest alternating with xeric *Dryas*-dominated tundra. These outcrops provide suitable habitat for several rare (in the area) bryophytes, like *Encalypta mutica*, *E. longicolla*, *Didymodon* spp., *Seligeria tristichoides*, *Orthotrichum anomalum*, *Jungermannia atrovirens*, *Mesoptychia badensis*, *Mannia sibirica*, *etc*.

The present list is mainly based on the collection made by Fedosov in the period from 12 of July to 3 of August, 2015. The list of collecting localities is given in Table 1, they are also mapped in Fig. 1. In total, 177 specimens were collected; they were identified by Bakalin (leafy hepatics) and Borovichev (Marchantiales). The primary

checklist compilation and literature review was done by Yanov. As identification was based on the study of 'dry plants' morphology, we have no data on oil bodies. It could result in misidentification of some *Lophozia* species.

Species List

In the present list of hepatics taxa are arranged alphabetically. Nomenclature follows Konstantinova *et al*. (2009), with few recent updates. The species name is followed by locality number preceded by 'L' letter (in accordance with the Table 1), description of ecological features of the taxon in the area treated, list of accompanying taxa (if any) and field numbers of the specimens. Aforementioned information is sometimes supplemented by some notes or literature references. Specimens are kept in VBGI, with duplicates in MW and (for some Marchantiales) in KPABG. New records for Putorana Plateau are marked by asterisk.

***Aneura pinguis** (L.) Dumort. L1, 2 – On peat in wet depressions of minerotrophic bogs and on silty alluvium along lake shore. 15-0317, 15-0787.

Apotreubia nana (S. Hatt. & Inoue) S. Hatt. & Mizut. – Recorded by Zhukova (1986a), but not found in our collections.

***Arnellia fennica** (Gottsche) Lindb. L2 – Soil in *Dryas* and *Cassiope*-dominated tundra. With *Blepharostoma trichophyllum* var. *brevirete*, *Mesoptychia heterocolpos* var. *heterocolpos*, *Sphenolobus minutus*. 15-0380. Recorded nearby from Dudinka (Lindberg & Arnell, 1889)

Anthelia juratzkana (Limpr.) Trev. L1 – Humificated and fine mineral soil on eroded slopes and cliff crevices. With *Blasia pusilla L*., *Calypogeia muelleriana*, *Fuscocephaloziopsis pleniceps*, *Gymnomitrion concinnatum*, *Pseudolophozia sudetica*, *Solenostoma hyalinum*. 15-0019, 15-0144, 15-0234, 15-0243. Also recorded by Zhukova (1986b).

***Barbilophozia barbata** (Schmid. ex Schreb.) Loeske L2, 3, 4, 6 – Bare or covered with fine soil cliff ledges, relatively dry peat, mesic rotten wood. In pure mats or with *Ptilidium ciliare* and *Trilophozia quinquedentata*. 15-0298, 15-0689, 15-0761, 15-0769, 15-0830.

B. hatcheri (Evans) Loeske L3, 6 – Fine soil at cliff bases and dry tundras. In pure mats or with *Cephalozia bicuspidata*, *Sphenolobus minutus*. 15-0782, 15-0839. Also recorded by Zhukova (1986b).

***B. lycopodioides** (Wallr.) Loeske L1. – Soil in birch-spruce-larch forest. 15-0412, 15-0426. Recorded nearby from Kurejka River lower course (Zhukova & Kudryavtseva, 1975).

Blasia pusilla L. L1 – Humificated soil or mineral ground on eroded slopes. Together with *Anthelia juratzkana*, *Calypogeia muelleriana*, *Solenostoma hyalinum*. 15-143, 15-0144, 15-0152, 15-0953. Also recorded by Zhukova (1986b).

Blepharostoma trichophyllum (L.) Dumort. var. ***brevirete*** Bryhn et Kaal. L1, 2, 3 – Moist soil or mineral ground in mesic tundras as well as along streams and lake shore. In pure mats or together with *Arnellia fennica*, *Cephaloziella divaricata*, *Mesoptychia bantriensis*, *M. heterocolpos* var. *heterocolpos*, *Odontoschisma macounii*, *Schljakovia kunzeana*, *Schljakovianthus quadrilobus*, *Scapania crassiretis*, *S. degenii*, *S. hyperborea*, *S. irrigua*, *Schistochilopsis opacifolia*, *Sphenolobus minutus*, *Trilophozia quinquedentata*. 15-0071, 15-0091, 15-136, 15-0197, 15-0274, 15-0296, 15-0380, 15-0503, 15-0508, 15-0893. Zukova (1986b) recorded for Putorana Plateau *B. trichophyllum* without indication of the variety. In our collection the only var. *brevirete* was found; whether the record by Zhukova (l.c.) belongs to the same variety or var. *trichophyllum* remains unclear.

***Calypogeia integristipula** Steph. L1, 4 – Fine soil in the crevices of limestone outcrops and mesic eroded peat of tussock side in peat-moss mire. In pure mat or together with *Cephaloziella spinigera*. 15-0403, 15-0718.

***C. muelleriana** (Schiffn.) Müll. Frib. L1. – Humificated soil in eroded slope and eroded peat in tussock side of peat-moss bog. With *Anthelia juratzkana*, *Blasia pusilla*, *Cephalozia bicuspidata*, *Gymnocolea inflata*, *Solenostoma hyalinum*. 15-0144, 15-0425.

C. neesiana (C.Massal. & Carestia) Müll. Frib. – Recorded by Zhukova (1986b), but we suspect that this record may be based on misidentification of *C. integristipula*. The specimen on which this record was based could not be studies in the course of this account preparation.

C. sphagnicola (Arnell & J.Perss.) Warnst. & Loeske L2 – Bare peat of peat moss tussock in the mire. Together with *Fuscocephaloziopsis pleniceps*, *Cephaloziella spinigera*, *Mylia anomala*, *Schljakovia kunzeana*, *Scapania hyperborea*. 15-0327, 15-0416. Also recorded by Zhukova (1986b).

Cephalozia bicuspidata (L.) Dumort. L1, 2, 3 – Fine soil along snowbeds, stream sides, on moist cliff ledges; on eroded peat in peat-moss bogs. In pure mats or with *Barbilophozia hatcheri*, *Calypogeia muelleriana*, *Cephaloziella* cf. *divaricata*, *C. uncinata*, *Odontoschisma francisci*, *Endogemma caespiticia*, *Gymnocolea inflata*, *Lophozia longiflora*, *Odontoschisma elongatum*, *Fuscocephaloziopsis albescens*, *Riccardia latifrons*, *Saccobasis polymorpha*, *Scapania hyperborea*, *Schistochilopsis incisa*, *Schljakovia kunzeana*, *Sphenolobus minutus*. 15-0241, 15-0260, 15-0425, 15-0525, 15-0613, 15-0620, 15-0839. Also recorded by Zhukova (1986b).

C. macounii (Austin) Austin – Recorded by Zhukova (1986b), but we suspect that this record may represent the misidentification of *Fuscocephaloziopsis leucantha* or something else. The specimen on which this record was based could not be studies in the course of this account preparation.

***Cephaloziella divaricata** (Sm.) Schiffn. L1, 2 – Bare peat in minerotrophic bogs. With *Blepharostoma trichophyllum* var. *brevirete*, *Cephalozia bicuspidata*, *Lophozia ventricosa* var. *ventricosa*, *Odontoschisma elongatum*, *Scapania hyperborea*, *S. irrigua*, *Schljakovia kunzeana*, *Schljakovianthus quadrilobus* var. *glareosa*, *Trilophozia quinquedentata*. 15-0296, 15-0310, 15-0431. Recorded nearby from Dudinka by Lindberd & Arnell (1889).

C. elachista (J.B.Jack ex Gottsche & Rabenh.) Schiffn. – Recorded by Andreeva (2009) from Kapchuk Lake environs, but not found in our collections.

C. grimsulana (J.B.Jack ex Gottsche & Rabenh.) Lacout. – Recorded by Zhukova (1986b), but not found in our collections. The record by Zhukova (l.c.) may be based on *C. varians*.

C. spinigera (Lindb.) Jørg. L1, 2 – Bare peat on hummock sides in minerotrophic bogs, also moist crevices between rocks in rock field. With *Calypogeia integristipula*, *C. sphagnicola*, *Mylia anomala*, *Tetralophozia setiformis*. 15-0212, 15-0327, 15-0403. Also recorded by Zhukova (1986b).

C. uncinata R.M. Schust. L1, 2 – Moist mineral ground in cliff crevices and snowbeds. With *Cephalozia bicuspidata*, *Fuscocephaloziopsis albescens*, *Preissia quadrata*, *Riccardia*

latifrons, *Sphenolobus minutus*. 15-0241, 15-0478. Also recorded by Zhukova (1986b).

***C. varians** (Gottsche) Steph. L1, 6 – Wet silty alluvium near lake shore and fine soil near stream. In pure mats or with *Pseudolophozia sudetica*, *Scapania hyperborea*. 15-0777, 15-0919.

***Chiloscyphus polyanthos** (L.) Corda L1 – Alluvium in temporarily flooded area along lake shore. With *Pellia neesiana*. 15-0944.

***Cordaea flotoviana** Nees L2 – Meadow near stream in place with late snow melting. In pure mats. 15-0278.

***Diplophyllum taxifolium** (Wahlenb.) Dumort. L1 – Fine soil in cliff crevices. Together with *Gymnomitrion concinnatum*, *Isopaches bicrenatus*, *Schistochilopsis opacifolia*. 15-0479. Also recorded by Zhukova (1986b).

***Endogemma caespiticia** (Lindenb.) Konstant., Vilnet & A.V. Troitsky L1 – Humificated soil and eroded peat in slopes. With *Cephalozia bicuspidata*, *Odontoschisma francisci*, *Gymnocolea inflata*, *Mylia anomala*, *Sphenolobus minutus*. 15-0404, 15-0427, 15-0620.

***Fossombronia alaskana** Steere & Inoue – Recorded by Andreeva (2009) from Talnakh Mts., but not found in our collections.

***Fuscocephaloziopsis albescens** (Hook.) Váňa & L.Söderstr. [=*Pleurocladula albescens* (Hook.) Grolle] L2, 3 – Moist soil in spotty tundras and snowbeds. With *Cephalozia bicuspidata*, *Cephaloziella uncinata*, *Lophozia longiflora*, *L. savicziae*, *L. ventricosa* var. *ventricosa*, *Riccardia latifrons*, *Scapania* cf. *irrigua*, *Sphenolobus minutus*, *Trilophozia quinquedentata*. 15-0241, 15-0864, 15-0883, 15-0914. Also recorded by Zhukova (1986b).

***F. connivens** (Dicks.) Váňa & L. Söderstr. – Recorded by Zhukova (1986b), but we suspect that this record may represent the misidentification of *F. pleniceps* or something else. The specimen on which this record was based could not be studies in the course of this account preparation.

***F. leucantha** (Spruce) Váňa & L. Söderstr. L2 – Over peat in wet depression in minerotrophic bog. With *Mylia anomala*. 15-0305.

***F. loitlesbergeri** (Schiffn.) Váňa & L. Söderstr. – Recorded by Zhukova (1986b). The specimen on which this record was based could not be studies in the course of this account preparation.

***F. lunulifolia** (Dumort.) Váňa & L. Söderstr. – Recorded by Zhukova (1986b), but not found in our collections.

***F. pleniceps** (Austin) Lindb. L1, 3, 5 – Moist soil in snowbeds, eroded peat of minerotrophic bogs and swampy meadows, also on humificated soil in eroded slopes. With *Anthelia juratzkana*, *Calypogeia sphagnicola*, *Lophozia ventricosa* var. *ventricosa*, *Lophoziopsis* cf. *pellucida*, *Nardia geoscyphus*, *Scapania hyperborea*, *Scapania irrigua*, *Schistochilopsis grandiretis*, *Schljakovia kunzeana*, *Sphenolobus minutus*, *Trilophozia quinquedentata*. 15-0019, 15-0416, 15-0439, 15-0669, 15-0834, 15-0881, 15-0888.

***Gymnocolea inflata** (Huds.) Dumort. L1, 4. – Moist soil in depressions near lake, wet bare peat in peat moss bogs. In pure mats or with *Calypogeia muelleriana*, *Cephalozia bicuspidata*, *Lophozia ventricosa* var. *ventricosa*, *Mylia anomala*. 15-0188, 15-0189, 15-0425, 15-0719. Recorded nearby from Dudinka (Lindberg & Arnell, 1889).

***Gymnomitrion concinnatum** (Lightf.) Corda L1, 2 – Cliff crevices filled by fine soil or not, spots of bare ground on slopes. In pure mats or with *Anthelia juratzkana*, *Diplophyllum taxifolium*, *Isopaches bicrenatus*, *Pseudolophozia sudetica*, *Schistochilopsis opacifolia*. 15-0799, 15-0234, 15-0243, 15-0479. Also recorded by Zhukova (1986b).

***Haplomitrium hookeri** (Sm.) Nees – Mapped by Schuster and Konstantinova (1996), but whether the point in the map is referable to Putorana Plateau is not known for us.

***Harpanthus flotovianus** (Nees) Nees L2 – Peat moss hummock in minerotrophic bog. In pure mat. 15-0300. Recorded nearby from "Vershinskoye" (Lindberg & Arnell, 1889).

***Isopaches bicrenatus** (Schmidel ex Hoffm.) H. Buch L1, 2 – Cliff ledges covered with fine soil, mesic ground in snowbeds, dry eroded peat in peat-moss bog, compressed sandy soil near dune top. In pure mats or with *Diplophyllum taxifolium*, *Gymnomitrion concinnatum*, *Lophozia silvicola*, *Lophozia ventricosa* var. *ventricosa*, *Nardia insecta*, *Schistochilopsis opacifolia*, *Trilophozia quinquedentata*. 15-0035, 15-0053, 15-0382, 15-0400, *15-0479*, *15-0504*, 15-0507. Also recorded by Zhukova (1986b).

***Jungermannia atrovirens** Dumort. L1 – Cliffs near waterfall in stream canyon. In pure mat. 15-0475. Recorded nearby from Kurejka River lower course (Zhukova & Kudryavtseva, 1975).

***J. polaris** Lindb. L4 – Fine soil in niche near base of limestone outcrop. In pure mat. 15-0698.

***J. pumila** With. L1 – Moist cliff ledge and crevices near or aside of streams. In pure mats or with *Lophoziopsis polaris*, *Scapania gymnostomophila*. 15-0115, 15-0482. Also recorded by Zhukova (1986b).

***Lophozia ascendens** (Warnst.) R.M. Schust. – Recorded for the plateau by Zhukova (1986), but not found in our collections. The record may be based on greengemmous modification of *Lophoziopsis longidens*.

***L.** cf. ***guttulata** (Lindb. & Arnell) A. Evans L1. – Moist soil in larch-spruce open forest. With *Neoorthocaulis binsteadii*, *Schljakovia kunzeana*. 15-0015. The plants are characterized by large trigones in leaf cells and longer than wide leaves, but in the absence of oil bodies we are doubt in the identification of the taxon from such unusual habitat.

***L. longiflora** (Nees) Schiffn. L1, 3 – Moist humificated soil in eroded slopes, alder communities near streams and *Dryas* dominated spotty tundras. With *Cephalozia bicuspidata*, *Fuscocephaloziopsis albescens*, *Saccobasis polymorpha*, *Scapania irrigua*, *S. obcordata*, *Schljakovia kunzeana*, *Trilophozia quinquedentata*. 15-0013, 15-0434, 15-0613, 15-0703, 15-0883. Also recorded by Zhukova (1986b).

***L. murmanica** Kaal. L1 – Eroded peat in peat-moss bog. With *Trilophozia quinquedentata*. 15-0398. Also recorded (as *Lophozia groenlandica* (Nees) Macoun) by Zhukova (1986b).

***L. savicziae** Schljakov L2, 3 – Moist soil near snowbeds. In pure mats or with *Lophoziopsis polaris*, *Fuscocephaloziopsis albescens*, *Scapania* cf. *irrigua*, *Scapania obcordata*, *Schistochilopsis opacifolia*, *Sphenolobus minutus*. 15-0169, 15-0351, 15-0356, 15-0914.

***L. silvicola** H. Buch L1, 2 – Decaying wood, humificated soil on eroded slopes and fine soil in snowbeds. In pure mats or with *Odontoschisma francisci*, *Isopaches bicrenatus*, *Mylia anomala*, *Trilophozia quinquedentata*. 15-0035, 15-0069, 15-0344. Also recorded by Bakalin (2005).

***L. ventricosa** (Dicks.) Dumort. L1, 2, 3, 5 – Moist peat, mineral ground, moist soil along streams and lake shores in various types of communities. In pure mats or with *Cephaloziella di-*

varicata, *Fuscocephaloziopsis albescens*, *F. pleniceps*, *Gymnocolea inflata*, *Isopaches bicrenatus*, *Lophoziopsis longidens*, *L. polaris*, *Mesoptychia heterocolpos* var. *heterocolpos*, *Nardia geoscyphus*, *Odontoschisma elongatum*, *Pellia neesiana*, *Scapania curta*, *S. irrigua*, *Schljakovia kunzeana*, *Trilophozia quinquedentata*. 15-0005,15-0014, 15-0022, 15-0049, 15-0189, 15-0294, 15-0310, 15-0400, 15-0439, 15-0441, 15-0501, 15-0540, 15-0592, 15-0594, 15-0595, 15-0618, 15-0699, 15-0864, 15-0888. Also recorded by Zhukova (1986b).

Lophozia wenzelii (Nees) Steph. – Recorded by Zhukova (1986b), but not found in our collections.

Lophoziopsis excisa (Dicks.) Konstant. & Vilnet. L1 – Wet soil near stream along boggy lake shore. Together with *Mesoptychia heterocolpos* var. *heterocolpos*, *Scapania irrigua*. 15-0090. Also recorded by Zhukova (1986b).

L. longidens (Lindb.) Konstant. & Vilnet L1, 3 – Decaying wood and cliff crevices in alder and larch communities. *Lophozia ventricosa* var. *ventricosa*, *Trilophozia quinquedentata*. 15-0236, 15-0447, 15-0501, 15-0609. Also recorded by Zhukova (1986b).

****L.*** cf. ***pellucida*** (R.M. Schust.) Konstant. & Vilnet L3 – Soil near stream in boggy meadow with rare willow shrubs. With *Fuscocephaloziopsis pleniceps*, *Scapania irrigua Schistochilopsis grandiretis*, *Trilophozia quinquedentata*. 15-0881.

L. polaris (R.M. Schust.) Konstant. & Vilnet L1, 2, 3 – Soil and mineral ground near snowbed and streams. With *Jungermannia pumila*, *Lophozia* cf. *savicziae*, *Lophozia ventricosa* var. *ventricosa*, *Schljakovia kunzeana*, *Scapania gymnostomophila*, *Scapania irrigua*, *Scapania obcordata*, *Schistochilopsis opacifolia*, *Trilophozia quinquedentata*. 15-0169, 15-0359, 15-0482, 15-0595, 15-0612, 15-0618, 15-0848. Also recorded by Zhukova (1986b).

Lepidozia reptans (L.) Dumort. – Recorded by Zhukova (1986b), but not found in our collections.

Mannia gracilis (F. Weber) D.B. Schill & D.G. Long L4 – Niche at limestone cliff base, on soil. 15-0664, 15-0632. Also recorded by Zhukova (1986b).

M. pilosa (Hornem.) Frye et L.Clark – Recorded by Andreeva (2009) from Kapchuk Lake environs, but not found in our collections.

****M. sibirica*** (Müll. Frib.) Frye & L.Clark L4 – Niche at limestone cliff base, on soil. 15-0636.

Marchantia quadrata Scop. (*Preissia quadrata* (Scop.) Nees L1, 2 – Cliff ledges and crevices filled by soil near streams and snowbeds. In pure mats or with *Cephaloziella uncinata*, *Scapania gymnostomophila*, *Pseudotritomaria heterophylla*. 15-0150, 15-0229, 15-0330, 15-0364, 15-0470, 15-0478, 15-0926. Also recorded by Zhukova (1986b).

M. polymorpha subsp. ***ruderalis*** Bischl. & Boissel.-Dub. L1 – Boulders near streams, humificated soil on slopes. 15-0139, 15-0394. Also recorded by Zhukova (1986b).

M. polymorpha L. subsp. ***polymorpha*** (= *M. aquatica* (Nees) Burgeff) – recorded by Zhukova (1986b), but not found in our collection.

****M. romanica*** (Radian) D.G. Long, Crandall-Stotler, L.L. Forrest & Villarreal [=*Bucegia romanica* Radian] L1 – Brook canyon under small snow bed on NW slope of Sunduk Mt., on soil in cliff crevice. 15-0116.

****Marsupella condensata*** (Ångstr. ex C.Hartm.) Lindb. ex Kaal. L3 – Moist rocks near snowbed. In pure mats. 15-0906.

****Mesoptychia badensis*** (Gottsche ex Rabenh.) L. Söderstr. & Váňa L4 – Fine soil filling niche at the base of limestone cliff. In pure mats. 15-0701.

M. bantriensis (Hook.) L. Söderstr. & Váňa L1 – Wet soil near swampy lake shore. Together with *Blepharostoma trichophyllum* var. *brevirete*, *Scapania hyperborea*, *Schljakovia kunzeana*. 15-0091. Also recorded by Zhukova (1986b).

M. collaris (Nees) L. Söderstr. & Váňa L1 – Alluvial sediments in temporarily flooded area near lake shore. With *Schljakovianthus quadrilobus*, *Pellia neesiana*, *Scapania cuspiduligera*. 15-0943. Also recorded by Zhukova (1986b).

****M. gillmanii*** (Austin) L. Söderstr. & Váňa L1, 3 – Mountain peat-moss bog, on hummock. 15-0418, 15-0859.

M. heterocolpos (Thed. ex Hartm.) L. Söderstr. & Váňa var. ***heterocolpos*** L1, 2 – Moist to wet soil near streams and boggy lake shores, also on mesic cliff ledges and on soil in *Dryas* and *Cassiope* dominating tundra. In pure mats or with *Arnellia fennica*, *Blepharostoma trichophyllum*. var. *brevirete*, *Lophozia ventricosa* var. *ventricosa*, *Lophoziopsis excisa*, *Scapania degenii*, *S. irrigua*, *S. obcordata*, *Schljakovia kunzeana*, *Schljakovianthus quadrilobus* var. *glareosa*, *Sphenolobus minutus*, *Trilophozia quinquedentata*. 15-0005, 15-0090, 15-0187, 15-0197, 15-0274, 15-0380, 15-0508. The record of *Lophozia heterocolpos* (Thed.) M. Howe in Zhukova (1986) is probably referable to this variety.

****M. heterocolpos*** var**.** ***arctica*** (S.W. Arnell) L. Söderstr. & Váňa L3. – Bare soil in mountain mire. In pure mats. 15-0849.

****M. sahlbergii*** (Lindb.) A.Evans L1 – Wet peat in minerotrophic bog. With *Trilophozia quinquedentata*.

Mylia anomala (Hook.) Gray L1, 2, 4 – Moist peat in hummocks in peat-moss bogs, rarer wet depressions in places with late snow melting. With *Calypogeia sphagnicola*, *Cephaloziella spinigera*, *Fuscocephaloziopsis leucantha*, *Gymnocolea inflata*, *Lophozia* cf. *silvicola*, *Odontoschisma francisci*. 15-0069, 15-0305, 15-0327, 15-0719. Also recorded by Zhukova (1986b).

****Nardia geoscyphus*** (De Not.) Lindb. L1 – Humificated soil in eroded slope, silty alluvium along lake shore. With *Fuscocephaloziopsis pleniceps*, *Lophozia* cf. *ventricosa* var. *ventricosa*, *Scapania irrigua*, *Schljakovia kunzeana*, *Solenostoma hyalinum*. 15-0045, 15-0439, 15-0793.

****N. insecta*** Lindb. L1 – Humificated soil in eroded slope. With *Isopaches bicrenatus*. 15-0504.

Neoorthocaulis attenuatus (Mart.) L. Söderstr., De Roo & Hedd. – Recorded by Zhukova (1986b), but not found in our collections.

N. binsteadii (Kaal.) L. Söderstr., De Roo & Hedd. L1 – Soil in larch-spruce open forest. With *Schljakovia kunzeana*, *Lophozia* cf. *guttulata*. 15-0015. Also recorded by Zhukova (1986b).

****Odontoschisma elongatum*** (Lindb.) A. Evans L1, 2 – Wet peat in minerotrophic bogs. With *Cephalozia bicuspidata*, *Cephaloziella divaricata*, *Lophozia ventricosa* var. *ventricosa*, *Scapania hyperborea*, *S. irrigua*, *Schljakovia kunzeana*, *Schljakovianthus quadrilobus* var. *glareosa*, *Trilophozia quinquedentata*. 15-0310, 15-0321, 15-0431. Recorded nearby from Dudinka by Lindberg & Arnell (1889).

****O. francisci*** (Hook.) L. Söderstr. & Váňa L1 – Fine soil in moist eroded slopes and snowbeds. With *Cephalozia bicuspidata*, *Endogemma caespiticia*, *Lophozia* cf. *silvicola*, *Mylia anomala*. 15-0069, 15-0620.

O. macounii (Austin) Underw. L1 – Moist cliff ledges (also near waterfalls). With *Blepharostoma trichophyllum* var. *brevirete*, *Mesoptychia heterocolpos*, *Scapania hyperborea*, *Solenostoma subellipticum*, *Trilophozia quinquedentata*. 15-0497, 15-0508, 15-0509, 15-0790. Also recorded by Zhukova (1986b).

***Oleolophozia perssonii** (H. Buch & S.W. Arnell) L. Söderstr., De Roo & Hedd. L1 – Mineral soil near snowbed. In pure mats. 15-0100, 15-0146. RF.

Orthocaulis atlanticus (Kaal.) H. Buch – Recorded by Zhukova (1986b), but not found in our collections. The record may be based on misidentification of *Neoorthocaulis binsteadii*.

Pellia epiphylla (L.) Corda – Recorded by Zhukova (1986b), but not found in our collections.

P. neesiana (Gottsche) Limpr. L1, 2 – Wet boulders near streams, moist to wet soil along streams, mineral soil in minerotrophic bogs, alluvium along lake shore. With *Chiloscyphus polyanthos*, *Lophozia ventricosa* var. *ventricosa*, *Mesoptychia collaris*, *Schljakovianthus quadrilobus*, *Scapania cuspiduligera*, *S. irrigua*. 15-0294, 15-0401, 15-0540, 15-0943, 15-0944. Also recorded by Zhukova (1986b).

***Plagiochila arctica** Bryhn & Kaal. L2 – On peat in peat moss dominated minerotrophic bog. 15-0293. Recorded nearby from Kurejka River lower course (Zhukova & Kudryavtseva, 1975).

***Protolophozia elongata** (Steph.) Schljakov L1 – Alluvial fine soil and stones near stream and swampy lake shore. With *Scapania irrigua*, *Solenostoma subellipticum*, *Tritomaria scitula*. 15-0483, 15-0941.

***Pseudolophozia sudetica** (Nees ex Huebener) Konstant. & Vilnet L2, 6 – Fine soil in snowbeds and near streams. With *Anthelia juratzkana*, *Cephaloziella varians*, *Gymnomitrion concinnatum*. 15-0243, 15-0777.

***Pseudotritomaria heterophylla** (R.M. Schust.) Konstant. & Vilnet [=*Tritomaria heterophylla* R.M. Schust.] L1 – Cliff ledge in stream canyon. With *Preissia quadrata*, *Scapania gymnostomophila*. 15-0470.

Ptilidium ciliare (L.) Hampe L2, 4 – Bare peat in minerotrophic bogs and soil covering cliff ledges. In pure mats 15-0298, 15-0689. Also recorded by Zhukova (1986b).

P. pulcherrimum (Weber) Vain. L1, 6 – On birch branches and on fine soil at cliff base. 15-0177, 15-0752. Also recorded by Zhukova (1986b).

Radula prolifera Arnell – Recorded by Zhukova (1986b), but not found in our collections.

***Riccardia latifrons** (Lindb.) Lindb. L2 – Fine soil near snowbed in rocky slope. With *Cephalozia bicuspidata*, *Cephaloziella uncinata*, *Fuscocephaloziopsis albescens*, *Sphenolobus minutus*. 15-0241.

Riccia glauca L. – Recorded by Zhukova (1986b), but not found in our collections.

***Saccobasis polymorpha** (R.M. Schust.) Schljakov L3 – Moist shaded soil in alder communities. With *Cephalozia bicuspidata*, *Lophozia longiflora*, *Scapania irrigua*, *Schljakovia kunzeana*. 15-0613, 15-0703.

Sauteria alpina (Nees) Nees – Recorded by Zhukova (1986b), but not found in our collections.

Scapania crassiretis Bryhn L1, 3 – Moist cliffs near waterfalls, stones and soil near snowbeds. With *Blepharostoma trichophyllum* var. *brevirete*, *Scapania mucronata*, *Sphenolobus minutus*, *Trilophozia quinquedentata*. 15-0211, 15-0213, 15-0503, 15-0870. Also recorded by Zhukova (1986b).

S. curta (Mart.) Dumort. L1 – Humificated soil in eroded slope. With *Lophozia ventricosa* var. *ventricosa* 15-0441.

S. cuspiduligera (Nees) Müll. Frib. L1 – Alluvium in willow-shrub community in temporarily flooded area on lake shore. With *Mesoptychia collaris*, *Pellia neesiana*, *Schljakovianthus quadrilobus*. 15-0943. Also recorded by Zhukova (1986b).

S. degenii Schiffn. ex Müll. Frib. L1 – Mesic cliff ledges. With *Blepharostoma trichophyllum* var. *brevirete*, *Mesoptychia heterocolpos*, *Odontoschisma macounii*, *Schistochilopsis opacifolia*, *Sphenolobus minutus*, *Trilophozia quinquedentata*. 15-0494, 15-0508.

S. gymnostomophila Kaal. L1 – Cliff ledges in stream canyons. With *Jungermannia pumila*, *Lophoziopsis polaris*, *Preissia quadrata*, *Pseudotritomaria heterophylla*. 15-0470, 15-0482. Also recorded by Zhukova (1986b).

***S. hyperborea** Jørg. L1 – Cliffs near waterfalls, peat in peat-moss mires, silty alluvium along lake shore. With *Blepharostoma trichophyllum* var. *brevirete*, *Calypogeia sphagnicola*, *Cephalozia bicuspidata*, *Cephaloziella* cf. *divaricata*, *C. varians*, *Fuscocephaloziopsis pleniceps*, *Mesoptychia bantriensis*, *Odontoschisma elongatum*, *O. macounii*, *Schljakovia kunzeana*. 15-0091, 15-0416, 15-0431, 15-0497, 15-0919.

S. irrigua (Nees) Nees L1, 2, 3 – Moist to wet soil and peat in mires, eroded slopes, temporarily flooded area near lake shores, streams in various communities, including snowbeds. In pure mats or with *Blepharostoma trichophyllum* var *brevirete*, *Cephaloziella divaricata*, *Fuscocephaloziopsis albescens*, *F. pleniceps*, *Lophozia longiflora*, *L. savicziae*, *L.* cf. *ventricosa* var. *ventricosa*, *Lophoziopsis excisa*, *L.* cf. *pellucida*, *L. polaris*, *Mesoptychia heterocolpos* var. *heterocolpos*, *Nardia geoscyphus*, *Odontoschisma elongatum*, *Pellia neesiana*, *Protolophozia elongata*, *Saccobasis polymorpha*, *Schistochilopsis grandiretis*, *Schistochilopsis hyperarctica*, *Schljakovia kunzeana*, *Schljakovianthus quadrilobus* var. *glareosa*, *Solenostoma hyalinum*, *S. subellipticum*, *Trilophozia quinquedentata*. 15-0090, 15-136, 15-0294, 15-0296, 15-0312, 15-0428, 15-0435, 15-0436, 15-0429, 15-0433, 15-0540, 15-0580, 15-0595, 15-0618, 15-0703, 15-0793, 15-0881, 15-0914. Also recorded by Zhukova (1986b).

S. lingulata H. Buch L1 – Cliff near waterfall. In pure mat. 15-0495.

S. mucronata H. Buch L1 – On soil in cliff crevice in stream canyon below snowbed. With *Scapania crassiretis*. 15-0211.

S. obcordata (Berggr.) S.W. Arnell L1 – On soil or mineral ground near snowbeds and streams. With *Lophozia longiflora*, *L.* cf. *savicziae*, *Lophoziopsis polaris*, *Mesoptychia heterocolpos* var. *heterocolpos*, *Schistochilopsis opacifolia*, *Schljakovianthus quadrilobus*, *Trilophozia quinquedentata*. 15-0169, 15-0187, 15-0434, 15-0542.

S. scandica (Arnell & H. Buch) Macvicar var. ***scandica*** L1 – Mineral soil along small brook below snowbed. 15-0193

S. scandica var. ***grandirelis*** (Schljakov) Schljakov L1 – Humificated soil on eroded slope. 15-0440.

S. simmonsii Bryhn & Kaal. – Recorded by Zhukova (1986b), but not found in our collections.

S. spitsbergensis (Lindb.) Müll. Frib. – Recorded by Zhukova (1986b), but not found in our collections.

***Schistochilopsis grandiretis** (Lindb. ex Kaal.) Konstant. L3 – Wet soil in boggy meadow with rare willow shrubs near stream. With *Fuscocephaloziopsis pleniceps*, *Lophoziopsis* cf. *pellucida*, *Scapania irrigua*, *Trilophozia quinquedentata*. 15-0881.

S. hyperarctica (R.M. Schust.) Konstant. L1 – Soil near snowbed, humificated soil and on eroded slope. With *Scapania* cf. *irrigua*. 15-0113, 15-0436.

S. incisa (Schrad.) Konstant. L2 – Soil covering cliff ledge near stream canyon. With *Cephalozia bicuspidata*. 15-0260. Also recorded by Zhukova (1986b).

S. opacifolia (Culm. ex Meyl.) Konstant. L1, 3 – Moist mineral ground near snowbeds, in *Dryas*-dominated tundra, cliff crevices partly filled with soil. With *Blepharostoma trichophyllum* var. *brevirete*, *Diplophyllum taxifolium*, *Gymnomitrion concinnatum*, *Isopaches bicrenatus*, *Scapania degenii*, *Sphenolobus minutus*, *Trilophozia quinquedentata*. 15-0169, 15-0226, 15-0479, 15-0494 15-0893. Also recorded by Zhukova (1986b).

Schljakovia kunzeana (Huebener) Konstant. & Vilnet L1, 2, 3 – On fine soil and humus along watercourses, lake shores in various types of communities; peat in minerotrophic bogs. With *Blepharostoma trichophyllum* var. *brevirete*, *Calypogeia sphagnicola*, *Cephalozia bicuspidata*, *Cephaloziella divaricata*, *Fuscocephaloziopsis pleniceps*, *Lophozia* cf. *guttulata*, *L. longiflora*, *L. ventricosa* var. *ventricosa*, *Lophoziopsis polaris*, *Mesoptychia bantriensis*, *M. heterocolpos*, *Nardia geoscyphus*, *Neoorthocaulis binsteadii*, *Odontoschisma elongatum*, *Saccobasis polymorpha*, *S. hyperborea*, *S. irrigua*, *Schljakovianthus quadrilobus*, *Solenostoma hyalinum*. 15-0005, 15-0013, 15-0015, 15-0022, 15-0091, 15-0296, 15-0311, 15-0314, 15-0416, 15-0431, 15-0432, 15-0618, 15-0703, 15-0793. Also recorded by Zhukova (1986b).

Schljakovianthus quadrilobus (Lindb.) Konstant. & Vilnet var. ***quadrilobus*** L1, 2 – Wet soil and peat near snowbeds, swampy lake shores and streams. With *Blepharostoma trichophyllum* var. *brevirete*, *Mesoptychia collaris*, *Pellia neesiana*, *Scapania cuspiduligera*, *S. obcordata*, *Schljakovia kunzeana*. 15-0071, 15-0314, 15-0542, 15-0943. Also recorded by Zhukova (1986b).

****S. quadrilobus*** var. ***glareosa*** (Jørg.) Konstant. & Vilnet L1, 2 – Wet soil in *Betula nana* dominated community; peat in minerotrophic bog. With *Blepharostoma trichophyllum* var. *brevirete*, *Cephaloziella divaricata*, *Mesoptychia heterocolpos* var. *heterocolpos*, *Odontoschisma elongatum*, *Scapania irrigua*, *S. obcordata*, *Schljakovia kunzeana*, *Trilophozia quinquedentata*. 15-0187, 15-0296, 15-0312.

****Solenostoma hyalinum*** (Lyell) Mitt. L1 – Silty alluvium near lake shore. With *Nardia geoscyphus*, *Scapania irrigua*, *Schljakovia kunzeana*. 15-0793.

S. sphaerocarpum (Hook.) Steph. – Recorded by Zhukova (1986b), but not found in our collections.

S. subellipticum (Lindb. ex Heeg) R.M. Schust. L1 – Alluvium in willow-shrub community in temporarily flooded area along lake shore. With *Odontoschisma macounii*, *Protolophozia elongata*, *Scapania irrigua*. 15-0790, 15-0941. Also recorded by Zhukova (1986b).

Sphenolobus minutus (Schreb.) Berggr. L1, 2, 3 – Mesic soil filling cliff crevices, near snowbeds, eroded mesic peat in minerotrophic bogs. In pure mats or with *Arnellia fennica*, *Barbilophozia hatcheri*, *Blepharostoma trichophyllum* var. *brevirete*, *Cephalozia bicuspidata*, *Cephaloziella uncinata*, *Fuscocephaloziopsis albescens*, *F. pleniceps*, *Gymnocolea inflata*, *Lophozia savicziae*, *Mesoptychia* var. *heterocolpos*, *Mylia anomala*, *Riccardia latifrons*, *Scapania crassiretis*, *S. degenii*, *Schistochilopsis opacifolia*, *Sphenolobus minutus*, *Trilophozia quinquedentata*. 15-0241, 15-0356, 15-0380, 15-0427, 15-0494, 15-0503, 15-0834, 15-0839. Also recorded by Zhukova (1986b).

S. saxicola (Schrad.) Steph. – Recorded by Zhukova (1986b), but not found in our collections.

Tetralophozia setiformis (Ehrh.) Schljakov L1. – Boulders and crevices between them in rockfields. In pure mats or with *Cephaloziella spinigera*. 15-0106, 15-0212. Also recorded by Zhukova (1986b).

Trilophozia quinquedentata (Huds.) Bakalin L1, 2, 3, 6 – Mesic to moist soil in eroded slopes, various tundras, along watercourses, lakes, also cliffs and their crevices, eroded peat in minerotrophic bogs; one of the most common species in study area. In pure mats or with *Barbilophozia barbata*, *Blepharostoma trichophyllum* var. *brevirete*, *Fuscocephaloziopsis albescens*, *F. pleniceps*, *Cephaloziella divaricata*, *Isopaches bicrenatus*, *Lophozia longiflora*, *L. murmanica*, *Lophozia silvicola*, *L. ventricosa* var. *ventricosa*, *Lophoziopsis longidens*, *L.* cf. *pellucida*, *L. polaris*, *Mesoptychia heterocolpos*, *M. heterocolpos* var. *heterocolpos*, *Odontoschisma elongatum*, *O. macounii*, *Scapania crassiretis*, *S. degenii*, *S. irrigua*, *S. obcordata*, *Schistochilopsis grandiretis*, *S. opacifolia*, *Schljakovianthus quadrilobus* var. *glareosa*, *Sphenolobus minutus*. 15-0035, 15-0064, 15-0065, 15-0086, 15-0178, 15-0185, 15-0187, 15-0206, 15-0236, 15-0247, 15-0267, 15-0272, 15-0274, 15-0310, 15-0398, 15-0494, 15-0496, 15-0508, 15-0509, 15-0612, 15-0761, 15-0881, 15-0883, 15-0834, 15-0848, 15-0864, 15-0870, 15-0893. Also recorded by Zhukova (1986b).

T. exsecta (Schmidel) Schiffn. ex Loeske – Recorded by Zhukova (1986b), but not found in our collections.

T. exsectiformis (Breidl.) Schiffn. ex Loeske – Recorded by Zhukova (1986b), but not found in our collections.

T. scitula (Taylor) Jørg. L1, 4 – On mineral ground near snowbeds and in filling cliff (also limestone) crevices. In pure mats or with *Lophozia ventricosa* var. *ventricosa*, *Protolophozia elongata*. 15-0191, 15-0483, 15-0699. Also recorded by Zhukova (1986b).

Discussion

In total 70 species were previously recorded for Putorana Plateau in various literature sources. We found 92 species, 47 of them are new for the plateau, while 26 of previously recorded taxa were not collected. Therefore, the summarized list of liverworts known in Putorana Plateau counts 118 taxa. The number of taxa found in our collections is relatively high and comparable with, *e.g.*, Eriechka River (Fedosov *et al.*, 2015) in Anabar Plateau, where thoroughness of collecting and area size was nearly the same. In the latter locality, 66 species of liverworts were recorded. Higher species number on Putorana Plateau can be explained by more wide diversity of habitats.

The majority of previously recorded taxa that were not collected in 2015 are undoubtful, with the exception of five taxa records that may be based on misidentification. These are as follow: 1) *Calypogeia neesiana* may represent the misidentification of *C. integristipula*, the species common in the area, but not mentioned by Zhukova (1986b); 2) *Cephalozia macounii* is the species of mostly sub-Atlantic boreo-temperate distribution, hardly expected in continental Hemiarctic; 3) *Fuscocephaloziopsis connivens* is rather cool temperate taxon with suboceanic distribution, and its record for Putorana Plateau may be based on *F. pleniceps*, that is relatively common in our collections, but not mentioned by Zhukova (1986b); 4) *Lophozia ascendens* is not known elsewhere in Hemiarctic, and the report in Zhukova (1986b) may be based

on misidentification of *Lophoziopsis longidens* that sometimes produces green gemmous modifications; 5) *Orthocaulis atlanticus* has a northern amphi-Atlantic distribution, and its records from Siberian Subarctic are likely erroneous and referable to *Neoorthocaulis binsteadii*, a highly polymorphic and morphologically convergently intergrading to *Orthocaulis atlanticus* in northern Asia.

Even at the first sight, the present list has strong 'negative' peculiarity in poor presence of Gymnomitriaceae that are mostly associated with acidic rocks and rarely occur on rocks of neutral and basic reaction. We found only one species of *Marsupella* (*M. condensata*, new for the plateau), one species of *Gymnomitrion* (*G. concinnatum*, also recorded by Zhukova, 1986b) and no *Prasanthus*. Noticeably, this trait joins the present flora with recently studied hepatic flora of the upper course of Eriechka River (Fedosov *et al.*, 2015). In the latter flora, only one species of *Marsupella* and two species of *Gymnomitrion* were recorded, although altitude variation and orography could suggest much larger number of the latter family members.

The majority of taxa that are newly recorded for the Putorana Plateau are quite expectable in the area if the landscape variation would be taken into account. Nevertheless some records deserve additional comments:

1) *Odontoschisma francisci* is distributed mostly in the areas under oceanic air masses influence and it was previously unknown so far northward in East Siberia (although known in western and South Siberia). Its occurrence in the area may indicate either the relatively high humidity due to Atlantic cyclones, or a relic nature.

2) *Saccobasis polymorpha* is a relatively rare (and imperfectly studied) species known in Old World in European North and Beringian sector of North-East Asia. Our new record shows a somewhat similar distributional pattern with *Odontoschisma francisci*.

3) *Endogemma caespiticia* is sparsely distributed in several regions of Siberia, although it was hitherto unknown in its eastern part (recorded as doubtful for Arctic Yakutia, cf. Sofronova, 2005). Due to our observation, this species may fast spread within recent decades across man-made habitats, at least in some areas of North European Russia and the Far East. However, the record from Putorana originates from eroded slopes far from the areas under anthropogenic influence.

4) The distribution of *Marchantia romanica* (= *Bucegia romanica* Radian) seems to be poorly understood. It was regarded as a rare arctomontane taxon (Konstantinova *et al.*, 2014). However, the species frequency may be underestimated due to its superficial similarity to *Marchantia quadrata* (= *Preissia quadrata*) that may cause misidentifications and/or overlookings in the fields.

In general, if to compare the flora of Putorana Plateau and neighboring Anabar Plateau, the latter looks much more 'interesting' due to the complex of rare taxa showing relict, amphi-Beringian distribution pattern in Siberia. The taxa like *Frullania subarctica* Vilnet, Borovich. & Bakalin, *Herbertus arcticus* (Inoue & Steere) Schljakov, *Ascidiota blepharophylla* C. Massal., *Cryptocolea imbricata* R.M. Schust., *Biantheridion undulifolium* (Nees) Konstant. & Vilnet , *etc*., are currently not known in Putorana Plateau. Whether the latter fact reflects under-collecting in Putorana or may be referred to phytogeographic reasons is unclear, although we tend to be inclined to suggest the leading role of the second reason, as it also may be evidenced from the moss flora comparison of the areas (cf. Fedosov *et al*., 2011; Borovichev *et al*., 2016). The list of livirwort taxa of Putorana Plateau (according to the present data) is composed by species rather expected in the area, with a few exclusions mentioned above. However, we may suggest that the current data on the composition of Putorana Plateau liverwort flora are quite incomplete and, probably, the further exploration (especially in the eastern margins of the territory) will add several new taxa to the list.

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