

## Checklist of liverworts of the Pasvik State Nature Reserve (Murmansk Region, Russia)

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**Abstract:** Liverworts flora of the Pasvik State Nature Reserve (Pasvik Reserve) consists of 103 species, 5 subspecies and 2 varieties. We have summarized all available data on the diversity of liverworts of the Pasvik Reserve, including approximately 650 specimens collected by the authors. *Calycularia laxa* and *Oleolophozia perssonii* are reported for the second time from Murmansk Region. The territory is quite representative for protection and sustainable development of rare liverworts species – we found new localities for four red-listed European species (*Barbilophozia rubescens*, *Haplomitrium hookeri*, *Lophozia ascendens* and *Nardia japonica*), three liverworts included in the Red Data Book of the Russian Federation (*Haplomitrium hookeri*, *Nardia breidlerii* and *Oleolophozia perssonii*) and 12 red-listed in the Murmansk Region.

**Keywords:** liverworts, biodiversity, Pasvik State Nature Reserve, Murmansk Region, rare species

### INTRODUCTION

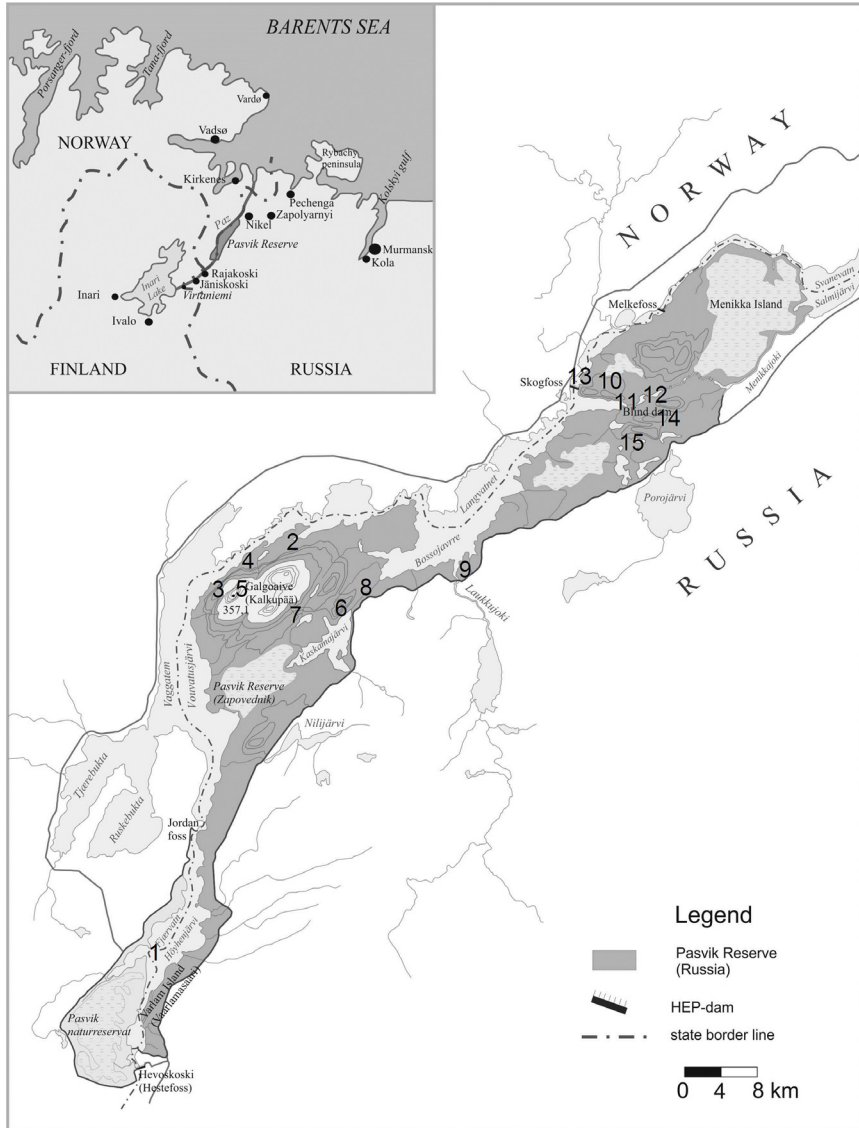
The Pasvik State Nature Reserve is situated between 69°07' and 69°25' N, in the north-west of Russia and in the north-western part of Murmansk Region (Fig. 1). The protected area occupies 147.3 km<sup>2</sup> (excluding waters – 117 km<sup>2</sup>). Reserve lies as a narrow 44 km long belt on the east bank of the Pasvik River, along the Russian-Norwegian border. Pasvik Reserve was established in 1992 for study and conservation of old-growth pine forests on the northern limit of distribution, it is the youngest Nature State Reserve in the Murmansk Region.

The territory is situated on the northern margin of Fennoscandian (Baltic) shield composed by ancient bedrocks (granites, granite-gneisses, gneiss, diorite, dacite, gabbro, amphibolites, schists, and others). The crystalline basement is covered by Quaternary sediments, but sometimes comes to the surface. Relief of the Reserve is formed by glaciation, denudation and tectonic processes. The numerous moraine hills and ridges (of height less than 200 m above sea level) alternate with depressions. Absolute elevations of the Reserve is Kalkupya Mt. (357 m alt.).

The climate is predominantly affected by the North Atlantic and the Polar arctic front (Alisov, 1969), but Moen (1999) define this area as slightly continental. Due to the Gulf Stream, the

winter temperatures are relatively high preventing the development of permafrost. The climate is characterized by relatively mild winters and cool short summers; there may be brief spells with negative temperatures in any summer months, excluding July (Yakovlev, 1961). January is the coldest month, with average temperatures ranging from -9°C to -14°C, temperature minimum -43°C; July is the warmest month, with average temperature +13°C, temperature maximum +33°C. The mean annual precipitation is relatively low, 550–600 mm, much of which falls on the summer months. The snow normally covers the ground from November to the second half of May; both its distribution and the time of melting in the mountains depend on the relief. Snow depth reaches 40–60 cm. Soil cover represents the mosaic of podzol and paludified soils, also with locally distributed podbures and primitive mountain tundra soil.

The Reserve belongs to biogeographic provinces of the Lapponia petsamoënsis (Lps) (Heikinheimo & Raatikainen, 1971; Uotila, 2013) and is situated in the Northern boreal zone according to T. Ahti & al. (1968). Forests cover most of the territory of the Reserve (51.7%). Pine forests (of *Pinus sylvestris* ssp. *sylvestris*) occupy about 90% of the forested area. They are of old age, older than 140 years old pine forests occupy



**Fig. 1.** The location of the Pasvik State Nature Reserve, Murmansk Region, Russia and collecting localities. I. Southern part of the Pasvik Reserve: 1 – Varlama Island, 69°08'26.44"N 29°14'57.32"E; II. Middle part of the Pasvik Reserve: 2 – Northern part of the Kalkupya Mt., 69°18'10"N 29°21'26"E; 3 – Western part of the Kalkupya Mt., 69°18'16"N 29°20'46"E; 4 – North-west part of the Kalkupya Mt., 69°18'16"N 29°20'00.4"E; 5 – North-west part of the Kalkupya Mt., mountain-tundra belt, 69°17'33.3"N 29°20'00.4"E; 6 – North-west bank of the Kaskamajarvi Lake, 69°17'07"N 29°26'41"E; 7 – near top of the Mt on eastern slope of Kalkupya Mt, 69°17'14.6"N 29°22'21.2"E; 8 – Stream from Kaskamajarvi Lake to Bossojavrrre Lake, 69°17'21.4"N 29°27'35.5"E; 9 – Bank of Bossojavrrre Lake near the mouth of Laukkujoki River, near the old pier; III. Northern part of the Pasvik Reserve: 10 – Purivaara Mt. and surroundings, ~69°22.1"N 29°42.3"E.; 11 – vicinity of «Glukhaya Plotina» area, 69°21'56.5"N 29°44'48.7"E; 12 – Mennikajoki River in vicinity of «Glukhaya Plotina» area, 69°22'16"N 29°47'46"E; 13 – Paz River bank below Skogfoss hydropower station, 69°22'22.5"N 29°42'29"E; 14 – unnamed Mt. with top 162.3, 69°21'21.5"N 29°45'43.2"E; 15 – unnamed Mt. (more southern Mt. «162.3»), 69°20'56.8"N 29°46'33.2"E.

59% of forest area. Moreover, birch forests (of *Betula pubescens*) are frequent and are confined to the banks of rivers and streams (Kravchenko & Kuznetsov, 2016). Aspen (*Populus tremula*) rarely forms dominant stands, and is mainly found in mixture with pine and birch on more fertile soils (Moshnikov & Krutov, 2010). Altitude zones are well-expressed on Kalkupya Mt. The foot is covered by woodland, higher up, at 200 m alt., is crooked birch forest wedging out on slopes and the upper part of the slopes and summits are occupied by mountain tundra. Narrow rock fields, detritus and bedrock outcrops sometimes occur in the Pasvik Reserve. Mires are numerous and occupy about 25% of the Pasvik Reserve area. High variety of mires is due to different forms of relief and bedrocks. Ombrotrophic hollow-ridge bogs and hollow-ridge bogs with secondary pools predominate. Besides lapland aapa mires, transitional sedge-sphagnum mires and eutrophic fens also occur (Kuznetsov & Kutenkov, 2013). Lakes, pools, springs and rivers comprise 25.5% of the Pasvik Reserve, Paz system of lakes and rivers is regulated by construction of the cascade of Paz hydroelectric power station.

Special studies of liverwort flora have never been carried out in the Pasvik Reserve. For this reason, our aim was the inventory of liverworts diversity of this territory. In 2011–2012, M.A. Boychuk studied mosses of the Pasvik Reserve and collected some liverworts. Furthermore, herbarium of the Polar-Alpine Botanical Garden-Institute (KPABG) kept eight specimens collected by V.A. Kostina and identified by N.A. Konstantinova, namely *Anthelia juratzkana*, *Cephalozia bicuspidata*, *Cephalozia pleniceps* (Austin) Lindb. [= *Fuscocephalozopsis pleniceps*], *Harpanthus flotovianus*, *Marchantia alpestris* (Nees) Burgeff [= *Marchantia polymorpha* subsp. *montivagans*], *Pellia neesiana*, *Saccobasis polita*, *Scapania irrigua*. In addition, 13 species (*Aneura pinguis*, *Barbilophozia barbata*, *B. lycopodioides*, *Cephalozia bicuspidata*, *Harpanthus flotovianus*, *Lophozia ventricosa*, *Lophozopsis longidens*, *Obtusifolium obtusum*, *Ptilidium ciliare*, *Riccardia chamaedryfolia*, *Saccobasis polita*, *Scapania paludicola*, *Schljakovia kunzeana*) were referred in Report about the study of the flora and vegetation of the Pasvik Reserve and adjacent areas (Study of the flora and vegetation..., 2010). The species were collected by A.V. Kravchenko in Varlama Island and identified by E.A. Borovichev.

## MATERIALS AND METHODS

Materials were collected by the authors in 2011–2015 in different areas of the Pasvik Reserve, moreover, some other collections were identified. The total number of specimens collected by E.A. Borovichev in 2013–2015 is about 500 and M.A. Boychuk collected ca. 150 specimens. Furthermore, there have been identified or examined a number of specimens gathered earlier by V.A. Kostina (ca. 10 specimens), A.V. Polikarpova (ca. 5 specimens), G.P. Urbanavichus (ca. 35 specimens), A.V. Kravchenko (ca. 15) and Yu.R. Khimich (ca. 25 specimens). Specimens are deposited in KPABG and are available in CRIS (Cryptogamic Russian Information System, <http://kpabg.ru/cris/?q=node/16>).

## RESULTS

### List of species

The taxa are arranged in alphabetical order. The nomenclature generally follows L. Söderström et al. (2016) with some updates from other literature (Konstantinova, Bakalin et al., 2009; Long et al., 2016). Treatment of *Cephalozia ambigua* as a subspecies of *C. bicuspidata* is in accordance with R.M. Schuster (1974). Common synonyms are given in parenthesis. In terms of frequency, the liverworts in the Pasvik Reserve are arranged as follows: frequent (species collected more than 15 times), not rare (in 9–15 sites), sporadic (in 6–9 sites), rare (in 3–5 sites) and unique (found 1–2 times). The name of the area where a species was collected was marked as follows: I – Southern part of the Pasvik Reserve (1); II – Middle part of the Pasvik Reserve (2–9); III – Northern part of the Pasvik Reserve (10–15). After the number of the area there is given the localities number (1–15, cf. Fig. 1). Species included in the Red Data Book of Murmansk Region (2014) are marked as MP, in the Red Data Book of the Russian Federation (2008) as RF, and in the Red Data Book of European Bryophytes (1995) – EB.

ANEURA PINGUIS (L.) Dumort. – Not rare. I: 1; II: 2, 5, 7, 8; III: 11, 12, 13, 14.

ANTHELIA JURATZKANA (Limpr.) Trevis. – Frequent.

II: 2, 3, 4, 5, 6, 7, 8; III: 10, 11, 12, 13, 14.

BARBILOPHOZIA BARBATA (Schmidel ex Schreb.)

Loeske – Sporadic. I: 1; II: 6, 8; III: 10, 11.

- BARBILOPHOZIA HATCHERI (A.Evans) Loeske – Sporadic. II: 3, 4; III: 10, 11.
- BARBILOPHOZIA LYCOPODIODES (Wallr.) Loeske – Frequent. I: 1; II: 2, 3, 4, 5, 6, 7, 8; III: 10, 12, 13, 14, 15.
- BARBILOPHOZIA RUBESCENS (R.M.Schust. et Damsh.) Kartt. et L.Söderstr. [= *Barbilophozia hatcheri* (A.Evans) Loeske var. *grandiretis* H.Buch ex Lammes, *Barbilophozia lycopodioides* var. *grandiretis* (Lammes) Schljakov, *Lophozia rubescens* R.M.Schust. et Damsh.] – Unique. II: 3. EB: K (insufficiently known taxon), MP: 3 (Rare).
- BLASIA PUSILLA L. – Rare. II: 3, 9; III: 14.
- BLEPHAROSTOMA TRICHOPHYLLUM (L.) Dumort. s.l. – Frequent. I: 1; II: 2, 3, 4, 5, 6, 7, 8; III: 10, 11, 12, 13, 14, 15.
- CALYCVULARIA LAXA Lindb. et Arnell – Unique. II: 4. MP: 2 (Vulnerable).
- CALYPOGEIA INTEGRISTIPULA Steph. – Sporadic. II: 3, 4, 6, 8; III: 10, 14.
- CALYPOGEIA MUELLERIANA (Schiffn.) Müll.Frib. – Sporadic. II: 2, 3, 7, 8.
- CALYPOGEIA NEESIANA (C.Massal. et Carestia) Müll.Frib. – Rare. II: 3, 4; III: 13.
- CALYPOGEIA SPHAGNICOLA (Arnell et J.Perss.) Warnst. et Loeske – Unique. II: 7.
- CEPHALOZIA BICUSPIDATA (L.) Dumort. subsp. BICUSPIDATA – Frequent. I: 1; II: 2, 3, 4, 7, 8, 9; III: 10, 11, 12, 14, 15.
- CEPHALOZIA BICUSPIDATA (L.) Dumort. subsp. AMBIGUA (C. Massal.) R.M.Schust. [= *Cephalozia ambigua* C. Mass.] – Rare. II: 5, 8; III: 10.
- CEPHALOZIELLA DIVARICATA (Sm.) Schiffn. – Sporadic. II: 3, 6; III: 11, 12.
- CEPHALOZIELLA GRIMSULANA (J.B.Jack ex Gottsche et Rabenh.) Lacout. – Unique. II: 2.
- CHILOSYPHUS POLYANTHOS (L.) Corda – Sporadic. II: 8; III: 10, 12, 13, 14.
- CLEVEA HYALINA (Sommerf.) Lindb. [= *Athalamia hyalina* (Sommerf.) S. Hatt.] – Unique. III: 13, 15. MP: 3 (Rare).
- CROSSOCALYX HELLERIANUS (Nees ex Lindenb.) Meyl. – Unique. II: 4. MP: 3 (Rare).
- DIPLOPHYLLUM ALBICANS (L.) Dumort. – Rare. II: 4; III: 14, 15.
- DIPLOPHYLLUM TAXIFOLIUM (Wahlenb.) Dumort. – Not rare. II: 3, 4, 5, 6, 7, 8; III: 11, 13, 14, 15.
- FUSCOCEPHALOZIOPSIS ALBESCENS (Hook.) Váňa et L.Söderstr. [= *Pleurocladula albescens* (Hook.) Grolle] – Sporadic. II: 3, 4, 5, 6, 7; III: 12, 14, 15.
- FUSCOCEPHALOZIOPSIS LEUCANTHA (Spruce) Váňa et L.Söderstr. [= *Cephalozia leucantha* Spruce] – Sporadic. I: 1; II: 2, 3, 4; III: 10.
- FUSCOCEPHALOZIOPSIS LUNULIFOLIA (Dumort.) Váňa et L.Söderstr. [= *Cephalozia lunulifolia* (Dumort.) Dumort.] – Sporadic. II: 2, 3, 4, 7, 8; III: 10, 11.
- FUSCOCEPHALOZIOPSIS PLENICEPS (Austin) Váňa et L.Söderstr. [= *Cephalozia pleniceps* (Austin) Lindb.] – Sporadic. II: 3, 5; III: 12, 14.
- GYMNOCOLEA INFLATA (Huds.) Dumort. – Not rare. I: 1; II: 2, 5, 6, 7, 8; III: 12, 14, 15.
- GYMNOMITRION CONCINNATUM (Lightf.) Corda – Not rare. II: 2, 3, 4, 5, 6; III: 11, 13, 14.
- GYMNOMITRION CORALLIOIDES Nees – Rare. II: 3, 5, 6, 7.
- HAPLOMITRIUM HOOKERI (Sm.) Nees – I: 1. Unique. EB: Rare, RF: 2a (Vulnerable), MP: 3 (Rare).
- HARPANTHUS FLOTOVIANUS (Nees) Nees – Not rare. I: 1; II: 2, 3, 4, 8; III: 10, 12, 15.
- ISOPACHES BICRENATUS (Schmidel ex Hoffm.) H.Buch – Not rare. I: 1; II: 2, 6, 7, 9; III: 10, 13.
- JUNGERMANNIA BOREALIS Damsh. et Váňa – Rare. II: 8; III: 15.
- LEPIDOZIA REPTANS (L.) Dumort. – Rare. II: 8; III: 10, 11.
- LIOCHLAENA LANCEOLATA Nees – Rare. II: 2; III: 10.
- LOPHOCOLEA HETEROPHYLLA (Schrad.) Dumort. – Sporadic. II: 4, 8, 9; III: 13.
- LOPHOZIA ASCENDENS (Warnst.) R.M.Schust. – Unique. II: 4. EB: Rare, MP: 3 (Rare).
- LOPHOZIA GUTTULATA (Lindb. et Arnell) A.Evans – Rare. II: 4, 8, 9; III: 13.
- LOPHOZIA MURMANICA Kaal. [= *Lophozia wenzelii* (Nees) Steph. var. *groenlandica* (Nees) Bakalin] – Not rare. II: 3, 6, 7; III: 10, 12, 14, 15.
- LOPHOZIA SAVICZIAE Schljakov – Sporadic. II: 3, 5, 7; III: 10, 14.
- LOPHOZIA SILVICOLA H.Buch – Sporadic. II: 2, 4, 7; III: 10, 11, 12.
- LOPHOZIA VENTRICOSA (Dicks.) Dumort. var. LONGIFLORA (Nees) Macoun – Frequent. I: 1; II: 2, 3, 6, 7, 8, 9; III: 10, 11, 13, 14, 15.
- LOPHOZIA VENTRICOSA (Dicks.) Dumort. var. VENTRICOSA – Rare. I: 1; II: 4, 6, 8.
- LOPHOZIOPSIS EXCISA (Dicks.) Konstant. et Vilnet [= *Lophozia excisa* (Dicks.) Dumort.] – Rare. II: 3, 6; III: 15.
- LOPHOZIOPSIS LONGIDENS (Lindb.) Konstant. et Vilnet subsp. LONGIDENS [= *Lophozia longidens* (Lindb.) Macoun] – Not rare. I: 1; II: 3, 4, 8, 9; III: 10, 13.

- LOPHOZIOPSIS LONGIDENS subsp. ARCTICA (R.M.Schust.) Váňa et L.Söderstr. [=Lophozia longidens subsp. arctica R.M.Schust.] – Unique. III: 11, 15.
- MANNIA GRACILIS (F. Weber) Schill et D.G. Long [=Asterella gracilis (F. Weber) Underw.] – Unique. II: 6.
- MANNIA PILOSA (Hornem.) Frye et L. Clark – Unique. III: 15. MP: 4 (Data defition).
- MARCHANTIA QUADRATA Scop. [=Preissia quadrata (Scop.) Nees] – Sporadic. II: 6, 7, 8; III: 11, 10, 14, 15.
- MARCHANTIA POLYMORPHA L. subsp. RUDERALIS Bischl. et Boissel.-Dub. [=Marchantia latifolia Gray, Marchantia polymorpha auct. non L.] – Sporadic. II: 1, 4, 8, 9; III: 11.
- MARCHANTIA POLYMORPHA subsp. MONTIVAGANS Bischl. et Boissel.-Dub. [=Marchantia alpestris (Nees) Burgeff] – Sporadic. II: 2, 5, 6; III: 14, 15.
- MARSUPELLA BOECKII (Austin) Lindb. ex Kaal. – Rare. II: 7; III: 10, 15.
- MARSUPELLA EMARGINATA (Ehrh.) Dumort. – Rare. II: 3, 5, 7.
- MARSUPELLA SPHACELATA (Giesecke ex Lindenb.) Dumort. – Unique. II: 4
- MESOPTYCHIA BADENSIS (Gottsche ex Rabenh.) L.Söderstr. et Váňa [=Leiocolea badensis (Gottsche) Jørg.] – Unique. II: 6. MP: 3 (Rare).
- MESOPTYCHIA BANTRIENSIS (Hook.) L. Söderstr. et Váňa [=Leiocolea bantriensis (Hook.) Jørg.] – Unique. III: 10.
- MESOPTYCHIA GILLMANII (Austin) L.Söderstr. & Váňa [=Leiocolea gillmanii (Austin) A. Evans] – Rare. II: 6; III: 14, 15.
- MESOPTYCHIA HETEROCOLPOS (Thed. ex Hartm.) L.Söderstr. et Váňa [=Leiocolea heterocolpos (Thed. ex C.Hartm.) H.Buch] – Rare. II: 6; III: 12, 14, 15.
- MESOPTYCHIA RUTHEANA (Limpr.) L.Söderstr. et Váňa [=Leiocolea rutheana (Limpr.) Müll. Frib.] – Rare. I: 1; II: 3; III: 12.
- METZGERIA FURCATA (L.) Dumort. – Unique. III: 13, 14. MP: 3 (Rare).
- MOERCKIA FLOTOVIANA (Nees) Schiffn. [=M. hibernica (Hook.) Gottsche f. flotoviana] – Unique. I: 1.
- MYLIA ANOMALA (Hook.) Gray – Not rare. II: 3, 4, 5, 7, 8; III: 10, 11, 12.
- NARDIA BREIDLERI (Limpr.) Lindb. – Unique. II: 7. RF: 4 (insufficiently known); MP: 5 (special status).
- NARDIA GEOSCYPHUS (De Not.) Lindb. – Sporadic. II: 6, 7; III: 13, 14, 15.
- NARDIA JAPONICA Steph. – Unique. II: 9, 10. EB: Rare
- NEOORTHOCAULIS ATTENUATUS (Mart.) L.Söderstr., De Roo et Hedd. [=Orthocaulis attenuatus (Mart.) A.Evans, Barbilophozia attenuata (Mart.) Loeske] – Sporadic. II: 6, 7, 9; III: 10, 13.
- NEOORTHOCAULIS BINSTEADII (Kaal.) L. Söderstr., De Roo et Hedd. [=Orthocaulis binsteadii (Kaal.) H.Buch, Barbilophozia binsteadii (Kaal.) Loeske] – Rare. III: 11, 14.
- NEOORTHOCAULIS FLOERKEI (F.Weber et D.Mohr) L.Söderstr., De Roo et Hedd. [=Orthocaulis floerkei (F.Weber et D.Mohr) H.Buch, Barbilophozia floerkei (F.Weber et D.Mohr) Loeske] – Not rare. II: 2, 3, 5, 6, 7; III: 11, 12, 14.
- OBTUSIFOLIUM OBTUSUM (Lindb.) S.W.Arnell – Sporadic. I: 1; II: 4, 8; III: 10, 12.
- ODONTOSCHISMA ELONGATUM (Lindb.) A.Evans – Not rare. II: 3, 4, 5, 6, 7, 8; III: 10, 12.
- ODONTOSCHISMA FLUITANS (Nees) L.Söderstr. et Váňa [=Cladopodiella fluitans (Nees) Jørg.] – Not rare. II: 3, 4, 7, 8; III: 10, 11, 12.
- ODONTOSCHISMA MACOUNII (Austin) Underw. – Rare. II: 6; III: 14, 15
- OLEOLOPHOZIA PERSSONII (H. Buch & S. W. Arnell) L. Söderstr., De Roo et Hedd. [=Lophozia perssonii (H.Buch et S.W.Arnell) Konstant. et Vilnet =Lophozia perssonii H. Buch et S.W. Arnell] – Unique. III: 15. RF: 3 (Rare), MP: 2 (Vulnerable).
- PELLIA NEESIANA (Gottsche) Limpr. – Not rare. II: 2, 3, 5, 8, 9; III: 10, 12, 14, 15.
- PLAGIOCHILA PORELLOIDES (Torr. ex Nees) Lindenb. – Rare. II: 4; III: 11, 13.
- PSEUDOLOPHOZIA DEBILIFORMIS (R.M.Schust. et Damsh.) Konstant. et Vilnet – Unique. 5.
- PSEUDOLOPHOZIA SUDETICA (Nees ex Huebener) Konstant. et Vilnet [=Lophozia sudetica (Nees ex Huebener) Grolle] – Not rare. II: 2, 3, 4, 5, 6, 7; III: 10, 11, 14, 15.
- PTILIDIUM CILARE (L.) Hampe – Frequent. I: 1; II: 2, 3, 5, 6, 7, 8; III: 10, 11, 12, 13, 14, 15
- PTILIDIUM PULCHERRIMUM (Weber) Vain. – Frequent. I: 1; II: 2, 4, 6, 8, 9; III: 10, 13
- RADULA COMPLANATA (L.) Dumort. – Rare. III: 13, 14.
- RICCARDIA LATIFRONS (Lindb.) Lindb. subsp. ARCTICA R.M.Schust. et Damsh. – Unique. III: 12.

RICCARDIA LATIFRONS (Lindb.) Lindb. subsp. LATIFRONS – Sporadic. I: 1; II: 4, 6, 7, 8; III: 12.  
 RICCARDIA CHAMEDRYFOLIA (With.) Grolle – Unique. I: 1.  
 SACCOBASIS POLITA (Nees) H.Buch – Sporadic. I: 1; II: 2, 3, 4, 8; III: 10.  
 SCAPANIA APICULATA Spruce – Unique. II: 4. MP: 3 (Rare).  
 SCAPANIA CRASSIRETIS Bryhn – Unique. II: 8.  
 SCAPANIA CURTA (Mart.) Dumort. – Rare. II: 3, 7; III: 10.  
 SCAPANIA CUSPIDULIGERA (Nees) Müll.Frib. – Rare. II: 6; III: 14, 15.  
 SCAPANIA GYMNSTOMOPHILA Kaal. – Rare. II: 6; III: 4, 15.  
 SCAPANIA HYPERBOREA JØRG. – Rare. II: 4, 7; III: 10.  
 SCAPANIA IRRIGUA (Nees) Nees – Not rare. I: 1; II: 2, 3, 4, 5, 7, 8, 9; III: 10, 12.  
 SCAPANIA OBCORDATA (Berggr.) S.W.Arnell – Unique. II: 4.  
 SCAPANIA PALUDICOLA Loeske et Müll.Frib. – Rare. I: 1; III: 10, 12.  
 SCAPANIA PRAETERVISA Meyl. – Unique. II: 4.  
 SCAPANIA SUBALPINA (Nees ex Lindenb.) Dumort. – Sporadic. II: 2, 5, 8; III: 10, 11.  
 SCAPANIA ULIGINOSA (Lindenb.) Dumort. – Sporadic. II: 2, 3, 4; III: 13, 14.  
 SCAPANIA UNDULATA (L.) Dumort. – Rare. II: 8; III: 10, 12.  
 SCHISTOCHILOPSIS GRANDIRETIS (Lindb. ex Kaal.) Konstant. – Rare. III: 10, 11.  
 SCHISTOCHILOPSIS INCISA (Schrad.) Konstant. – Rare. II: 4; III: 15.  
 SCHISTOCHILOPSIS OPACIFOLIA (Culm. ex Meyl.) Konstant. – Sporadic. II: 2, 3, 4; III: 12.  
 SCHLJAKOVIA KUNZEANA (Huebener) Konstant. et Vilnet – Not rare. I: 1; II: 3, 4, 5, 6, 7, 8; III: 10, 11, 12, 15.  
 SCHLJAKOVIANTHUS QUADRILOBUS (Lindb.) Konstant. et Vilnet [= *Orthocaulis quadrilobus* (Lindb.) H. Buch] – Rare. II: 5, 6, 7; III: 14.  
 SOLENOSTOMA OBOVATUM (Nees) R.M.Schust [= *Plectocolea obovata* (Nees) Mitt.] – Rare. III: 11, 12, 14.  
 SOLENOSTOMA SPHAEROCARPUM (Hook.) Steph. – Rare. II: 2, 3; III: 11.  
 SPHENOLOBUS MINUTUS (Schreb.) Berggr. – Not rare. I: 1; II: 2, 3, 4, 5, 6, 7, 8; III: 10, 11, 14, 15.  
 TETRALOPHOZIA SETIFORMIS (Ehrh.) Schljakov – Frequent. II: 2, 3, 4, 5, 6, 7, 8, 9; III: 12, 14, 15.  
 TRILOPHOZIA QUINQUEDENTATA (Huds.) Bakalin [= *Tritomaria quinquedentata* (Huds.) H.Buch]

– Not rare. II: 2, 3, 4, 5, 6, 7; III: 10, 11, 12, 13, 15.

TRITOMARIA SCITULA (Taylor) Jørg. – Unique. III: 12, 13.

## DISCUSSION

As a result of the exploration 103 species (including 5 subspecies and 2 varieties) have been found. The species belong to three classes – Haplomitriopsida (1 species), Marchantiopsida (6 species) and Jungermanniopsida (96 species). Nowadays, the liverwort flora of the Pasvik Reserve comprises 50.2% of liverwort flora of the Murmansk Region. In spite of small area and a low diversity of habitats in the Reserve, liverwort flora is considered as rich. Further research of Pasvik Reserve could enlarge the number of liverwort species even more.

Majority of the list of liverworts comprises fairly common species in the Murmansk Region. However, twenty eight species are known, at present, in the Pasvik Reserve in only single location and are considered as rare. Among them there are very rare in the Region species.

In the present study, *Calycularia laxa* and *Oleolophozia perssonii* are reported for the second time from Murmansk Region. *Calycularia laxa* was collected in north-west part of the Kalkupya Mt. under hillock sedge at the water's edge (KPABG (H): 21369) and on fine-earth at the water's edge (KPABG (H): 21368). *Calycularia laxa* is an Arctic-montane liverwort with predominantly Asian-western North American distribution with single localities in East European North (Konstantinova & Mamontov, 2010). In Europe, the species was found earlier only in Arkhangelsk Region (Konstantinova & Lavrinenko, 2002). *Calycularia laxa* was reported for the Murmansk Region from Lumbovka Bay of Barents Sea (Borovichev, 2013). The species presumably represents post-glacial invasion. *Oleolophozia perssonii* is calciphylous montane circumpolar species, which earlier was found in Murmansk Region in Lapland State Nature Reserve (Borovichev, 2014). We found it in Pasvik Reserve on unnamed Mt. more southern of Mt. «162.3» on south-west oriented Ca-rich rocks, on the fine-earth under full shade (KPABG (H): 120124). Both *Calycularia laxa* and *Oleolophozia perssonii* were included in Red Data Book of the Murmansk Region (2014) as vulnerable species.

In addition very rare calciphilous species are *Mannia pilosa*, *Clevea hyalina* and *Mesoptychia badensis*.

Remarkable findings are three species with boreal circumpolar distribution: *Crossocalyx hellerianus*, *Lophozia ascendens*, *Scapania apiculata*. Their distribution is connected mainly with rich and wet coniferous forests which in investigated area are very rare.

A few species are poorly known in neighboring countries and here we will discuss them. *Barbilophozia rubescens* has an Arctic-montane disjunctive distribution. The species was found in western part of the Kalkupya Mt. on dry Ca-rich rocks (KPABG (H): 21921). It is known in Murmansk Region from Lovozero Mts., Nyavka-Tundra Mts. and some localities on islands and on White Sea shore (Red Data Book..., 2014). *Barbilophozia rubescens* is also rare in neighboring countries: the species has category DD (Data deficient) in both Red List of Finnish species (2010) and Norwegian Red List for Species (2010). *Lophozia savicziae* Schljakov is not rare in Murmansk Region (Schuster & Konstantinova, 1996; Bakalin, 2005; Borovichev, 2014). In Pasvik Reserve it was found in five localities and grows on wet rocks; once it was collected in lapland aapa mire (KPABG (H): 21322). In Finland it is very rare and has category Vu (Vulnerable) in Red Data List of Finland (2010). *Nardia japonica* Steph. is sporadic in Murmansk Region (Schuster & Konstantinova, 1996; Konstantinova, 2005; Borovichev, 2014). In Pasvik Reserve it was found twice and grows on bare soil along roads. In Finland the species is very rare and is known from a single locality (Laaka-Lindberg et al., 2009).

The territory is quite representative for protection and sustainable development of rare liverworts. Among the liverworts collected in Pasvik Reserve, four species are red-listed in Europe. Three of them, *Haplomitrium hookeri*, *Lophozia ascendens* and *Nardia japonica* are vulnerable in Europe and one of them (*Barbilophozia rubescens*) is insufficiently known. All species included in the Russian Red Data Book (2008) as well as in Red Data Book of Murmansk Region (2014) are protected by law. Three liverworts are included in the Red Data Book of the Russian Federation (2008) – *Haplomitrium hookeri*, *Nardia breidlereri* and *Oleolophozia perssonii*. The species are also rare in neighboring countries:

in Norway, according to the Norwegian Red List for Species (2010), *Haplomitrium hookeri* and *Oleolophozia perssonii* have category NT (Near Threatened); in Finland, according to the Red List of Finnish Species (2010), *Haplomitrium hookeri* is Regionally Extinct species, *Oleolophozia perssonii* is Critically Endangered species and *Nardia breidlereri* has NT category. Twelve species are protected in Murmansk Region (Red Data Book..., 2014): two species (*Calycularia laxa* and *Oleolophozia perssonii*) are vulnerable, eight (*Barbilophozia rubescens*, *Clevea hyalina*, *Crossocalyx hellerianus*, *Haplomitrium hookeri*, *Lophozia ascendens*, *Mesoptychia badensis*, *Metzgeria furcata*, *Scapania apiculata*) are rare in the Region, *Mannia pilosa* has deficient of data and one species (*Nardia breidlereri*) has special status (the species was included in the Red Data Book of the Russian Federation (2008), but in Murmansk Region it is not rare).

The most interesting areas in Pasvik Reserve for bryologists are: 1) Rocks on the north-east part of the Kalkupya Mt., 2) area on north-west part of the Kalkupya Mt. and Ca-rich hills in vicinity of «Glukhaya Plotina» area. Further research will focus on some areas of the Pasvik Reserve: south-western part of the Kalkupya Mt., territory adjacent to the south-eastern shore of the Vouvatossjarvi Lake as well as Varlama Island.

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