

# The liverworts of the Khulga River Basin (Subpolar Urals, Khanty-Mansi Autonomous Area – Yugra)

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**Abstract:** The annotated list of liverworts of Khulga River Basin (Subpolar Urals, north-east part of Khanty-Mansi Autonomous Area – Yugra) is compiled based on identification of 300 specimens gathered by E. D. Lapshina and I. V. Filippov in 2018. It counts 84 species, among them two species new for the Urals and five species (*Arnellia fennica*, *Frullania austinii*, *Mesoptychia rutheana*, *Metzgeria furcata*, *Scapania sphaerifera*) new for Subpolar Urals. Annotations to the species include distribution, description of habitats and data on reproduction structures. Comparison with two previously studied local floras as well as the full list of liverworts of Asian part of the Urals is provided. A total of 144 species have now been recorded in three studies of the Urals territories within the Khanty-Mansi Autonomous Area.

**Keywords:** liverworts, ecology, distribution, phytogeography, flora, Subpolar Urals, Russia

## INTRODUCTION

The liverworts of the Urals are still a relatively poorly studied. Most of the studies covered mainly the Western slopes of the Northern and Middle Urals (Zinovjeva, 1973; Baisheva & Potemkin, 1998; Bakalin et al., 2001; Dulin, 2007; Konstantinova et al., 2010; Konstantinova & Bezgodov, 2005; Ignatova et al., 2019;). Information about the liverworts of the Polar and Subpolar Urals is extremely limited. There is only one publication on the Sob' river valley in the Polar Urals (Konstantinova & Chernyadjeva, 1995). Data on liverworts of the Eastern slopes of the Urals are presented in two more or less comprehensive lists of species of the Subpolar Urals: the Ner-Oika Mountain and the basin of Puiva river (Konstantinova & Lapshina, 2014, 2017). This paper provides the results of identifications of specimens collected in the basin of the Khulga River, located in the North-Eastern part of the Subpolar Urals, about 120 km from the previously studied sites.

## STUDY AREA

The study area is located in the Beresovskiy District in north-west part of the Khanty-Mansi Autonomous Area (Yugra). The sources of the Khulga River are located slightly south of the Arctic circle on the border of the Polar and Subpolar Urals. The river flows along the eastern slope of the Ural Mountains to the South to the

Severnaya Sosva River which is a left tributary of the Ob River. In the middle and lower reaches, the river flows through a flat, sometimes gently undulating plain with absolute elevations of 40–90 m above sea level. The narrow regularly flooded part of river valley is occupied by well-drained forests and wet lowlands. Flat river valley terraces are poorly drained and covered with raised and transitional peat bogs and swampy open woodlands with *Pinus sibirica* Du Tour and *Picea obovata* Ledeb. Local permafrost is widespread in the peatlands and thermokarst landforms are widely represented.

On the right bank in the upper reaches of the river, up to a height of 350–400 m alt. mountain birch-spruce-larch forests and their derivatives predominate. In the subalpine zone, up to a height of 450–500 m, *Pinus sibirica*-*Betula pubescens* Ehrh. with an admixture of *Larix sibirica* Ledeb. open forests, alternating with thickets of *Betula nana* L. and *Duschekia fruticosa* Opiz are widespread. The mountain tundra is represented on the highest peaks, reaching a height of 600–750 m.

Mountains are composed of metamorphic and intrusive rocks, with frequent outcrops of carbonates. This provides a diversity of rocks from pure carbonates to rocks of basic, neutral and acidic compositions. For a more detailed descrip-

tion of the vegetation and habitats see Lapshina et al. (2020).

## MATERIAL AND METHODS

Liverworts were gathered in the basin of the Khulga River from 7 to 18 July 2018 by Elena Lapshina and Ilya Filippov. The routes were planned to cover all the diversity of the main vegetation types. Landsat 8 satellite images with a resolution of 15 m were used for this purpose. The valleys of small rivers and streams, rock outcrops, banks of rivers and lakes were studied most thoroughly. In total 300 specimens were collected from 190 sites at altitudes from 24 to 625 m. On the map all collecting sites are grouped into 24 locations within four key territories (Fig. 1). For all collecting sites the coordinates and elevations were measured using GPS. The collected specimens were studied in the laboratory of the Polar-Alpine Botanical Garden-Institute (Kirovsk, Murmansk Province). The specimens are deposited in the Biological collection of Yugra State University (YSU); some duplicates are deposited in the Herbarium of Polar-Alpine Botanical Garden-Institute of the Kola Scientific Center, Russian Academy of Sciences (KPABG). Label data of duplicates are incorporated in the CRIS – Cryptogamic Russian Information System ([kpabg.ru/cris/?q=node/16](http://kpabg.ru/cris/?q=node/16)).

### Collecting localities (Fig. 1.)

I. Upper Khulga River near the mouth of Tykotlova River (right tributary of Khulga River).

Valley of Khulga River: 1 – right bank, 2 km below mouth of Tykotlova River, 65.252°N, 62.170°–62.177°E, 61 m alt.; 2 – near the mouth of Tykotlova River, 65.253°–65.269°N, 62.177°–62.184°E, 61 m alt.; 3 – left bank, 2 km above mouth of Tykotlova River, 65.278°–65.286°N, 62.189°–62.207°E, 66 m alt.

Tykotlova peatland area between the valleys of the Khulga and Tykotlova Rivers: 4 – flat palsa bog, 65.275°–65.285°N, 62.132°–62.147°E, 66 m alt.; 5 – rich fen in area of carbonate groundwater discharge, 65.253°–65.269°N, 62.177°–62.184°E, 68 m alt.; 6 – sloping bog at base of carbonate rock outcrops, 65.297°N, 62.128°E, 72 m alt.

Mid-mountain belt eastern ridges of Subpolar Urals: 7 – shore of lake in intermontane basin, 65.302°N, 62.075°E, 75 m alt.; 8 – rich fen

at base of carbonate rock by lake, 65.298°N, 62.095°E, 75 m alt.; 9 – carbonate rocks and carbonate outcrops in spruce-larch forest, 65.301°N, 62.119°E, 105 m alt.; 10 – dry carbonate rocks on steep slope of southern exposure, 65.298°N, 62.085°E, 81 m alt.; 11 – huge boulder on gentle north-eastern faced slope, 65.277°N, 62.111°E, 92 m alt.; 12 – valley in the middle reaches of Tykotlova River, 65.278°N, 62.101°E, 72 m alt.

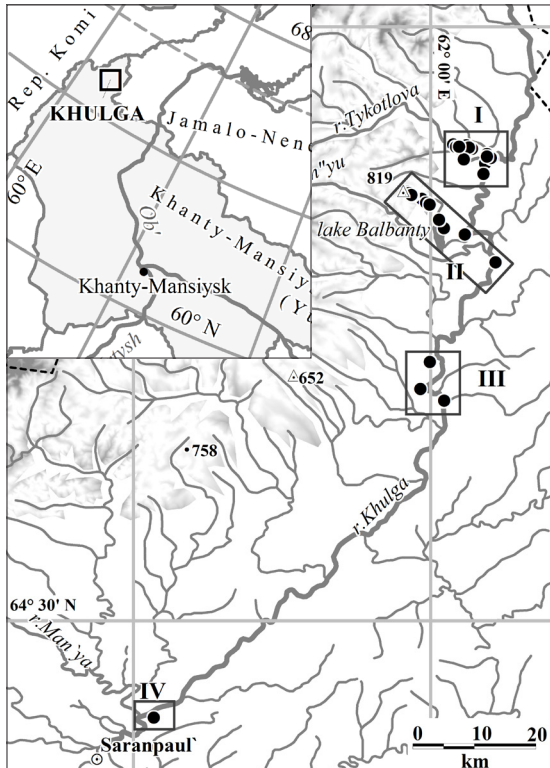
II. Upper reaches of the Khulga River in the area of the Balbanty Lake. 13 – valley of Khulga River, 2 km east of the Balbanty Lake, 65.150°–65.154°N, 62.108°–62.126°E, 52 m alt. The eastern spurs of the Subpolar Urals: 14 – lower part of western slope and swampy valley of Balbanshor Brook on northern shores of lake in forest belt, 65.161°–65.176°N, 62.026°–62.048°E, 81 m alt.; 15 – deep intermontane brook valley near the timberline, 65.201°N, 61.996°E, 487 m alt.; 16 – gentle slopes and plateaus at the top of mountain tundra belt, 65.202°–65.210°N, 61.970°–61.986°E, 510 m alt.; 17 – upper Balbanshor Brook under snowfield, 65.216°–65.222°N, 61.922°–61.939°E, 608 m alt.; 18 – valley of the Khulga River, near the mouth of Balban'yu River, 65.104°N, 62.216°–62.218°E, 46 m alt.

III. Valley of the Khulga River in its middle course: 19 – high palsa-hollow complex on right bank of Khulga River, 64.936°–64.937°N, 61.993°–61.999°E, 45 m alt.; 20 – coastal silty-sand sediment outcrop along on left bank of river, 64.870°N, 62.034°E, 40 m alt.; 21 – meso-oligotrophic aapa mire complex with palsas on left-bank terrace of the Khulga River, 64.870°–64.871°N, 62.042°–62.046°E, 43 m alt.; 22 – left bank of the Khulga River opposite the mouth of Khalmer'yu River, 64.558°N, 61.642°E, 43 m alt.

IV. Valley of the Khulga River at its lower reaches. Left-bank terrace near the mouth of Man'ya River (right tributary of the Khulga River): 23 – aapa mire complex, 64.348°–64.349°N, 61.107°–61.150°E, 25 m alt.; 24 – mesotrophic poor fen, 64.337°–64.339°N, 61.066°–61.067°E, 24 m alt.

## ANNOTATED LIST OF SPECIES

The annotated list of liverworts includes 84 species. The nomenclature of bryophytes generally follows Hodgetts et al. (2020). The species in the list are arranged in alphabetical order. Common synonyms are given in square brackets. After



**Fig. 1.** Collecting localities.

the species name the presence of reproductive structures is given in parentheses (and. – androecia; gyn. – gynoecia; per. – perianths or pseudoperianths; spor. – sporophytes; gem. – gemmae). Habitat characteristics and some accompanying species are given for sporadic and widespread species, and at least one reference to a herbarium number in the Cryptogamic Russian Information System – CRIS (kpubg.ru/cris/?q=node/16) or the Biological collection of Yugra State University (YSU) is cited. For species collected from 1–2 (3) localities, labels are given in full and the herbarium numbers of specimens in the Herbarium of Polar-Alpine Botanical Garden-Institute (KPABG) or Biological collection of Yugra State University (YSU) are specified. The frequency is characterized as: sporadic (Sp., 3–6 localities), frequent (Fr., 7–13 localities) and common (Com., more than 13 localities). New records for the Khanty-Mansiysk Autonomous Area – Yugra are marked as one asterisk (\*), new records for the Subpolar Urals – as two asterisks (\*\*), and new records for the Urals as three asterisks (\*\*\*).

*ANEURA PINGUIS* (L.) Dumort. – 5, 17, 21: on bare peat in poor fens or scattered in mats of *Sphagnum warnstorffii*, *Ptychostomum pseudotriquetrum* in rich fens and dwarf shrubs (*Betula nana*, *Salix*)-sedge (*Carex arctisibirica*)-*Sphagnum warnstorffii* mires in forest and tundra zone [YSU-MH-00521].

*ANTHELIA JURATZKANA* (Limpr.) Trevis. (per., spor.) – 16, 17: on clay spots in rocky dwarf shrub tundra on top of mountain, [YSU-MH-00503], on stream banks under snowfield, on moist organic-mineral substrate. Often mixed with other arctomontane liverworts (*Marsupella sprucei*, *Prasanthus suecicus*, *Barbilophozia sudetica* etc.) or liverworts widespread in the north of holarctic (*Blepharostoma trichophyllum*, *Fuscocephaloziopsis pleniceps*, *Mesoptychia heterocolpos*, etc) [KPABG(H):22287].

\*\* *ARNELLIA FENNICA* (Gottsche) Lindb. – 9: carbonate boulders in coniferous (*Picea obovata*, *Larix sibirica*, *Pinus sibirica*) dwarf shrub-green-moss forest, between rocks, mixed with *Tritomaria scitula*, *Mesoptychia heterocolpos* [YSU-MH-00148]; 10: rock outcrop, in moist shaded niches, in pure mats and mixed with *Myurella tenerrima*, *Pohlia cruda*, *Bryoerythrophyllum recurvirostrum*, *Scapania gymnostomophila*, *Cyrtomnium hymenophylloides*, *Platydictya jungermanniioides* [KPABG(H):122255]; 11: huge boulder, in shaded niches, single shoots in turf of *Scapania gymnostomophila* [YSU-MH-00344]. Previously the species was only known on the European slopes of the Urals. It is reported for the first time for the Asian part of the Urals.

*BARBILOPHOZIA BARBATA* (Schmidel ex Schreb.) Loeske – 1, 3, 7, 9, 11, 15 (Fr.): in dark coniferous and mixed (*Picea obovata*, *Pinus sibirica*, *Betula pubescens*, *Larix sibirica*) shrub-herb and grass-green-moss short-flooded river valley forests, in the forest floor, in pure mats [KPABG(H):122250] or mixed with *Sciuro-hypnum curtum*, *Eurhynchiastrum pulchellum*, *Pleurozium schreberi*, *Abietinella abietina*, *Hypnum cupressiforme* and *Lophocolea minor*.

*BARBILOPHOZIA HATCHERI* (A. Evans) Loeske – 15: rock outcrops on steep slopes, on cliff ledges on forest litter [YSU-MH-00418], in pure mats or mixed with *Lescurea saxicola* [YSU-MH-00417].

*BARBILOPHOZIA SUDETICA* (Nees ex Huebener) L. Söderstr., De Roo & Hedd. [*Lophozia sudetica* (Nees ex Huebener) Grolle, *Pseudolophozia su-*

*detica* (Nees ex Huebener) Konstant. & Vilnet] (gem.) – 16 (Sp.): in rocky dwarf shrub tundra, between rocks, on fine earth, mixed with *Diplophyllum taxifolium* and *Lophozia murmanica* [KPABG(H):122273]; in *Betula nana* dominated tundra on clay spots, single shoots among *Prasanthus suecicus*, *Gymnomitrium concinnatum*, *G. corallioides*, *Solenostoma sp.*, *Sphenolobus minutus*, *Isopaches bicrenatus* and *Scapania parvifolia* [YSU-MH-00504]; 17: on bank of stream under snowfield, on fine earth mixed with *Mesoptychia heterocolpos*, *Anthelia juratzkana*, *Blepharostoma trichophyllum*, *Schljakovianthus quadrilobus* and *Fuscocephaloziopsis pleniceps* [YSU-MH-00535].

BLASIA PUSILLA L. (gem.) – 20: on river-bank on silty sandy soil [KPABG(H):122292].

BLEPHAROSTOMA TRICHOPHYLLUM (L.) Dumort. – 3, 11, 14, 15, 17 (Fr.): on soil in moist river valley forests, on rock outcrops covered by fine earth, between rocks in mountain forests and dwarf shrub tundras, on banks of streams under snowfield in pure mats [KPABG(H):122263] or mixed with other bryophytes.

CALYPOGEIA NEESIANA (C. Massal. et Carestia) Müll. Frib. (spor.) – 6, 13, 14 (Sp.): on decaying wood, in boggy shrub-peat-moss (*Sphagnum fuscum*, *S. girgensohnii*) open spruce and *Pinus sibirica*-spruce woodlands, [YSU-MH-00096], on peat in hollows between roots in moist *Calamagrostis*-herb-birch forests [KPABG(H):122264], in pure mats or mixed with other bryophytes.

CALYPOGEIA SPHAGNICOLA (Arnell et J.Perss.) Warnst. et Loeske – 6: *Betula nana*-*Rubus chamaemorus*-*Sphagnum fuscum* spruce open woodland, on peat [KPABG(H):122247] and in *Sphagnum* turfs, always as single shoots with *Cephalozia leucantha*, *Mylia anomala* etc. [YSU-MH-00103]; 13: boggy shrub-*Sphagnum girgensohnii*-*Pinus sibirica*-spruce open woodland, on decayed wood, single shoots in *Lophozia silvicola* mats [YSU-MH-00365].

CEPHALOZIA AMBIGUA C. Massal. – 6: spruce *Betula nana*-*Rubus chamaemorus*-*Sphagnum fuscum* open woodland, on peat, mixed with *Cephalozia leucantha*, *Protolophozia elongata*, *Calypogeia sphagnicola*, *C. neesiana*, *Sphenolobus minutus* [KPABG(H):122247].

CEPHALOZIA BICUSPIDATA (L.) Dumort. (per.) – 3, 13, 16, 17 (Sp.): on soil and decaying wood in birch-spruce shrub-herb floodplain forests

[YSU-MH-00198], in boggy peat-moss woodlands, on stream banks under snowfields [KPABG(H):122287], on clay spots in dwarf birch tundra, usually mixed with other bryophytes, more often with *Anthelia juratzkana*, *Blepharostoma trichophyllum*, *Trilophozia quinqueidentata*.

CEPHALOZIELLA cf. HAMPEANA (Nees) Schiffn. – 1: birch-willow sedge-*Sphagnum* bog [YSU-MH-00231], single shoots among *Scapania paludicola* and *Ptychostomum pseudotriquetrum*.

CEPHALOZIELLA SPINIGERA (Lindb.) Warnst. – 21: on edge of cotton grass-peat-moss (*Sphagnum balticum*) hollow at base of flat palsa [KPABG(H):122293], single shoots mixed with *Mylia anomala*.

DIPLOPHYLLUM TAXIFOLIUM (Wahlenb.) Dumort. – 15, 16, 17 (Sp.): on cliffs in forest zone, between rocks, in rocky dwarf shrub tundra in pure mats [YSU-MH-00501] or mixed with *Barbilophozia sudetica*, *Lophozia murmanica*, *Gymnomitrium concinnatum*, *Gymnocolea inflata* and *Tetralophozia setiformis* [KPABG(H):122273].

\*\*\* FRULLANIA AUSTINII J. J. Atwood, Vilnet, Mamontov et Konstant. – 15: rock outcrops on mountainside in young birch forest, single shoots in turf of *Grimmia longirostris* [KPABG(H):122267] and among *Zygodon sibiricus* [YSU-MH-00433]; 16: large boulder in dwarf birch tundra, on rock in turf of *Orthotrichum* sp. [KPABG(H):122274]. This is a recently described species (Mamontov et al., 2020) previously referred to *F. bolanderi*.

FUSCOCEPHALOZIOPSIS ALBESCENS (Hook.) Váňa et L. Söderstr. [*Pleurocladula albescens* (Hook.) Grolle] – 17: bank of stream under snowfield, on fine earth, mixed with *Lophozia murmanica*, *Diplophyllum taxifolium*, *Pohlia drummondii*. [KPABG(H):122283]

FUSCOCEPHALOZIOPSIS CONNIVENS (Dicks.) Váňa et L. Söderstr. [*Cephalozia connivens* (Dicks.) Lindb.] – 6: boggy *Betula nana*-*Rubus chamaemorus*-*Sphagnum fuscum* open spruce woodland at the base of carbonate outcrops [YSU-MH-00103], mixed with *Mylia anomala*.

FUSCOCEPHALOZIOPSIS LEUCANTHA (Spruce) Váňa et L. Söderstr. [*Cephalozia leucantha* Spruce] – 6: boggy *Betula nana*-*Rubus chamaemorus*-*Sphagnum fuscum* open spruce woodland at the base of carbonate outcrops, on peat, mixed with *Protolophozia elongata*, *Cephalozia ambigua*, *Calypogeia* spp. and *Sphenolobus minutus*

[KPABG(H):122247]. It is the second record for Khanty-Mansi Autonomous Area, until now the species was only found in the Nature Park "Numto" (Lapshina et al., 2018).

FUSCOCEPHALOZIOPSIS LUNULIFOLIA (Dumort.) Váňa et L. Söderstr. [*Cephalozia lunulifolia* (Dumort.) Dumort.] (per, spor.) – 3, 6, 14 (Sp.): in birch and moist mixed forests, boggy *Betula nana*-*Rubus chamaemorus*-*Sphagnum fuscum* open spruce woodland, on decayed wood in pure mats [KPABG(H):122262] or mixed with *Lophocolea heterophylla*, *Lophozia guttulata*, *L. ascendens*, *Lophozia longidens*, *Tritomaria exsectiformis*, *Riccardia latifrons* and *Scapania curta*.

FUSCOCEPHALOZIOPSIS PLENICEPS (Austin) Váňa et L. Söderstr. [*Cephalozia pleniceps* (Austin) Lindb.] (per., ant.) – 3, 6, 13, 14, 17 (Sp.): on soil in floodplain forests and boggy dwarf birch-peat-moss *Pinus sibirica*-spruce woodlands in mats with *Schistochilopsis grandiretis*, *Rhizomnium pseudopunctatum* [KPABG(H):122261], on banks of streams in the mountain-tundra, with *Barbilophozia sudetica*, *Blepharostoma trichophyllum*, *Mesoptychia heterocolpos*, *M. collaris*, *Anthelia juratzkana* and *Schljakovianthus quadrilobus*.

GYMNOCOLEA INFLATA (Huds.) Dumort. – 16: dwarf shrub (*Betula nana*, *Vaccinium uliginosum*, *Empetrum hermaphroditum*) tundra, on fine earth mixed with *Diplophyllum taxifolium*, *Lophozia murmanica* and *Gymnomitrium concinatum* [YSU-MH-00493].

GYMNOMITRION CONCINNATUM (Lightf.) Corda – 16: rocky dwarf shrub tundra, between stones on fine earth, in pure mats [KPABG(H):122272] and mixed with *Lophozia wenzelii*, *L. murmanica*, *Diplophyllum taxifolium* and *Sphenobolus minutus*; and dwarf birch tundra on clay spots, mixed with *Gymnomitrium corallioides*, etc. (see below). [YSU-MH-00504].

GYMNOMITRION CORALLIOIDES Nees – 16: dwarf birch tundra, on clay spots, some shoots mixed with *Gymnomitrium concinatum*, *Prasanthus suecicus*, *Solenostoma* sp., *Sphenobolus minutus*, *Barbilophozia sudetica*, *Isopaches bicrenatus* and *Scapania parvifolia* [YSU-MH-00504].

HETEROGEMMA LAXA (Lindb.) Konstant. et Vilnet – 6, 14, 21 (Sp.): sides of *Sphagnum* hummocks, often on dried *Sphagnum* in boggy *Betula nana*-*Sphagnum fuscum* open *Pinus sibirica*-*Picea*

*obovata* woodlands, on side of hummock in aapa mire, sedge-*Menyanthes* hollow. Always scattered in mats or turfs of bryophytes, more often among *Sphagnum fuscum*, *Tomentypnum nitens* and *Rhizomnium pseudopunctatum* [YSU-MH-00048];

ISOPACHES BICRENATUS (Schmidel ex Hoffm.) H. Buch – 16: dwarf birch tundra on bare clay spots, single shoots among *Gymnomitrium corallioides*, *G. concinatum*, *Prasanthus suecicus*, *Solenostoma* sp., *Sphenobolus minutus*, *Barbilophozia sudetica* and *Scapania parvifolia* [YSU-MH-00504].

JUNGERMANNIA PUMILA With. (per., ant., spor) – 17 in pure mat on rocks in stream bed under snowfield [KPABG(H):122277] and on fine earth on stream bank mixed with *Marchantia quadrata*, *Solenostoma confertissimum*, *Trilophozia quinqueidentata*, *Mesoptychia heterocolpos*, *Philonotis tomentella* and *Bartramia ithyphylla*.

LEPIDOZIA REPTANS (L.) Dumort. – 1: larch-birch-spruce shrub-green moss old-growth forest in river valley, on decayed wood in pure mats [KPABG(H):122251]; 23: aapa mire, dwarf shrub-*Sphagnum divinum* ridge with stunted *Pinus silvestris*, at the base of pine trunk, mixed with *Pohlia nutans* and *Schljakovia kunzeana* [YSU-MH-00798].

LOPHOCOLEA HETEROPHYLLA (Schrad.) Dumort. (per.) – 3, 14 (Sp.): birch and birch-spruce with herb- shrub layer floodplain forests, on decayed wood, in pure mats and mixed with *Fuscocephaloziopsis lunulifolia*, *Lophozia ascendens*, *L. guttulata* and *Lophocolea minor* [KPABG(H):122243].

LOPHOCOLEA MINOR Nees (gem.) – 1, 3, 7 (Sp.): on soil in birch-spruce and mixed (*Picea obovata*, *Betula pubescens*, *Pinus sibirica*, *Larix sibirica*) shrub-herb-green moss forests in river valley, on dry peat ledge along lake shore [KPABG(H):122294].

LOPHOZIA ASCENDENS (Warnst.) R. M. Schust. (gem.) – 1: birch-spruce river valley forest, on decaying wood numerous in mats with dominance of *Lophozia guttulata*; [KPABG(H):122244]; 3: birch-spruce river valley forest, on decayed wood in mats with dominance of *Lophocolea heterophylla* [KPABG(H):122294].

LOPHOZIA GUTTULATA (Lindb. et Arnell) A. Evans (gem., ant., per.) – 1: birch-spruce river valley

forest, on decayed wood, mixed with *Lophozio-opsis longidens*, *Tritomaria exsectiformis*, *Scapania curta*, *Lophozia ascendens*, *Fuscocephaloziopsis lunulifolia*, *Lophocolea heterophylla* and *Cephalozia bicuspidata* [KPABG(H):122244]; 3: birch-spruce river valley forest, on decayed wood, mixed with *Lophozia ascendens*, *Lophocolea heterophylla* and *L. minor* [KPABG(H):122294].

LOPHOZIA LONGIFLORA (Nees) Schiffn. [*Lophozia ventricosa* var. *longiflora* (Nees) Macoun] – 6: boggy *Betula nana*-*Rubus chamaemorus*-*Sphagnum fuscum* open spruce woodland at the base of mountain slope, mixed with *Cephalozia leucantha*, *Calypogeia sphagnicola*, *Calypogeia neesiana* and *Sphenolobus minutus* [YSU-MH-00096]; 16: dwarf birch tundra, on clay spots, mixed with *Anthelia juratzkana* and *Cephalozia bicuspidata* [YSU-MH-00607].

LOPHOZIA SILVICOLA H.Buch (gem., ant., per.) – 1, 3, 13, 14, 18, 19 (Fr.): on soil, litter and decayed wood in river valley coniferous forests [KPABG(H):122269], in secondary mountain birch-green moss forests, in boggy peat-moss spruce open woodlands in pure mats [YSU-MH-00207] but more often mixed with other bryophytes of such habitats: *Lophozioopsis longidens*, *Fuscocephaloziopsis lunulifolia*, *Tritomaria exsectiformis*, etc.

LOPHOZIA WENZELII (Nees) Steph. var. *wenzelii* (gem.) – 16: rocky dwarf shrub (*Betula nana*, *Vaccinium uliginosum*, *V. vitis-idaea*, *Empetrum hermaphroditum*, *Diapensia lapponica*) tundra between rocks, mixed with *Gymnomitrium concinnatum* and *Sphenolobus minutus* [YSU-MH-00492].

LOPHOZIA MURMANICA Kaal. [*Lophozia wenzelii* var. *groenlandica* (Nees) Bakalin] (gem.) – 1, 9, 16, 17 (Sp.): in dwarf shrub and rocky dwarf-shrub tundra, between rock, in pure mats or mixed with *Trilophozia quinqueidentata*, *Barbilophozia sudetica*, *Diplophyllum taxifolium* [KPABG(H):122285], on bank of stream under snowfield, on fine earth mixed with *Anthelia juratzkana*, *Fuscocephaloziopsis albescens* and *Diplophyllum taxifolium* [KPABG(H):122287] in open woodlands and on organic litter on ledges of carbonate rocks in forest belt.

LOPHOZIOPSIS EXCISA (Dicks.) Konstant. et Vilnet (per., gem.) – 16: dwarf shrub tundra, in *Dicranum fragilifolium* turf mixed with *Lophozia murmanica* [YSU-MH-00519]; 17: bank of stream

under snowfield, single shoots among mosses [YSU-MH-00540].

LOPHOZIOPSIS LONGIDENS (Lindb.) Konstant. et Vilnet (per., ant., gem.) – 1, 2, 13, 15, 17 (Sp.): in mixed birch-spruce forests in river valley and on slopes of mountains, at base of trunks and on decaying wood [KPABG(H): 122242], mixed with other liverworts characteristic for decaying wood (*Lophozia guttulata*, *L. ascendens* *Tritomaria exsectiformis*, etc.). It was once collected in dwarf-shrub-green moss tundra in turf dominated by *Dicranum fragilifolium*.

MARCHANTIA POLYMORPHA ssp. MONTIVAGANS Bischl. et Boissel.-Dub. – 12: floodplain forest, on bare soil; 22: dwarf willow-herb-green moss community on silty-gravel river bank [YSU-MH-00792].

MARCHANTIA QUADRATA Scop. [*Preissia quadrata* (Scop.) Nees] (per., spor.) – 17: on fine earth on bank of stream under snowfield, mixed with bryophytes [KPABG(H):122286].

MARSUPELLA SPRUCEI (Limpr.) Bernet (per., spor.) – 16 rocky dwarf shrub tundra on top of mountain, on clay spots, mixed with *Solenostoma confertissimum*, *S. sphaerocarpum*, *Anthelia juratzkana* and *Prasanthus suecicus* [YSU-MH-00503].

MESOPTYCHIA COLLARIS (Nees) L. Söderstr. et Váňa [*Leiocolea collaris* (Nees) Schljakov] – 7, 9, 15, 17 (Sp.): on fine earth between rocks on rock outcrops on mountain slopes in forest belt, [YSU-MH-00150], on peat on bank of lake, on banks of streams under snowfields in pure mats or mixed with other bryophytes, mostly calciphytes (*Scapania gymnostomophila*, *Tritomaria scitula*, *Marchantia quadrata*, etc.)

MESOPTYCHIA HETEROCOLPOS (Thed. ex Hartm.) L. Söderstr. et Váňa [*Leiocolea heterocolpos* (Thed. ex C. Hartm.) H. Buch] (gem., per.) – 5, 9, 17 (Sp.): on peat-moss hummocks and decayed stumps in moist *Picea obovata*-*Equisetum*-*Sphagnum* open woodlands [KPABG(H):122245], on mountain slope between carbonate rocks in coniferous dwarf shrub-green moss forest, on fine earth on bank of stream under snowfield [YSU-MH-00584], usually mixed with other bryophytes.

\*\* MESOPTYCHIA RUTHEANA (Limpr.) L. Söderstr. et Váňa [*Leiocolea rutheana* (Limpr.) Müll. Frib.] – 8: dwarf birch-sedge-moss rich fen at the base of carbonate rock [KPABG(H):122253], mixed with *Scorpidium revolvens*, *S. scorpioides*, *Meesia*

*triquetra* and *Campylium stellatum*. The species was previously recorded in the Northern Urals (Zheleznova & Shubina, 1998; Konstantinova & Bezgodov, 2005). This is the first record of the species for Subpolar Urals.

\*\* METZGERIA FURCATA (L.) Corda – 17: rock outcrops in dwarf birch tundra, in shaded niches between rocks, mixed with *Isopterygiopsis pulchella*, *Cynodontium strumiferum*, *Trilophozia quinquedentata*, *Tritomaria scitula* and *Distichium capillaceum* [KPABG(H):122291]. This is the northernmost locality in the Urals and the first record of the species in the Asian part of the Urals

MYLIA ANOMALA (Hook.) Gray (gem.) – 4, 6, 14, 21 (Sp.): in boggy dwarf birch-peat-moss (*Sphagnum fuscum*) open spruce woodlands, in flat palsa mires usually mixed with *Sphagnum* [KPABG(H):122293].

NARDIA GEOSCYPHUS (De Not.) Lindb. – 17: bank of stream under snowfield, on fine earth, mixed with *Plectocolea subelliptica* [YSU-MH-00539].

ODONTOSCHISMA ELONGATUM (Lindb.) A. Evans – 3: palsa mire complex, waterlogged hollow in thermokarst depression [YSU-MH-00795, YSU-MH-00796], in mossy *Equisetum-Carex rostrata* community, single shoots among *Sphagnum centrale* and *Scorpidium revolvens*.

ODONTOSCHISMA FLUITANS (Nees) L.Söderstr. & Våna [*Cladopodiella fluitans* (Nees) Jørg.] – 24: aapa mire, in *Menyanthes trifoliata*-sedge-moss hollows, some shoots mixed with *Sphagnum centrale* and *S. platyphyllum* [YSU-MH-00639], in waterlogged hollow with *Trichophorum cespitosum* and *Drosera anglica*, and on peat with *Sphagnum subsecundum*, *Scapania paludicola* and *Straminergon stramineum*.

PELLIA NEESIANA (Gottsche) Limpr. (ant., per.) – 12: floodplain forest, on soil; 22: dwarf willow-herb-green moss community on silty-gravel on bank of river, mixed with *Ptychostomum pallens*, *Calliergon cordifolium* and *Calliergonella lindbergii* [KPABG(H):122236].

PLECTOCOLEA HYALINA (Lydell) Mitt. [*Solenostoma hyalinum* (Lydell) Mitt.] – 18: gravelly flooded river bank, in pure mats [KPABG(H):122240]; 22: dwarf willow-herb-green moss community on silty-gravel bank, mixed with *Scapania irigua*, *Calliergonella lindbergii* and *Pohlia filum* [KPABG(H):122238].

\* PORELLA PLATYPHYLLA (L.) Pfeiff. – 9, 10, 17 (Sp.): on shaded carbonate rocks in forest belt [KPABG(H):122256] or in niches on cliffs in dwarf birch tundra [YSU-MH-00138, 00591] usually in pure mats. The species is recorded for the first time for the Asian part of Subpolar Urals.

PRASANTHUS SUECICUS (Gottsche) Lindb. – 16: dwarf shrub tundra, on clay spots, two specimens with single shoots in mats with other arctic-montane liverworts: *Marsupella sprucei*, *Anthelia juratzkana*, *Gymnomitrium* spp., etc. [YSU-MH-00503, 504].

PROTOLOPHOZIA ELONGATA (Steph.) Schljakov – (per.) 6: boggy *Betula nana-Rubus chamaemorus-Sphagnum fuscum* open spruce woodland at the base of slope, on peat, in mixed with *Fuscocephaloziopsis leucantha*, *Cephalozia ambigua*, *Calypogeia sphagnicola*, *C. neesiana*, *Sphenobolus minutus* [KPABG(H):122247] and in almost pure mat with some shoots of *Cephalozia ambigua* [YSU-MH-00097]. Red-listed in Russia (as *Lophozia elongata* Steph., Bardunov, 1998). This species was known previously in Urals from two findings in Vishera State Nature Reserve (Konstantinova & Bezgodov, 2005) and one collection in the Upper Puiva River area (Konstantinova & Lapshina, 2017).

PYLIDIDIUM CILARE (L.) Hampe – 3, 11, 14, 17, 19 (Sp.): in birch and birch-spruce mountain and river valley forests, on rock outcrops, and on litter and soil in forest floor; in swampy willow thickets [KPABG(H):122266], in low shrub (*Salix* spp., *Betula nana*)-sedge (*Carex arctisibirica*)-peat moss mire in tundra belt.

PYLIDIDIUM PULCHERRIMUM (Weber) Vain. (per., spor.) – 1, 2, 3, 13 (Sp.): in birch-spruce and mixed (*Pinus sibirica*, *Picea obovata*, *Betula pubescens*) dwarf shrub-herb river valley forests at base of trees and on decayed wood, in pure mats and mixed with *Sanionia uncinata*, *Lophozia longidens*, *Lophocolea heterophylla* and *Dicranum fragilifolium* [KPABG(H):122241]

RADULA COMPLANATA (L.) Dumort. (per., spor.) – 11: huge boulder on gentle mountain slope, on rock [YSU-MH-00337], mixed with *Neckera oligocarpa*; 15: rock outcrops on mountainside in young birch forest, on shaded rocks, in pure mats or with mixed with *Neckera oligocarpa*, *Pseudoleskeella rupestris*, *Zygodon sibiricus*, *Chionoloma tenuirostre* and *Frullania austini* [YSU-MH-00454].

RICCARDIA cf. CHAMEDRYFOLIA (With.) Grolle – 21 central part of aapa mire, *Menyanthes*-sedge waterlogged hollow, single shoots on peat with *Sarmentypnum exannulatum* [YSU-MH-00647].

RICCARDIA LATIFRONS (Lindb.) Lindb. – 3: birch-spruce river valley forest, on decayed wood, mixed with *Lophoziopsis longidens* and *Fuscocephaloziopsis lunulifolia* [YSU-MH-00084].

SACCOBASIS POLITA (Nees) H. Buch – 17: on bank of stream under snowfield on fine earth mixed with *Lescuraea saxicola* and *Bartramia ithyphylla* [KPABG(H):122280].

SCAPANIA CURTA (Mart.) Dumort. (per.) – 3: birch-spruce river valley forest, on decayed wood, single shoots with *Lophozia guttulata*, *Lophoziopsis longidens*, *Tritomaria exsectiformis*, *Lophozia ascendens* and *Fuscocephaloziopsis lunulifolia* [KPABG(H):122244].

SCAPANIA CUSPIDULIGERA (Nees) Müll.Frib. (gem.) – 15: rock outcrops on steep mountain slope in young birch forest, on organic litter covered rocks, single shoots among *Blepharostoma trichophyllum* and *Pohlia cruda* [YSU-MH-00420].

SCAPANIA GYMNSTOMOPHILA Kaal. (gem.) – 9, 10, 11 (Sp.): carbonate rocks in forest belt, in shaded niches between rocks, often in pure mats [KPABG(H):122248, KPABG(H):122254] or mixed with other calciphiles.

SCAPANIA IRRIGUA (Nees) Nees (gem.) – 1, 17, 21, 22 (Sp.): birch-willow-sedge-peat-moss mires, [YSU-MH-00228], in sedge (*Carex lasiocarpa*)-peat-moss ridge in aapa mire, on silty-gravel soil in willow-grass-green moss community on river banks [KPABG(H):122237], on slope along stream bank under snowfield.

SCAPANIA MUCRONATA H. Buch – 1, 3, 11(Sp.): on decayed wood in birch-spruce river valley forest [YSU-MH-00089], in mixed *Pinus sibirica*-birch-spruce river valley forest, [YSU-MH-00068], on fine earth covered ledge on boulder on gentle slope. Usually mixed with other bryophytes (*Sanionia uncinata*, *Lophoziopsis longidens*, *Pohlia nutans*, *Fuscocephaloziopsis lunulifolia* etc.).

SCAPANIA OBCORDATA (Berggr.) S. W. Arnell – 18: gravelly flooded river bank [KPABG(H):122239].

SCAPANIA PALUDICOLA Loeske et Müll.Frib. – 1, 17, 21, 24 (Sp.): in hollows and on hummocks in transitional fens, aapa mires, on stream banks under snowfield, in pure mats

[KPABG(H):122297] or mixed with *Ptychostomum pseudotriquetrum*, *Polytrichum jensenii*, *Sanionia uncinata* and *Schljakovia kunzeana* [KPABG(H):122252].

SCAPANIA PARVIFOLIA Warnst. – 16: dwarf birch tundra, on clay spots, single shoots mixed with *Prasanthus suecicus*, *Gymnomitrium corallioides*, *G. concinnatum*, *Solenostoma* sp., *Sphenolobus minutus*, *Barbilophozia sudetica* and *Isopaches bicrenatus* [YSU-MH-00504].

\*\* (\*) SCAPANIA SPHAERIFERA H. Buch et Tuom. – 11: large boulder on gentle mountain slope, on ledge of rock, on fine earth [KPABG(H):122121]. The species is extremely rare in Europe where it is recorded in the type locality in Murmansk Province and recently in Ural in Vishera State Nature Reserve (Konstantinova et al. 2019). However the species is not rare in Siberia including the mountains of South Siberia (l. c.) so its finding in the Asian part of the Urals is more or less predictable.

SCAPANIA SUBALPINA (Nees ex Lindenb.) Dumort. – 1: bank of small stream, on silted fine earth [YSU-MH-00243]; 17: bank of stream under snowfield, on fine earth [KPABG(H):122281].

SCAPANIA ULIGINOSA (Sw. ex Lindenb.) Dumort. – 21: central part of aapa mire complex, *Carex lasiocarpa*-peat-moss hummock in small hollow [KPABG(H):122296].

SCAPANIA UNDULATA (L.) Dumort. – 2: river bank, on flooded rocks, pure mats [YSU-MH-00646].

\*\*\* SCHISTOCHILOPSIS GRANDIRETIS (Lindb. ex Kaal.) Konstant. – 14: *Betula nana*-*Rubus chamaemorus*-peat-moss open spruce woodland, mixed with *Fuscocephaloziopsis pleniceps* and *Rhizomnium pseudopunctatum* [KPABG(H):122261]; 15: rock outcrops on slope in young birch forest, on fine earth between rocks, single shoots mixed with *Blepharostoma trichophyllum*, *Mesoptychia collaris* and *Pohlia cruda* [YSU-MH-00419]; 17: on bank of stream under snowfield, single shoots among *Blepharostoma trichophyllum* *Plectocolea* cf. *subelliptica*, *Trilophozia quinquedentata* f. *gracilis* and *Fuscocephaloziopsis pleniceps* [YSU-MH-00587]. This arctomontane species is widespread in the north of the Holarctic but usually occurs in small populations and is probably overlooked.

SCHLJAKOVIA KUNZEANA (Huebener) Konstant. et Vilnet (gem., per., spor.) – 1, 11, 14, 17, 23 (Fr.):



in boggy dwarf birch-*Rubus chamaemorus*-peat moss open spruce woodlands, in swampy forests and willow thickets, on hummocks in transitional fens, in dwarf shrub-sedge-*Sphagnum warnstorffii* dominated bogs, sporadic in moist niches on carbonate rock outcrops, in pure mats [KPABG(H):122265 or mixed with other bryophytes.

SCHLJAKOVIANTHUS QUADRILOBUS (Lindb.) Konstant. et Vilnet – 17: low dwarf shrub (*Salix*, *Betula nana*-*Carex arctisibirica*-peat-moss) mire in *Sphagnum warnstorffii* turf [KPABG(H):122275] and on bank of stream under snowfield, on fine earth, mixed with *Scapania subalpina* and *S. paludicola* [KPABG(H):122288].

SOLENOSTOMA CONFERTISSIMUM (Nees) Schljakov (per., spor.) – 16: dwarf shrub tundra on top of mountain, on bare spots, mixed with *Marsupella sprucei*, *Anthelia juratzkana*, *Prasanthus suecicus* and *Solenostoma sphaerocarpum* [YSU-MH-00503]; 17: stream bank under snowfield [KPABG(H):122282].

SOLENOSTOMA SPHAEROCARPUM (Hook.) Steph. – 16: dwarf birch tundra, on clay spots, mixed with *Solenostoma confertissimum* [YSU-MH-00608]; and single shoots mixed with *Solenostoma confertissimum*, *Marsupella sprucei*, *Anthelia juratzkana* and *Prasanthus suecicus* [YSU-MH-00503]. Very small plants that fits well in description *Solenostoma pusillum* (C. E. O. Jensen) Steph. or *Solenostoma sphaerocarpum* var. *nanum* (Nees ex Flot.) R. M. Schust., both were recently synonymized with *S. sphaerocarpum* (Hodgetts et al., 2020).

SOLENOSTOMA SUBELLIPTICUM (Lindb. ex Heeg) R.M.Schust. [*Plectocolea subelliptica* (Lindb. ex Heeg) A. Evans] – 17: stream bank under snowfield, on fine earth, mixed with *Nardia geoscyphus* [YSU-MH-00539].

SPHENOLOBUS MINUTUS (Schreb.) Berggr. – 6, 9, 11, 16, 19 (Sp.): dwarf shrubs, dwarf birch rocky tundra, on clay spots and between rocks; in boggy dwarf shrub-peat moss open spruce woodlands; on carbonate rock outcrops in forests. Usually mixed with other bryophytes [KPABG(H):122247].

SPHENOLOBUS SAXICOLA (Schrud.) Steph. – 11: huge boulder on gentle mountain slope, on ledge of rock, in pure mats [KPABG(H):122257] and mixed with *Tetralophozia setiformis* [KPABG(H):122258].

TETRALOPHOZIA SETIFORMIS (Ehrh.) Schljakov – 11: Huge rock block on gentle mountain slope, on ledge of rock with *Sphenolobus saxicola* [KPABG(H):122258]; 16: rocky dwarf shrub tundra, on rocks [KPABG(H):122270].

TRILOPHOZIA QUINQUEDENTATA (Huds.) Bakalin [*Tritomaria quinquedentata* (Huds.) H.Buch] – 6, 9, 11, 17 (Fr.): in moist dwarf shrubs gravelly tundras, on litter on cliff ledges both in forests and mountain-tundra, in *Betula nana*-*Carex arctisibirica*-peat-moss mires, in boggy *Betula nana*-peat-moss open spruce forests, in pure mats or mixed with other bryophytes [KPABG(H):122271]. Once on bank of stream under snowfield the arctic form *Trilophozia quinquedentata* f. *gracilis* was collected mixed with *Anthelia juratzkana*, *Cephalozia bicuspidata* and *Fuscocephaloziopsis pleniceps* [YSU-MH-00586].

TRITOMARIA EXSECTIFORMIS (Breidl.) Loeske (gem., ant.) – 3, 19: on decayed wood in birch-spruce and *Pinus sibirica*-birch-spruce river valley forests, usually mixed with other species of decaying wood (*Lophozia ascendens*, *L. guttulata*, *Lophozia longidens*, etc. [YSU-MH-00074; YSU-MH-00068]; 19: birch-larch-*Pinus sibirica* dwarf shrub-peat moss community in high palsa complex, on decayed wood mixed with *Lophozia silvicola* and *Sphenolobus minutus* [YSU-MH-00207].

TRITOMARIA SCITULA (Taylor) Jørg. – 9: on organic litter on ledges of carbonate rocks, mixed with *Trilophozia quinquedentata* and *Barbilophozia barbata* [YSU-MH-00141] and on slope between carbonate rocks in *Pinus sibirica*-larch-spruce shrub-green-moss forest mixed with *Mesoptychia heterocolpos*, *Scapania gymnostomophila* and *Arnellia fennica* [KPABG(H):122249]; 17: rock outcrops in dwarf birch tundra, in shaded niches between rocks, single shoots among *Metzgeria furcata*, *Isopterygiopsis pulchella*, *Distichium capillaceum* and *Trilophozia quinquedentata* [YSU-MH-00606].

## DISCUSSION

The liverwort flora of the Khulga River basin counts 84 species including seven (*Arnellia fennica*, *Frullania austinii*, *Mesoptychia rutheana*, *Metzgeria furcata*, *Porella platyphylla*, *Scapania sphaerifera* and *Schistochilopsis grandiretis*) new for the Khanty-Mansi Autonomous Area. Of these, *Scapania sphaerifera* was not previ-

ously known for the Urals and was only recently discovered almost simultaneously on both the European and Asian parts of these mountains (Konstantinova et al., 2019). Locations in the Urals are almost 1,500 kilometers away from the only known location of the species in Europe and 1,800 kilometers and more from the Asian locations of the species. (l.c.) *Frullania austinii* is a recently described species which is not rare in Eurasia but found generally in more southern areas (Mamontov et al., 2020). The record from the Khulga River Basin is one of the northernmost known at present. The rest of the liverworts firstly recorded for the Autonomous Area are mainly mountain species more or less widespread in the North of Holarctic. Since most of the studied region's territory is swampy lowlands, there are very few suitable habitats for these species here.

A total of 144 species incl. 2 subspecies and one variety have been recorded in three territories studied on the Asian slopes of the Urals within the Khanty-Mansi Autonomous Area. Of these 55 species or ca. 37% are represented in all three studied areas. All liverworts common for three studied areas are widespread in the north of Holarctic and they are mostly the most common species in the studied areas (Appendix). The diversity of liverworts in the Khulga River basin is slightly less than in the previously studied flora of Ner-Oika mountain (97 species) or the Upper Puiva River basin (104 species), located 120 km further south (Konstantinova & Lapshina, 2014, 2017). This is mainly due to the fact that the Khulga river flows through low mountains and plains: most collecting sites were located here at altitudes not exceeding 100 meters and only three were located at altitudes of ca. 500–600 m. The studied areas of the Ner-Oika Mt. (325–960 m alt.) and Puiva River basin (680–1030 m alt.) are located significantly higher. Of 17 liverworts specific to the Khulga River basin eleven are primarily or exclusively peat mires and swampy area species (*Aneura pinguis*, *Riccardia chamedryfolia*, *Fuscocephaloziaopsis conivens*, *F. leucantha*, *Odontoschisma fluitans*, *Cephalozia hampeana*, *Mesoptychia rutheana*, *Heterogemma laxa*, *Scapania uliginosa* and *Schistochilopsis grandiretis*). This is due to the much wider distribution and diversity of mires ecosystems in the Khulga River basin compared to other studied areas on the Eastern slopes

of the Urals. Three species (*Metzgeria furcata*, *Radula complanata* and *Porella platyphylla*) are not rare in the Eurasia mainly mountain species, but more common in southern areas. For these species there are rather few appropriate habitats at high altitudes explored in Ner-Oika Mt. and Puiva River basin. *Lophozia guttulata* is a not rare species of coniferous forests that were not quite carefully studied in mentioned above areas because collecting there was mostly done in the upper belts. *Arnellia fennica* is a rather rare and scattered occurring species everywhere and *Scapania sphaerifera* is a rare species just recently found in Urals.

Twenty species known from both high mountain areas (Ner-Oika Mt. and Upper Puiva River Basin) have not been found in the Khulga River basin. These are mostly not rare arctomontane species of rocky areas in subalpine and tundra zones (*Diplophyllum albicans*, *D. obtusifolium*, *Neoorthocaulis floerkei*, *N. binsteadii* and *Sacobasis polymorpha*) or mountain species characteristic of rocky banks and beds of mountain cricks (*Scapania paludosa* and *Plectocolea obovata*) or species of bare soil (*Cephalozia varians*, *Nardia japonica* and *Solenostoma caespiticium*).

Significant differences in the composition of the floras of the compared areas can be explained by differences not only in geology and geomorphology described above but as well by relatively the small size of territories and representation by a small numbers of collections in each type of habitat.

Among the species of phytogeographic interest in addition to *Scapania sphaerifera* discussed above should be noted *Protolophozia elongata*. It is a rather rare worldwide species red-listed in Russia (Bardunov, 2008). In the Urals the species is recorded in the western slope of the Northern Urals in the Visher State Nature reserve (Konstantinova, Bezgodov, 2005; Ignatova et al., 2019) and in one locality in Asian slopes of Urals (Konstantinova, Lapshina, 2017).

In general the liverwort flora of the Khulga river Basin is not very diverse and original. But the data obtained significantly expand our understanding of both the flora of the Subpolar Urals and the distribution and ecology of species in the Urals.

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**Appendix.** List of liverworts of the Asian part of the Subpolar Urals

Taxon	Number of collected specimens in studied areas		
	Surroundings of the Ner-Oika Mt.	Upper Puiva River Basin	Khulga River Basin
<i>Aneura pinguis</i> (L.) Dumort.	.	.	2
<i>Anthelia juratzkana</i> (Limpr.) Trevis.	16	12	2
<i>Arnellia fennica</i> (Gottsche) Lindb.	.	.	2
<i>Asterella lindenbergiana</i> (Corda ex Nees) Lindb. ex Arnell	.	9	.
<i>Barbilophozia barbata</i> (Schmidel ex Schreb.) Loeske	2	5	5
<i>Barbilophozia hatcheri</i> (A.Evans) Loeske	9	24	1
<i>Barbilophozia lycopodioides</i> (Wallr.) Loeske	9	17	.
<i>Barbilophozia sudetica</i> (Nees ex Huebener) L.Söderstr., De Roo & Hedd. [ <i>Pseudolophozia sudetica</i> (Nees ex Huebener) Konstant. & Vilnet]	33	14	2
<i>Biantheridion undulifolium</i> (Nees) Konstant. & Vilnet	2	1	.
<i>Blasia pusilla</i> L.	7	3	1
<i>Blepharostoma trichophyllum</i> (L.) Dumort. subsp. <i>brevirete</i> (Bryhn & Kaal.) R.M.Schust.	.	13	.
<i>Blepharostoma trichophyllum</i> (L.) Dumort. var. <i>trichophyllum</i>	10	6	5
<i>Calycularia laxa</i> Lindb. & Arnell	.	3	.
<i>Calypogeia integristipula</i> Steph.	2	.	.
<i>Calypogeia muelleriana</i> (Schiffn.) Müll.Frib.	2	.	.
<i>Calypogeia neesiana</i> (C.Massal. & Carestia) Müll.Frib.	.	4	2
<i>Calypogeia sphagnicola</i> (Arnell & J.Perss.) Warnst. & Loeske	2	3	2
<i>Cephalozia ambigua</i> C.Massal.	7	3	1
<i>Cephalozia bicuspidata</i> (L.) Dumort.	38	14	2
<i>Cephaloziella arctogena</i> (R.M.Schust.) Konstant.	7	5	.
<i>Cephaloziella divaricata</i> (Sm.) Schiffn.	3	4	.
<i>Cephaloziella grimsulana</i> (J.B.Jack ex Gottsche & Rabenh.) Lacout.	3	.	.
<i>Cephaloziella hampeana</i> (Nees) Schiffn. ex Loeske	.	.	1
<i>Cephaloziella rubella</i> (Nees) Warnst.	.	1	.
<i>Cephaloziella spinigera</i> (Lindb.) Jorg.	2	3	1
<i>Cephaloziella varians</i> (Gottsche) Steph.	4	1	.
<i>Chiloscyphus pallescens</i> (Ehrh.) Dumort.	3	.	.
<i>Chiloscyphus polyanthos</i> (L.) Corda	2	3	.
<i>Clevea hyalina</i> (Sommerf.) Lindb. [ <i>Athalamia hyalina</i> (Sommerf.) S.Hatt.]	.	3	.
<i>Conocephalum conicum</i> (L.) Dumort.	2	1	.
<i>Diplophyllum albicans</i> (L.) Dumort.	2	9	.
<i>Diplophyllum obtusifolium</i> (Hook.) Dumort.	2	6	.
<i>Diplophyllum taxifolium</i> (Wahlenb.) Dumort.	17	6	3
<i>Endogemma caespiticia</i> (Lindenb.) Konstant., Vilnet & A.V.Troitsky	2	1	.
<i>Frullania austinii</i> J. J. Atwood, Vilnet, Mamontov et Konstant.	.	.	2
<i>Fuscocephaloziopsis</i> (Hook.) Vána & L.Söderstr.	10	7	1
<i>Fuscocephaloziopsis connivens</i> (Dicks.) Vána & L.Söderstr.	.	.	1
<i>Fuscocephaloziopsis leucantha</i> (Spruce) Vána & L.Söderstr.	.	.	1
<i>Fuscocephaloziopsis lunulifolia</i> (Dumort.) Vána & L.Söderstr.	13	8	3
<i>Fuscocephaloziopsis lunulifolia</i> (Dumort.) Vána & L.Söderstr.	7	4	3
<i>Gymnocola inflata</i> (Huds.) Dumort.	9	4	1
<i>Gymnomitrium brevissimum</i> (Dumort.) Warnst.	6	.	.
<i>Gymnomitrium concinatum</i> (Lightf.) Corda	6	9	2
<i>Gymnomitrium corallooides</i> Nees	.	4	1
<i>Harpanthus flotovianus</i> (Nees) Nees	10	4	.
<i>Heterogemma laxa</i> (Lindb.) Konstant. & Vilnet	.	.	2
<i>Hygrobiella laxifolia</i> (Hook.) Spruce	5	.	.

<i>Isopaches bicrenatus</i> (Schmidel ex Hoffm.) H.Buch	7	4	1
<i>Jungermannia atrovirens</i> Dumort.	.	6	.
<i>Jungermannia borealis</i> Damsh. & Váňa	4	.	.
<i>Jungermannia eucordifolia</i> Schljakov [ <i>Jungermannia exsertifolia</i> subsp. <i>cordifolia</i> (Dumort.) Váňa]	.	1	.
<i>Jungermannia polaris</i> Lindb.	.	1	.
<i>Jungermannia pumila</i> With.	2	3	1
<i>Lepidozia reptans</i> (L.) Dumort.	.	3	1
<i>Lophocolea heterophylla</i> (Schrad.) Dumort.	2	3	2
<i>Lophocolea minor</i> Nees	2	6	3
<i>Lophozia ascendens</i> (Warnst.) R.M.Schust.	.	1	1
<i>Lophozia guttulata</i> (Lindb. & Arnell) A.Evans	.	.	1
<i>Lophozia longiflora</i> (Nees) Schiffn.	13	19	2
<i>Lophozia murmanica</i> Kaal.	21	12	3
<i>Lophozia silvicola</i> H.Buch	6	7	4
<i>Lophozia ventricosa</i> (Dicks.) Dumort.	3	5	.
<i>Lophozia wenzelii</i> (Nees) Steph.	13	13	1
<i>Lophozia wenzelii</i> (Nees) Steph. var. <i>massularioides</i> Bakalin	.	1	.
<i>Lophozioopsis excisa</i> (Dicks.) Konstant. & Vilnet	12	7	1
<i>Lophozioopsis jurensis</i> (Meyl. ex Müll.Frib.) Mamontov & Vilnet [ <i>Lophozia propagulifera</i> auct. eur.]	3	.	.
<i>Lophozioopsis longidens</i> (Lindb.) Konstant. & Vilnet	7	6	3
<i>Lophozioopsis pellucida</i> (R.M.Schust.) Konstant. & Vilnet	.	1	.
<i>Lophozioopsis polaris</i> (R.M.Schust.) Konstant. & Vilnet	2	.	.
<i>Marchantia polymorpha</i> L. ssp. <i>montivagans</i> Bischl. & Boissel.-Dub.	9	12	1
<i>Marchantia quadrata</i> Scop. [ <i>Preissia quadrata</i> (Scop.) Nees]	2	7	1
<i>Marsupella apiculata</i> Schiffn.	6	.	.
<i>Marsupella boeckii</i> (Austin) Lindb. ex Kaal.	6	.	.
<i>Marsupella condensata</i> (Ångstr. ex C.Hartm.) Lindb. ex Kaal.	.	1	.
<i>Marsupella emarginata</i> (Ehrh.) Dumort.	4	.	.
<i>Marsupella sprucei</i> (Limpr.) Bernet	9	5	1
<i>Mesoptychia gillmanii</i> (Austin) L.Söderstr. & Váňa	2	8	.
<i>Mesoptychia badensis</i> (Gottsche ex Rabenh.) L.Söderstr. & Váňa	.	1	.
<i>Mesoptychia bantriensis</i> (Hook.) L.Söderstr. & Váňa	.	.	1
<i>Mesoptychia collaris</i> (Nees) L.Söderstr. & Váňa	2	7	2
<i>Mesoptychia heterocolpos</i> (Thed. ex Hartm.) L.Söderstr. & Váňa	.	12	2
<i>Mesoptychia rutheana</i> (Limpr.) L.Söderstr. & Váňa	.	.	1
<i>Metzgeria furcata</i> (L.) Corda	.	.	1
<i>Mylia anomala</i> (Hook.) Gray	3	1	3
<i>Nardia breidlerii</i> (Limpr.) Lindb.	6	.	.
<i>Nardia geoscyphus</i> (De Not.) Lindb.	14	6	1
<i>Nardia japonica</i> Steph.	6	3	.
<i>Neoorthocaulis binsteadii</i> (Kaal.) L.Söderstr., De Roo & Hedd. [ <i>Orthocaulis binsteadii</i> (Kaal.) H.Buch]	2	3	.
<i>Neoorthocaulis floerkei</i> (F.Weber & D.Mohr) Loeske [ <i>Orthocaulis floerkei</i> (F.Weber & D.Mohr) H.Buch]	10	5	.
<i>Obtusifolium obtusum</i> (Lindb.) S.W.Arnell	.	1	.
<i>Odontoschisma elongatum</i> (Lindb.) A.Evans	3	1	1
<i>Odontoschisma fluitans</i> (Nees) L.Söderstr. & Váňa [ <i>Cladopodiella fluitans</i> (Nees) H.Buch]	.	.	2
<i>Odontoschisma macounii</i> (Austin) Underw.	.	1	.
<i>Odontobisma francisci</i> (Hook.) L.Söderstr. & Váňa [ <i>Cladopodiella francisci</i> (Hook.) Jørg.]	2	.	.
<i>Pellia neesiana</i> (Gottsche) Limpr.	19	11	2
<i>Plectocolea obovata</i> (Nees) Lindb. [ <i>Solenostoma obovatum</i> (Nees) C.Massal.]	9	3	.

<i>Porella platyphylla</i> (L.) Pfeiff.	.	.	2
<i>Prasanthus suecicus</i> (Gottsche) Lindb.	4	4	1
<i>Protolophozia elongata</i> (Steph.) Schljakov	.	1	1
<i>Psilidium ciliare</i> (L.) Hampe	19	15	3
<i>Psilidium pulcherrimum</i> (Weber) Vain.	4	4	3
<i>Radula complanata</i> (L.) Dumort.	.	.	1
<i>Riccardia chamedryfolia</i> (With.) Grolle	.	.	1
<i>Riccardia latifrons</i> (Lindb.) Lindb.	2	1	1
<i>Saccobasis polita</i> (Nees) H.Buch	3	3	1
<i>Saccobasis polymorpha</i> (R.M.Schust.) Schljakov	2	1	.
<i>Sauteria alpina</i> (Nees) Nees	.	3	.
<i>Scapania crassiretis</i> Bryhn	2	.	.
<i>Scapania curta</i> (Mart.) Dumort.	10	8	1
<i>Scapania cuspiduligera</i> (Nees) Müll.Frib.	.	5	1
<i>Scapania degenii</i> Schiffn. ex Müll.Frib.	6	.	.
<i>Scapania gymnostomophila</i> Kaal.	.	3	2
<i>Scapania hyperborea</i> Jørg.	.	1	.
<i>Scapania irrigua</i> Nees	13	9	2
<i>Scapania irrigua</i> Nees subsp. <i>rufescens</i> (Loeske) R.M.Schust. (as var. <i>rufescens</i> )	.	5	.
<i>Scapania kaurinii</i> Ryan	2	.	.
<i>Scapania mucronata</i> H.Buch	2	1	2
<i>Scapania obcordata</i> (Berggr.) S.W.Arnell	9	4	1
<i>Scapania paludicola</i> Loeske & Müll.Frib.	7	6	3
<i>Scapania paludosa</i> (Müll.Frib.) Müll.Frib.	10	7	.
<i>Scapania parvifolia</i> Warnst.	7	7	1
<i>Scapania praetervisa</i> Meyl.	.	1	.
<i>Scapania scandica</i> (Arnell & H.Buch) Macvicar	2	.	.
<i>Scapania sphaerifera</i> H.Buch & Tuom.	.	.	1
<i>Scapania spitsbergensis</i> (Lindb.) Müll.Frib.	3	.	.
<i>Scapania subalpina</i> (Nees ex Lindenb.) Dumort.	16	7	1
<i>Scapania tundrae</i> (Arnell) H.Buch	.	3	.
<i>Scapania uliginosa</i> (Lindenb.) Dumort.	.	.	1
<i>Scapania undulata</i> (L.) Dumort.	4	1	1
<i>Schistochilopsis grandiretis</i> (Lindb. ex Kaal.) Konstant.	.	.	2
<i>Schistochilopsis incisa</i> (Schrad.) Konstant.	.	6	.
<i>Schistochilopsis opacifolia</i> (Culm. ex Meyl.) Konstant.	10	9	.
<i>Schljakovia kunzeana</i> (Huebener) Konstant. & Vilnet	10	8	4
<i>Schljakovianthus quadrilobus</i> (Lindb.) Konstant. & Vilnet	3	3	1
<i>Solenostoma confertissimum</i> (Nees) Schljakov	6	3	2
<i>Solenostoma hyalinum</i> (Lyell) Mitt. [ <i>Plectocolea hyalina</i> (Lyell) Mitt.]	9	7	2
<i>Solenostoma sphaerocarpum</i> (Hook.) Steph. [ <i>Solenostoma pusillum</i> (C.E.O.Jens.) Steph., <i>Solenostoma sphaerocarpum</i> var. <i>nanum</i> (Nees ex Flot.) R.M.Schust.]	15	4	2
<i>Solenostoma subellipticum</i> (Lindb. ex Heeg) R.M.Schust. [ <i>Plectocolea subelliptica</i> (Lindb. ex Kaal.) A.Evans]	.	3	1
<i>Sphenolobus minutus</i> (Schreb. ex D.Crantz) Berggr.	10	9	3
<i>Sphenolobus saxicola</i> (Schrad.) Steph.	4	3	1
<i>Tetralophozia setiformis</i> (Ehrh.) Schljakov	9	9	2
<i>Trilophozia quinqueidentata</i> (Huds.) Bakalin	14	12	4
<i>Tritomaria exsectiformis</i> (Breidl.) Schiffn. ex Loeske	.	1	2
<i>Tritomaria scitula</i> (Taylor) Jørg.	.	9	2