Arctoa (2025) 34: *1–23*
doi: 10.15298/arctoa.34.01

MOSS FLORA OF MONDY (EAST SAYAN MOUNTAINS, REPUBLIC OF BURYATIA, ASIAN RUSSIA)

ФЛОРА МХОВ ОКРЕСТНОСТЕЙ СЕЛА МОНДЫ (ВОСТОЧНЫЙ САЯН, РЕСПУБЛИКА БУРЯТИЯ, АЗИАТСКАЯ ЧАСТЬ РОССИИ)

VLADIMIR E. FEDOSOV[1], OLGA YU. PISARENKO[2], ALINA V. FEDOROVA[3] & ELENA A. IGNATOVA[1]

ВЛАДИМИР Э. ФЕДОСОВ[1], ОЛЬГА Ю. ПИСАРЕНКО[2], АЛИНА В. ФЕДОРОВА[3], ЕЛЕНА А. ИГНАТОВА[1]

Abstract

A brief survey of the diversity of mosses in the dry western part of the Tunkinskaya Valley and the S-faced slope of Tunkinskie Goltsy Range above Mondy Settlement yielded 329 taxa including rare and interesting *Amblyodon dealbatus, Andreaea heinemanii, Pseudaongstroemia fuji-alpina, Blindiadelphus diversifolius, Brachytheciastrum leiocarpum, Bryoerythrophyllum inaequalifoilum, B. latinervium, Bryum kuntzei, Campylopus schimeri, Catoscopium nigritum, Crossidium squamiferum, Didymodon anserinocapitatus, D. zanderi, Ditrichum orientale, Grimmia fuscolutea, G. mollis, Hydrogonium amplexifolium, H. gregarium, Indusiella thianschanica, Leptopterigynandrum tenellum, Lewinskya transcaucasica, Meesia hexasticha, Oncophorus virens* ssp. *minus, Oreas martiana, Orthotrichum crenulatum, O. sibiricum, Pararhexophyllum sollmanianum, Philonotis falcata, Plagiobryum zierii, Pohlia saprophila, Pterygoneurum sibiricum, Schistidium austrosibiricum, S. chenii, S. transbaikalense, Sphagnum olafii, S. talbotianum, S. tundrae, Stegonia latifolia, Symblepharis vaginata, Tayloria hornschuchii, Tortella spitzbergensis, T. splendida, Tortula atrovirens, T. laureri,* etc. Twenty species are first reported for Republic of Buryatia based on our survey. A check-list of species and comments on the most interesting records are provided. Based on morpho-molecular study, *Tortula sayanensis*, a new species closely related to *T. laureri* is described from the alpine zone of Tunkinskie Goltsy Range; it also occurs in Tyva Republic and Okinskoe Plateau. Both "northern" species distributed mostly in permafrost area of North Asia, and "southern" Central Asian mountain species occur in this area; it results in a rich bryophyte flora despite of the rather low diversity of vegetation types.

Резюме

Обследован ключевой участок в западной части Тункинской долины близ п. Монды, расположенный в западной части Тункинской долины, включающий южный макросклон западной оконечности хребта Тункинские гольцы и прилегающую часть Мондинской котловины. Здесь выявлено 329 таксонов листостебельных мхов. Наибольший интерес представляют находки редких видов *Amblyodon dealbatus, Andreaea heinemanii, Pseudaongstroemia fuji-alpina, Blindiadelphus diversifolius, Brachytheciastrum leiocarpum, Bryoerythrophyllum inaequalifoilum, B. latinervium, Bryum kuntzei, Campylopus schimeri, Catoscopium nigritum, Crossidium squamiferum, Didymodon anserinocapitatus, D. zanderi, Ditrichum orientale, Grimmia fuscolutea, G. mollis, Hydrogonium amplexifolium, H. gregarium, Indusiella thianschanica, Leptopterigynandrum tenellum, Lewinskya transcaucasica, Meesia hexasticha, Oncophorus virens ssp. minus, Oreas martiana, Orthotrichum crenulatum, O. sibiricum, Pararhexophyllum sollmanianum, Philonotis falcata, Plagiobryum zierii, Pohlia saprophila, Pterygoneurum sibiricum, Schistidium austrosibiricum, S. chenii, S. transbaikalense, Sphagnum olafii, S. talbotianum, S. tundrae, Stegonia latifolia, Symblepharis vaginata, Tayloria hornschuchii, Tortella spitzbergensis, T. splendida, Tortula atrovirens, T. laureri* и других. Двадцать видов впервые указываются для Республики Бурятия. Приведен список видов и комментарии к наиболее интересным находкам. На основании морфологических и молекулярных данных из гольцового пояса хребта Тункинские Гольцы описан новый вид *Tortula sayanensis*, близкородственный *T. laureri*. Флора мхов исследованной территории очень богата, несмотря на относительно низкое разнообразие типов растительности. Ее специфика определяется присутствием как "северных" видов, распространение которых связано преимущественно с зоной вечной мерзлоты Северной Азии, так и "южных" горных видов, большая часть ареалов которых находится в Центральной Азии.

KEYWORDS: biogeography, biodiversity, DNA barcoding, rare species

[1] – Lomonosov Moscow State University, Biological Faculty, Geobotany Dept., Moscow 119234 Russia. fedosov_v@mail.ru, arctoa@list.ru; ORCID (VF) 0000-0002-5331-6346 (EA) 0000-0001-6287-5660.
[2] – Central Siberian Botanical Garden, Zolotodolinskaya 101, Novosibirsk 630090 Russia. E-mail: o_pisarenko@mail.ru; ORCID: 0000-0003-4108-4821
[3] – Tsitsin Main Botanical Garden, Russian Academy of Sciences, Botanicheskaya 4, Moscow 127276 Russia. alina_77777@mail.ru; ORCID 0000-0001-7362-2124.

INTRODUCTION

The surroundings of Mondy settlement, which is located in the western extremity of the Tunkinskaya Valley near Russian-Mongolian border, have attracted our attention due to the presence of several rare mosses, including *Pseudaongstroemia fuji-alpina* and *Oreas martiana* listed in the first edition of the Red Book of the Russian Federation (Bardunov, 2008). These species were revealed here by Bardunov in the early 1960s, and a return visiting and reassessment of their localities were highly relevant in the course of preparation of the reissue of the Red Book of Russia. Moreover, collections of these rare mosses were made here accidentally, despite of the low degree of general bryofloristic exploration of the Mondy settlement area.

Published data on mosses is available for many locations in the Tunkinskie Goltsy Range[1], Tunkinskaya valley and the surrounding area, but in several cases these data are obviously incomplete. For example, identification of the collection of A.A. Elenkin resulted in the list of 104 moss species (Brotherus & Savicz, 1932); in the monograph of L.V. Bardunov (1965), 130 species were provided for the territory currently representing Tunkinsky National Park, and only 42 of them are listed for the Mondy settl. surroundings. Other surveys dealt with more humid parts of the area, situated eastward: 162 species were reported for the surroundings of Nilova Pustin' settlement (Afonina, 2021) and 185 species for the transect along Echo-Ger – Shumak rivers (Dugarova *et al.,* 2022). Finally, Tubanova *et al*. (2024) reported 239 moss species for Sayano-Dzhidinskoe Upland forming southern slope of Tunkinskaya valley; in their paper, a brief historical account of the Tunkinsky National Park bryological exploration is provided. On the website of the *Arctoa* database (http://81.17.153.132/rbf1/select_7_1.pl), 623 samples of 230 species were accounted for the Tunkinskie Goltsy Range and Tunkinskaya valley in November 2024. Many rare species remain known only from old records, while current studies have revealed many species previously unknown in the area, including rare and poorly known Central Asian taxa, such as *Leptopterigynandrum decolor, Pararhexophyllum sollmanianum*, etc.

In a botanical and geographical sense, the area "is one of the regions in the South Siberian Mountains, which combine humid and semi-arid geosystems within the same landscape; this is the area of penetration of Central Asian influences into the dominant environment of the Siberian mountain taiga" (Sochava *et al.,* 1963). Due to a strong climatic gradient within the territory, from the humid western extremity of Baikal area westwards along the Tunkinskaya Valley and Tunkinskie Goltsy Range, this Central Asian impact is expected to be higher in the western extremity of the area that remains the least explored for bryophytes. As the legend says, famous Russian traveler and geographer Vladimir Obruchev called the Mondy area the "Center of Asia", that may indicate its significant phytogeographical importance. A few occasional records of xerophyte mosses recently made in Mondy (Tubanova *et al*., 2017; Sandanov & Pisarenko, 2018) indicated the distinctness of the moss flora around it, and wider representation of the weakly studied Central Asian element could be expected here.

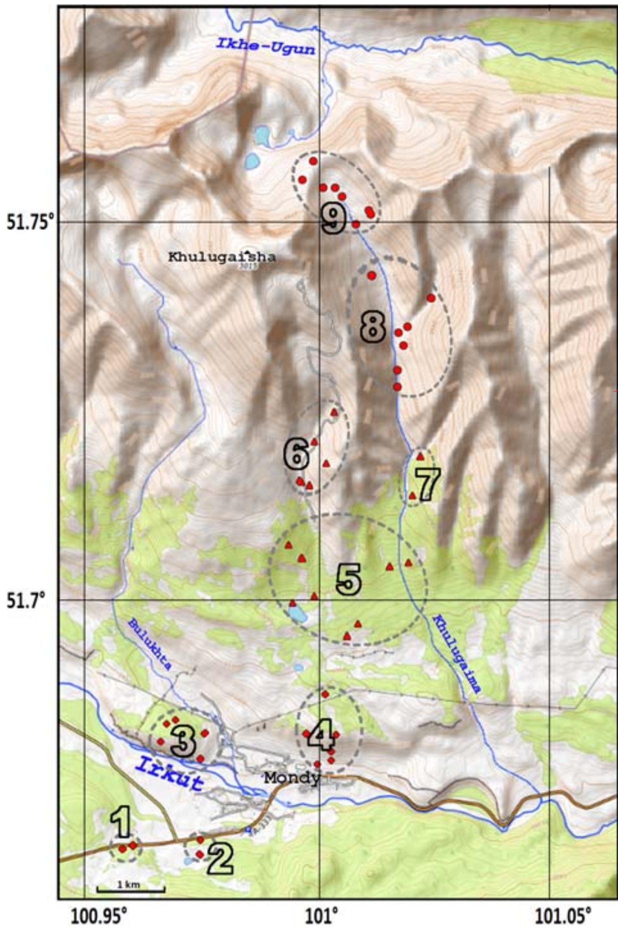
Therefore, VF and OP visited Mondy in July 2023 and made extensive collections of mosses in the settlement outskirts and on the adjacent slopes of Tunkinskie Goltsy Range. While proceeding collections, we applied an integrative floristic approach (Fedosov *et al.,* 2022a) to better understand the affinities of several specimens. Some preliminary results focused on the affinities of rare and interesting species were published separately (Ignatova *et al.,* 2023a,b, 2024a,b; Fedosov *et al.,* 2023), while completing a check-list of mosses of the area was postponed until the progress in taxonomy of several groups (first of all, the genus *Didymodon*) allowed identification of Central Asian material; here we present it.

STUDY AREA

Mondy is an ancient name of the area at the foot of the southwestern end of the Tunkinskie Goltsy Range. The Mondy depression is the westernmost, the most elevated and the smallest in the chain of depressions of the Tunka Rift Valley, through which Irkut River flows; its bottom is at altitudes of 1200–1400 m and has a hilly terrain (Shchetnikov, 2016). In the south-west, through a low pass the Mondy depression adjoins to the high-mountain Khubsugul depression (Mongolia). In the northwest, the valley of the Irkut River sharply narrows, and the orientation of the valley changes. This ancient fault inherited by the Irkut River valley separates the Tunkinskie Goltsy Range and the Munku-Sardyk Mountain massif, the highest mountains of East Sayan system (3491 m).

The Tunkinskie Goltsy Range is about 30 km wide; it stretches for 150 km in sublatitudinal direction; in the north it is bounded by the valley of the Kitoi River, while in the south it adjoins the Tunka Rift Valley (Ufimtsev, 1992; Lunina, 2016). The amplitude of altitudes is about 2 km. The mountain slopes are steep with significant vertical dissection. The crests of the ridges are jagged and sawtooth-shaped, with pointed peaks; cliffs are abundant only above 2500 meters, while middle and lower parts of slopes are covered by loose sediments with scattered boulders and few outcrops. Geologically, Tunkinskie Goltsy Range has a complex fold structure. Terrigenous and carbonate rocks, as well as their metamorphic counterparts are widespread at lower elevations. The upper part of the ridge consists of decomposed plagiogranites and gneiss-granites; slopes are formed by gneiss, plagiogneis, quartzites, amphibolites and crystalline schists with rare layers of marble (Samburg, 1971).

[1] – "Goltsy" is a Siberian name for flattened mountain tops that are treeless and covered by tundra or stone fields; the term is widely used in Russian botanical literature to describe such landscapes.



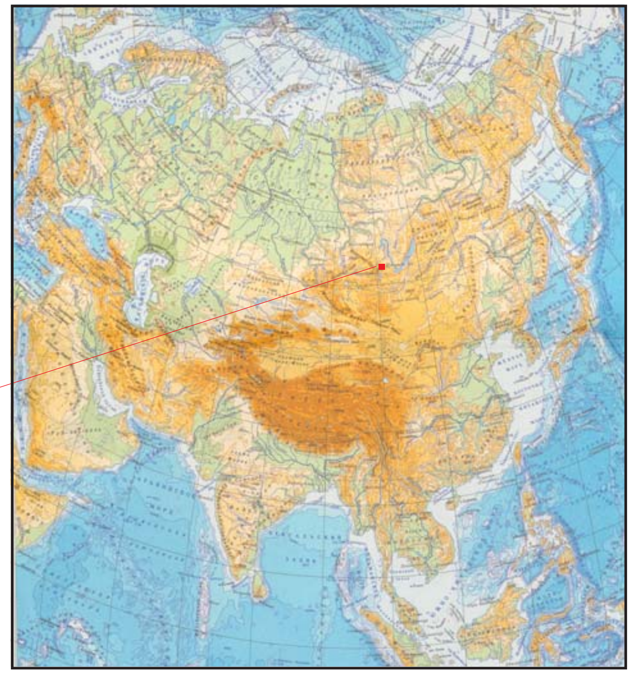


Fig. 1. The collecting localities in Mondy settlement area: diamonds mark points in the forest-steppe zone, triangles in the forest zone, circles in alpine (also called the goltsy) zones. Full list of collecting localities is provided in the Supplementary materials.

1 – right bank of Irkut River upstream Mondy, south of the Tunkinsky tract (federal highway A-333), the southern side of the Mondy depression, the foot of the northern macroslope, Ovoo-gorkhi Creek; 51.666°N, 100.958–100.960°E, 1350-1360 m a.s.l., 9.VII.2023: creek banks and *Larix*-forest on the adjscent steep slope.

2 – right bank of Irkut River upstream Mondy, the southern side of the Mondy basin; 51.664–51.667°N, 100.969–100.976°E, 1340-1350 m a.s.l., 9.VII.2023: swampy depression among eskers (remnants of the glacial period) – wet *Kobresia*-dominated communities with exposed peat, *Larix*-forests and steppes on the knolls.

3 – left bank of Irkut River upstream Mondy, a moraine hill at the interfluve of rivers Irkut and Bulukhta; 51.677–51.685°N, 100.965–100.978°E, 1320-1420 m a.s.l., 11.VII.2023: steppes on the top of the hillock and on the southern slope, with outcrops on steep spots; grassy forests dominated by birch and larch on the northern slope.

4 – a ledge of the lateral moraine along the southern macroslope of the Tunkinskie Goltsy Range, at the foot of Khulugaisha Mount, 51.677–51.687°N, 100.997–101.904°E, 1300-1500 m a.s.l., 7-8.VII.2023: petrophytic steppes on the steep slope and grassy *Larix*-forest upstairs.

5 – the southern slope of the Khulugaisha Mount in the lower part, 51.694–51.707°N, 100.993–101.020°E, 1530-1770 m a.s.l., 8, 9, 16.VII.2023: vegetation is dominated by grassy *Larix*-forests (with scattered granite boulders under the canopy) in combination with secondary grassy *Betula*-forests; minerotrophic mire with sparse oppressed *Larix*-stand and shallow lakes take place in a concave sites of the slope.

6 – the southern slope of the Khulugaisha Mount in the middle part, 51.714–51.725°N, 100.996–101.004°E, 1830-2150 m a.s.l., 10.VII.2023: open forests from *Larix* and *Pinus sibirica*, brooks with stony and peat banks under the canopy, outcrops along the ridge.

7 – the narrow valley of the Khulugaima creek in the middle course, 51.713–51.719°N, 101.020–101.022°E, 1720-1860 m a.s.l., 18.VII.2023: open forests from *Larix* and *Pinus sibirica*-dominated forest with scattered granite boulders under the canopy, brook with stony banks.

8 – Khulugaima creek in the upper course, 51.728–51.743°N, 101.011–101.025°E, 2120-2300 m a.s.l., 16, 17, 18.VII.2023: mountain tundra, stone fields, stream beds and banks, snowbeds.

9 – the northeast slope of the Khulugaisha Mount in the upper part, the sources of the Khulugaima creek, 51.750–51.759°N, 100.996–101.012°E, 2400-2550 m a.s.l., 17.VII.2023: different types of mountain tundra (ranging from boggy moss covered to well-drained *Dryas*-dominated), snowbeds, brooks, stone fields, outcrops.

Pleistocene glaciation played an important role in shaping the relief of the region (Obruchev, 1931; Olyunin,1965; Grosswald, 1987, 2003; Matsera, 1993; Nemchinov *et al.,* 1999; Ufimtsev *et al.,* 2003). The glaciation had a center on the Munku-Sardyk massif and on the Oka Plateau, with valley glaciers descended from here into the Mondy depression along the valley of the Irkut River. It left shafts of moraine steps of various height and length, kame terraces, marginal channels and thermokarst depressions; the height interval with prominent moraine ridges on the valley slopes is 150–400 meters on the slopes and at the bottom of the Mondy depression with small lakes among moraine hills (Arzhannikov *et al.,* 2015).

During the Quaternary periods of glaciation, permafrost strata were formed in the region. The Tunkinskie Goltsy Range is a region where permafrost is continu-

Fig. 2. The Mondy Obruchev' monument of "Centre of Asia" (A) and moss habitat diversity (B–H): B: south-faced slope of Tunkinskie Goltsy Range behind Mondy, showing steppe, forest amd alpine zones; C: petrophytic steppe, with low outcrops, a habitat of *Indusiella thianschanica*; D: Irkut River valley with swampy *Kobresia*-dominated depressions; E: stony brook in a dip on a slope near timberline; a habitat of *Oreas martian;*.F: *Larix sibirica+Betula nana+Sphagnum* spp. along a outlet of the groundwater, slope of Khulugaima Mt.; G–H: near the top of Khulugaisha Mt:, mountain tundra variants, ranging from boggy and mossy to well-drained *Dryas*-dominated, also late snowbeds and scees.

ously distributed (Sumgin, 1937; Logachev, 1958). Permafrost layer thickness ranges from 100 to 500 m with temperature between –1 to –5 °C (Sochava, 1967). The parameters of the frozen layers correspond to the altitude: above 1500–2000 meters, the permafrost is continuous; as altitude increases, so does the thickness of frozen rock, while the temperature and depth of the seasonally thaw layer decrease.

The climate of the region is sharply continental with increased aridity and harsh temperature seasonality. Long-term meteorological data is available only for the Mondy Settlement, where the weather station is located (at 1303 m above sea level): mean annual temperature is –2,7°C; mean temperature of July 14.2°C, mean temperature of January –19.9°C, and the frost-free period is 59 days on average (Kovel', 1989). Winter is long and harsh, with little snow. Also, in Tunkinskaya valley including Mondy vicinities, a phenomenon of temperature inversion periodically created by cold air flows from the mountains to the lowlands appear, but its influence on the N-faced and S-faced slopes is different, and the slopes of Tunkinskie Goltsy above Mondy are weakly affected by it, especially during warm period. Mean annual precipitation is low, 342 mm (329 mm from April to October). The amount of precipitation in the mountains is significantly higher than in the adjacent valleys. As a result, the humidification coefficient (the ratio of precipitation to evaporation) in the warm months for the Tunkinskie Goltsy Range is three times higher than for the Tunkinskaya Valley (Sochava, 1967). From May to August, the coefficient varies from semiarid to humid in the Range and from very arid to humid in the Valley.

The vegetation of the area according to L.I. Malyshev (1963) resembles that of the mountains of Central Asia, and there are no analogues in the mountains of Eastern Siberia. The forest-steppe zone is restricted to the bottom of Mondy depression and slope foots. This is an expositional larch forest-steppe: the difference in environmental conditions on slopes according to exposure and steepness provides a mosaic of *Larix sibirica*-forest and steppe spots (nomenclature of vascular plants follows Malyshev *et al*. (2012)). Steppe communities are dominated by bunchgrasses (*Festuca lenensis, Poa botryoides, Agropyron cristatum, Koeleria cristata*). The South Siberian mountain steppe species are diverse: *Cleistogenes squarrosa, Stipa krylovii, Carex duriuscula, Artemisia frigida, Potentilla acaulis, Pulsatilla turczaninovii, Bupleurum bicaule, Schizonepeta multifida)*, including endemic and subendemic *Cotoneaster lucidus, Oxytropis nitens, O. muricata,* and *Delphinium triste* (Malyshev, 1963; Kholboeva, 2011). Mosses in these communities are confined mainly to stone outcrops and boulders. On steep sunny S-faced slopes, steppe communities can be found up to 1500 m a. s. l. Bryophytes (*Aloina rigida, Grimmia tergestina, Indusiella thianschanica, Jaffueliobryum latifolium, Gymnostomum aeruginosum, Orthotrichum crenulatum, Tortula atrovirens*) are sparse and mostly occur around outcrops and in rock crevices, while in open steppe communities xerophylous mosses *Bryoerythrophyllum latinervium, Crossidium squamigerum, Pterygoneurum sibiricum, P. subsessile, Tortula acaulon,* and *Weissia* spp. occur (composition of mosses in the main types of ecotopes is provided based on author' field experience).

Bryophytes are diverse on alluvium along creeks in Irkut river valley: *Aongstroemia grevilleana, Brideliella demetrii, Bryoerythrophyllum recurvirostrum, Calliergonella lindbergii, Ceratodon purpureus, Didymodon aperifolius, D. ferrugineus, D. validus, D. zanderii, Hydrogonium gregarium, Niphortichum panschii, Pogonatum urnigerum, Schistidium papillosum, Tortella fragilis, T, spitzbergensis*, etc. On eroded slopes *Bryobrittonia longipes, Calcidicranella varia*, various species of *Didiymodon, Encalypta procera, Fissidens* cf. *viridulus, Myurella julacea, Pohlia cruda, Saelania glaucescens, Timmia bavarica*, and many other pioneers of eroded ground occur.

The forests are mostly dominated by *Larix sibirica*; neither spruce nor poplar stands characteristic for the lower altitudinal zone of Baikal area, including Tunkinskaya valley, occur in Mondy surroundings, while birch and aspen forests are secondary, developing after fires. The composition of the lower layers of larch forests is diverse; in lower part of forest altitudinal zone, shrublets (*Vaccinium vitis-idaea, Rhododendron tomentosum*), various grasses (*Festuca ovina, Calamagrostis obtusata*) and herbs (*Pulsatilla patens*, *Anemone sylvestris* in the lower parts of the slopes, *Trollius asiaticus, Aconitum barbatum, A. septentrionale, Geranium krylovii* in the upper parts) occur. Moss cover is typically uniform and poor, dominated mostly by *Rhytidium rugosum, Entodon concinnus,* and *Abietinella abietina*. Epiphytes are poorly represented in such forests, mainly by the members of the Orthotrichaceae; most specialized epiphytes occur on willows in lower altitudinal zone. The main moss diversity is concentrated on eroded soil and decaying wood (*Amblystegium serpens, Brothera leana, Cynodontium asperifolium, Dicranum* spp., *Haplocladium* spp., *Leptodontium styriacum, Lewinskya iwatsukii, Myuroclada maximowiczi, Pararhexophyllum sollmanianum, Pohlia saprophila, Symblepharis sinensis, Sanionia uncinata*). Also mosses are very diverse on dry boulders (*Didymodon fragilicuspis*, *Encalypta ciliata, Grimmia* spp., *Hedwigia* spp., *Hypnum* spp., *Isopterygiopsis catagonioides, Leptopterigynandrum tenellum, Lewinskya iwatsukii, Pararhexophyllum sollmanianum, Platygyrium repens, Syntrichia submontana* are the most characteristic) and especially on outcrops along forest brooks (*Blindia acuta, Bryum* spp., *Cratoneuron filicinum, Dichodontium pellucidum, Distichium capillaceum, Drepanocladus polygamus, Hygrohypnella polaris, Hygrohypnum luridum, Isopterygiella* spp., *Myurella si-*

birica, Oncophorus virens, Philonotis falcata, P. fontana, Platyhypnum duriusculum, Schistidium spp., *Tortula* spp., and many others).

Mires in the lower altitudinal zones of the studied area are rare and occupy small areas, measuring no more than a few tens of square meters. Their floristic composition varies depending on the quality of the water that feeds them. Swampy larch forests are found in flattened spots of slopes: the stand is sparse and stunted; groundlayer is dominated by mosses (*Aulacomnium palustre, Campylium stellatum, Loeskypnum badium, Tomentypnum nitens,* etc.); *Salix* spp., *Vaccinium uliginosum, Rhododendron parvifilium, Pentaphylloides fruticosa, Ledum palustre,* and *Rubus chamaemorus* are common above them. In richer in nutrient conditions, in swampy depression among eskers in the bottom of Irkut River valley, wet communities with domination of *Kobresia* spp., *Carex* spp., and *Trichophorum alpinum* were found; *Amblyodon dealbatus, Catoscopium nigritum, Cinclidium* spp., *Meesia hexasticha,* and *Splachnum ampullaceum* grew there.

In sheltered niches of steep forested rocky slopes, *Duscheckia fruticosa*-dominated communities occur, often with *Rosa*, *Atragene*, *Ribes*, various herbs, and mosses, such as *Ptilium crista-castrensis*, *Pleurozium schreberi*, *Mnium* spp., *Plagiomnium* spp., *etc*. On mesic calcareous outcrops at the upper forest limit, *Blindiadelphus diversifolia, Didymodon perobtusus, Drepanium fastigiatum, Encalypta* spp., *Flexitrichum* spp., *Pseudoleskeella catenulata*, *Seligeria tristichoides*, *Timmia norvegica, Tortella tortuosa, Tortula* spp., etc. occur.

Pinus sibirica rarely occurs in the upper part of the forest zone, which reaches 2100–2200 m a.s.l. In the transitional (subalpine) zgoltsyone to the upper parts of the ridges covered with tundra (“goltsy”), shrub communities composed of *Betula rotundifolia, Rhododendron adamsii, R. aureum, R. parvifilium, Caragana jubata, Juniperus sibirica, Salix glauca,* and *Spirea alpina* prevail. The height of the shrubs depends on the thickness of the winter snow and can reach 1 m. Bryophyte cover under dense shrub canopy is sparse and largely consists of widespread mosses, such as *Pleurozium schreberi, Rhytidium rugosum, Sanionia uncinata, Pohlia nutans, Polytrichum* spp., and *Dicranum* spp.

Dryas oxyodonta-dominated tundras with *Rhytidium rugosum, Pleurozium schreberi, Racomitrium lanuginosum, Dicranum* spp., *Cynodontium strumiferum, Cnestrum* spp., etc. cover better drained turf-covered spots, often exposed to snow and wind abrasion. However, due to the slow melting of permafrost during the short summer period, vast areas of highlands are poorly drained, so outcrops and rock fields on steep mountain slopes alternate mostly with tundra-like communities on damp ground, which occupy flat and gentle surfaces at slope bases. *Carex ensifolia*, *Kobresia myosuroides, K. simpliciuscula,* and *Deschampsia* spp. are the most common among vascular plants; mosses are abundant and diverse: *Drepanocladus* spp., *Meesia* spp., *Sarmentypnum* spp., *Scorpidium* spp. *Cinclidium* spp., *Orthothecium retroflexum, Tomentypnum involutum, Tortella spitzbergensis, T. splendida,* etc. occur here. Large areas are occupied by rock fields; outcrops mostly occur along watercourses or on steepest parts of mountain slopes. The bottom of mountain cirque where Khulugaisha Creek starts from, is occupied by poor fen, where different *Sphagnum* and *Polytrichum* species form hummocks, alternating with flowing depressions with gravely bottom, occupied by *Sarmentypnum sarmentosum, S. exannulatum, Scorpidium revolvens,* and *Schistidium agassizii*. Along the brooks in alpine zone, a variety of mosses including *Fissidens osmundioides, Oncophorus integerrimus, O. virens* ssp. *minor, Platyhypnum* spp., and *Tayloria* spp. occur.

Rockfields are generally covered by acidophilous members of the *Grimmiaceae, Arctoa* spp., *Andreaea rupestris, Dicranum* spp., *Hypnum cupressiforme, Lewinskya iwatsukii,* and few other mosses, but in niches among boulders, cliff crevices, on shelves and in other microhabitats typical for the outcrops, a great variety of calciphilous saxicolous mosses, such as *Amphidium* spp., *Claopodium pelucinerve, Distichium inclinatum, Encalypta rhaptocarpa, Molendoa hornschuchii* var. *tenuinervis, Oreas martiana, Plagiobryum zierii, Pseudaongstroemia fuji-alpina,* and *Tortula* spp. occur. Long-term snow patches remain at shadow exposures starting from about 2400 m a.s.l. In snowbeds and brooks running from them, *Andreaea heinemanii, A. papillosa, A. rupestris, Arctoa* spp., *Grimmia mollis, Hymenoloma crispulum, Paraleucobryum enerve, Oligotrichum falcatum, Pohlia drummondii,* and *Polytrichastrum septentrionale* occur.

MATERIALS AND METHODS

The area surveyed for mosses covers the valley of the Irkut River in the lower reaches of its tributaries Ovo-gorkhi and Bulukhta, the southern slope of the Khulugaisha and the upper reaches of the Khulugaima River to the watershed with the Ikhe-Ugun River (Fig. 1, Supplementary materials). Mosses were collected here in July 2023. The plot is limited within 51.66–51.76°N and 100.95–101.02°E, its area is approximately 30 km^2; collection altitude starts from 1310 in the bottom of Irkut River and reaches 2610 m in the montane pass eastwards Khulugaisha Mt., the highest peaks reaching 2988 and 3015 m.

During a week of field work, about 1500 specimens of mosses were collected; VF-specimens are inserted in MW, OP-specimens are in NSK.

Since morphological diversity in several groups appeared unfamiliar for the authors and hardly alignable with the existing taxonomic treatments, we employed DNA barcoding to assess the affinities of collections that could not be estimated based solely on morphology. In different groups we studied different DNA markers depending on their representation in GenBank. Nuclear ITS sequences were obtained using the protocol described in details by Gardiner *et al*. (2004). Plastid *trn*F–*trn*S region was obtained according to the protocol described by Fedosov *et al.* (2022a), while the protocol for plastid *trn*-MV spacer follows Kučera *et al*. (2013). In most cases DNA barcoding and further judgments about the affinities of a target specimen were based on the results of BLAST search https://blast.ncbi.nlm.nih.gov/Blast.cgi, but in case which required introducing taxonomic novelties, within- and between group uncorrected p-distances were calculated in Mega ver. 11 (Tamura *et al.*, 2021) separately for nr ITS and plastid data. To account for indel data, it was coded using simple indel coding approach (Simmons & Ochoterena, 2000). Results of DNA barcoding of *Aloina, Lewinskya iwatsukii,* and *Symblepharis* are postponed to be treated within the specially focused morpho-molecular studies.

Cluster analysis of several local floras of Baikal Siberia was calculated in Past ver. 4 (Hammer *et al*., 2001). Since lists of species published for Tunkinskaya valley strongly differ in number of species, we used inclusion measures to compare them; they were calculated in IBIS (Zverev, 2007), see Table 2. This method is considered to be the most appropriate for comparing floras that differ in size (Yurtsev, 1968; Semkin & Komarova, 1977).

Results

The list of 329 moss species found during our field trip is presented in the Table 1.

Discussion

Comments on the taxonomically and phytogeographically interesting records and DNA barcoding results

Amblyodon dealbatus. This species was already known from the valley of the Irkut River near Turan settlement (Bardunov, 1966, 1974; Makry & Kazanovsky, 2002); in Buryatia, it also occurs in SE spurs of East Sayan Mountains (Okinsky Distr.), Yuzhno-Muisky and Barguzinsky Ranges (Tubanova *et al.,* 2017). In Russia, *Amblyodon* is known from few scattered localities, mostly stretched along its southern border in the Caucasus and mountains of southern Siberia; it was also recorded from the NW European Russia and Chukotka (Ignatov *et al.,* 2018). In the vicinity of Mondy it grew in a swampy periphery of a small pool, in the moss cover of wet *Kobresia*-dominated communities with patches of exposed peat and flooded mineral ground outcrops.

Andreaea heinemanii.This species was previously revealed in the subalpine altitudinal zone of the Tunkinskie Goltsy Range in the vicinity of Arshan settl. (Sofronova *et al.,* 2017), so here we present its second record for Buryatia from the more xeric part of the range. It probably occurs throughout the alpine zone of the Range but was not found before 2017 due to a low degree of its bryofloristic exploration.

Blindiadelphus diversifolius was newly reported for Buryatia by Tubanova *et al.* (2024) from Sayano-Dzhidinskoe Upland southwards of Kyren Settl.; the present record is the first for the Tunkinskie Goltsy Range. We collected it at the upper limit of forest altitudinal zone on moist base of calcareous rock, along with *Drepanium fastigiatum*.

Brachytheciastrum leiopodium. Until recently, this species was known in Russia from few records in the Altai mountains (Ivanov *et al.,* 2017; Ignatov *et al.,* 2020a). According to Ignatov *et al*. (2020a), this is a poorly known Central Asian species, also revealed in several localities in Mongolia. In Tunkinskie Goltsy it grew on outcrop near waterfall in alpine altitudinal zone together with *Distichium inclinatum, Mnium* sp., *Pseudostereodon procerrimus*, etc.

Bryoerythrophyllum inaequalifolium occurs along the southern border of Russia from Altai Mountains to southern part of the Primorsky Territory; in Buryatia, it was earlier reported from the vicinity of Nilova Pustyn' settl. in Tunkinskaya valley (Afonina, 2021); it was also found in Temnik River lower course (Ivanov *et al.,* 2017). We collected it on eroded loamy soil near road in larch forest.

Bryoerythrophyllum latinervium has a scattered distribution in continental Asia, from Mongolia to Anabar Plateau and Yakutia, which aligns with its morphological and molecular diversity. On dry steppe slopes in vicinities of Mondy settlement, we collected two distinct morphotypes of this species: along with the typical specimens with acute leaves and short excurrent costa, we collected several specimens first assigned to the genus *Pseudocrossidium* due to lingulate upper leaf portion with obtuse to rounded leaves and percurrent costae. Molecular barcoding showed that the specimens with acute leaves (TF55 PV746514, TF56 PV746515) resemble specimens from Zabaikalsky Territory (FJ952616) and Mongolia (FJ952618) in ITS sequence, while the specimen with blunt leaf tips has a unique ITS sequence (TF50 PV746513), which shares several molecular traits with the specimen from Yunnan (Shevock 52356, Be1794S MN683490). This may reflect the ongoing processes of diversification within this group of xeric mosses with strongly fragmented distribution range. A report of *Pseudocrossidium revolutum* from Mongolian Gobi (Ignatov *et al.,* 2004) is probably based on this blunt-leaved morphotype of *B. latinervium*.

Campylopus schimperi. This species was reported by Tubanova *et al.* (2024) as new for Tunkinsky National Park from Sayano-Dzhidinskoe Upland, while our record is the first for Tunkinskie Goltsy Range. It grew on soil in mountain tundra together with *Polytrichum juniperinum*. In the revision of the genus *Campylopus* in Russia (Fedosov *et al.,* 2022b), all reports of *C. subulatus* from continental Asia were referred to *C. schimperi,* and the recently published record of *C. subulatus* from Tunkinsky National Park (Tubanova *et al.,* 2024) is probably based on misidentification of *C. schimperi*.

Cnestrum glaucescens. In Russia, this species occurs mostly in northern Siberia with few scattered localities in the southern part of East Siberia (Ivanov *et al.,* 2017); it was reported earlier neither for Tunkinsky National

Table 1. Mosses found in the vicinity of Mondy and their distribution along sampling localities and altitudinal zones.

The nomenclature follows “Moss flora of Russia” (Ignatov *et al*., 2017, 2018, 2020a, 2022) with further amendments. Collection localities are shown in the Figure 1, in Table 1 they are provided separately for three altitudinal zones.

Constancy of species is provided as follow: **cm** – common in at least one of widespread / in 2 or more ecotope types; **sp** – constantly occurs in few rarer ecotopes or rare in wide range of ecotopes; **r** – few specimens (less than five) from different places or found in a single locality with high abundance; **un** – single locality with low abundance.

Species commented for their taxonomy and distribution are marked with (!!); the comments with brief characteristic of localities, habitats of rare species and results of DNA barcoding where it was applied, are provided in the discussion. Species newly found in the Republic of Buryatia are marked with (**)

Altitudinal zones: FS: forest-steppe, F: forest, A: alpine.

The types of **habitats** are abbreviated as follow: **bt** – bark of trees, **dw** – decaying wood, **pd** – plants debris (including forest litter), **rk** – rock surfaces and fissures, **fe** – fine earth in cracks, niches and on ledges among cliffs and rock fields, **sn** – on ground/ stones in snowbeds, **wa** – watercourse banks and beds, **mi** – cover in mires and wetlands, **eg** – eroded mineral ground, **hm** – humus-rich exposed soil, **tu** – cover in mountain tundra.

Species	Const.	Altitudinal zones			Habitat
		FS	F	A	
Abietinella abietina	cm	1, 2, 3, 4	5, 6, 7	8, 9	dw, pd, hm, tu
Aloina rigida	sp	3, 4			eg, fe
Amblyodon dealbatus !!	un	2			mi
Amblystegium serpens	sp	1, 2, 3			fe, dw
Amphidium asiaticum	sp	3	6, 7	8	rk
A. lapponicum	r		7	8	rk
A. mougeotii	r			8	rk
Andreaea heinemanii !!	r			9	sn
A. papillosa	un			9	sn
A. rupestris	sp	1	6, 7	8, 9	rk, sn
Anomobryum concinnatum	sp	1, 2	6	7, 8	fe, hm, eg
Aongstroemia grevilleana	r	1		8	eg
Arctoa blyttii	r	1		8, 9	rk, sn
Arctoa fulvella	r		7	8	rk
Arctoa glacialis	r			8	rk, sn
Aulacomnium palustre	cm	2, 3, 4	5, 6	9	mi, tu, pd, wa
A. turgidum	sp	1, 3	6	8, 9	tu
Barbula unguiculata	r	4			eg
Bartramia deciduaefolia	r		6, 7	8	fe
B. ithyphylla	r			8	hm, tu
Blindia acuta	r		6	8, 9	rk
Blindiadelphus diversifolius !!	un		6		rk
Brachytheciastrum leiopodium !!**	un			8	fe
B. trachypodium	sp	1, 4	7	8	hm, pd
Brachythecium cirrosum	sp	1, 3	6, 7	8	fe
B. rotaeanum	sp	1, 4	5		bt, dw
B. turgidum	r			9	wa, tu
Brideliella demetrii	r		6	8	mi
B. wahlenbergii	r	1, 2			mi, wa
Brothera leana	sp	1, 4			dw
Bryobrittonia longipes	un	1			eg
Bryoerythrophyllum ferruginascens	r		6	8, 9	fe, eg, tu
B. inaequalifolium !!	un	4			eg
B. latinervium !!	r	3, 4		9	eg, fe
B. recurvirostrum	cm	1, 2, 3, 4	5	8, 9	eg, fe
Bryum algovicum	r	1, 2			mi
B. argenteum	sp	1, 3, 4		9	eg, fe
B. bimum	r			9	mi
B. cryophilum	r			8, 9	wa, sn
B. cyclophyllum	r		6	8	wa
B. elegans	r	4	6		fe
B. kunzei	un	3			eg
B. pseudotriquetrum	sp	2	5, 6	8, 9	mi, wa
B. rutilans	un			9	tu
B. schleicheri	r	1	5		mi
Buckia vaucherii	cm	2, 3, 4	6		fe, hu
Bucklandiella microcarpa	sp	1	7	8, 9	rk, sn
B. sudetica	un			8	rk
Calcidicranella varia	un	2			eg
Callicladium haldaneanum	sp	1, 4	7		dw
Calliergon megalophyllum	un			9	mi, wa
C. richardsonii	r		5	9	mi
Calliergonella cuspidata	un	2			mi
C. lindbergii	r		6	8	wa
Campylium chrysophyllum	r	1	5		wa
C. stellatum	cm	2	5, 6	8, 9	mi, wa
Campylophyllopsis sommerfeltii	r	3		dw	
Campylopus schimperi !!	r			8	tu, fe
Catoscopium nigritum	r	2		9	mi
Ceratodon purpureus	cm	1, 4	5, 6, 7	8	eg, hm, dw
Chionoloma tenuirostris	sp		6, 7	8	rk, fe
Cinclidium arcticum	r			9	mi
C. stygium	un	2			mi
C. subrotundum	r	2		9	mi
Claopodium pellucinerve	un			8	rk
Climacium dendroides	cm	1, 2, 4	5	9	pd, mi, wa
Cnestrum alpestre	un			8, 9	eg, fe
C. glaucescens !!	r			8	eg
Conostomum tetragonum	r			9	tu, sn
Cratoneuron curvicaule **	r		5	8	wa
C. filicinum	cm	1, 2	5		wa
Crossidium squamigerum	r	3			eg, fe
Cynodontium asperifolium	cm	1	5, 6, 7	8, 9	eg, fe, dw, bt
Cyrtomnium hymenophylloides	un	1			eg
Dichodontium pellucidum	r		6	8	wa
Dicranum acutifolium	sp	3, 4	7	9	dw, mi, tu
D. bardunovii	r	1	6, 7		pd, dw
D. bonjeanii	r	1, 2			mi
D. dispersum	r	2	6		pd
D. elongatum	sp		6	8, 9	tu
D. flexicaule	r		6		pd
D. fragilifolium	r	1, 4			dw
D. fuscescens	sp	1, 3, 4	5		dw
D. groenlandicum	r		5	8	tu, pd
D. majus	r			8	tu, fe
D. montanum	r	3, 4			bt, dw
D. schljakovii	r			8	fe
D. scoparium	sp	2, 3, 4			dw
D. spadiceum	sp		6	8, 9	tu
Didymodon abramovae **	r	1	6		eg
D. anserinocapitatus !!	r	3, 4			fe, eg

Species	Const.	Altitudinal zones FS	F	A	Habitat
D. asperifolius	r	1		8	fe
D. baikalensis	r	3, 4			eg
D. borealis **	un			9	fe
D. ferrugineus	r	1, 2			eg
D. fragilicuspis	r	4	5		fe
D. hedysariformis	sp	4	5, 6	8	fe, eg
*D. hengduanensis***	un	4			fe
D. mongolicus	r	1, 4			fe
D. perobtusus	r	3	6		rk
D. cf. *daqingi* **	r		6		fe
D. subandreaeoides	un	3			rk
D. validus	r	1, 4			eg
D. zanderi	r	1	6		rk
Distichium capillaceum	cm	1, 2	6, 7	8, 9	rk, fe, tu, eg
D. inclinatum	un			8	rk
Ditrichum orientale !! **	un			9	eg
D. zonatum	un			8	rk
Drepanium fastigiatum	r		6		rk
Drepanocladus aduncus	r	2			mi, wa
D. polygamus	r	1			wa
D. turgescens !!	r			9	mi
Encalypta alpina	un			9	fe
E. ciliata	sp	4	6	8	fe
E. pilifera	r		6		fe
E. procera	r	1	6		eg, fe
E. rhaptocarpa	r			8	fe
E. trachymitria	sp	1, 4	6	8	fe
Entodon concinnus	cm	1, 2, 3, 4	5, 6, 7		pd, fe
E. schleicheri	sp	1, 3, 4	6		pd, dw, fe
Entosthodon pulchellus	un	3			fe
Eurhynchiastrum pulchellum	r		6		fe
Fissidens adiantoides	un		6		mi
F. cf. *viridulus*	r	1	6		eg, hm
F. osmundioides	un			9	eg/wa
Flexitrichum flexicaule	r	1			fe
F. gracile	r		6	9	fe, eg
Funaria hygrometrica	r	4			eg
Grimmia anodon	r	3			fe
G. elatior	r			8	rk
G. funalis	r		6	8	rk
G. fuscolutea !! **	r		7	8	rk
G. incurva	r			8	rk
G. jacutica	sp			8, 9	rk, fe
G. longirostris	cm	4, 5	6	8	rk
G. mollis	r			8	rk, sn
G. reflexidens	sp			8, 9	rk
G. tergestina	cm	3, 4			rk
G. unicolor	un	3			rk
Gymnostomum aeruginosum	r	3, 4			rk
Haplocladium angustifolium	un	3			dw
H. capillatum	un	3			dw
Hedwigia czernyadjevae	un		6		rk
H. emodica	r	1, 4			rk
Helodium blandowii	un		5		mi
Homomallium connexum	un	1			rk
H. incurvatum	un	1			dw, rk
Hydrogonium amplexifolium	un	3			fe
H. gregarium !!	r	1, 3	6		fe, eg, wa
Hygroamblystegium humile	un	2			wa

Species	Const.	Altitudinal zones FS	F	A	Habitat
Hygrohypnella ochracea	un		6		wa
H. polaris	sp		6	8	wa
Hygrohypnum luridum	r		6	8	wa
Hylocomiastrum pyrenaicum	r			9	tu
Hylocomium splendens	r		6	8, 9	pd, dw
Hymenoloma crispulum	sp			8, 9	rk, sn
Hymenostylium recurvirostrum	r	2, 3	6		rk, eg
Hypnum cupressiforme	sp		6	8, 9	rk
H. leptothallum	un		6		rk
Indusiella thianschanica !!	r	3			rk, fe
Isopterygiella alpicola	un			8	fe
I. pulchella	sp			8, 9	fe, tu
Isopterygiopsis catagonioides	sp		6, 7	8	rk
Iwatsukiella leucotricha	r		7	8	fe
Jaffueliobryum latifolium	sp	3, 4			rk
Jochenia pallescens	r	1			bt, dw
Leptobryum pyriforme	sp	1	5		eg
Leptodictyum riparium	un	1			dw/wa
Leptodontium styriacum	sp	3, 4	6		dw
Leptopterigynandrum austro-alpinum	r		5, 6, 7		rk
L. tenellum !!	R	4	6	8	rk
Lescuraea radicosa	un			8	rk
Lewinskya elegans	r	3, 4			bt
L. iwatsukii !!	cm	2, 3, 4	5, 6	8	bt, dw, rk
L. sordida	sp	3, 4	5		bt
L. transcaucasica	r	3, 4			bt
Loeskypnum badium	r		5	9	mi
Meesia hexasticha !! **	un	2			mi
M. minor	r	2		9	eg
M. triquetra	r			9	mi
M. uliginosa	sp	2	5, 6	9	mi
Mnium blyttii	r	1		8	hm
M. lycopodioides	sp	1, 3	6	8	rk/fe, eg
M. marginatum	r	1	7		pd
M. spinosum	r		7	8	hm
M. thomsonii	sp	1	6, 7		eg, hm
Molendoa hornshuchiiana !!	r	1, 3	6	8	fe
M. schliephackei	r	3, 4			fe
Myurella julacea	cm	1	2, 5, 6	8, 9	eg, fe, rk, tu
M. sibirica	un	1			eg, fe
M. tenerrima	r			8, 9	rk, fe
Myuroclada maximowiczi	sp	3, 4	6		bt, dw, rk, fe
Neckera oligocarpa	r		6	8	rk
Niphotrichum panschii	r		6	8, 9	eg, rk
Nyholmiella obtusifolia	r	4			bt
Oligotrichum falcatum	r			8, 9	sn, fe
Oncophorus integerrimus	r			9	wa
O. virens	sp	2	5	9	wa
O. virens ssp. *minor* !! **	r			9	wa
Oreas martiana !!	UN			8	rk
Orthothecium chryseum	un			9	tu, mi
O. retroflexum !!	un			9	tu, mi
O. strictum	un				rk
Orthotrichum crenulatum !!	r	3, 4			rk
O. sibiricum !! **	un	4			bt
Paludella squarrosa	un		5		mi
Paraleucobryum enerve	r		6	8	rk, sn
P. longifolium	un			8	rk
Pararhexophyllum sollmanianum !!	sp	3, 4	5, 6		rk, dw

Species	Const.	Altitudinal zones			Habitat
		FS	F	A	
Philonotis fontana	un	1			wa
P. falcata	r	2	5		wa
P. tomentella	r			9	wa, tu
Plagiobryum demissum	r		5	8, 9	mi, tu, hm
P. zierii	un			8	rk
Plagiomnium acutum	un	1			pd
P. confertidens	sp	1, 3, 4	6, 7		pd
P. cuspidatum	r	1	3, 4		dw, pd
P. ellipticum	r		5, 6		mi, wa
Plagiopus oederianus	un			8	fe
Plagiothecium cavifolium	r		7	8	rk
P. denticulatum	sp		5, 7	9	hm, eg
P. svalbardense	sp	2	6	8	fe
Platygyrium repens	sp	3, 4	5		bt
Platyhypnum cochlearifolium	r		6		wa, rk
P. duriusculum	r		6	9	wa, rk
Pleurozium schreberi	sp		6		pd, dw
Pogonatum dentatum	un			8	fe
P. urnigerum	cm	1, 4	6	8	fe, eg
Pohlia cf. *beringiensis*	r			8, 9	eg/wa
P. cf. *elongata*	un	3			rk
P. cruda	cm	1, 4	7	8, 9	rk, hm, fe, dw
P. drummondii	r			8	fe, sn
P. longicollis	r	4	6	8	rk
P. nutans	sp	4	5, 7		dw, hm
P. obtusifolia	un			8	fe
P. saprophila !!	sp	1, 3, 4			dw
P. wahlenbergii	sp	2	5		eg, wa
Polytrichastrum alpinum	cm		5, 6	8, 9	tu, sn, rk
P. septentrionale	r			8	sn
P. longisetum	r	1, 4	5		hm/pd
P. commune !!	r		7	8	hm, sn/tu
P. hyperboreum	r		5	8	tu
P. juniperinum	sp	4	6		pd, eg, fe
P. piliferum	r			8, 9	pd, eg, fe
P. strictum	r		5		mi
Pseudaongstroemia fuji-alpina !!	r			8	rk, fe
Pseudoleskeella catenulata	r		6	8	rk
P. rupestris	r		5	8	rk
Pseudostereodon procerrimus	un			8	fe
Pterigynandrum filiforme	un			8	rk
Pterygoneurum sibiricum	un	3			eg
P. subsessile	un	3			eg
Ptilium crista-castrensis	r	4	5, 7		pd
Pylaisia polyantha	sp	2, 4	6, 7		bt, dw, rk
Racomitrium lanuginosum	r			8, 9	rk, fe, sn
Rhabdoweisia crispata	un		6		fe
Rhizomnium andrewsianum	un			9	tu
R. pseudopunctatum	un		5		mi/wa
Rhodobryum ontariense	sp	1, 2, 3, 4			pd, hm
R. roseum	un	4			pd
Rhytidium rugosum	cm	1, 3, 4	5, 6, 7	8, 9	pd, fe, tu
Roaldia revoluta	r			9	tu
Saelania glaucescens	sp			8	fe, eg, tu
Sanionia uncinata	cm	1, 2, 3, 4	5, 6, 7	8, 9	pd, bt, fe, dw, sn
Sarmentypnum exannulatum	r	2			mi/wa
S. sarmentosum	r	2	5	9	mi/wa
Schistidium agassizii	un			9	rk/wa
S. austrosibiricum	r	2	6		rk

Species	Const.	Altitudinal zones			Habitat
		FS	F	A	
S. chenii !! **	un		6		rk/wa
S. liliputanum	un		7		fe
S. papillosum	r		6	9	rk, wa
S. platyphyllum	sp		6	8	rk/wa
S. pulchrum	sp	2	6		rk
S. sibiricum	un		6		rk
S. transbaicalense !! **	un		5		rk
Sciuro-hypnum reflexum	r	3, 4			pd, tb, dw
Scorpidium cossonii	cm	2	6	9	mi, wa
S. revolvens	sp		6	9	mi, tu
S. scorpioides	r			9	mi, tu
Seligeria tristichoides	un		6		rk
Sphagnum capillifolium	r		5		mi
S. inexpectatum	r			9	mi, tu
S. olafii !! **	r			8, 9	mi, tu
S. orientale	r			9	mi, tu
S. talbotianum !! **	sp		5, 6, 7	9	mi
S. tescorum	r		7		mi
S. tundrae !!	r		5	9	mi, tu
Splachnum ampullaceum	un	2			mi
Stegonia latifolia	un			9	fe
Stereodon pratensis	un		5		mi/wa
S. subimponens	r		6, 7		rk/hm
Straminergon stramineum	r		5	8, 9	mi
Streblotrichum convolum	un		6		eg
Symblepharis vaginata !!	r	4	6		dw
S. sinensis !!	sp	3, 4	5, 7	8, 9	dw
Syntrichia leptotricha **	r	4			rk
S. norvegica	r		7	9	fe, tu
S. ruralis	r	2, 4			rk/hm
S. sinensis	sp	3, 4			rk
S. submontana	cm	2, 3, 4	6		rk/hm
Tayloria hornschuchii !!	un			9	Fe/tu/wa
T. lingulata	un		5		rk/wa
Tetraplodon angustatus	un	3			hm
T. mnioides	r		5	9	hm
T. urceolatus	un	3			hm
Thuidium assimile !!	un		6		pd
Thuidium recognitum	un	1			pd
Timmia bavarica	r	1	7		eg
Timmia comata	r	1		8	eg
Timmia norvegica	un	1			eg
Tomentypnum involutum	sp			9	mi/tu
T. nitens	sp		5, 6	9	mi
Tortella fragilis	cm	2, 3, 4	5	9	fe
T. spitsbergensis	un			9	fe/wa
T. splendida !!	r			8, 9	mi/tu
T. tortuosa	sp	4	6	9	fe
Tortula acaulon	un	3			eg
T. atrovirens !! **	un	3			eg
T. hoppeana	sp		5, 6	8	hm
T. laureri !! **	un		6		hm
T. cf. *laureri***	sp		6	8, 9	fe
T. mucronifolia	sp	1	6	8	fe, hm
T. systilia	r			8, 9	fe/hm
Trichostomum crispulum	un	3			rk/fe
Ulota curvifolia	r		6		rk
Warnstorfia fluitans	un		5		wa
Weissia controversa	r	1			eg, bt
W. cf. exserta **	un	3			eg
Zygodon sibiricus	r	4	6		bt

Park, nor for the Eastern Sayan Mountains as a whole, and most records of the genus in the area belong to *C. schisti*. However, in the studied area *C. glaucescens* is rather frequent in the alpine zone; we also collected *C. alpestre* but not *C. schisti*.

Didymodon anserinocapitatus. This species occurs predominantly in Sino-Himalayan region with few records in Kazakhstan, southern Siberia, and North America. Our record is the third for Buryatia; *D. anserinocapitatus* was found earlier in the vicinity of Nilova Pustyn' settl. in Tunkinskaya valley (Afonina, 2021). Our collections were made on dry calcareous rocks.

Didymodon spp. Specimens of this genus from the vicinities of Mondy settl. were revised by EI after the treatment of *Didymodon* s. str. in Russia was published (Ignatova *et al.,* 2024b), so many *Didymodon* species recognized in the studied flora (*D. abramovae, D. baikalensis, D. borealis, D. hengduanensis, D. mongolicus,* and *D.* cf. *daqingi* (see also Ignatova *et al.*, 2025) appeared to be recently described or poorly known species with mainly Central Asian distribution. All of them are rare in the vicinity of Mondy, occurring mainly in forest-steppe or forest altitudinal zone, except for *D. borealis* which was collected in alpine zone.

Ditrichum orientale. Until recently, this rare species was known in Russia only from Zabaikalsky Territory (Afonina *et al.,* 2017); our record from the Tunkinskie Goltsy Range is the first for the Republic of Buryatia. Outside Russia, it is known from Japan, Sino-Himalayan region, Taiwan, Philippines, Sulawesi, Central and South America, but some of these records may need in revision.

Drepanocladus turgescens. This widespread northern species is rare in the mountains of southern Siberia; in the Eastern Sayan Mts, it was known from few locations (Bardunov, 1965; Afonina & Tubanova, 2010). We collected this species in a rich fen in the alpine zone along with *Tortella splendida, Catoscopium nigritum, Orthothecium retroflexum*, etc.

Grimmia fuscolutea. The plants tentatively assigned to this taxon were rather common on rock outcrops in the middle course of Hulugayma Creek in subalpine zone and in the upper part of forest altitudinal zone. Among GenBank accessions available for comparison, isolate BF181 from the vicinities of Mondy settl. (MW9131587 trnSF PV755944) appears to be closest to KX024324, *Grimmia fuscolutea* voucher MA 21398 (pairwise distance 0.009); it also shows the distance of 0.0203 with KX024323 *Grimmia muehlenbeckii* voucher MA 22709, and of 0.0284 with KX024322 *Grimmia lisae* voucher S B13712. Therefore, at the moment we assign our specimens to *G. fuscolutea* despite of its difference in sequences and morphology. This species is rare throughout its worldwide range; the closest localities are known in Khamar-Daban Range and Altai Mountains.

Hydrogonium gregarium. This species was first reported from Russia rather recently (Ignatova *et al*., 2013) and since that time many additional records appeared, indicating that it has a wide distribution in Asian Russia in areas with calcareous bedrocks (Cherdantseva *et al.,* 2018; Fedosov *et al.,* 2022a; etc.). It was also reported from Okinsky Distr. of Buryatia just 25 km upstream of Mondy, on the bank of Irkut River (Ellis *et al.,* 2018). In the vicinity of Mondy settl., it is rather abundant, forming pure mats at wet bases of boulders on the bank of Irkut River, and on pebbly banks of creeks, along with *Tortella spitzbergensis, Didymodon asperifolius, Brachythecium cirrosum*, etc.

Indusiella thianschanica. This species was considered as having a predominantly Central Asian distribution until an extensive collecting in Yakutia revealed its wide distribution in continental North Asia. It was reported from Okinskoe Plateau (Afonina & Tubanova, 2010), westward of the studied area, but it is newly found inTunkinskaya valley. It is frequent on dry open outcrops on slope of Irkut River valley, growing with *Jaffueliobryum latifolium, Bryoerythrophyllum latinervium, Crossidium squamigerum, Aloina rigida, Didymodon* spp., *Grimmia anodon, G. tergestina,* and other xerophylous species.

Leptopterigynandrum tenellum. Until 2012, this rare Central Asian species was known only from China (He, 2005). It was later found in several localities in the Altai Mountains (Ignatov *et al.,* 2012) and also in the Tunkinskaya valley (Tubanova *et al.,* 2024). Here we report this species from the vicinity of Mondy, where it appeared to be not rare in the middle part of the forested slope, growing on dry boulders under the larch canopy together with *Pararhexophyllum sollmanianum, Didymodon fragilicuspis, Entodon schleicheri, Hedwigia czernyadjevae*, etc. Its identification was also confirmed with molecular data (nr ITS); it is important to count that the identification of this species bases on few overlapping quantitative traits and therefore is tricky. Studied specimens (MW9131423, isolate BF182, nr ITS PQ659510, MW9131371, isolate BF184, nr ITS PQ659511, MW9131516, isolate BF185, nr ITS PQ659512) have identical ITS sequences which also are identical to KC121295 obtained from the specimen from Altai Mts (voucher Ignatov #8/159, MHA).

Lewinskya iwatsukii. It is one of the commonest species of *Lewinskya*, occurring both on trees and rocks throughout the explored altitudinal range; within the area, it demonstrates morphological variation which may be caused by environmental heterogeneity and/ or represent several independent taxa. The record of suboceanic, predominantly amphiatlantic saxicolous *Ulota hutchinsiae* for Tunkinskaya valley "on rotten log in birch forest" (Tubanova *et al.,* 2024) is apparently based on the misidentification of *L. iwatsukii*.

Meesia hexasticha.This rare northern species is known in Russia by few records in Murmansk and Arkhangelsk Provinces, western Chukotka, and scattered localities in the mountains of Yakutia (Ignatov *et al.,* 2018). We found it in Buryatia for the first time; it grew in minerotrophic bog in the valley of Irkut River, with *Catoscopium nigritum, Cinclidium stygium, Scorpidium scorpioides, Meesia uliginosa,* and other marsh mosses.

Molendoa hornshuchiana. This species complex is often considered to represent a single polymorphic species (cf. Zander, 1977; Geissler, 1985), which includes *M. sendtneriana* and *M. tenuinervis*. In the context of molecular variability, this problem is mentioned by Sollman *et al.* (2020), but no special morpho-molecular revision of the group has been undertaken. In the alpine zone of the Tunkinskie Goltsy Range near Mondy, on rock near a waterfall we collected a strange pottiaceous moss which largely resembled *Molendoa* but differed in having smooth or nearly so laminal cells. In short leaves and partially bistratose lamina it agreed with the circumscription of *M. tenuinervis*, while in the other traits fit the "andreaeoid" morphotype briefly commented by Zander (1977). In GenBank, *M. tenuinervis* is represented by two accessions: from Mongolia (isolate JK 134) and from the Alps (isolate JK 108), which possess different nr ITS and plastid rps4 sequences. The latter accession can be considered as representing "true" *M. tenuinervis*, which was described from the Tirolian Alps. Despite the close proximity of the studied area to Mongolia, our specimen appeared to be identical to that from the Alps in plastid *rps*4 sequence (isolate BF179, PV755945, but it differs from the latter in lacking a single specific substitution in the nrITS sequence (PV746516). Due to a very weak if any molecular differentiation, we agree with its synonymization first effected by Zander (1977); otherwise, *Molendoa hornschuchiana* var. *tenuinervis* (Limpr.) Szafran might deserve considering a separate subspecies based on morphological and ecological distinctness.

Oncophorus virens ssp. *minor*. This recently described taxon has an insufficiently known distribution, mostly in the Arctic and Kamchatka Peninsula (Afonina *et al.,* 2023). We report it for the first time from Buryatia; this intriguing plant resembling *Brideliella* grew on damp soil near brook in alpine zone in the upper course of Khulugaima Creek together with *Meesia minor* and *Fissidens osmundioides*.

Oreas martiana. This species was already known to occur in Tunkinskie Goltsy Range near Mondy (Bardunov, 1965), and we managed to confirm this record; however, in the studied locality it formed a single compact cushion in a shaded rock niche partly covered by shoots of surrounding species, and subsequent efforts did not reveal *O. martiana* nearby. Brief label in the specimen by Bardunov does not provide exact information, so it is impossible to say if we visited the same locality or a different one.

Orthothecium retroflexum. This recently described species is fairly common in the Arctic and mountains of Subarctic with few records southward (Ignatov *et al.,* 2020b). It is known from Buryatia from single record in Kitoyskie Goltsy Range; in Tunkinsie Goltsy Range it occurs in rich fen with *Tortella splendida, Meesia* spp., *Scorpidium* spp., and *Catoscopium nigritum*.

Orthotrichum crenulatum. This predominantly Central Asian species was recently found in southern Siberia, including xeric areas of Buryatia in Tarbagatay, Dzhidinsky and Bichursky Districts (Fedosov *et al.,* 2017a); here we newly report it for Tunkinsky District and East Sayan Mountains. This species grows on sheltered surfaces of dry boulders on steppe slopes.

Orthotrichum sibiricum. This species has a scattered distribution in subarctic Eurasia with few records from mountains of southern Siberian (Fedosov *et al.,* 2017b). Our record is the first for Buryatia Republic. This species grew on fallen birch trunk on a slope of moraine hill.

Pararhexophyllum sollmanianum. Until recently, this Central Asian species described from Himalayan region was considered to be subendemic of China, known also from Nepal and India (Sikkim). Later Kučera *et al*. (2020) reported it from two localities in Russia, one of them in the vicinity of Turan settl. on Tunkinskie Goltsy Range. An additional record of this species originates from the opposite slope of Tunkinskaya valley (Tubanova *et al.,* 2024). According to our experience, *P. sollmanianum* is rather common in the middle part of forest altitudinal zone in the vicinity of Mondy settl.

Pohlia saprophila. According to Czernyadjeva *et al.* (2017), this Central Asian species is known in Russia from few localities, mostly along the southern border of its Asian part, but also from Kamchatka. Like the previous species, in the studied area *P. saprophila* was found to be frequent in the lower and middle parts of forest altitudinal zone, where it grows on rotten wood.

Polytrichum commune. In the alpine zone of Tunkinskie Goltsy Range, we collected an unusual morphotype of this species. It grew below the snowbed and in the field it was referred to *Lyellia aspera* due to the combination of serrate leaf margins and presence of hyaline hair point. However, the transverse leaf section revealed unistratose leaf laminae and bifid cells atop the ventral lamellae, suggesting an affinity to *P. commune*. Since hyaline hair point is not typical trait of this species in Russia, we obtained the sequence of plastid region rps4 to get a molecular proof of the species identification. BLAST search revealed that our specimen (isolate BF111, rps4 PV755943) has an identical sequence to AF208428 obtained from "Hyvonen 6168" from Finland, while all other sequences referred to *P. commune* differ in two indels, and all but one also differ in several substitutions. The taxonomy of *P. commune* complex may need in a worldwide taxonomic revision.

Pseudaongstroemia fuji-alpina. This species remains known in Russia only from the highlands of Tunkinskie Goltsy Range and those of Tyva Republic. In the upper course of Khulugayma Creek, it was found on rocks in four different places, so one may expect its occurrence also in other valleys in the western part of Tunkinskie Goltsy Range and in neighboring mountain ranges of the East Sayany, though it was absent in collections by L.V. Bardunov from Kitoyskie Goltsy. DNA voucher MW9131444, Isolate FDt253, *trn*S–*trn*F PP209661, Nad5 PP197064. Phylogenetic position of this species was studied with molecular data by Fedosov *et al.* (2025), who identified its affinity within the Ceratodontaceae, where a new genus was created to accommodate it. The specimen from Mondy appeared to be identical in sequences to the specimens from Mongolia and China (Sichuan). Like many other reported species, this rare species finds the northern limit of its distribution in the southern extremity of Siberia.

Schistidium chenii. The record of this poorly known Central Asian endemic with unique hood-like leaves was considered separately by Ignatova *et al.* (2023a).

Schistidium transbaicalense. This species was recently described from southern Siberia (Ignatova *et al.,* 2023b). Our record is the first for Buryatia and East Sayan Mountains. It grew on boulder in the S-faced forested slope of Hulugaisha Mt. at ca. 1500 m a.s.l.

Sphagnum olafii. This rare and insufficiently known arctic species was first reported for Russia based on specimens from Chukotka and Transbaikalia (Flatberg *et al.,* 2016) and since that time quite a few additional records, mostly from the Arctic, were published. Our record from the highlands of Tunkinskie Goltsy Range confirms its occurrence in Asian mountains far beyond Arctic and highlights arctic connections of the alpine flora of southern Siberia. It grew on damp tundra soil in boggy bottom of mountain cirque.

Sphagnum talbotianum. Until recently, this species remained insufficiently known; the study by Shkurko *et al*. (2023) showed that the majority of Asian specimens representing red plants and assigned earlier *to S. warnstorfii, S. rubellum,* and *S. andersonianum* actually belong to *S. talbotianum*. However, in East Sayany this species is found far southward from its previously known localities; it is first reported here for the Republic of Buryatia. It occurs in paludified larch forests and poor fens in alpine altitudinal zone. Four specimens from the area were referred to this species, which means that it probably is not rare in other mountain areas of southern Siberia with continental climate and permafrost.

Sphagnum tundrae. This northern species occurs sporadically in mountains throughout permafrost area in Asia. Here we newly report it for the East Sayan Mountains; in the Republic of Buryatia it was already known from several localities in Angirski sanctuary (Ivanov *et al*., 2017, Herbarium specimens of Russian mosses. 2023. Available from: http://arctoa.ru/Flora/basa.php Last accessed 03.03.2025).

Symblepharis sinensis. This species is common in the area on rotten wood; it was also occasionally found in mountain tundra. Hedenäs (2017) did not separate it from *Oncophorus elongatus*, but claimed that the latter species is represented by several haplotypes. A preliminary results of our barcoding (not presented here) suggest that epixilous plants and those growing on soil above tree line represent different haplotypes; however, this needs to be confirmed within the integrative taxonomic framework based on a wider sampling.

Symblepharis vaginata. This species was first recorded for Russia by Afonina *et al.* (2010) based on specimens from Zabaikalsky and Primorsky Territories. Later it was found in the Udinsky Range (East Sayan, Irkutsk Province) and Tunkinskaya valley (Ivanov *et al.,* 2017; Tubanova *et al.,* 2024). We found it in the same environments as in the vicinity of Turan settl., on rotten log in birch-dominated forest, together with *Pohlia saprophila*. Molecular data, including phylogenetic reconstruction presented by Fedosov *et al.* (2024) confirms identification of the specimen (DNA voucher MW9133042, Isolate SyF30, trnF-trnT PQ593635, rps4-trnS PQ593601, trnG PQ593582, nr ITS PQ590647).

Tayloria hornschuchii. This species is rare in Russia; most its records originate from Chukotka, and scattered localities are known in Yakutia (Ivanov *et al.,* 2017, Ignatov *et al.,* 2018). It was also found recently in the highlands of Sayano-Dzhidinskoe Upland southwards of Kyren Settl. (Tubanova *et al.,* 2024). We collected it on moist eroded soil near brook, together with *Meesia minor* and *Fissidens osmundioides*.

Thuidium assimile was found in one location, in shady ravine on the forested slope of Khulugaysha Mt. The plants are atypical, with uniseriate leaf acumina 5–10 cells long. Long leaf acumina are characteristic for *T. cymbifolium*; this species is known in Russia by some records from the southern Russian Far East, while its main distribution area extends southward to subtropical and tropical East Asia. According to the recent treatment of the genus (Ignatov *et al.,* 2022), *T. cymbifolium* is close to *T. assimile* and differs from it in having longer uniseriate leaf acumina (6–15 vs. 2–6 cells long) and inner perichaetial leaves with ciliate margins. We couldn't find perichaetia in our plants; in the case, we don't consider the long acumina a sufficient reason to refer our specimens to the East Asian species. Apparently, morphological variability of these two species in Asian Russia requires further study.

Tortella splendida. We follow Köckinger & Hedenäs (2023) when considering arctic and mountain plants that were previously treated as *T. arctica*. Three terricolous specimens from mountain tundra and rich fens in the upper course of Khulugaima Creek were used for DNA barcoding to check whether morphological variability in the area agrees with the molecular data. The results of molecular barcoding were involved in the treatment of *Tortella* in the Russian Arctic (Ignatova *et al.,* 2024a). All three specimens had gradual transition from rectangular, hyaline, smooth basal leaf cells to rounded-quadrate, chlorophyllose, papillose upper leaf cells, which is considered typical for *T. arctica* (cf. Eckel, 1998), but only the specimen MW9131305 possessed two layers of guide cells typical for *T. splendida* according to Köckinger & Hedenäs (2023). All-three obtained sequences were different, representing "*T. splendida* s.l." (Ignatova *et al.,* 2024a): isolates BF107 (nr ITS PQ659500) and BF109 (nr ITS PQ659502) represent "southern haplogroup" where the *T. splendida* type belongs, while isolate BF108 (nr ITS PQ659501) represents "*T. arctica*" haplogroup mostly including northern specimens.

Tortula atrovirens. Our record of this species is third for Asian Russia and first for Buryatia; it was previously reported from Transbaikalia (Afonina *et al.,* 2017) and collected in Tyva Republic (Ivanov *et al.,* 2017); this species also occurs in Mongolia where it is rather common in Mongolian Gobi (Ignatov *et al.,* 2004). In the vicinity of Mondy, it grew on dry mineral ground near base of rock in open steppe community, together with *Bryoerythrophyllum latinervium*.

Tortula laureri. This rare species occurs in Russia in the East Sayan and Transbaikalia. Already in the field, our attention was drawn to an unusual morphological diversity of the plants superficially assignable to this species. Several specimens collected in the same locality on moist shaded rocky slope near brook in the forest zone were represented by large plants with short-apiculate leaves, entire or with few teeth above, reddish setae 1–1.5 mm long, and twisted peristome teeth; they fit the description of *T. laureri* in Savicz-Lyubitskaya & Smirnova (1970) and agree with the specimens from Transbaikalia and East Sayan (Chornaya Durgomzha, coll. L.V. Bardunov 26.IV.1961, MHA9110781) referred to this species. At the same time, several our specimens collected in different places at or above the upper limit of the forest zone, are smaller in size, have leaves ending in slender hair-point, regularly serrulate upper leaf margins, shorter setae which have a remarkable bright yellow color or are just a little reddish, young capsules also are yellow, and peristome teeth are straight in mature capsules. A deeper morphological study revealed additional differences between these morphotypes, mainly in morphometrics.

Therefore, we barcoded two specimens of the "alpine morphotype" (isolates TF53 MW9131306 and TF58 MW9131307), two specimens which we refer to *T. laureri* s.str. from the vicinities of Mondy settl. (isolates TF54 MW9131300 and TF59 MW9131354), and one specimen of *T. laureri* from Transbaikalia (isolate BF199, MHA9110782); for each specimen, nrITS and plastid *rps*4–*trn*S and *trn*MV were obtained. Sequences of plastid markers for the "typical morphotype" of *T.* cf. *laureri* from Mondy and Transbaikalia were identical, while those of "alpine morphotype" differed in several stable substitutions. Likewise, nrITS sequences were very close in TF54 and BF199, representing "typical mortphotype" (PV759588 and PV759587, two substitutions in ITS2) and remarkably distinct in TF53 and TF58, representing an "alpine morphotype" (PV759589 and PV759590). BLAST search revealed single ITS sequence of *T. laureri* represented in GenBank (JN544711, CBFS: Kucera-9218) as the closest to our original ITS sequences obtained from both morphotypes, but with different percent identity (96–97%), while further items in the list of BLAST output showed the percent identity lower than 92%. For the plastid markers, no data for *T. laureri* is represented in GenBank excepting *rps*4 sequence EU274608 (specimen_voucher="HIMC: X.L. Bai 3779"), which includes many uncertain characters and therefore cannot be used for assessing affinities based on such conservative marker. Thus, BLAST search for the closest *rps*4 sequences revealed *Pterygoneurum ovatum* sequence AY908038 as the closest to those obtained from the "typical morphotype" (98.48%), followed by those of *Pterygoneurum papillosum* (PQ587225, PQ587226), *Crossidium crassinervium* (PQ587216, PQ587217), and *Tortula hoppeana* (PQ587236), all five with percent identity of 98.11%. BLAST search for *rps*4 sequence of the "alpine morphotype" revealed the same sequences as closest with "*Pterygoneurum ovatum* AY908038" yielding percent identity 98.63 and that for five other accessions 98.26%. BLAST search for *trn*MV sequence of our "typical morphotype" revealed GenBank accessions *T. hoppeana* PQ587263 (97.18%) and *T. muralis* JQ890421 (96.89%) as closest, and the same sequences appeared closest to those obtained from the "alpine morphotype", both with the percent identity of 97.46.

Further assessment of similarity among the obtained sequences was performed using Mega 11 software, where following groups of sequences were introduced: "European *T. laureri*" (JN544711, CBFS: Kucera-9218) for ITS only; "Asian *T. laureri* typical morphotype" (BF199, TF54, TF59)", and "Asian *T. laureri* alpine morphotype" (TF53, TF58)". For nrITS, between group distance in the pair "European *T. laureri"* / "Asian *T. laureri* typical morphotype" was 0.0104, while in the pair "European *T. laureri"* / "Asian *T. laureri* alpine morphotype" it reached 0.0223, and in the pair "Asian *T. laureri* typical morphotype" / "Asian *T. laureri* alpine morphotype" 0.0203. Concatenation of plastid markers showed between group distance in the pair "Asian *T. laureri* typical morphotype" / "Asian *T. laureri* alpine morphotype" 0.0061 (i.e. ca. six substitutions per 1000 positions of the alignment). Thus, our sequence data shows a stable molecular differentiation between two groups in all-three markers and very weak (if any) differentiation within each of them. Therefore, below we describe the alpine plants of *T.* cf. *laureri* as a new species.

Tortula sayanensis Fedosov & Ignatova sp. nova. Fig. 3.

Diagnosis: In possessing a combination of bordered, partially bistratose leaf margins, papillose laminal cells, paired and fused at bases peristome teeth, and inclined to drooping capsules, the species resembles *T. cernua* and *T. laureri*. It differs from both these species in having leaves attenuate into a slender filiform point, partly filled by costa, bordered and regularly serrate upper leaf margins, and yellow setae and capsules; from *T. cernua* it

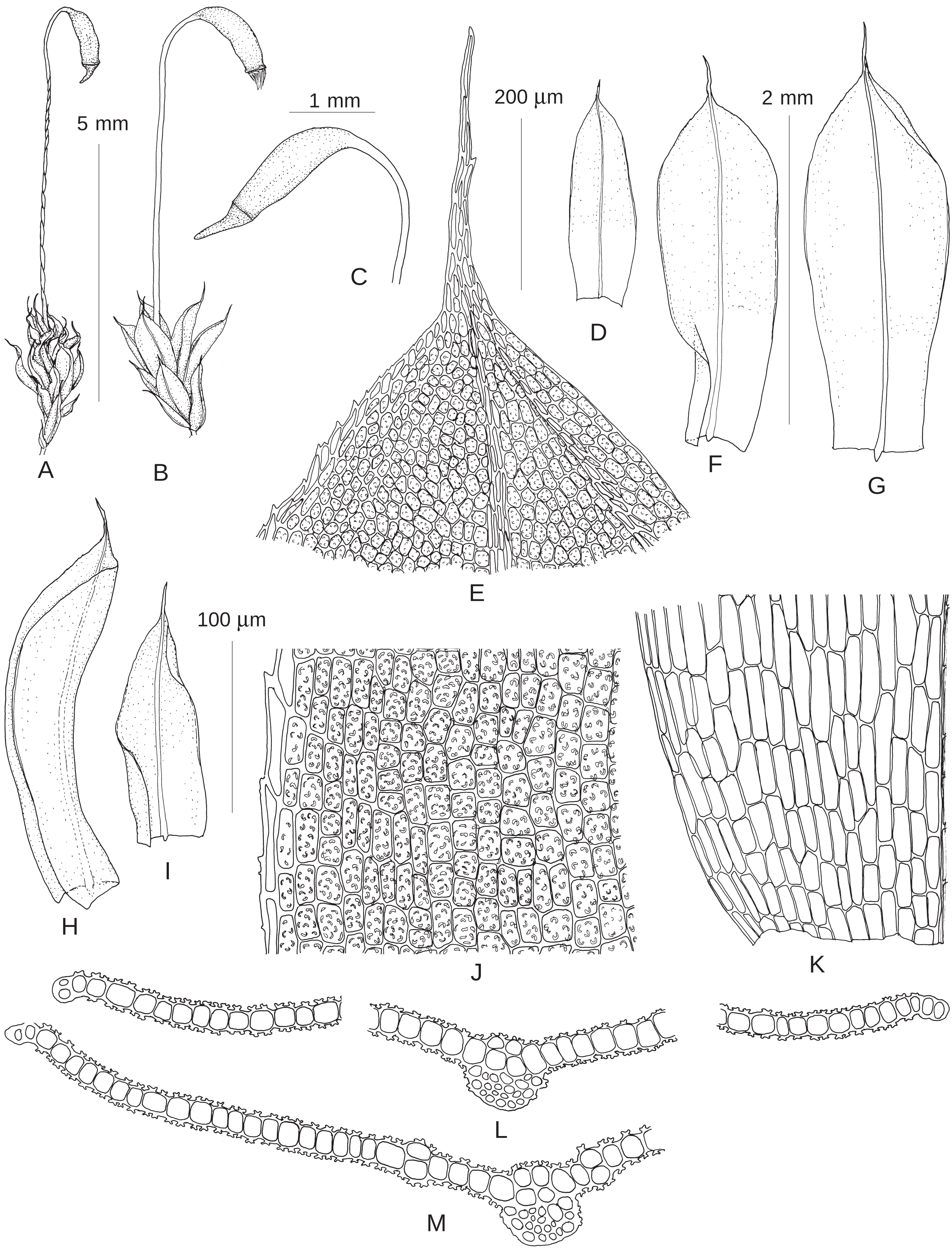


Fig. 3. *Tortula sayanensis* (from holotype). A: habit, dry; B: habit, wet; C: capsule; D, F–G, H–I: leaves; E: upper leaf cells; J: mid-leaf cells; K: basal leaf cells; L–M: leaf transverse sections. Scale bars: 5 mm for A–B; 2 mm for D, F–G, H–I; 1 mm for C; 200 µm for E, K; 100 µm for G, L–M.

also differs in having strongly papillose laminal cells and a weakly curved capsules on flexuose or arcuate setae, while from *T. laureri* it differs in smaller plant size, smaller laminal cells, weaker leaf border, and straight peristome teeth.

Type: Russia, The Republic of Buryatia, East Sayan Mountains, Tunkinsky Distr., "Tunkinskaya valley" National Park, vicinity of Mondy settl., Hulugayma Creek upper course, 51.735429N, 101.017443E, ca. 2150 m alt., alpine belt, rocks along dry brook bed, in shaded niche on finesoil. 16.VII.2023, *V.E. Fedosov 23-0058*. Holotype MW (MW9131307!). DNA: *trn*MV: PV170952, *rps*4: PQ593617, ITS PV759590.

Etymology: the species name refers to the name of the mountain system Sayany, where its type specimen was collected.

Description: *Plants* in loose tufts or groups, green or yellowish- to brownish-green. *Stems* up to 0.5 cm long, densely foliate in upper portion, with central strand. *Leaves* bent inwards or slightly flexuose to contorted when dry, spreading when wet, 1.3–1.6×0.5–0.65 mm, ovate, oblong to obovate, acute and attenuate into a slender filiform point 0.15–0.3 mm long partly filled with costa; *margins* plane or narrowly recurved at leaf base, entire in basal and middle leaf portion, serrate distally due to protruding cell angles, bordered by 1–3 rows of linear cells in basal and middle leaf portion, and elongate-rhomboid cells distally, cells of leaf border smooth, thick-walled, greenish or yellowish, in 1–2 layers proximally and 1 layer distally, reaching leaf apices; *costa* excurrent, with quadrate, papillose cells on ventral surface, elongate, smooth or weakly papillose cells on dorsal surface, mostly with 2 guide cells, dorsal stereid band, dorsal epidermis absent or weakly differentiated, and ventral epidermis differentiated; *lamina* unistratose, often with few bistratose patches; upper leaf cells 13–30×12–20 µm, rounded-quadrate or polygonal, with numerous, small, C-shaped or branched papillae, opaque; proximal leaf cells rectangular, 45–100(–140)×13–30 µm. *Goniautoicous*, perigonia well below perichaetia. *Setae* 0.4–0.7 cm, flexuose or cygneous, yellow, later brownish, rarely slightly reddish proximally. *Capsules* inclined, horizontal to pendent, 1–1.5 mm long, ovate to short cylindric, slightly asymmetric to nearly symmetric, straight to slightly curved, bright yellow. *Opercula* conic-rostrate. *Annuli* persistent. *Peristome teeth* up to 200 µm, arranged in pairs, fused at bases, straight, pale orange to reddish, papillose. *Spores* 27–35 µm.

Ecology and distribution: This species grows on fine soil in niches and crevices of basic rocks, mainly in the goltsy altitudinal zone (all samples from altitudes above 2000 m a.s.l.). It was collected in several places within the studied area and also in the Okinsky Distr. of Buryatia Republic in the course of the short-term field trip to the vicinity of Okinskie Lakes; also we revealed one specimen of *T. sayanensis* in the OP collection from Tyva Republic.

Differentiation: In combination of widely ovate to obovate, bordered leaves, densely papillose laminal cells, and inclined to pendent capsules, *T. sayanensis* resembles *T. laureri*; these two species are also close phylogenetically. Moreover, both species occur in the same area, although in somewhat different ecotopes: *T. laureri* was found in sheltered humid niches in forest zone, while *T. sayanensis* occurs in subalpine and alpine zones, growing in dry niches between rocks. Morphological differences of *T. sayanensis* include smaller size of plants, with leaves 1.3–1.6 mm long vs 3.5–5 mm in *T. laureri*; upper leaf cells 12–15 µm vs 17–40 µm; and setae 0.4–0.7 cm vs 1–1.5 cm. In *T. sayanensis,* smooth, thick-walled cells of the leaf border are in 1–3 rows, partly bistratose in one row, weakly inflated, reaching leaf apex; they become elongate-rhomboid distally, and their protruding upper angles form a regular serration. In *T. laureri,* cells of leaf border are in 3–5 rows in proximal part of leaves, more clearly inflated, bistratose in 1–2 rows, border disappears in the upper leaf portion, not reaching leaf apex; one or few teeth often occur near apiculus, but regular serrulation is absent. In *T. sayanensis,* upper leaf margins form a right angle at apex, and costae is excurrent as slender filiform point, while in *T. laureri* upper leaf margins form a wider angle, and leaves have short, attenuate, reflexed apiculi. Setae and young capsules in *T. sayanensis* are bright yellow vs reddish in *T. laureri,* and peristome teeth in *T. sayanensis* are shorter (up to 200 µm), straight vs reaching 350 µm, oblique in *T. laureri*. Superficially *T. sayanensis* may resemble *T. cernua*, which is very variable in size, capsule shape, degree of leaf lamina papillosity, and leaf border expression. However, in the latter species leaves have a sharp mucro, papillae occur mostly in distal leaf portion around the costa, gradually disappearing towards margins or absent; setae are straight, and both setae and capsules are dark brown, red to blackish.

Affinities: *T. sayanensis* is closely related to *T. laureri*, which sporadically occurs in South Siberian mountains from East Sayan to Transbaikalia.

Other specimens examined (paratypes): RUSSIA: **Republic of Buryatia**: (1) East Sayan Mountains, Tunkinsky Distr., "Tunkinskaya valley" National Park, vicinity of Mondy settl., upper limit of forest belt on southern slope of Hulugaisha Mt., 51.71789N, 101.00191E, ca. 2042 m alt., calcareous rock outcrops along the ridge, in rock niche. 10.VII.2023, *Fedosov s.n.* (MW). (2) Okinsky Distr., vicinity of Okinskie Lakes in the watershed of Oka and Irkut Rivers, northward the road Mondy-Orlik, 51.94012N, 100.65123E, ca. 2203 m alt., steep rocky slope with rock outcrops, in ledge on finesoil. 13.VII.2023, *Fedosov 23-0060* (MW9131306); Isolate TF53, DNA: *trn*MV PV170951, *rps*4 PQ593616, ITS PV759589. **Republic of Tyva**: Mongun-Taiga Distr., Mongun-Taiga Mt., NE-macroslope, Mugur River basin, 50.30905N, 90.21408E, 2760 m alt., *Dryas*-dominated tundra, on bare soil. 30.VII.2019, *Pisarenko* (NSK2010622). *Tortula laureri* specimens used for DNA study: Russia: Buryatia republic, Mondy settl. vicinity, 10.VII.2023, V.E. Fedosov, MW9131300. Isolate TF54, DNA: trnMV

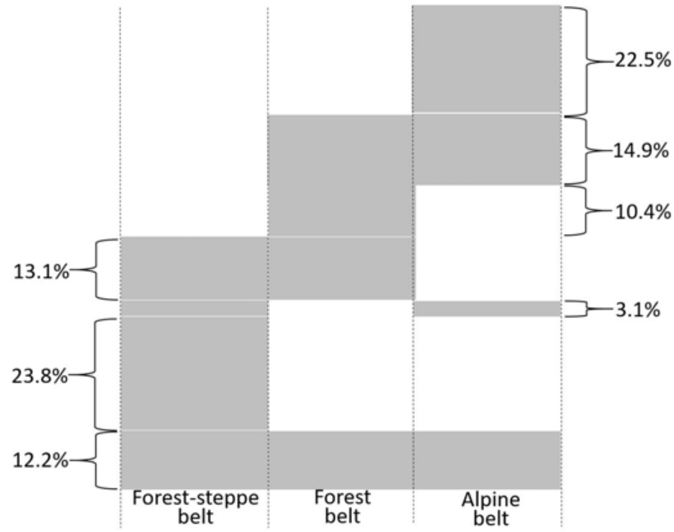


Fig. 4. Scheme of quantitative distribution of moss species by altitudinal zones in Mondy surroundings. The height of the grey column reflects the rate of species with corresponding distribution patterns.

PV170953, rps4 PQ593618, ITS PV759588. The same place and date, MW9131354. Isolate TF59, DNA: trnMV PV170954, rps4 PQ593619. Zabaikalsky Territory, Agin-Buryat Autonomous Area, Alkhanai National Park, rock outcrops near waterfall, 24.VII.2007, O.M. Afonina 8307 (MHA9110782). Isolate BF199, DNA: ITS PV759587.

***

Species distribution within the area

As a result of our survey completed within just 8 days, 329 moss taxa including one subspecies, *Oncophorus virens* ssp. *minor,* were revealed in the area. Twenty species are first reported for the Republic of Buryatia; this number includes several records considered separately earlier, such as *Schistidium chenii, S. transbaikalense, Weissia* cf. *exserta*, several species of *Didymodon* (Ignatova *et al.*, 2023a,b, 2024; Fedosov *et al.*, 2023). We did not collect twelve species reported for this territory by Bardunov (1965): *Calliergon cordifolium, Campylium protensum, Dicranum flagellare, Drepanocladus sendtneri, Fabronia ciliaris, Hamatocaulis vernicosus, Hygroamblystegium tenax, Meesia longiseta, Mielichhoferia mielichhoferiana, Pseudoleskeella tectorum, Seligeria trifaria,* and *Splachnum sphaericum*.

The list of mosses of Mondy surroundings (Table 1), is by no means exhaustive for the territory, but it already significantly exceeds the lists of the nearest local floras (Afonina & Tubanova, 2010; Dugarova *et al.,* 2022; Tubanova *et al.,* 2024). This may indicate a reasonable level of exploration and allow analyzing species distribution within the area and brief comparison with other lists of species published for Baikal Siberia. So, below we outline briefly the main trends, keeping in mind that the exact numbers may change slightly as research continues.

The species diversity is evenly distributed along the altitude profile, without decreasing in the drier forest-steppe altitudinal zone or increasing in the alpine zone: 171 species are registered in the forest-steppe zone, 166 in forest zone, and 173 in alpine zone. These numbers partly reflect nearly equal collecting effort devoted to each of these altitudinal zones, but also may be explained by natural reasons. Our data show remarkable species turnover among altitudinal zones. About 12% species were observed in all zones (Table 1, Fig. 4).

As many as 22.5% species are restricted to the alpine zone. Almost all of them have either arctic-alpine or alpine/montane distribution (*Arctoa glacialis, Bartramia ithyphylla, Brachythecium turgidum, Cinclidium arcticum, Conostomum tetragonum, Encalypta alpina, Grimmia reflexidens, Hymenoloma crispulum, Myurella tenerrima, Orthothecium chryseum, Polytrichastrum septentrionale, Racomitrium lanuginosum, Rhizomnium andrewsianum, Roaldia revoluta,* and also rare species *Andreaea heinemanii, Campylopus schimperi, Drepanocladus turgescens, Grimmia mollis, Oligotrichum falcatum, Schistidium agassizii, Tortella spitzbergensis, Tortula systilia*)*.* Interestingly, among the montane species restricted to the alpine zone, several species have in general more southern distribution and are found in the area on the northern limit of their ranges (*Pseudaongstroemia fuji-alpina, Brachytheciastrum leiopodium*, possibly also *Tortula sayanensis*, etc.). On the other hand, a number of typical arctic-alpine species occur in the area also in lower zones (*Arctoa blyttii, A. fulvella, Aulacomnium turgidum, Catoscopium nigritum, Cinclidium subrotundum, Didymodon asperifolius,* etc.). This might be explained by the fact that the altitudinal range within the area starts from ca. 1200–1300 m, where vegetation is formed under the influence of permafrost and temperature inversion.

About a quarter of species is limited to the forest-steppe zone (Table 1, Fig. 3). Most of them are xerophilous (*Aloina rigida, Crossidium squamigerum, Grimmia tergestina, Indusiella thianschanica, Jaffueliobryum latifolium, Pterygoneurum sibiricum, P. subsessile, Tortu-*

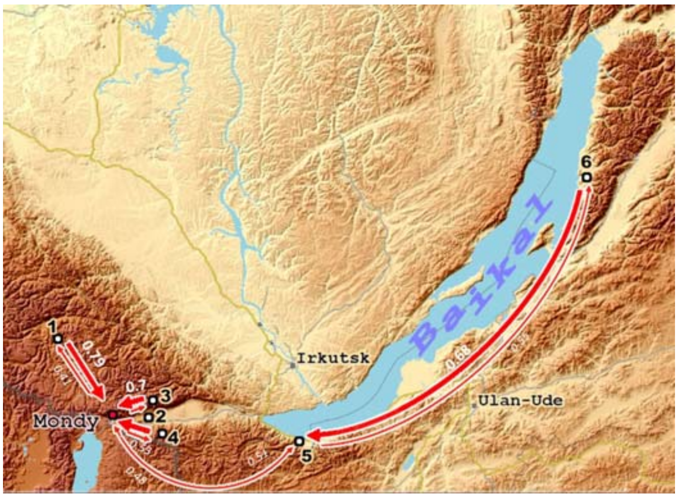


Fig. 5. Similarity of the moss flora of Mondy area and several local floras of cis-Baikal Region assessed through measures of mutual inclusion. The local moss floras used for the comparison are marked by numbers:

1. Zhakhna – Sorok upstreams, Eastern Sayan, Oka Upland (Afonina, 2009; Afonina & Tubanova, 2010) – 178 species;
2. Ikhe-Ugun downstreams in the vicinity Nilova Pustin' settlement, Eastern Sayan, Tunkinskaya valley (Afonina, 2021) – 162 species;
3. Yekhe-Ger–Shumak upstreams, Eastern Sayan, Tunkinsky range (Dugarova et al., 2022) – 185 species;
4. Sayan-Dzhida upland (Tubanova *et al*., 2024) – 239 species;
5. Snezhnaya – Mamai – Vydrinaya downstreams, Middle Khamar-Daban (Fedosov *et al*., 2022) – 313 species;
6. Barguzin Nature Reserve (Afonina *et al*., 2018) – 256 species.

la atrovirens, Weissia cf. *exerta,* etc.) or pioneer mosses occurring on alluvium and bare loamy ground (species of the genera *Aongstroemia, Barbula, Bryoerythrophyllum, Didymodon, Hydrogonium, Streblotrichum,* etc.). Also some ruderals are limited by the lower zone which undergoes higher disturbance by human activity. As for the species recorded in the forest zone, more than half of them also occur in one or both neighboring zones. The situation where the forest zone has the same or even lower diversity of mosses than the higher and lower-lying zones is not typical both for the Eastern Sayan (Bardunov, 1965) and for the other mountains of southern Siberia and the Far East (Bardunov, 1974; Pisarenko *et al.,* 2022; Pisarenko & Nozinkov, 2023). Indeed, less than quarter of listed species (Table 1, Fig. 4) were recorded in forest habitats, which is a low value for forest communities (Bardunov, 1992). This might be explained by low diversity of forests, absence of moist shaded forests of lower zone with hemiboreal species of herbs and bryophytes; most forests are open and, additionally, many earlier forested places were destroyed by fires and currently *Chamaenerion angustifolium* dominated communities with very sparse mosses dominate there, so such a low diversity of forest mosses is quite expectable. Low precipitation rate and absence or weak development of the tree species hosting diverse epiphytic sinusia (first of all, *Populus* and *Salix* species) also decrease the diversity of mosses in the forest zone.

Despite the quantitative similarities, species composition in the three altitudinal zones differs considerably. Although moss flora of larch forests and dry open steppe communities constituting the background vegetation in the area is rather poor, its overall diversity is unexpectedly high, first of all because of the high diversity of xeric, montane (including arctic-alpine), and pioneer species. The largest number of species is associated with rocky habitats, and more than half of them were not found in other types of habitats. Among the reasonable explanations, rather high diversity of rocks within the area seems most probable. The phenomenon of temperature inversion occurs in the studied area (Vasilenko & Voropay, 2015) and, apparently, it supports the existence of alpine species outside the highlands. Therefore, we consider the revealed species turnover along the altitudinal gradient to be caused mainly by the moisture gradient and availability of suitable substrates.

Phytogeographic consideration

When we attempted to compare studied local flora with those of nearby areas, very few lists of local flora appeared available in literature (Fig. 5, Table 2). Among the listed floras, those under the numbers 2 and 3 are located close to each other (at a distance of 15 km), covering different altitudinal zones, therefore we merged these two lists. Also we added our list by 8 species which were reported by Bardunov (1965) for this territory, and their presence here is very plausible, while *Drepanocla-*

Table 2. Measures of mutual inclusion between the moss flora of Mondy settl. surroundings and other local floras of Baikal area, cf. Fig. 4. The values are asymmetric similarity of areas: the ratio of the number of common species for each pair to the total number of species in each flora. DomInd is the prevalence index (Semkin et al., 2009), showing which flora in more 'inclusive'.

	0	1	2 & 3	4	5	6	[DomInd]	N species
0. Mondy	1.00	0.79	0.70	0.75	0.51	0.63	0.19	329
1. Zhakhna – Sorok upstreams	0.41	1.00	0.45	0.44	0.29	0.39	-0.23	178
2. Nilova Pustin' & 3. Yekhe-Ger–Shumak upstreams	0.56	0.68	1.00	0.70	0.51	0.54	0.03	269
4. Sayan-Dzhida upland	0.53	0.58	0.61	1.00	0.43	0.49	-0.07	239
5. Middle Khamar-Daban	0.48	0.51	0.59	0.58	1.00	0.68	0.11	313
6. Barguzin Reserve	0.48	0.55	0.51	0.52	0.55	1.00	-0.02	256

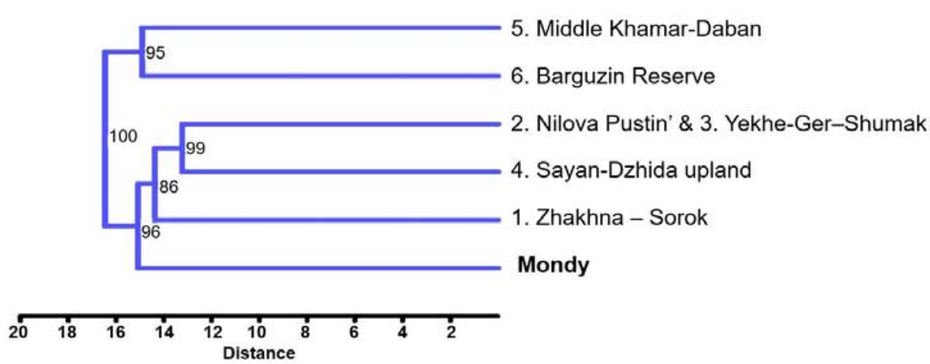


Fig. 6. Dendrogram of similarity of moss lists of the cis-Baikal region (UPGMA, Euclidean distance). Black numbers reflect bootstrap values calculated from the 100 pseudoreplications of the analysis.

dus sendtneri, Hygroamblystegium tenax, Mielichhoferia mielichhoferiana, and *Seligeria trifaria* were not included since we doubt if these records are correct.

The most diverse of the compared floras, of Mondy area and middle Khamar-Daban, demonstrate the least similarity: the measures of mutual inclusion are only 47–49% (Table 2, Fig. 4). It might be expected because these two areas represent opposite poles of the humidity gradient in Baikal Siberia, for which bryological data exist. Altitudinal range in Mondy starts from the values corresponding to the subalpine zone in Khamar-Daban where precipitation is ca. 4–5 times higher than in Mondy area. Moreover, northern slope of Khamar-Daban Range is known as an important refugium, where many Tertiary relicts may have persisted glacial events (Chepinoga *et al*., 2017). Many boreal and hemiboreal mosses concentrated in lower forest zone in the Middle Khamar-Daban do not penetrate into Tunkinskaya valley: *Anomodontopsis rugelii, Atrichum tenellum, Buxbaumia aphylla, Hedwigia nemoralis, Heterophyllium nemorosum, Hylocomiastrum umbratum, Plagiomnium drummondii, Rhytidiadelphus* spp., *Schistostega pennata, Sciuro-hypnum ornellanum*, *Thamnobryum neckeroides, Ulota rehmannii, etc*.

Contra wise, in the vicinity of Mondy we did not collect even such common boreal species as *Atrichum* spp., *Brachythecium rivulare, Dicranella heteromalla, Hylocomiadelphus triquetrus,* and *Tetraphis pellucida*, which were registered in lower parts of Tunkinskaya valley; probably, they do occur there but are very rare. Also, common thermophilous saxicolous mosses such as *Anomodon* species were not found in the area. Instead, in the vicinities of Mondy, many Arctic (including hypoarctic) and xeric mosses occur in the lower altitudinal zone.

Also in the subalpine and alpine zones of Khamar-Daban, many montane species sensitive to humidity occur, such as *Bucklandiella macounii* ssp. *alpinum*, *Coscinodon* spp., *Grimmia anomala, Kiaeria falcata, Lescuraea* spp., *Polytrichastrum sexangulare, etc.*, while in the upper altitudinal zones of Mondy area these species were not found; instead, other elements, mostly associated with Arctic or xeric continental climate contribute to the bryophyte diversity.

Other moss lists are largely included into these two: for Barguzin Reserve moss flora, the maximum inclusion measure is into the Khamar-Daban one, 67% (Table 2), while for the moss floras situated in Tunkinskaya valley and westward, in Oka River basin, the inclusion into the moss flora of Mondy is higher (69–77%); however, many species of these floras (23–31%) were not found in the Mondy area, which is the driest and the highest among four areas of the East Sayan cluster. The results of cluster analysis (Fig. 6) agrees with the obtained inclusion metrics in supported grouping species lists of Barguzinsky Reserve and Middle Khamar-Daban and placing four floras of East Sayan in another supported cluster.

As it was shown above, the moss flora of the Mondy settl. vicinity is very rich and very unusual in many respects. For example, the leading genus in terms of number of species is *Didymodon*, which could seem impossible few years ago. The genus *Sphagnum*, which typically is the most diverse in Holarctic moss floras, counts twice less species and is obviously underrepresented; moreover, among seven *Sphagnum* species found in the area, most were described recently, and their distribution remains insufficiently known. Due to a high elevation and harsh continental climate, thermophilous temperate or hemiboreal species are absent and, due to this reason, a number of species reflecting eastern and especially western phytogeographical connections is very low. However, along with the well pronounced negative specifics, unexpectedly high number of groups and species reflecting its positive specifics was revealed. Arctic, Arctic-montane and montane species are numerous, widespread and common throughout the altitudinal range, added by xerophyles in lower elevations. Another phytogeographic peculiarity of the studied flora is a very high proportion of species with Central Asian or predominantly Central Asian distribution. This group comprises many rare and insufficiently known species, such as *Didymodon* spp., *Leptopteryginandrum* spp., *Orthotrichum crenulatum, Pararhexophyllum sollmanianum, Pseudaongstroemia fuji-alpina, Schistidium chenii*, *Tortula sayanensis*, etc. (see comments to species); some of them were found to occur rather frequently in the area. At the same time, we did not collect several other Central Asian endemics, such as *Afoninia daurica, Pleuridium baicalense,* and *P. clausum*, which were expected in the Mondy surroundings. Earlier, a detailed bryofloristic exploration in xeric Kosh-Agach District of Altai, several areas of Tyva Republic, xeric areas of Buryatia southwards of Baikal Lake, Transbaikalia, and Yakutia brought numerous records of xeric Central Asian species, and our brief survey contributes to the understanding of composition and distribution of this poorly sampled phytogeographical element.

To sum up, unexpectedly high representation of "northern" Arctic, Hypoarctic or Arctic-alpine species combines here with that of "southern continental" xeric and montane species, while elements associated with forest vegetation (boreal, hemi-boreal, nemoral) are either underrepresented or absent. Similar unexpected combination of arctic, beringian and arid phytogeographical elements was mentioned as a unique peculiarity of Yakutian moss flora (Ignatova *et al*., 2018). In case of Mondy area, the moss flora is enriched by rare and insufficiently known Central Asian species, so we consider it as essentially Central Asian. Such combination seems to be rather typical for continental Asian mountains, where permafrost reaches the zone of subtropic deserts, supporting populations of Arctic and Arctic-alpine species. So, the field experience in these areas allows understanding how the Pleistocene cryoxeric biomes may have looked and what they were composed of.

Acknowledgements

We thank Alla Verkhozina (SIFIBR, SB RAS) for help with the field trip organization, Anna Shkurko (Tsitsin Main Botanical Garden, RAS) for identification our *Sphagnum* collection, Olga Afonina (Botanical Institute RAS) and Dolgor Tubanova (Institute of general and experimental biology, SB RAS) for helpful comments on the manuscript. The work was supported by the Russian Science Foundation project 23-14-00043 (field and laboratory work, sequencing). Herbarium collections in MW and NSK (USU 440537) are supported by 121032500090-7 and AAAA-A21-121011290026-9.

Literature Cited

[AFONINA, O.M.] АФОНИНА О.М. 2008. К флоре мхов Бурятии. – [To the moss flora of Buryatia] *Новости систематики низших растений* [*Novosti Sistematiki Nizshikh Rastenij*] **42**: *225–234*.

[AFONINA, O.M.] АФОНИНА О.М. 2021. Флора мхов Ниловой пустыни (Восточный Саян, Республика Бурятия). – [The moss flora of Nilova Pustin' (Eastern Sayan, Republic of Buryatia)] *Ботанический журнал* [*Botanicheskij Zhurnal*] **106**(10): *971–985*. https://doi.org/10.31857/S0006813621100021

[AFONINA, O.M. & D.YA. TUBANOVA] АФОНИНА О.М., Д.Я. ТУБАНОВА. 2010. К флоре мхов юго-западной части Бурятии (Восточный Саян). – [To moss flora of south-west part of Buryatia (East Sayan)] *Новости систематики низших растений* [*Novosti Sistematiki Nizshikh Rastenij*] **44**(2): *257–271.*

[AFONINA, O.M., V.YA. CHERDANTSEVA, E.A. IGNATOVA & M.S. IGNATOV] АФОНИНА О.М., В.Я. ЧЕРДАНЦЕВА, Е.А. ИГНАТОВА, М.С. ИГНАТОВ. 2010. *Symblepharis vaginata* (Dicranaceae, Bryophyta) – новый род и вид для флоры мхов России. – [*Symblepharis vaginata* (Dicranaceae, Bryophyta), a new genus and species for the moss flora of Russia] *Ботанический журнал* [*Botanicheskij Zhurnal*] **95**(12): *1765–1770.*

[AFONINA, O.M., I.V. CZERNYADJEVA, E.A. IGNATOVA & Yu.S. MAMONTOV] АФОНИНА, О.М., И.В. ЧЕРНЯДЬЕВА, Е.А. ИГНАТОВА, Ю.С. МАМОНТОВ. 2017. Мхи Забайкальского края. – [Mosses of Zabaikalsky Territory] *СПб.: Изд-во СПбГЭТУ "ЛЭТИ"* [*St. Petersburg, Publishing house of ETU*], *301 pp.*

AFONINA, O.M., I.V. CZERNYADJEVA & D.YA. TUBANOVA. 2018. Mosses of the Barguzin State Nature Reserve (Republic of Buryatia). – *Arctoa* 27: *140–156*. https://doi.org/10.15298/arctoa.27.14_1

AFONINA, O.M., O.D. DUGAROVA, V.E. FEDOSOV & D.YA. TUBANOVA. 2023. On the genus *Oncophorus* (Rhabdoweisiaceae, Bryophyta) in Russia. – *Novosti Sistematiki Nizshikh Rastenij* **57**(1): *123–142*. https://doi.org/10.31111/nsnr/2023.57.1.123

[ARZHANNIKOV, S.G., R. BRAUCHER, M. JOLIVET & A.V. ARZHANNIKOVA] АРЖАННИКОВ С.Г., Р. БРОШЕ, М. ЖОЛИВЕ, А.В. АРЖАННИКОВА. 2015. К вопросу о позднеплейстоценовом оледенении юга Восточного Саяна и выделении конечных морен MIS 2 на основе бериллиевого датирования (10 Be) ледниковых комплексов. – [Late Pleistocene glaciations in southern East Sayan and detection of MIS 2 terminal moraines based on beryllium (10Be) dating of glacier complexes] *Геология и геофизика* [*Geology & Geophysics*] **56**(11): *1917–1933.*

[BARDUNOV, L.V.] БАРДУНОВ Л.В. 1965. Листостебельные мхи Восточного Саяна. – [Mosses of the East Sayan Mts.] *М.- Л., Наука* [*Moscow-Leningrad, Nauka*]*, 160 pp.*

[BARDUNOV, L.V.] БАРДУНОВ Л.В. 1966. Новые подрод и вид мха из рода *Mielichhoferia* Hornsch. (Bryaceae) из Южной Сибири. – [New subgenus and species of moss from the genus *Mielichhoferia* Hornsch. (Bryaceae) from Southern Siberia] *Новости систематики низших растений* [*Novosti Sistematiki Nizshikh Rastenij*] **3:***326–330.*

[BARDUNOV, L.V.] БАРДУНОВ Л.В. 1974. Листостебельные мхи Алтая и Саян. – [Mossesof the Altai and Sayan Mts.] *Новосибирск, Наука* [*Novosibirsk, Nauka*], *168 pp.*

[BARDUNOV, L.V.] БАРДУНОВ Л.В. 1992. Очерк бриофлоры Сибири. – [An essay on the bryoflora of Siberia] *Новосибирск, Наука* [*Novosibirsk, Nauka*], *97 pp.*

[BARDUNOV, L.V.] БАРДУНОВ Л.В. 2008. Мохообразные. – [Bryophytes]. *В кн.: Красная Книга Российской Федерации (Растения и грибы), 1-е издание.* [*In: Red Data Book of the Russian Federation. Plants and fungi. 1st ed.*]: *599–662*.

[BROTHERUS, V.F. & L.I. SAVICZ] БРОТЕРУС В.Ф., Л.И. САВИЧ. 1932. Список мхов, собранных А.А. Еленкиным в 1902 году в Саянских горах и в Монголии. – [Bryophytes collected by A.A. Elenkin in 1902 in Sayan and Mongolia]. *Известия Ботанического сада АН СССР [Izvestiya Botanicheskogo Sada Akademii Nauk SSSR*] **30**(1–2): *81–95.*

CHEPINOGA, V.V., M.V. PROTOPOPOVA & V.V. PAVLICHENKO. 2017. Detection of the most probable Pleistocene microrefugia on the Northern macroslope of the Khamar-Daban Ridge (Southern Prebaikalia). – *Contemporary Problems of Ecology* **10**(1): *38–42*.

CHERDANTSEVA, V.YA., O.YU. PISARENKO, M.S. IGNATOV, E.A. IGNATOVA, V.E. FEDOSOV, S.V. DUDOV & V.A. BAKALIN. 2018. Mosses of the southern Russian Far East, an annotated check-list. – *Botanica Pacifica* **7**(2): *53–81*. https://doi.org/10.17581/bp.2018.07206

CZERNYADJEVA, I.V., O.I. KUZNETSOVA & M.S. IGNATOV. 2017. On *Pohlia saprophila* (Mielichhoferiaceae, Bryophyta). – *Arctoa* **26**(2): *181–186.*

[DUGAROVA, O.D., O.M. AFONINA & D.YA. TUBANOVA] ДУГАРОВА О.Д., О.М. АФОНИНА, Д.Я. ТУБАНОВА. 2022. К флоре мхов Тункинского хребта (Восточный Саян, Республика Бурятия). – [Contribution to the moss flora of the Tunka Range (Eastern Sayan, Republic of Buryatia)] *Новости систематики низших растений* [*Novosti Sistematiki Nizshikh Rastenij*] **56**(2): *441–461*. https://doi.org/10.31111/nsnr/2022.56.2.441

ECKEL, P.M. 1998. Re-evaluation of *Tortella* (Musci, Pottiaceae) in conterminous USA and Canada with a treatment of the European species *Tortella nitida*. – *Bulletin of the Buffalo society of natural sciences* **36**: *117–191.*

ELLIS, L.T., O. M. AFONINA, R. L. ANDRIAMIARISOA, G. ASTHANA, R. BHARTI, P. AYMERICH, B. BAMBE *et al*. 2018. New national and regional bryophyte records, 56. – *Journal of Bryology* **40**(3): *271–296.* https://doi.org/10.1080/03736687.2018.1487687.

FEDOSOV, V.E., G.YA. DOROSHINA, D.YA. TUBANOVA, O.M. AFONINA & E.A. IGNATOVA. 2017a. On four Orthotrichaceae species new for Russia. – *Arctoa* **26**(2): *154–165.*

FEDOSOV, V.E., A.V. FEDOROVA & E.A. IGNATOVA. 2017b. On the two poorly known *Orthotrichum* species from north Asia. – *Arctoa* **26**(2): *144–153.*

FEDOSOV, V.E., O.M. AFONINA, M.S. IGNATOV, E.A. IGNATOVA, S.G. KAZANOVSKY, O.I. KUZNETSOVA, YU.S. MAMONTOV *et al.* 2022a. Integrative floristics: a modern approach to biodiversity surveys in the molecular era, as applied to an expedition to the Khamar-Daban range, southern Siberia, Russia. – *Journal of Bryology* **44**(2):*107–133.* https://doi.org/10.1080/03736687.2022.2078767

FEDOSOV, V.E., A.V. FEDOROVA & E.A. IGNATOVA. 2022b. Integrative taxonomic revision of the genus *Campylopus* (Leucobryaceae, Bryophyta) in Russia. – *Arctoa* **31**(2): *205–222.*

FEDOSOV, V.E., A.V. FEDOROVA & E.A. IGNATOVA. 2023. *Weissia exserta* (Pottiaceae, Bryophyta) in Russia. – *Arctoa* **32**(2): *237–242.*

FEDOSOV, V.E., O.YU. PISARENKO, A.V. FEDOROVA, O.M. AFONINA & E.A. IGNATOVA. 2024. On the cryptic speciation in the mosses with East Asia–East North America disjunction: a case study of two poorly understood mosses from the southern extremity of the Russian Far East. – *Plants* **13**(24):*3558*. https://doi.org/10.3390/plants13243558

FEDOSOV, V.E., A.V. FEDOROVA, E.A. IGNATOVA, J.C. BRINDA & J. KUČERA. 2025. Overlooked and misunderstood: A morpho-molecular revision of Ditrichaceae s.str. (Dicranidae, Bryophyta), with a focus on the Holarctic species of *Ditrichum*. – *Taxon* **74**(2): *223–259*. https://doi.org/10.1002/tax.13298

FLATBERG, K.I., O.M. AFONINA, YU.S. MAMONTOV, V. E. FEDOSOV & E.A. IGNATOVA. 2016. On *Sphagnum mirum* (subgen. Squarrosa) and *S. olafii* (subgen. Acutifolia) (Sphagnaceae, Bryophyta) in Russia. – *Arctoa* **25**(1): *96–101.*

GARDINER, A., M. IGNATOV, S. HUTTUNEN & A. TROITSKY. 2005. On resurrection of the families Pseudoleskeaceae Schimp. and Pylaisiaceae Schimp. (Musci, Hypnales). – *Taxon* **54**: *651–663*.

GEISSLER, P. 1985. Notulae Bryofloristicae Helveticae II. – *Candollea* **40**: *193–200*.

[GROSSWALD, M.G.] ГРОСВАЛЬД М.Г. 1987. Последнее оледенение Саяно-Тувинского нагорья: морфология, интенсивность питания, подпрудные озера. – [The last glaciation of the Sayano-Tuvan Highlands: morphology, feeding intensity, and underground lakes] *В кн: Взаимодействие оледенения с атмосферой и океаном.* [*In: Interaction of glaciation with the atmosphere and ocean*] *М., Наука* [*Moscow, Nauka*]: *151–171*.

[GROSSWALD, M.G.] ГРОСВАЛЬД М.Г. 2003. Оледенения и вулканизм Саяно-Тувинского нагорья. – [Glaciation and volcanism of the Sayano-Tuvan highlands] *Известия АН. Серия географическая* [*Izvestiya Academii Nauk. Seriya geograficheskaya*] **2**: *83–92.*

HAMMER, O., D.A.T. HARPER & P.D. RYAN. 2001. PAST Paleontological Statistics Software Package for Education and Data Analysis. – *Palaeontologia Electronica* **4**, 9 pp.

HE, S. 2005. A revision of the genus *Leptopterigynandrum* (Bryopsida, Leskeaceae). – *Journal of the Hattori Botanical Laboratory* **97**:*1–38.*

HEDENÄS, L. 2017. Scandinavian *Oncophorus* (Bryopsida, Oncophoraceae): species, cryptic species, and intraspecific variation. – *European Journal of Taxonomy* **315**: *1–34*. https://doi.org/10.5852/ejt.2017.315

IGNATOV, M., T. TSEGMED, B. TAN, X. BAI & V. ZOLOTOV. 2004. Mosses of Gobi in Mongolia. – *Journal of the Hattori Botanical Laboratory* **96**: *193–210.*

IGNATOV, M.S., O.M. AFONINA, O.I. KUZNETSOVA & E.A. IGNATOVA. 2012. The genus *Leptopterigynandrum* (Taxiphyllaceae, Bryophyta) in Russia. – *Arctoa* **21**: *207–220.*

[IGNATOV, M.S., E.A. IGNATOVA, V.E. FEDOSOV, E.I. IVANOVA, H.H. BLOM, J. MUÑOZ, H. BEDHAREK-OCHYRA, O.M. AFONINA, L.E. KURBATOVA, I.V. CZERNYADJEVA & V.YA. CHERDANTSEVA] ИГНАТОВ М.С., Е.А. ИГНАТОВА, В.Э. ФЕДОСОВ, Е.И. ИВАНОВА, Х.Х. БЛОМ, И. МУНЬОС, Х. БЕДНАРЕК-ОХЫРА, О.М. АФОНИНА, Л.Е. КУРБАТОВА, И.В. ЧЕРНЯДЬЕВА, В.Я. ЧЕРДАНЦЕВА. 2017. Флора мхов России. Том 2. Oedipodiales – Grimmiales. – [Moss flora of Russia. Vol. 2: Oedipodiales – Grimmiales] *М., КМК* [*Moscow, KMK*], *560 pp*.

[IGNATOV, M.S., E.A. IGNATOVA, V.E. FEDOSOV, V.I. ZOLOTOV, T. KOPONEN, I.V.CZERNYADJEVA, G.YA. DOROSHINA, D.YA. TUBANOVA & N.E. BELL] ИГНАТОВ М.С., Е.А. ИГНАТОВА, В.Э. ФЕДОСОВ, И.В. ЗОЛОТОВ, Т. КОПОНЕН, И.В. ЧЕРНЯДЬЕВА, Г.Я. ДОРОШИНА, Д.Я. ТУБАНОВА, Н.Э. БЕЛЛ. 2018. Флора мхов России. Том 4. Bartramiales – Aulacomniales. – [Moss flora of Russia. Vol. 4: Bartramiales – Aulacomniales] *М., КМК* [*Moscow, KMK*], *543 pp*.

[IGNATOV, M.S., E.A. IGNATOVA, V.E. FEDOSOV, I.V. CZERNYADJEVA, O.M. AFONINA, A.I. MAKSIMOV, J. KUČERA, T.V. AKATOVA & G.YA. DOROSHINA] ИГНАТОВ М.С., Е.А. ИГНАТОВА, В.Э. ФЕДОСОВ, И.В. ЧЕРНЯДЬЕВА, О.М. АФОНИНА, А.И. МАКСИМОВ, Я. КУЧЕРА, Т.В. АКАТОВА. 2020a. Флора мхов России. Том 5. Hypopterygiales – Hypnales (Plagiotheciaceae – Brachytheciaceae). – [Moss flora of Russia. Vol. 5: Hypopterygiales – Hypnales (Plagiotheciaceae – Brachytheciaceae)] *М., КМК* [*Moscow, KMK*], *600 pp*.

IGNATOV, M. S., J. KUČERA, L. HEDENÄS, O.I. KUZNETSOVA & E.A. IGNATOVA. 2020b. A revision of the genus *Orthothecium* (Plagiotheciaceae, Bryophyta) in Northern Eurasia. – *Arctoa* **29**(1): *10– 48.*

[IGNATOV, M.S., E.A. IGNATOVA, V.E. FEDOSOV, O.M. AFONINA, I.V. CZERNYADJEVA, L. HEDENÄS & V.YA. CHERDANTSEVA] ИГНАТОВ М.С., Е.А. ИГНАТОВА, В.Э. ФЕДОСОВ, О.М. АФОНИНА, И.В. ЧЕРНЯДЬЕВА, Л. ХЕДЕНАС, В.Я. ЧЕРДАНЦЕВА. 2022. Флора мхов России. Том 6. Hypnales (Calliergonaceae – Amblystegiaceae). – [Moss flora of Russia. Vol. 6: Hypnales (Calliergonaceae – Amblystegiaceae)] М., *КМК* [*Moscow, KMK*], *472 pp*.

IGNATOVA, E.A., J. KUČERA, O.I. KUZNETSOVA & M.S. IGNATOV. 2013. First record of *Hydrogonium gregarium* (Pottiaceae, Bryophyta) in Russia: an interesting extension of the species' distribution to the heart of the permafrost zone. – *Polish Botanical Journal* **58**(2): *565–572.*

IGNATOVA, E. A., E. I. IVANOVA & M. S. IGNATOV. 2018. Moss flora of Sette-Daban Range (Yakutia). – *Arctoa* **27**(2): *119–130*.

IGNATOVA, E.A., O.I. KUZNETSOVA, V.E. FEDOSOV & M.S. IGNATOV. 2023a. An enigmatic species of *Schistidium* (Grimmiaceae, Bryophyta) from the Sayan mountains, Asian Russia. – *Arctoa* **32**(2): *189–198.*

IGNATOVA, E.A., E.M. RYZHOVA, O.I. KUZNETSOVA & M.S. IGNATOV. 2023b. Does *Schistidium marginale* occur in Asian Russia? – *Arctoa* **32**(2): *199–206*.

IGNATOVA, E.A., I.V. CZERNYADJEVA, A.V. FEDOROVA & V.E. FEDOSOV. 2024a. On the genus *Tortella* (Pottiaceae, Bryophyta) in Russian Arctic. – *Arctoa* **33**(2): *195–209.*

IGNATOVA, E.A., V.E. FEDOSOV, O.I. KUZNETSOVA, A.V. FEDOROVA & M.S. IGNATOV. 2024b. On the genus *Didymodon* s. str. (Pottiaceae, Bryophyta) in Russia. – *Arctoa* **33**(2): *129–155.*

IGNATOVA, E.A., V.E. FEDOSOV, A.V. FEDOROVA, O.I. KUZNETSOVA & M.S. IGNATOV. 2025. Two new species of *Didymodon* (Pottiaceae, Bryophyta) from Russia. – *Arctoa* **34**(1): *24–30.*

IVANOV, O.V., M.A. KOLESNIKOVA, O.M. AFONINA, T.V. AKATOVA, E.Z. BAISHEVA, O.A. BELKINA, A.G. BEZGODOV, I.V. *et al*. 2017. The database of the moss flora of Russia. – *Arctoa* **26**(1): *1–10.*

[KHOLBOEVA, S.A.] ХОЛБОЕВА С.А. 2011. Лесостепь Мондинской котловины (Восточный Саян). – [The forest-steppe vegetation of

Mondy hollow (East Sayan)] *Вестник Бурятского государственного университета. Биология, география.* [*Bulletin of the Buryat State University. Biology, geography*] **4**(a): *136–140*.

[KOVEL', L.V.] КОВЕЛЬ Л.В. 1989. Научно-прикладной Справочник по климату СССР. Серия 3. Многолетние данные. Бурятская АССР, Читинская область. – [Scientific and applied climate reference book of the USSR. Series 3. Long-term data. Buryat Autonomous Soviet Socialist Republic, Chita Province] *СПб, Гидрометеоиздат* [*Saint-Petersburg, Gidrometeoizdat*], *550 pp*.

KÖCKINGER, H. & L. HEDENÄS. 2023. The supposedly well-known carbonate indicator *Tortella tortuosa* (Pottiaceae, Bryophyta) split into eight species in Europe. – *Lindbergia* 2023: e24903 [*1–35*]. https://doi.org/10.25227/linbg.24903

KUČERA, J., J. KOŠNAR & O. WERNER. 2013. Partial generic revision of *Barbula* (Musci: Pottiaceae): Re-establishment of *Hydrogonium* and *Streblotrichum*, and the new genus *Gymnobarbula*. –*Taxon* **62**(1): *21–39.*

KUČERA J., P. SOLLMAN, O.M. AFONINA, E.A. IGNATOVA, V.E. FEDOSOV, J.R. SHEVOCK, D.YA. TUBANOVA & M.S. IGNATOV. 2020. Range extensions for *Bryoerythrophyllum sollmanianum* and *Tortula yuennanensis* (Pottiaceae, Musci) with reconsideration of their phylogenetic affinities including *Pararhexophyllum*, gen. nov. – *Nova Hedwigia* **150**: *273–292*. https://doi.org/10.1127/nova-suppl/2020/273

[LOGACHEV, N.A.] ЛОГАЧЕВ Н.А. 1958. Кайнозойские континентальные отложения котловин байкальского типа. – [Cenozoic continental deposits of Baikal-type basins] *Известия АН СССР. Серия геологическая* [*Izvestiya Akademii Nauk SSSR. Geologicheskaya seriya*] **4**: *18–29*.

[LUNINA, O.V.] ЛУНИНА О.В. 2016. Цифровая карта разломов для плиоцен-четвертичного этапа развития земной коры юга Восточной Сибири и сопредельной территории Северной Монголии. – [The digital map of the Pliocene-Quaternary crustal faults in the southern East Siberia and the adjacent Northern Mongolia] *Геодинамика и тектонофизика* [*Geodynamics & Tectonophysics*] **7**(3): *407–434*. https://doi.org/10.5800/GT–2016–7–3–0215.

[MAKRY, T.V. & S.G. KAZANOVSKY] МАКРЫЙ Т.В., С.Г. КАЗАНОВСКИЙ. 2002. Новые находки *Megadenia bardunovii* M. Pop. в Тункинской долине. – [New findings of *Megadenia bardunovii* M. Pop. in the Tunka Valley] *В кн.: Проблемы ботаники Южной Сибири и Монголии. Материалы международной конференции, Барнаул* [*In: Problems of botany of Southern Siberia and Mongolia. Materials of the international conference, Barnaul*]: *42–44*.

[MALYSHEV, L.I.] МАЛЫШЕВ Л.И. 1963. Растительность Восточного Саяна в пределах Бурятской АССР. – [The vegetation of the Eastern Sayan mountains within the boundaries of the Buryat Autonomous Soviet Socialist Republic] *В кн.: Научные чтения памяти М.Г. Попова (ред. Малышев Л.И.) V. Иркутск: Иркутское книжное изд-во* [*In: Malyshev L.I. (ed.) Scientific readings in memory of M.G. Popov. V. Irkutsk, Irkutsk Book Publishing House*]: *3–47*.

[MALYSHEV, L.I., V.M. DORON'KIN, V.V. ZUEV, N.V. VLASOVA, O.D. NIKIFOROVA, S.V. OVCHINNIKOVA, K.S. BAJKOV *et al*.] МАЛЫШЕВ Л.И., В.М. ДОРОНЬКИН, В.В. ЗУЕВ, Н.В. ВЛАСОВА, ОД. НИКИФОРОВА, СВ. ОВЧИННИКОВА, К.С. БАЙКОВ и др. 2012. Конспект флоры Азиатской России: Сосудистые растения. – [Conspectus florae Rossiae Asiaticae: plantae vasculares] *Новосибирск: Изд-во СО РАН* [*Novosibirsk, Izdatelstvo Sibirskogo otdelenia Akademii Nauk*]*, 640 pp.*

[MATSERA, A.V.] МАЦЕРА А.В. 1993. Рельефообразующая роль оледенения Восточного Саяна. – [The relief-forming role of the glaciation of the Eastern Sayan] *Геоморфология* [*Geomorphologiya*] **3**: *84–92*.

NEMCHINOV, V.G., R.T. BUDAEV & I.N. REZANOV. 1999. Pleistocene glaciations of the eastern Sayan Mountains – *Antropozoikum* **23**: *11–15.*

[OBRUCHEV, V.A.] ОБРУЧЕВ В.А. 1931. Признаки ледникового периода в Северной и Центральной Азии (Исторический очерк и сводка наличных данных). – [Signs of an Ice Age in Northern and Central Asia (Historical review and summary of available data)]. Бюллетень комиссии по изучению четвертичного периода [Bulletin de la commission pour l'etude du Quaternaire] **3**: *43–101.*

[OLYUNIN, V.N.] ОЛЮНИН В.Н. 1965. Неотектоника и оледенение Восточного Саяна. – [Neotectonics and glaciation of the Eastern Sayan] *М., Наука* [*Moscow, Nauka*], *128 pp*.

[PISARENKO, O. YU. & A.E. NOZINKOV] ПИСАРЕНКО О.Ю., А.Е. НОЖИНКОВ. 2023. Листостебельные мхи. – [Mosses] *В кн.: Флора Кемеровской области (ред. Шереметова С.А.)* [*In: Sheremetova, S.A. (ed.) Flora of the Kemerovo Province*] *Новосибирск: издательство СО РАН* [*Novosibirsk: Izdatelstvo Sibirskigo otdelenia Akadademii Nauk*]: *454–461.*

PISARENKO, O. YU., V.E. FEDOSOV, K.A. KORZNIKOV, A.V. SHKURKO & E.A. IGNATOVA. 2022. The moss flora of the Badzhal Mountain Range (Khabarovsk Territory, Russian Far East). – *Botanica Pacifica* **11**(1): *98–114*. https://doi.org/10.17581/bp.2022.11105

[SAMBURG, A.L.] САМБУРГ А.Л. 1971. Объяснительная записка к геологической карте СССР (масштаб 1:200000). Серия Восточно-Саянская. Лист M-48-I. – [Explanatory note to the geological map of the USSR (scale 1:200000). The East Sayan series. Sheet M-48-I] *М* [*Moscow*], *90 pp.*

SANDANOV, D.V. & O.YU. PISARENKO. 2018. Bioclimatic modeling of *Crossidium squamiferum* (Viv.) Jur. (Pottiaceae, Bryophyta) distribution. – *Arctoa* **27**: *29–34.*

[SAVICZ-LYUBITSKAYA, L.I. & Z.N. SMIRNOVA] САВИЧ-ЛЮБИЦКАЯ Л.И., З.Н. СМИРНОВА. 1970. Определитель листостебельных мхов СССР. Верхоплодные мхи. – [Handbook of mosses of the USSR. The acrocarpous mosses] *Л., Наука* [*Leningrad, Nauka*]*, 822 pp.*

[SEMKIN, B.I. & T.A. KOMAROVA] СЁМКИН Б.И., Т.А. КОМАРОВА. 1977. Анализ фитоценотических описаний с использованием мер включения (на примере растительных сообществ долины реки Амгуэмы на Чукотке). – [Analysis of phytocenotic descriptions using inclusion measures (on the example of plant communities of the Amguema River valley in Chukotka)] *Ботанический Журнал* [*Botanicheskij Zhurnal*] **62**(1): *54–63*.

[SEMKIN, B.I., A.P. ORESHKO & M.V. GORSHKOV] СЁМКИН Б.И., А.П. ОРЕШКО, М.В. ГОРШКОВ. 2009. Об использовании биоинформационных технологий в сравнительной флористике II. Меры включения дескриптивных множеств и их использование . – [On the use of bioinformation technologies in comparative floristic studies. II. Measures of inclusion of descriptive sets and their application] *Бюллетень Ботанического сада-института ДВО РАН* [*Bulletin of the BGI FEB RAS*] **4**: *58-70.* http://botsad.ru/media/oldfiles/journal/number4/number4_58-70.pdf

[SHCHETNIKOV, A.A.] ЩЕТНИКОВ А.А. 2016. Морфотектоника Юго-Западного Прибайкалья и Прихубсугулья. – [Morphotectonics of the south-western cis-Baikal and cis-Hovsgol] *Известия Сибирского отделения РАЕН. Геология, поиски и разведка рудных месторождений.* [*Izvestiya Sibirskogo otdelenija RANS. Geologija, poiski i razvedka rudnyh mestorozhdenij*] **56**: *134–143*. https://doi.org/10.21285/0130-108X-2016-56-3-134-143.

SHKURKO, A.V., O.I. KUZNETSOVA & V.E. FEDOSOV. 2023. *Sphagnum warnstorfii* complex in Northern Asia. – *Arctoa* **32**(2): *176–188*.

SIMMONS, M.P.& H. OCHOTERENA. 2000. Gaps as characters in sequence-based phylogenetic analyses. – *Systematic Biology* **49**: *369–381.*

[SOCHAVA, V.B. (ed.)] СОЧАВА В.Б. (отв. ред.) 1967. Атлас Забайкалья (Бурятская АССР и Читинская область). – [Atlas of Transbaikalia (Buryat Autonomous Soviet Socialist Republic and Chita Province)] *М.-Иркутск, ГУГиК* [*Moscow, Irkutsk, Glavnoe upravlenie geodezii i kartografii*], *176 pp.*

[SOCHAVA, V.B., V.A. RYASHIN & A.V. BELOV] СОЧАВА, В.Б., В.А. РЯШИН, А.В. БЕЛОВ. 1963. Главнейшие природные рубежи в южной части Восточной Сибири. – [The main natural boundaries in the southern part of Eastern Siberia] *Доклады Ин-та географии Сибири и Дальнего Востока* [*Reports of the Institute of Geography of Siberia and the Far East*] **4**: *19–24*.

SOFRONOVA, E.V. (ed.), O.M. AFONINA, E.A. BOROVICHEV, M.A. BOYCHUK, G.YA. DOROSHINA, V.E. FEDOSOV, M.S. IGNATOV et al. 2017. New bryophyte records. 9. – *Arctoa* **26**(2): *214–227.*

SOLLMAN, P., J. KUČERA, J.R. SHEVOCK, W.Z. MA & D.G. LONG. 2020. Additions and taxonomic insights regarding several rarely or newly reported Pottiaceous mosses of China primarily from the Hengduan Mountains, Easternmost Himalayas. – *Chenia* **14**: *1–44*.

[SUMGIN, M.I.] СУМГИН М.И. 1937. Вечная мерзлота почвы в пределах СССР. – [Permafrost of the soil within the USSR] *М.-Л., Изд-во АН СССР* [*Moscow, Leningrad, Izdatelstvo Akademii Nauk SSSR*], *380 pp.*

TAMURA, K., G. STECHER & S. KUMAR. 2021. MEGA11: Molecular Evolutionary Genetics Analysis version 11. – *Molecular Biology and Evolution* **38**:3022-3027. doi:10.1093/molbev/msab120

[TUBANOVA, D.YA., YU.S. MAMONTOV, O.M. AFONINA & A.D. POTEMKIN] ТУБАНОВА Д.Я., Ю.С. МАМОНТОВ, О.М. АФОНИНА, А.Д. ПОТЕМКИН. 2017. Новые и редкие виды мхов и печёночников во флоре Республики Бурятия. – [New and rare species in the moss and liverwort flora of the Republic of Buryatia)] *Ботанический журнал* [*Botanicheskij Zhurnal*] **102**(10): *1442–1454.*

[TUBANOVA, D.YA., O.M. AFONINA & O.D. DUGAROVA] ТУБАНОВА Д.Я., О.М. АФОНИНА, О.Д. ДУГАРОВА. 2024. К флоре мхов Тункинского национального парка (Саяно-Джидинское нагорье, Республика Бурятия). – [To the moss flora of the Tunka National Park (Sayan-Dzhida upland, Republic of Buryatia)] *Ботанический журнал* [*Botanicheskij Zhurnal*] **109**(2):*111–131.* https://doi.org/10.31857/S0006813624020014

[UFIMTSEV, G.F.] УФИМЦЕВ Г.Ф. 1992. Морфотектоника Байкальской рифтовой зоны. – [Morphotectonics of the Baikal rift zone]. *Новосибирск, Наука* [*Novosibirsk, Nauka*], *215 pp.*

[UFIMTSEV, G.F., A.V. PEREVALOV, V.P. REZANOVA, N.V. KULAGINA, I.M. MASHCHUK, A.A. SHCHETNIKOV, I.N. REZANOV & I.V. SHIBANOVA] УФИМЦЕВ Г.Ф., А.В. ПЕРЕВАЛОВ, В.П. РЕЗАНОВА, Н.В. КУЛАГИНА, И.М. МАЩУК, А.А. ЩЕТНИКОВ, И.Н. РЕЗАНОВ, И.В. ШИБАНОВА. 2003. Радиотермолюминесцентное датирование четвертичных отложений Тункинского рифта. – [Radio thermo luminescence dating of Tunka rift Quaternary sediments] *Геология и геофизика* [*Geology & Geophysics*] **44**(3): *226–232.*

[VASILENKO, O.V. & N.N. VOROPAY] ВАСИЛЕНКО О.В., Н.Н. ВОРОПАЙ. 2015. Особенности формирования климата котловин юго-западного Прибайкалья. – [Peculiarities of climate formation in the depressions of the southwestern Pribaikal'e]. *Известия РАН. Серия географическая* [*Izvesiya RAN, serija geograficheskaya*] **2015**(2): *104–111*.

[YURTSEV, B.A.] ЮРЦЕВ Б.А. 1968. Флора Сунтар-Хаята. Проблемы истории высокогорных ландшафтов Северо-Востока Сибири. – [Flora of Suntar-Hayata. Problems of the history of the high-altitude landshafts of the North-East of Siberia] *Л., Наука* [*Leningrad, Nauka*], *235 pp*.

ZANDER, R. 1977. The tribe Pleuroweisieae (Pottiaceae, Musci) in Middle America. – *The Bryologist* **80**(2): *233–269.*

[ZVEREV, A.A.] ЗВЕРЕВ А.А. 2007. Информационные технологии в исследованиях растительного покрова. – [Information technologies in studies of plant cover] *Томск, ТМЛ-Пресс* [*Tomsk, TML Press*], *304 pp.*

Received 3 March 2025 *Accepted 31 May 2025*

Supplementary materials 1. GPS points of studied localities
https://kmkjournals.com/upload/PDF/Arctoa/34/34_1_01_SM.pdf