

MOSESSES OF THE BYSTRINSKY NATURE PARK
(КАМЧАТКА PENINSULA, RUSSIAN FAR EAST)

МХИ БЫСТРИНСКОГО ПРИРОДНОГО ПАРКА
(ПОЛУОСТРОВ КАМЧАТКА, ДАЛЬНИЙ ВОСТОК)

I.V. CZERNYADJEVA¹ & E.A. IGNATOVA²

И.В. ЧЕРНЯДЬЕВА¹, Е.А. ИГНАТОВА²

Abstract

Annotated list of mosses of Bystrinsky Nature Park is presented. It includes 292 species and 13 intraspecific taxa, 19 of them are recorded for Kamchatka for the first time. Data on distribution, ecology and phytocoenology are provided.

Резюме

Впервые публикуется полный аннотированный список мхов Быстринского природного парка, включающий 292 вида и 13 внутривидовых таксонов, из них 19 указываются впервые для Камчатки. Приводятся данные по встречаемости видов, их экологии и ценологии.

KEYWORDS: mosses, flora, biodiversity, Russia, Kamchatka, Bystrinsky Park

INTRODUCTION AND STUDY AREA

Bystrinsky Nature Park is located in the central part of the Sredinnyi Ridge in the Kamchatka Peninsula, covering the area of 13340 sq. km. The Sredinnyi Ridge stretches in north-east direction across the whole peninsula as an “axis” of Kamchatka. It is a large mountain-volcanic system with average elevations of 1200-1400 m a. s. l.; the highest point being the Ichinsky volcano, 3621 m. Relief is represented by alpine and middle-alpine ranges, table-like mountains, different volcanic constructions and lava plateaus intersected by river valleys. The range has denudation-volcanogenic-tectonic origin and includes a number of Quaternary volcanic constructions. Besides, accumulative and sculptural forms of relief originated during two periods of the late-Pleistocene glaciation (Braitzeva et al., 1968) are well represented. Effusives formed by andesites and basalts occur in the region as well. Mountain tops in the area of the national park are flat and leveled, slopes are often steep. Ancient mountain plateaus are intersected by the river val-

leys of tectonic origin, such as the Anavgai and Bystraya River valleys. Volcanic constructions are represented, first of all, by the young Ichinsky Volcano, which has a perfect conic shape, and also by older and more destroyed volcanoes – Anaun and Alnei. Volcanic activity finished before the last glaciation in the most parts of the Sredinnyi Range (Lyubimova, 1961; Lobkov, 1999).

The climate of the region is moderate-continental. Annual precipitation is about 300-400 mm. Mean annual temperature at the elevation of 1000 m a.s.l. is about -3°C, mean diurnal temperature is minimal in January (-18– -20°C), and is maximal in July (+12– +14°C). The depth of snow cover is around 1m. Growing season lasts for about 50-60 days. Light frosts are possible during the whole vegetative season (Lobkov, 1999; Scientific-applied..., 2001). Soils of the Bystrinsky national park are classified as volcanic and high permeability to water and good aeration. Soil pH varies from slightly acidic to acidic. Permafrost and seasonally frozen ground stipulate the deve-

¹ — V. L. Komarov Botanical Institute, Russian Academy of Sciences, Prof. Popov Str., 2, St. Petersburg, 197376 Russia – Россия 197376, Санкт-Петербург, ул. Проф. Попова, 2, Ботанический институт им. В. Л. Комарова РАН; e-mail: le-bryo@mail.ru

² — Biological Faculty, Moscow State University, Moscow 119991 Russia – Россия 119991, Москва, Московский государственный университет, Биологический факультет; e-mail: arctoa@list.ru.

Table 1. Collecting localities of mosses in the Bystrinsky Nature Park on the Sredinnyi Range of Kamchatka (see also Fig. 1):

- 1 – western slope of Alnej volcano, valley of Shirokij glacier, 56°39'N, 159°29'E, alt. 1000-1600 m;
- 2 – 35 km north from Esso Settlement, Bystraya River valley, 55°56'N, 159°16'E, alt. ca. 240 m;
- 3 – 20 km north from Esso Settlement, Bystraya River valley, 56°02'N, 159°03'E, alt. ca. 270 m;
- 4 – vicinity of Esso Settlement, 55°56'N, 158°41'E, ca. 300-1600 m;
- 5 – 20 km south from Esso Settlement, middle course of Irakan River, 55°49'N, 158°16'E, ca. 900-1000 m;
- 6 – Sredinnyi Range, Anauna River (Persson, 1970);
- 7 – south-eastern slope of Ichinsky volcano, Arbunat Lake, 55°32'N, 157°37'E, ca. 800-1100 m.

lopment of cryogenic microrelief and re-distribution of moisture (Sokolov, 1973).

VEGETATION

Altitudinal vegetation belts are clearly expressed. Forest, elfin wood and mountain tundra belts are distinguished. Mountain slopes up to the altitude of 500-700 m a.s.l. are covered with larch and stone-birch forests. Herb and herb-moss types of forest are the most common. *Populus*, *Chosenia*, *Salix*, *Alnus* flood-plain forests occur along in the floodplains, often forming mixed stands. In the field layer *Calamagrostis* and herbs predominate.

In the middle parts of the mountain slopes at the altitude of about 700-900 m. *Alnus fruticosa* and *Pinus pumila* elfin woods, or 'stlannik', form dense cover. In the lower part of this elfin wood belt, larch and stone-birch scattered stands occur, while at its upper boundary elfin woods is alternated with fragments of mountain tundra. Above 900-1100 m a.s.l. different types of mountain tundra occur. Mountain tundra vegetation is characterized by complex composition and heterogeneity. The most common types include dwarf-shrub tundra with the dominance of *Diapensia obovata*, *Dryas punctata*, *Empetrum nigrum*, *Rhododendron camtschaticum*, *Salix reptans*, *S. reticulata*, *Vaccinium uliginosum*, etc. with different participation of herbs, sedges, lichens and mosses (vascular plant Latin names are given according to Yakubov & Chernyagina, 2004). In the most extreme conditions, at the altitude over 1400-1500 m, the role of dwarf-shrubs decreases and lichens dominate. In the mesic conditions the abundance of mosses increases, and different variants of dwarf-shrub-lichen-moss, dwarf-shrub-moss or herb-dwarf-shrub-moss tundras prevail. Wet places are occupied by boggy tundras with the dominance of willows, sedges, cotton-grass and moss-

es in different combinations; hummocky sedge-cotton-grass tundras also occur. Nival communities are developed near permanent and late snow beds; they are usually dominated by dwarf-shrubs and mosses, but nival herb meadows are also common. Above 1500-1600 m, a barren gravely ground with separate fragments of vegetation is prevailing. Places with meadow vegetation occur in all the belts. Tall herbs communities are extensive in floodplains, where *Calamagrostis* meadows occur as well. Subalpine meadow-like communities include: *Calamagrostis*-herb meadow-like communities occur in the elfin wood belt, and sedge-herb-dwarf-shrubs communities in the mountain tundra belt (Lyubimova, 1961; Lobkov, 1999; Neshataeva, 2006).

HISTORY OF EXPLORATION

The first small collection of mosses in the territory of Bystrinsky Nature Park was made in Anaun River by Swedish entomologist R. Malaese. It was identified by H. Möller and H. Persson, who published data on 14 moss species (Möller, 1927; Persson, 1970). Later the region of Esso was explored by Cherdantzeva and Osipov, who reported 56 mosses for this area (Cherdantseva, 1993; Cherdantseva & Osipov, 1998). Also three additional species from Esso were reported by Fedosov (2006). The first author, IC, extensively collected in several areas in the park in 2001, 2003 and 2007 (Fig. 1). Totally more than 2500 moss samples were collected and identified. Also Chernyadjeva identified mosses collected by V.A. Bakalin from the valley of Shiroky glacier at the western slope of the volcano Alnei. Some rather widely distributed species were included in the checklist of mosses of the Kamchatka Peninsula (Chernyadjeva, 2005), while the complete list of mosses of the Bystrinsky Nature Park is presented here.

LIST OF SPECIES

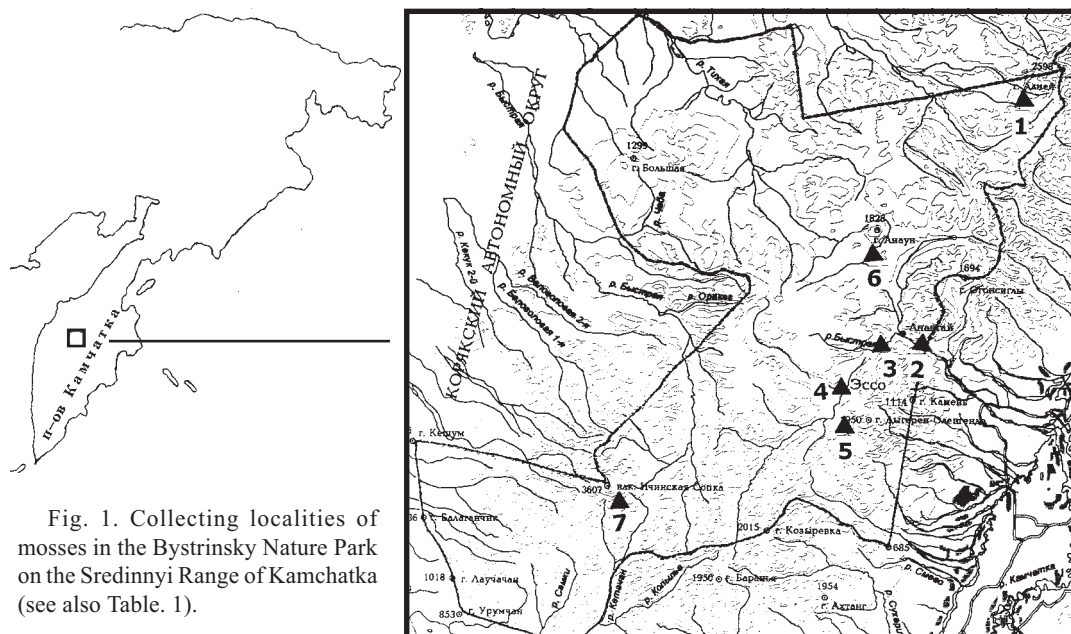


Fig. 1. Collecting localities of mosses in the Bystrinsky Nature Park on the Sredinnyi Range of Kamchatka (see also Table. 1).

The list includes all records confirmed by herbarium specimens, as well as literature records. The species for which only the data from publications are available are marked by asterisk.

Species are annotated by their frequency (Rar – 1-4 records, Spar – 5-9 records, Com – more than 10 records); localities (according to Table 1 and Fig. 1); substrates and types of vegetation; altitude; sporophytes, if present (S+).

In some cases associated species are listed. Local abundance is also indicated for species with a pronounced role in vegetation. Species names are given according to Ignatov et al. (2006).

Abietinella abietina (Hedw.) M. Fleisch. – Com. 2, 3, 4. On soil among herbs and on bare soil, on rocks covered with soil: rock outcrops, rock-fields, subalpine meadows, alder elfin woods; on river banks; on decayed wood in larch forests and poplar flood-plain forests. 280-700 m. Rarely abundant.

Amblystegium serpens (Hedw.) Bruch et al. – Com. 3, 4. On decayed wood and at trunk bases in flood-plain forests; on stream banks. 270-500 m. S+.

Amphidium lapponicum (Hedw.) Schimp. – Spar. 4, 7. On rock surface, on rocks covered with soil and in rock crevices: low bush tundras and *Pinus pumila* elfin woods, rock-fields, rock outcrops. 800-850 m. S+.

Anacamptodon latidens (Besch.) Broth. – Rar. 7. At trunk bases in stone-birch forest. 950 m. S+.

Andreaea nivalis Hook. – Rar. 7. On rock in nival com-

munity. 1100 m.

A. rupestris Hedw. var. *rupestris* – Com. 1, 4, 5, 7. On rocks in dwarf shrub-lichen tundras; on rock outcrops and rock-fields; on bare soil in nival community. 830-1600 m. S+.

A. rupestris var. *papillosa* (Lindb.) Podp. – Spar. 4, 5, 7. On rocks: dwarf-shrub-lichen tundras, rock-fields and *Pinus pumila* elfin woods. 800-1400 m. S+.

Anomobryum julaceum (Schrad. ex P. Gaertn., B. Mey. & Scherb.) Schimp. var. *concinatum* (Spruce) J.E. Zetterst. – Rar. 2, 4. On bare soil and in rock crevices on slopes; on rock outcrops. 300-750 m; with *Isopterygiopsis alpicola*, *Tortella fragilis*, etc.

Aongstroemia longipes (Sommerf.) Bruch et al. – Rar. 5. In hummocky dwarf-shrub-moss tundra, with *Ditrichum flexicaule*, *Tayloria lingulata*. 830 m. S+.

Arctoa fulvella (Dicks.) Bruch et al. – Com. 4, 5, 7. On rocks and in rock crevices: dwarf-shrub-lichen tundras, rock-fields, alder elfin woods. 800-1250 m. S+.

Aulacomnium palustre (Hedw.) Schwägr. – Com. 1, 2, 3, 4, 5, 7. On soil and decayed wood: larch forests and stone-birch forests; on soil, on rocks covered with soil and in rock crevices: tundras, subalpine meadows; on stream banks. 260-1450 m. Abundant, dominant in tundras.

A. turgidum (Wahlenb.) Schwägr. – Com. 2, 3, 4, 5, 7. On soil, on rocks covered with soil and in rock crevices: dwarf-shrub, dwarf-shrub-lichen-mossy and hummocky tundras, *Pinus pumila* elfin woods; on stream banks. 950-1400 m.

- Bartramia ithyphylla* Brid. – Com. 4, 5, 7. On soil, on rocks covered with soil and in rock crevices: dwarf-shrub, lichen and hummocky tundras, nival communities, subalpine meadows, *Pinus pumila* elfin woods, rock outcrops, rock-fields; on stream banks. 500-1250 m. S+.
- B. pomiformis* Hedw. – Rar. 4. On bare soil at river banks. 500 m. 7. On rocks covered with soil and on rock outcrops. 800 m. S+.
- Bartramiopsis lescurii* (James) Kindb. – Rar. 7. On soil and in rock crevices in *Pinus pumila* elfin woods; in rock crevices of rock-fields. 800-850 m.
- Brachythecium albicans* (Hedw.) Bruch et al. – Rar. 2. On decayed wood and at trunk bases in larch forest. 250 m. 4. On rocks at river bank. 500 m.
- B. buchananii* (Hook.) A. Jaeger – Rar. 3: on rocks of rock-fields, mixed with *B. cirrosusum*. 700 m.
- B. capillaceum* (F. Weber & D. Mohr) Giacom. – Spar. 3, 4. On decayed wood, at trunk bases, on soil: flood-plain forests, alder elfin woods. 250-750 m. Rarely abundant. S+.
- B. cirrosusum* (Schwägr.) Schimp. – Rar. 4. On bare soil and in rock crevices of rock-fields. 700 m.
- B. erythrorrhizon* Bruch et al. s.l. – Rar. 3. On soil: subalpine meadows, alder elfin woods and herb-dwarf-shrub tundra. 560-1054 m.
- B. rivulare* Bruch et al. – Rar. 4, 7. On soil and on rocks at stream and river banks. 500-800 m.
- B. salebrosum* (F. Weber & D. Mohr) Bruch et al. – Com. 2, 3, 4, 5, 7. On soil, decayed wood and at trunk bases: larch forests, stone-birch forests, flood-plain forests, subalpine meadows; disturbed places. 250-800 m. Rarely abundant. S+.
- B. turgidum* (Hartm.) Kindb. – Spar. 5, 7. On soil and on rocks covered with soil: mossy and hummocky tundras, *Pinus pumila* elfin woods. 850-1100 m.
- B. udum* I. Hagen – Rar. 4. On soil of boggy grass-sedge tundra, mixed with *Bryum pseudotriquetrum*. 1000 m.
- Breidleria pratensis* (W.D.J. Koch ex Spruce) Loeske – Rar. 4, 5. On soil in hummocky, dwarf-shrub and sedge-moss tundras. 1000-1260 m.
- Bryhnia novae-angliae* (Sull. & Lesq.) Grout – Rar. 3. On decayed wood in *Chosenia* flood-plain forest. 270 m.
- Bryoerythrophyllum ferruginascens* (Stirt.) Giacom. – Rar. 2, 3, 4. On rocks and in rock crevices: rock outcrops and rock-fields. 300-700 m.
- B. recurvirostrum* (Hedw.) P.C. Chen – Spar. 2, 3, 4, 7. On bare soil, on rocks covered with soil and in rock crevices: rock outcrops, rock-fields, disturbed places; at trunk bases in flood-plain forests. 300-750 m. S+.
- Bryoxiphium norvegicum* (Brid.) Mitt. var. *japonicum* (Berggr.) A. Löve & D. Löve – Rar. 3, 7. In rock crevices: rock outcrops and rock-fields; on rocks in *Chosenia* flood-plain forests. 300-800 m.
- Bryum amblyodon* Müll. Hal. – Rar. 4. On bare soil in dwarf-shrub-moss tundra; on stream bank; on decayed wood in poplar flood-plain forest. 500-1000 m. S+.
- B. archangelicum* Bruch et al. – Rar. 2. On rock covered with soil at rock outcrop. 300 m. S+.
- B. argenteum* Hedw. – Rar. 3, 4. On bare soil of roadsides; on rocks covered with soil: rock outcrops and rock-fields. 300-700 m.
- B. creberrimum* Taylor – Spar. 2, 3, 4. On bare soil of roadsides; on decayed wood in flood-plain forests; on stream banks. 250-500 m. S+.
- B. creberrimum* Taylor fo. *aulacodon* (Podp.) L.I. Savicz – Rar. 4. On bare soil at river banks. 500 m. S+.
- B. cyclophyllum* (Schwägr.) Bruch et al. – Rar. 4. On bare soil of roadsides; in rock crevices of rock-fields. 300-680 m.
- B. funckii* Schwägr. – Rar. 4. On bare soil in dwarf-shrub-lichen tundra, mixed to *Tortella fragilis*. 1050 m.
- B. knowltonii* Barnes – Rar. 4. On bare soil on rocky slope. 750 m. S+.
- B. moravicum* Podp. – Rar. 4. In rock crevices of rock-field, in mixture with *Eurhynchiastrum pulchellum*, *Sciuro-hypnum reflexum*, etc., 700 m; on bare soil at river bank, 500 m.
- B. neodamense* Itzigs. – Rar. 4. On soil in boggy tundra, 1000 m; on rock at river bank, 500 m. S+.
- B. pseudotriquetrum* (Hedw.) P. Gaertn., B. Mey & Scherb. – Com. 2, 3, 4, 5. On bare soil and rocks at banks of rivers and streams; on soil in hummocky and boggy tundras. 250-1100 m. S+.
- B. salinum* I. Hagen ex Limpr. – Rar. 4. On rock at river bank. 500 m. S+.
- B. schleicheri* Schwägr. – Rar. 4, 7. On rocks at river banks. 500-1200 m. S+.
- B. weigelii* Spreng. – Rar. 1, 5. On soil at stream banks, in mixture with *Philonotis tomentella*. 1000-1200 m. S+.
- Bucklandiella laeta* (Besch. & Cardot) Bednarek-Ochyra & Ochyra – Rar. 7. On rocks in dwarf-shrub-lichen-moss tundra. 850 m.
- B. microcarpa* (Hedw.) Bednarek-Ochyra & Ochyra – Rar. 5. On rocks of rock-field. 1100 m. 7. On rocks in moss *Pinus pumila* elfin wood. 830 m.
- B. microcarpa* fo. *afoninae* (Frisvoll) Bednarek-Ochyra & Ochyra – Rar. 7. On rocks in dwarf-shrub-lichen tundra. 1250 m.
- B. sudetica* (Funck) Bednarek-Ochyra & Ochyra – Com. 1, 3, 5, 7. On rock surface and on rocks covered with

- soil: rock outcrops, rock-fields, dwarf-shrub-lichen tundras, nival communities, alder elfin woods; on stream banks; on soil in subalpine meadow. 800-1600 m. S+.
- B. vulcanicola* (Frivoll & Deguchi) Bednarek-Ochyra & Ochyra – Rar. 5. On rocks of rock-field. 1070 m.
- Buxbaumia aphylla* Hedw. – Rar. 3, 4, 7. On bare soil in dwarf-shrub and hummocky tundras; on decayed wood in stone-birch forest. 260-1050 m. S+.
- Calliergon cordifolium* (Hedw.) Kindb. – Com. 2, 3, 4, 5. On soil and on rocks: stream and river banks, flood-plain forests, hummocky and boggy sedge tundras. 250-1050 m. Rarely abundant.
- C. giganteum* (Schimp.) Kindb. – Rar. 7. At stream bank. 830 m.
- Calliergonella lindbergii* (Mitt.) Hedenäs – Spar. 1, 4, 5, 7. On soil: stream and river banks, lake shores, boggy meadows. 500-1400 m; with *Calliergon cordifolium*, *Tayloria lingulata*, etc.
- Campylidium hispidulum* (Brid.) Ochyra – Spar. 3, 4. On decayed wood, at trunk bases, rarely on bare soil: flood-plain forests, stream banks, larch forests. 250-550 m; with *Amblystegium serpens*, *Sanionia uncinata*, etc. S+.
- C. sommerfeltii* (Myrin) Ochyra – Rar. 4. On rock covered with soil on rocky slope, 750 m; on bare soil at stream bank, 550 m.
- Campylium stellatum* (Hedw.) C.E.O. Jensen – Rar. 5. On soil in sedge-mosse tundra. 1070 m.
- Campylopus subulatus* Schimp. ex Milde – Rar. 3. On soil in dwarf-shrub-lichen tundra, in mixture with *Pohlia nutans*. 1000 m.
- Ceratodon purpureus* (Hedw.) Brid. – Com. 2, 3, 4, 5, 7. In wide range of habitats and communities. 250-1100 m. Rarely abundant. S+.
- Cinclidium stygium* Sw. – Rar. 7. At stream bank. 850 m. S+.
- Claopodium pellucinerve* (Mitt.) Best – Rar. 3. In rock crevices of rock outcrops. 300 m. 4. On rocks of rock-field. 700 m.
- Climacium dendroides* (Hedw.) F. Weber & D. Mohr – Spar. 4, 5, 7. On soil: hummocky and sedge-moss tundras, subalpine meadows; at stream banks; at trunk bases in flood-plain forests. 500-1050 m.
- Cnestrinum alpestre* (Wahlenb. ex Huebener) Nyholm ex Mogensen – Rar. 7. In rock crevices in dwarf-shrub-lichen-moss tundra, in mixture with *Eurhynchiastrum pulchellum*, 830 m; in rock crevices in *Pinus pumila* elfin wood, in mixture with *Isopterygiopsis muelleriana*, 850 m. S+.
- C. schistii* (F. Weber & D. Mohr) I. Hagen – Rar. 3. On bare soil on slope with herb community, 300 m. 4. In rock crevices on rock-field. 7. On rocks covered with soil at rock outcrop. S+.
- Codriophorus brevisetus* (Lindb.) Bednarek-Ochyra & Ochyra – Rar. 1. At stream bank. 1000 m.
- C. corrugatus* Bednarek-Ochyra – Rar. 7. On rock at stream bank, 830 m; on soil at subalpine meadow, 950 m; on rock in dwarf-shrub tundra, 1200 m. S+.
- Conostomum tetragonum* (Hedw.) Lindb. – Spar. 5, 7. On soil, on rocks covered with soil and in rock crevices: dwarf-shrub-lichen, dwarf-shrub-mossy and herb tundras, *Pinus pumila* elfin woods. 800-1400 m. S+.
- Cratoneuron filicinum* (Hedw.) Spruce – Rar. 4. On bare soil at stream bank. 560 m.
- Cynodontium asperifolium* (Lindb. & Arnell) Paris – Rar. 3. On decayed wood in stone-birch forest. 260 m. S+.
- C. strumiferum* (Hedw.) Lindb. – Com. 2, 3, 4, 5, 7. On soil, decayed wood, at trunk bases: stone-birch forests, larch forests, *Pinus pumila* elfin woods, low bush tundras; on rock surface and in rock crevices on rock outcrops and rock-fields. 300-1100 m; with *C. tenellum*, etc. S+.
- C. tenellum* (Schimp.) Limpr. – Spar. 4, 5, 7. On rock surface, on rocks covered with soil, in rock crevices, rarely on soil: low bush tundras, *Pinus pumila* elfin woods, alder elfin woods, rock-fields, rocks. 650-1050 m; with *C. strumiferum*, etc. S+.
- **Cyrtomnium hymenophyllum* (Bruch et al.) Holmen – Rar. 7. Recorded by Persson (1970).
- Dichelyma falcatum* (Hedw.) Myrin – Rar. 4. On soil at lake shore. 1025 m.
- Dichodontium palustre* (Dicks.) M. Stech – Rar. 5. On soil at stream bank, mixed with *Straminergon stramineum*, 1200 m; in hollow hummocky sedge-dwarf-shrub tundra, 1000 m; 7. On soil at stream bank. 800 m.
- D. pellucidum* (Hedw.) Schimp. – Rar. 2. On rocks. 300 m.
- Dicranella crispa* (Hedw.) Schimp. – Rar. 2. On bare soil at roadside, 300 m. 4. On bare soil at roadsides, 600 m, 500 m; on bare soil at river bank, 500 m; with *Dicranella subulata*, *Ditrichum cylindricum*, *Leptobryum pyriforme*, *Pohlia cruda*, etc. S+.
- D. grevilleana* (Brid.) Schimp. – Rar. 4. On bare soil in dwarf-shrub-lichen tundra. 1050 m. S+.
- D. subulata* (Hedw.) Schimp. – Com. 2, 4, 5, 7. On bare soil: dwarf-shrub and dwarf-shrub-lichen tundras, alder elfin woods, roadsides, stream and river banks. 300-1100 m; with *Dicranella crispa*, *Ditrichum cylindricum*, *Leptobryum pyriforme*, etc. S+.
- **Dicranodontium denudatum* (Brid.) E. Britton – Rar. 4. On rock covered with soil at rock outcrop. Recorded by Cherdantseva & Osipov (1998).
- Dicranum acutifolium* (Lindb. & Arnell) C.E.O. Jens-

- en – Spar. 4, 5, 7. On soil in hummocky, sedge-mossy and dwarf-shrub-lichen tundras; on bare soil at rock-field; on decayed wood in stone-birch forest. 600-1100 m. Rarely abundant. S+.
- D. angustum* Lindb. – Rar. 4. On soil in hummocky and dwarf-shrub-lichen tundras. 1050 m.
- D. bonjeanii* De Not. – Com. 4, 5, 7. On soil: dwarf-shrub, hummocky, dwarf-shrub-mossy, dwarf-shrub-lichen and boggy tundras, *Pinus pumila* elfin woods, subalpine meadows, nival communities; at trunk bases in stone-birch forests; on stream banks and lake shores. 600-1100 m. Rarely abundant.
- D. brevifolium* (Lindb.) Lindb. – Spar. 4, 7. On soil: hummocky, dwarf-shrub and herb tundras, *Pinus pumila* elfin woods, subalpine meadows; on rocks covered with soil at rock outcrops. 800-1250 m. Rarely abundant. S+.
- D. dispersum* Engelmark – Rar. 2. On rock covered with soil at rock outcrops, 300 m.
- D. drummondii* Müll. Hall. – Rar. 7. On soil in dwarf-shrub tundras. 1100-1200 m.
- D. elongatum* Schleich. ex Schwägr. – Com. 4, 5, 7. On soil and on rocks covered with soil: dwarf-shrub-lichen, dwarf-shrub-mossy and sedge-moss tundras, *Pinus pumila* elfin woods, rock-fields. 800-1370 m. Rarely abundant. S+.
- D. flexicaule* Brid. – Spar. 4, 7. On soil and on rocks covered with soil in dwarf shrub-lichen tundras, in *Pinus pumila* elfin woods, larch forests; at trunk bases in herb stone-birch forest. 620-1000 m. Rarely abundant. S+.
- D. fragilifolium* Lindb. – Com. 2, 3, 4, 7. On decayed wood and at trunk bases: larch forests, stone-birch forests, flood-plain forests, on river banks; in rock crevices at rock outcrops. 300-1000 m. S+.
- D. fuscescens* Turner – Com. 2, 3, 4, 5, 7. On soil and on rocks covered with soil: dwarf-shrub, dwarf-shrub-lichen-mossy and hummocky tundras, subalpine meadows, larch forests; at trunk bases and on decayed wood: stone-birch forests, alder elfin wood, *Pinus pumila* elfin woods. 220-1300 m. Rarely abundant. S+.
- D. groenlandicum* Brid. – Rar. 5. On soil in sedge-moss tundra and in rock crevices on rock-field. 1070 m.
- D. laevidens* R.S. Williams – Spar. 4, 5. On soil in boggy, dwarf-shrub-mossy and hummocky tundras; at lake shores. 950-1250 m.
- D. leioneuron* Kindb. – Rar. 7. On soil in dwarf-shrub-lichen tundra. 1100 m.
- D. majus* Turner var. *majus* – Com. 1, 2, 3, 4, 5, 7. On soil, decayed wood, at trunk bases: alder elfin wood, *Pinus pumila* elfin woods, stone-birch forests, larch forests; on soil, on rocks covered with soil, in rock crevices: dwarf-shrub, dwarf-shrub-lichen-moss tundras, rock outcrops and rock-fields; at lake shores. 250-1100 m. Abundant. S+.
- D. majus* var. *orthophyllum* A. Braun ex Milde – Rar. 4. On soil in boggy tundra. 1000 m.
- D. montanum* Hedw. – Com. 2, 3, 4, 7. At trunk bases and on decayed wood: dwarf-shrub larch forests, dwarf-shrub and herb stone-birch forests; on soil in alder elfin wood. 500-1000. S+.
- D. polysetum* Sw. – Rar. 2. On soil in dwarf-shrub larch forest, 300 m. 3. On soil and decayed wood in dwarf-shrub stone-birch forest, 260 m.
- D. spadiceum* J.E. Zetterst. var. *spadiceum* – Spar. 4, 5, 7. On soil in dwarf-shrub, hummocky, sedge-moss tundras; on rocks covered with soil in *Pinus pumila* elfin wood. 800-1100 m. Rarely abundant.
- D. spadiceum* var. *subscabrifolium* Schljakov – Rar. 7. On soil in dwarf-shrub-lichen tundra. 830 m.
- D. undulatum* Schrad. ex Brid. – Com. 2, 3, 4, 5, 7. On soil: larch forests, stone-birch forests, dwarf-shrub-lichen, mossy and boggy tundras. 250-1100 m. Abundant. S+.
- Didymodon asperifolius* (Mitt.) H.A. Crum, Steere & L.E. Anderson – Rar. 1. On soil in boggy moss tundra. 1000 m.
- D. glaucus* Ryan – Rar. 2. On rock at rock outcrop. 300 m.
- D. icmadophylus* (Schimp. ex Müll. Hal.) R.H. Zander – Rar. 1. On rock in boggy moss tundra, 1000 m. 2. On rock outcrop, mixed with *Bryoerythrophyllum recurvirostrum*, 300 m.
- D. zanderi* Afonina & Ignatova – Rar. 4. On rocks covered with soil at rock-field. 300 m.
- Diphyscium foliosum* (Hedw.) D. Mohr – Rar. 7. On soil in low bush tundras, 1100 m, 1470 m; in rock crevices in dwarf-shrub-lichen tundra, 830 m; on rocks covered with soil at rock outcrop, 800 m.
- Distichium capillaceum* (Hedw.) Bruch et al. – Com. 2, 3, 4, 7. In rock crevices and on rocks covered with soil: rock-fields, rock outcrops, *Pinus pumila* elfin woods; on soil in alder elfin wood and larch forests. 280-800 m. S+.
- Ditrichum cylindricum* (Hedw.) Grout – Rar. 2. On bare soil at roadside, 300 m. 4. On bare soil at roadsides, mixed with *Dicranella crisa*, *D. subulata*. 500-600 m.
- D. flexicaule* (Schwägr.) Hampe – Spar. 2, 5, 7, 7. On soil in dwarf-shrub-lichen, sedge-mossy and hummocky tundras; on rocks covered with soil at rock outcrops. 300-1100 m. S+.
- D. pallidum* (Hedw.) Hampe – Spar. 4, 5, 7. On soil, on rocks covered with soil and in rock crevices: dwarf-shrub and dwarf-shrub-lichen tundras, *Pinus*

- pumila* elfin woods, rock outcrops, rock-fields. 800-1400 m. S+.
- Drepanocladus aduncus* (Hedw.) Warnst. – Rar. 1. On stream bank, mixed with *Philonotis tomentella*, 1400 m. 7. On soil at stream bank, 800 m.
- D. polycarpus* (Blandow ex Voit) Warnst. – Rar. 3, 4. On rocks and soil at river and stream banks. 270-500 m.
- D. polygamus* (Bruch et al.) Hedenäs – Rar. 2. On bare soil at roadsides. 300 m.
- Encalypta affinis* R. Hedw. – Rar. 3. On rocks covered with soil at rock outcrops. 300 m. S+.
- E. brevicolla* (Bruch et al.) Ångstr. – Rar. 4. In rock crevices at rock-field. 700 m. S+.
- E. ciliata* Hedw. – Rar. 2. On rocks covered with soil at rock outcrop, 300 m. 3. On bare soil on slope with herb community, 300 m. 4. On rocks covered with soil and in rock crevices at rock-field, mixed with *Myurella julacea*, 700 m. S+.
- E. microstoma* Bals.-Criv. & De Not. – Rar. 4. On rocks covered with soil and in rock crevices at rock-field. 700 m. S+.
- E. rhapsocarpa* Schwägr. – Spar. 2, 3, 4. On rocks covered with soil and in rock crevices at rock outcrops and rock-fields. 300-700 m. S+.
- Eurhynchiastrum pulchellum* (Hedw.) Ignatov & Huttunen – Spar. 3, 4, 7. On rocks covered with soil and in rock crevices: dwarf-shrub-lichen tundras, *Pinus pumila* elfin woods, rock-fields and rock outcrops; on soil in alder elfin wood; on decayed wood in flood-plain forest. 300-800 m. S+.
- Fissidens bryoides* Hedw. – Rar. 3, 7. On rocks covered with soil and in rock crevices at rock-fields and rock outcrops. 300-800 m. S+.
- F. dubius* P. Beauv. – Rar. 7. On soil on subalpine meadows. 800 m.
- F. osmundoides* Hedw. – Rar. 4, 5, 7. On soil in sedge-mossy and hummocky tundras; at lake shore; in rock crevices at rock-field. 800-1100 m; with *Meesia uliginosa*, *Oncophorus compactus*.
- Funaria hygrometrica* Hedw. – Rar. 4. On bare soil at roadside, mixed with *Leptobryum pyriforme*. 600 m. S+.
- Grimmia donniana* Sm. – Rar. 5, 7. On rocks of rock-fields. 800-1300 m. S+.
- G. incurva* Schwägr. – Rar. 4, 5, 7. On rocks of rock-fields. 800-1070 m. S+.
- G. longirostris* Hook. – Spar. 2, 3, 4, 7. On rocks of rock-fields and rock outcrops, in dwarf-shrub-lichen tundra. 300-800 m. S+.
- G. mollis* Bruch et al. – Rar. 5, 7. On rocks at stream banks and in nival community. 1000-1100 m.
- G. reflexidens* Müll. Hal. – Rar. 5. On rocks of rock-field. 1070 m. S+.
- Hedwigia ciliata* (Hedw.) P. Beauv. var. *ciliata* – Rar. 4. On rocks of rock-field. 700 m. S+.
- H. ciliata* var. *leucophaea* Bruch & al. – Rar. 3. On rock at rock outcrop, 300 m. 4. On rocks of rock-field, 700 m. S+.
- Helodium blandowii* (F. Weber & D. Mohr) Warnst. – Rar. 5. On soil in hummocky sedge-dwarf-shrub tundra, 1000 m. 7. On soil on boggy subalpine meadow, 800 m.
- Hennediella heimii* (Hedw.) R.H. Zander var. *arctica* (Lindb.) R.H. Zander – Rar. 4. On rocks on rocky slope. 750 m. S+.
- **Herzogiella adscendens* (Lindb.) Z. Iwats. & W.B. Schofield – Rar. 7. Recorded by Persson (1970).
- H. striatella* (Brid.) Z. Iwats. – Rar. 7. On bark in alder elfin woods. 950 m.
- H. turfacea* (Lindb.) Z. Iwats. – Rar. 2. On decayed wood in dwarf-shrub larch forests, 300 m; on bare soil at roadside, 300 m. 3. On decayed wood in dwarf-shrub stone-birch forests, 250 m.
- Heterocladium dimorphum* (Brid.) Bruch et al. – Spar. 7. On soil, on rocks covered with soil and in rock crevices: dwarf-shrub-lichen, herb-dwarf-shrub and hummocky tundras, rock outcrops. 800-1100 m.
- Hygroamblystegium humile* (P. Beauv.) Vanderp., Goffinet & Hedenäs – Rar. 2. On bare soil at stream banks, 270 m. 3. On bare soil at roadside, 300 m. S+
- **H. tenax* (Hedw.) Jenn. – Rar. 4. On rock in dry stream bed. Recorded by Cherdantseva & Osipov (1998).
- Hygrohypnella bestii* (Renauld & Bryhn) Ignatov & Ignatova – Rar. 7. On rocks in water at stream banks. 800-850 m.
- H. ochracea* (Turner ex Wilson) Ignatov & Ignatova – Spar. 1, 4, 7. On rocks in water at stream and river banks. 500-1000 m.
- Hygrohypnum luridum* (Hedw.) Jenn. – Rar. 4. On rocks in water at river banks. 500 m.
- Hylocomiastrum pyrenaicum* (Spruce) M. Fleisch. – Spar. 4, 5, 7. On soil: hummocky, herb-dwarf-shrub, dwarf-shrub-mossy and sedge-moss tundras, stream banks, subalpine meadows; on rocks covered with soil at rock outcrops. 800-1250 m. Rarely abundant.
- Hylocomium splendens* (Hedw.) Bruch et al. var. *splendens* – Com. 3, 4, 5, 7. On soil, on decayed wood, at trunk bases, on rocks covered with soil: tundras, stone-birch forests, larch forests, flood-plain forests,

- alder elfin woods, *Pinus pumila* elfin woods, subalpine meadows, on rock outcrops. 250-1100 m. Abundant, dominant in tundra.
- H. splendens* var. *obtusifolium* (Geh.) Paris – Rar. 5. On soil in dwarf-shrub-lichen tundra, 1370 m; 7. On rocks covered with soil in dwarf-shrub-lichen-moss tundra, 830 m.
- Hymenoloma crispulum* (Hedw.) Ochyra – Spar. 1, 4, 5, 7. On rocks in tundras, subalpine meadows, nival communities, alder elfin woods, stream banks, rock outcrops and rock-fields. 800-1600 m. S+.
- H. intermedium* (J.J. Amman) Ochyra – Rar. 4. On rock on rocky slope and rock-field. 750 m, 800m.
- Hypnum cupressiforme* Hedw. – Spar. 2, 3, 4, 7. On rocks covered with soil and in rock crevices: rock outcrops and rock-fields; on decayed wood and at trunk bases: stone-birch forests, larch forests. 280-800 m. Rarely abundant.
- Isopterygiopsis alpicola* (Lindb. & Arnell) Hedenäs – Rar. 3, 4, 7. On rocks covered with soil and in rock crevices: rocks outcrops, rock-fields, alder elfin woods, *Pinus pumila* elfin woods. 300-830 m; with *Isopterygiopsis muelleriana*, *Plagiothecium cavifolium*, *Tortella tortuosa*, etc.
- I. muelleriana* (Schimp.) Z. Iwats. – Spar. 4, 7. In rock crevices: rock outcrops, rock-fields, dwarf-shrub-lichen and dwarf-shrub-moss tundras, *Pinus pumila* elfin woods, subalpine meadow; on bare soil at river bank. 500-1000 m; with *Isopterygiopsis alpicola*, *Plagiothecium cavifolium*, etc.
- I. pulchella* (Hedw.) Z. Iwats. – Com. 3, 4, 7, 6. In rock crevices and on soil: rock outcrops, rock-fields, dwarf-shrub-lichen tundras, *Pinus pumila* elfin woods; on bare soil at river banks and slopes; on decayed wood in stone-birch forests. 300-800 m; with *Plagiothecium cavifolium*, *Pohlia longicollis*, etc. S+.
- Kiaeria falcata* (Hedw.) I.Hagen – Rar. 1, 7. On soil in nival communities and on stream banks. 1000-1400 m.
- K. glacialis* (Berggr.) I. Hagen – Spar. 5, 7. On soil and on rocks covered with soil: hummocky, lichen and dwarf-shrub tundras, *Pinus pumila* elfin woods, rock-fields. 800-1350. Rarely abundant.
- K. starkei* (F. Weber & D. Mohr) I. Hagen – Rar. 5, 7. On soil in nival communities; on rocks covered with soil and in rock crevices of rock-fields; on bare soil at stream bank. 1000-1250 m. S+.
- Leptobryum pyriforme* (Hedw.) Wilson – Spar. 2, 3, 4. On bare soil: stream and river banks, roadsides, disturbed places; at trunk bases in poplar flood-plain forest. 270-600 m; with *Dicranella crispa*, *D. subulata*, etc. S+.
- Leptodictyum riparium* (Hedw.) Warnst. – Rar. 4. On decayed wood in poplar flood-plain forest, mixed with *Campylidium hispidulum*, 500 m; on soil in *Chosenia* flood-plain forest, 450 m.
- Lescuraea patens* Lindb. – Rar. 1. On stream banks. 1000-1400 m.
- L. radicata* (Mitt.) Mönk. – Rar. 7. On soil in subalpine meadow, 800 m; on soil in hummocky dwarf-shrub-herb tundra, 830 m.
- L. saxicola* (Bruch et al.) Molendo – Rar. 7. On soil in subalpine and nival meadows. 800-1100 m.
- L. secunda* Arnell – Rar. 7. On soil in hummocky and dwarf-shrub tundras, subalpine nival meadows, on stream banks. 800-1100 m; with *Brachythecium erythrorrhizon*, *B. salebrosum*, etc.
- Loeskypnum badium* (Hartm.) H.K.G. Paul – Rar. 4, 5, 7. On soil in hummocky, boggy and sedge-moss tundras; in moist depressions of rock-fields. 800-1250 m.
- Meesia uliginosa* Hedw. – Spar. 4, 5, 7. On soil in hummocky, dwarf-shrub-lichen and sedge-moss tundras; in rock crevices of rock outcrops. 800-1250 m. S+.
- Mnium lycopodioides* Schwägr. – Rar. 7. In rock crevices at rock-field, 800 m; in rock crevices in *Pinus pumila* elfin woods, 850 m.
- M. marginatum* (Dicks.) P. Beauv. – Rar. 3, 4. On bare soil: rocky slopes, stream banks. 300-750 m.
- M. spinosum* (Voit) Schwägr. – Rar. 4, 7. On soil: subalpine meadows, alder elfin wood. 750-800 m.
- M. thomsonii* Schimp. – Rar. 3. On decayed wood in stone-birch forests, 250 m. 4. In rock crevices at rock-field, 700 m. 7. On soil in subalpine herb meadow, 800 m.
- Myurella julacea* (Schwägr.) Bruch et al. – Rar. 4. In rock crevices at rock-field, mixed with *Myurella tenerrima*. 700 m. S+.
- M. tenerrima* (Brid.) Lindb. – Rar. 4. In rock crevices at rock-field, mixed with *Myurella julacea*. 700 m.
- Neckera pennata* Hedw. – Rar. 3. In rock crevices at rock outcrops, 300 m. 4. In rock crevices at rock-field. 700 m. S+.
- Niphotrichum canescens* (Hedw.) Bednarek-Ochyra & Ochyra – Spar. 1, 4, 5, 7. On soil, on rocks covered with soil: dwarf-shrub-lichen and dwarf-shrub-moss tundras, nival communities, subalpine meadows, rock-fields, stream and river banks. 800-1370 m.
- N. ericoides* (Brid.) Bednarek-Ochyra & Ochyra – Rar. 4. On soil in hummocky sedge-moss tundra, 1050 m. 5. On soil in hummocky dwarf-shrub-sedge tundra, 1000 m.
- N. muticum* (Kindb.) Bednarek-Ochyra & Ochyra – Rar. 7. On rock in nival community. 1100 m.

- Oligotrichum aligerum* Mitt. – Rar. 4. On bare soil at roadsides, 500 m. 7. On soil in alder elfin wood, mixed with *Dicranella subulata*, 800 m.
- O. falcatum* Steere – Rar. 7. In rock crevices in *Pinus pumila* elfin wood. 800 m. S+.
- O. hercynicum* (Hedw.) Lam. & DC. – Rar. 7. On rocks covered with soil in dwarf-shrub-lichen-moss tundra, 830 m; on soil in dwarf-shrub-lichen tundra, 1250 m.
- O. parallelum* (Mitt.) Kindb. – Spar. 1, 5, 7. On soil, on bare soil, on rocks covered with soil and in rock crevices: rock outcrops, rock-fields, nival communities, dwarf-shrub tundras, on stream and river banks. 800-1250 m.
- Oncophorus compactus* (Bruch et al.) Kindb. – Rar. 4. On soil at lake shore, 1020 m. 5. On soil in hummocky sedge-moss tundra, 1250 m.
- O. virens* (Hedw.) Brid. – Spar. 3, 4, 5. On soil and in rock crevices in dwarf-shrub-lichen, hummocky and sedge-moss tundras; on bare soil at stream banks and slopes with herb communities; on rocks covered with soil at rock-fields. 300-1370 m. S+.
- O. wahlenbergii* Brid. – Spar. 2, 3, 4. On decayed wood and at trunk bases in stone-birch forests and larch forests. 260-700 m. S+.
- **Orthothecium chryseon* (Schwäger.) Bruch et al. – Rar. 7. Recorded by Persson (1970).
- Orthotrichum obtusifolium* Brid. – Spar. 3, 4. On bark in flood-plain forests; on rocks covered with soil at rock outcrops and rock-fields. 250-700 m; with *Orthotrichum sordidum*, *Pylaisia polyantha*, etc. S+.
- O. sordidum* Sull. & Lesq. – Spar. 2, 3, 4. On bark, rarely on decayed wood in flood-plain forests, stone-birch forests, larch forests. 250-700 m; with *Orthotrichum obtusifolium*, *Pylaisia polyantha*, etc. S+.
- O. speciosum* Nees – Rar. 4. On rocks covered with soil at rock-field, 700 m. S+.
- Oxystegus tenuirostris* (Hook. & Taylor) A.J.E. Sm. – Rar. 4. On rocks covered with soil at rock-field, mixed with *Distichium capillaceum*, *Tortella fragilis*. 700 m.
- Paludella squarrosa* (Hedw.) Brid. – Spar. 1, 5, 7. Rar. 4. In hummocky sedge-mossy and dwarf-shrub-moss tundras, boggy subalpine meadow, on stream banks and lake shores. 800-1400 m; with *Tayloria lingulata*, etc. S+.
- Paraleucobryum longifolium* (Hedw.) Loeske – Rar. 7. On rocks at rock outcrops and on rocks covered with soil at stream bank. 800-850 m; with *Andreaea rupestris*, *Hymenoloma crispulum*, etc.
- Philonotis caespitosa* Jur. – Rar. 4. On bare soil at stream bank. 500 m.
- P. fontana* (Hedw.) Brid. – Rar. 4, 7. On rock beside water at stream and river banks. 500-800 m.
- P. tomentella* Molendo – Com. 1, 3, 4, 5. On rocks and soil beside water at stream and river banks and lake shores; in hollows of hummocky sedge-moss tundras. 250-1400 m. Rarely abundant. S+.
- Plagiomnium acutum* (Lindb.) T.J. Kop. – Rar. 3. On decayed wood and at trunk bases in *Chosenia* flood-plain forest. 270 m.
- P. cuspidatum* (Hedw.) T.J. Kop. – Spar. 3, 4. On soil, on decayed wood and at trunk bases in flood-plain forests; on bare soil on slope with herb community. 270-500 m. S+.
- P. curvatulum* (Lindb.) Schljakov – Rar. 4. In dry stream bed. Recorded by Cherdantseva & Osipov (1998).
- P. ellipticum* (Brid.) T.J. Kop. – Spar. 2, 4, 5, 7. On soil in subalpine meadows, flood-plain forest, boggy tundra; on bare soil at roadsides. 300-1000 m.
- P. medium* (Bruch et al.) T.J. Kop. – Rar. 7. On soil in stone-birch forest. 800 m.
- Plagiopus oederianus* (Sw.) H.A. Crum & L.E. Anderson – Rar. 4. In rock crevices of rock-field. 700 m. S+.
- Plagiothecium cavifolium* (Brid.) Z. Iwats. var. *cavifolium* – Spar. 3, 4, 7. In rock crevices and on rocks covered with soil in alder elfin woods, *Pinus pumila* elfin woods, rock outcrops, rock-fields; on decayed wood and at trunk bases in stone-birch forest. 250-850 m.
- P. cavifolium* var. *imbricatum* Ukrainskaya – Rar. 4. On bare soil at rock-field, mixed with *Saetania glaucescens*, 700 m. 7. In rock crevices in *Pinus pumila* elfin wood, 830 m.
- P. denticulatum* (Hedw.) Bruch et al. – Com. 3, 4, 5, 7. On soil and in rock crevices: dwarf-shrub-lichen-moss tundras, subalpine meadows, *Pinus pumila* elfin woods, alder elfin woods, rock outcrops; at trunk bases in larch forest. 270-1100 m. S+.
- P. laetum* Bruch et al. – Com. 2, 3, 4, 5, 7. On soil, on decayed wood and at trunk bases: stone-birch forests, larch forests, *Pinus pumila* elfin woods, alder elfin woods, on river banks; in rock crevices at rock-field. 270-1100 m. S+.
- P. latebricola* Bruch et al. – Rar. 2. On decayed wood in larch forest. 280 m.
- Pleurozium schreberi* (Brid.) Mitt. – Com. 2, 3, 4, 5, 7. On soil, on decayed wood and at trunk bases: stone-birch forests, larch forests, *Pinus pumila* elfin woods, alder elfin woods, on river banks; on soil, on rocks covered with soil and in rock crevices: tundras, subalpine meadows, rock-fields. 220-1400 m. Abundant, dominant in moss forests and moss tundras.

- Pogonatum contortum* (Brid.) Lesq. – Rar. 7. On bare soil, in rock crevices and on rocks covered with soil: dwarf-shrub-lichen tundras, rock-fields. 800-1100 m; with *Polytrichastrum alpinum*, *Racomitrium lanuginosum*, etc.
- P. dentatum* (Brid.) Brid. – Spar. 4, 5, 7. On bare soil, in rock crevices and on rocks covered with soil: dwarf-shrub-lichen tundras, alder elfin woods, *Pinus pumila* elfin woods, rock outcrops, roadsides, rock-fields. 500-1370 m.
- P. urnigerum* (Hedw.) P.Beauv. – Spar. 1, 4, 7. On soil in dwarf-shrub-lichen-moss tundras; on bare soil and in rock crevices: nival community, roadsides, rock-fields. 600-1600 m. S+.
- Pohlia andalusica* (Höhn.) Broth. – Rar. 3, 4. On bare soil at stream banks. 250 m, 550 m; with *Leptobryum pyriforme*, etc.
- P. andrewsii* A.J. Shaw – Spar. 4, 7. On bare soil in dwarf-shrub-lichen tundras, roadsides and river banks. 500-1250 m; with *Dicranella subulata*, *Pohlia prolifera*, etc.
- P. bulbifera* (Warnst.) Warnst. – Rar. 5. On bare soil at lake shore. 1070 m.
- P. cardotii* (Renauld & Cardot) Broth. – Rar. 5. In rock crevices at rock-field. 1260 m.
- P. cruda* (Hedw.) Lindb. – Com. 2, 3, 4, 5, 7. On bare soil, in rock crevices and on rocks covered with soil: tundras, *Pinus pumila* elfin woods, alder elfin woods, subalpine meadows, roadsides, rock outcrops, rock-fields, at stream and river banks; on soil, on decayed wood and at trunk bases: stone-birch forests, larch forest, flood-plain forests. 220-1530 m. S+.
- P. crudoides* (Sull. & Lesq.) Broth. – Com. 4, 5, 7. On soil, in rock crevices and on rocks covered with soil: tundras, *Pinus pumila* elfin woods, rock outcrops, rock-fields. 800-1370 m. S+.
- P. drummondii* (Müll. Hal.) A.L. Andrews – Spar. 4, 5, 7. On bare soil: hummocky sedge-moss tundras, subalpine meadows, stream banks and lake shores, rocky slopes. 800-1070 m; with *Pohlia nutans*, *P. prolifera*, etc. S+.
- P. elongata* var. *greenii* (Brid.) A.J. Shaw – Rar. 5. On bare soil at stream bank, mixed with *Pohlia drummondii*. 1070 m. S+.
- P. filum* (Schimp.) Mårtensson – Rar. 5. On rocks at river banks. 500 m; with *Philonotis tomentella*, etc.
- P. longicollis* (Hedw.) Lindb. – Spar. 3, 4. On bare soil at river banks; in rock crevices of rock outcrops and rock-fields. 300-700 m. S+.
- P. nutans* (Hedw.) Lindb. – Com. 2, 3, 4, 5, 7. In wide range of habitats and communities. 220-1300 m. S+.
- P. prolifera* (Kindb.) Lindb. ex Broth. – Rar. 3, 4. On bare soil at river banks, roadsides, slopes with herb communities. 220-1330 m. S+.
- P. tundrae* A.J. Shaw – Rar. 2. On bare soil at roadside, 300 m. 4. On bare soil at river bank, 500 m.
- P. wahlenbergii* (F. Weber & D. Mohr) A.L. Andrews – Com. 1, 2, 3, 4, 5, 7. On bare soil and rocks: stream and river banks and lake shores, slopes with herb communities, roadsides. 250-1200 m. S+.
- Polytrichastrum alpinum* (Hedw.) G.L. Sm. – Com. 1, 4, 7. On soil, on rocks covered with soil and in rock crevices: tundras, alder elfin woods, *Pinus pumila* elfin woods, subalpine meadows, rock-fields, stone-birch forests. 500-1100 m. Abundant. S+.
- P. formosum* (Hedw.) G.L. Sm. – Rar. 4. On soil at lake shore. 1020 m.
- P. longisetum* (Sw. ex Brid.) G.L. Sm. – Rar. 5. On soil in hummocky sedge-moss tundra, 1000 m. 7. On soil on subalpine meadows, 950 m, and at trunk bases in alder elfin woods, 800 m.
- P. pallidisetum* (Funck) G.L. Sm. – Rar. 5. On bare soil at lake shore. 1070 m.
- P. sexangulare* (Flörke ex Brid.) G.L. Sm. – Spar. 1, 5, 7. On soil in nival communities; on rocks covered with soil and in rock crevices at rock-fields; on bare soil at stream banks. 800-1400 m. S+.
- Polytrichum commune* Hedw. – Com. 2, 3, 4, 5, 7. On soil: tundras, alder elfin woods, *Pinus pumila* elfin woods, subalpine meadows, rock-fields, stone-birch forests, larch forests. 260-1000 m. Abundant.
- P. hyperboreum* R. Br. – Rar. 5. On bare soil in dwarf-shrub-lichen tundra, 1070 m. 7. On rock of rock-field 800 m.
- P. jensenii* I. Hagen – Rar. 5, 7. On soil at lake shores. 800 m, 1020 m.
- P. juniperinum* Hedw. – Com. 3, 4, 5, 7. On soil, decayed wood, at trunk bases, on rocks covered with soil: tundras, alder elfin woods, *Pinus pumila* elfin woods, subalpine meadows, rock outcrops, rock-fields, stone-birch forests, larch forests. 220-1400 m. Abundant. S+.
- P. piliferum* Hedw. – Com. 1, 3, 4, 5, 7. On soil and on rocks covered with soil: tundras, rock outcrops, rock-fields, alder elfin woods, *Pinus pumila* elfin woods, subalpine meadows, nival communities; on decayed wood and at trunk bases: stone-birch forests, larch forests. 300-1600 m. Rarely abundant. S+.
- P. strictum* Brid. – Spar. 3, 4. On soil: boggy and hummocky sedge-moss tundras, lake shores; on decayed wood and at trunk bases in stone-birch forest. 500-1050 m. S+.

- Pseudobryum cinclidioides* (Huebener) T.J. Kop. – Rar. 3. At stream bank, 270 m. 4. On lake shore, 1020 m. 5. In hollow in hummocky dwarf-shrub-moss tundra, 1000 m.
- Pseudoleskeella nervosa* (Brid.) Nyholm – Rar. 4. On rocks covered with soil at rock-field. 700 m.
- P. papillosa* (Lindb.) Kindb. – Rar. 3, 4, 7. On rocks in dwarf-shrub-lichen tundra and rock-field; in rock crevices of rock outcrops; on soil in herb alder elfin woods. 300-800 m.
- P. rupestris* (Berggr.) Hedenäs & Söderstr. – Rar. 3, 4, 7. On rocks, in rock crevices, on rocks covered with soil: rock-fields, rock outcrops. 300-800 m.
- P. tectorum* (Funck ex Brid.) Kindb. ex Broth. – Rar. 2. On rocks at rock outcrop. 300 m.
- Pseudotaxiphyllum elegans* (Brid.) Z. Iwats. – Rar. 4. On rocks of rock-field. 1050 m.
- Psilopilum cavifolium* (Wilson) I. Hagen – Rar. 4. On bare soil at roadside. 500 m.
- Ptilium crista-castrensis* (Hedw.) De Not. – Rar. 4. On soil in dwarf-shrub-lichen larch forest. 600 m.
- Pylaisia polyantha* (Hedw.) Bruch et al. – Com. 2, 3, 4, 7. On bark, on decayed wood and at trunk bases: stone-birch forests, larch forests, flood-plain forests; on rocks covered with soil: rock-fields, rock outcrops. 250-800 m; with *Orthotrichum obtusifolium*, *O. sordidum*, etc. S+.
- Racomitrium lanuginosum* (Hedw.) Brid. – Com. 4, 5, 7. On soil, on rocks covered with soil: tundras, *Pinus pumila* elfin woods, rock outcrops, rock-fields. 560-1620 m. Abundant, dominant in tundra.
- **Rhabdoweisia crispata* (Dicks. ex With.) Lindb. – Rar. 4. On rocks covered with soil at rock outcrops. Recorded by Cherdantseva & Osipov (1998).
- Rhizomnium andrewsianum* (Steere) T.J. Kop. – Rar. 7. On rocks covered with soil in dwarf-shrub-lichen tundra and rock-field. 800-850 m.
- R. gracile* T.J. Kop. – Rar. 5. In hollow in hummocky sedge-moss tundras; at lake shore. 7. On stream banks. 800-1260 m.
- R. magnifolium* (Horik.) T.J. Kop. – Rar. 5. At lake shore. 7. On stream banks. 800-1000 m. S+.
- R. nudum* (E. Britton & R.S. Williams) T.J. Kop. – Rar. 7. On soil in dwarf-shrub tundra and subalpine meadow. 800 m.
- R. pseudopunctatum* (Bruch & Schimp.) T.J. Kop. – Rar. 5. In hollow in hummocky sedge tundra; on stream bank. 7. On soil in subalpine boggy meadow. 800-1070 m.
- Rhodobryum roseum* (Hedw.) Limpr. – Rar. 7. On soil in stone-birch forests, subalpine meadow, dwarf-shrub tundra. 800-1200 m.
- Rhytidiadelphus squarrosus* (Hedw.) Warnst. – Rar. 7. On soil in subalpine boggy meadows. 800 m.
- R. subpinnatus* (Lindb.) T.J. Kop. – Rar. 7. On soil in dwarf-shrub tundra and subalpine herb meadow; at stream bank. 800 m.
- Rhytidium rugosum* (Hedw.) Kindb. – Com. 2, 3, 4, 5, 7. On soil and on rocks covered with soil: dwarf-shrub-lichen-moss tundras, larch forests, *Pinus pumila* elfin woods, rock outcrops and rock-fields. 300-1400 m. Abundant.
- Saelania glaucescens* (Hedw.) Broth. – Spar. 3, 4, 5, 7. On soil, on rocks covered with soil, in rock crevices: dwarf-shrub-lichen tundras, *Pinus pumila* elfin woods, alder elfin woods, rock outcrops and rock-fields. 500-1050 m. S+.
- Sanionia uncinata* (Hedw.) Loeske – Com. 1, 2, 3, 4, 5, 7. In wide range of habitats and communities. 220-1300 m. Abundant. S+.
- Schistidium apocarpum* (Hedw.) Bruch et al. subsp. *canadense* (Dupret) H. H. Blom. ex B.H. Allen & Pursell – Rar. 3. On decayed wood in stone-birch forest, 260 m. 4. On rock at stream bank, 550 m. S+.
- S. dupretii* (Thér.) W.A. Weber – Rar. 3. On rock at rock outcrop. 800 m. S+.
- S. frigidum* H.H. Blom – Rar. 4. On rocks of rock-field, 700 m. 7. On rock at rock outcrop, 800 m. S+.
- S. liliputanum* (Müll. Hall.) Deguchi – Rar. 7. On rock at rock outcrop, 800 m. S+.
- S. papillosum* Culm. – Rar. 3, 4, 7. On rock at rock outcrops and rock-fields; on rocks in *Chosenia* flood-plain forest. 300-800 m. S+.
- S. plathyphyllum* (Mitt.) Perss. – Rar. 4. On rocks at river banks, 500 m. 7. On rock in subalpine boggy meadow, 800 m. S+.
- S. pulchrum* H.H. Blom – Rar. 2, 4, 7. On rocks at rock outcrops and rock-fields. 300-800 m. S+.
- S. rivulare* (Brid.) Podp. – Rar. 4, 7. On rocks at river and stream banks. 500-800 m. S+.
- S. tenerum* (J.E. Zetterst.) Nyholm – Rar. 2, 3, 4. On rocks at rock outcrops and rock-fields. 300-700 m.
- Schistostega pennata* (Hedw.) F. Weber & D. Mohr – Rar. 4, 7. On bare soil between roots of trees: stone-birch forest, larch forest, alder elfin wood. 650-800 m. S+.
- Sciuro-hypnum curtum* (Lindb.) Ignatov – Rar. 4, 5, 7. On rocks covered with soil at rock outcrops and rock-fields; on rock in stone-birch forest. 500-1250. S+.
- S. latifolium* (Kindb.) Ignatov & Huttunen – Rar. 1, 7. At stream banks. 800-1000 m.

- S. reflexum* (Starke) Ignatov & Huttunen – Com. 2, 3, 4, 5, 7. On soil, on decayed wood, at trunk bases and on bark: stone-birch forests, larch forests, flood-plain forests, alder elfin woods, *Pinus pumila* elfin woods, tundras, nival communities; on rocks covered with soil and in rock crevices at rock-fields. 250-1100 m. Rarely abundant. S+.
- S. starkei* (Brid.) Ignatov & Huttunen – Spar. 3, 4, 7. On soil in stone-birch forests, hummocky tundras, subalpine meadows. 250-800 m. S+.
- Scorpidium revolvens* (Sw. ex anon.) Rubers – Spar. 5, 7. In hollow of hummocky and sedge-moss tundras; at stream banks. 800-1200 m.
- Sphagnum angustifolium* (C.E.O. Jensen ex Russow) C.E.O. Jensen – Rar. 4, 5. On soil in hummocky and dwarf-shrub tundras. 1000-1200 m. Rarely abundant.
- S. balticum* (Russow) C.E.O. Jensen – Rar. 4. On soil in boggy tundra. 1000 m.
- S. capillifolium* (Ehrh.) Hedw. – Spar. 4, 5, 7. On soil in hummocky, sedge-mossy and boggy tundras, *Pinus pumila* elfin wood. 800-1000 m. Rarely abundant.
- S. compactum* Lam. & DC. – Spar. 4, 5, 7. On soil in hummocky, dwarf-shrub-lichen, and boggy tundras; at stream banks and lakeshores; in moist depression of rock-field. 800-1400 m. Rarely abundant.
- S. contortum* Schultz – Rar. 4. On lake shore. 1020 m.
- S. fallax* (H. Klinggr.) H. Klinggr. – Rar. 4. On soil in boggy tundra. 1000 m.
- S. fuscum* (Schimp.) H. Klinggr. – Rar. 4. On soil in boggy and dwarf-shrub-lichen tundras. 1000-1100 m.
- S. girgensohnii* Russow – Com. 4, 5, 7. On soil in hummocky, dwarf-shrub-lichen, dwarf-shrub-mossy and boggy tundras, larch forests, *Pinus pumila* elfin woods; at stream banks and lake shores. 500-1200 m. Abundant, dominant in moss tundras.
- S. lindbergii* Schimp. – Rar. 7. In moist depression of rock-field. 800 m.
- S. russowii* Warnst. – Rar. 4. On soil in hummocky sedge-moss tundras. 1260 m. Abundant.
- S. squarrosom* Crome – Rar. 4. At stream bank. 500 m.
- S. teres* (Schimp.) Ångstr. ex C. Hartm. – Rar. 7. On soil in subalpine boggy meadow; in moist depression of rock-field. 800 m.
- S. warnstorffii* Russow – Spar. 4, 5, 7. On soil in hummocky sedge-mossy and dwarf-shrub-lichen-moss tundras, subalpine boggy meadow; at lake shore; in moist depression of rock-field. 800-1260 m. Rarely abundant.
- **Stereodon bambergeri* (Schimp.) Lindb. – Rar. 4. On rocks covered with soil at rock-field. Recorded by Cherdantseva & Osipov (1998).
- **S. callichrous* (Brid.) Braithw. – Rar. 7. Recorded by Persson (1970).
- S. plicatulus* Lindb. – Com. 2, 4, 5, 7. On soil, decayed wood, bark and at trunk bases: stone-birch forests, larch forests, alder elfin woods; on rocks covered with soil and in rock crevices: tundras, *Pinus pumila* elfin woods, rock-fields. 300-1050 m. S+.
- S. revolutus* (Mitt.) Lindb. – Rar. 4. On soil in alder elfin woods; in on rocks covered with soil and in rock crevices at rock-field. 700-800 m.
- S. vaucheri* (Lesq.) Lindb. ex Broth. – Rar. 2, 3. On rocks at rock outcrop, 300 m. 4. On rocks covered with soil at rock-field, mixed with *Tortela fragilis*. 700 m.
- Straminergon stramineum* (Dicks. ex Brid.) Hedenae – Spar. 5, 7. On soil in hummocky sedge-mossy and dwarf-shrub-lichen-moss tundras, subalpine boggy meadow; at stream banks. 800-1000 m.
- Syntrichia norvegica* F. Weber – Spar. 4. On decayed wood in poplar flood-plain forest and at river bank. 5. On lake shore. 7. On soil in dwarf-shrub and hummocky sedge-moss tundras, subalpine meadows. 500-1050 m.
- S. ruralis* (Hedw.) F. Weber & D. Mohr – Spar. 2, 3, 4. On rocks covered with soil at rock outcrops and rock-fields; at river bank; at trunk bases in poplar flood-plain forest. 300-700 m.
- Tayloria lingulata* (Dicks.) Lindb. – Spar. 1, 5, 7. On soil and in hollow: hummocky sedge-mossy and dwarf-shrub-moss tundras; at stream banks and lake shores. 800-1400 m; with *Ditrichum flexicaule*, *Meesia uliginosa*, etc. S+.
- Tetraphis pellucida* Hedw. – Spar. 2, 3, 4. On decayed wood and at trunk bases: stone-birch forests, larch forests, poplar flood-plain forest, at river bank. 250-600 m. S+.
- Tetraplodon angustatus* (Hedw.) Bruch et al. – Rar. 7. On rocks covered with soil in *Pinus pumila* elfin wood. 830 m. S+.
- T. mnioides* (Hedw.) Bruch et al. – Rar. 5, 7. On soil in hummocky sedge-mossy, dwarf-shrub-lichen and dwarf-shrub-moss tundras. 800-1250 m. S+.
- T. urceolatus* (Hedw.) Bruch et al. – Rar. 4. On soil in dwarf-shrub tundra. 800 m. S+.
- Tetrodontium repandum* (Funck) Schwägr. – Rar. 4. On rock in dwarf-shrub-lichen tundra; in rock crevices at rock-field. 7. In rock crevices in dwarf-shrub-lichen tundra. 680-1000 . S+.
- Timmia austriaca* Hedw. – Rar. 4. At trunk bases in poplar flood-plain forest. 500 m.
- **T. megapolitana* Hedw. – Rar. 7. Recorded by Persson (1970).

Tomentypnum nitens (Hedw.) Loeske – Spar. 4, 5, 7. On soil in hummocky sedge-mossy, boggy sedge-mossy and dwarf-shrub-sedge tundras, subalpine boggy meadows. 800-1250 m. Abundant.

**Tortella alpicola* Dixon – In rock crevices at rock outcrops. Recorded by Fedosov (2006).

T. fragilis (Hook. & Wilson) Limpr. – Rar. 1. Mossy boggy tundra. 2. On rocks covered with soil at rock outcrops. 4. On soil in dwarf-shrub tundra; on rocks covered with soil at rock-field. 300-1050 m.

T. tortuosa (Hedw.) Limpr. – Rar. 3. In rock crevices at rock outcrops, 300 m. 7. On soil in dwarf-shrub-lichen tundras, 1050 m; on rocks covered with soil in *Pinus pumila* elfin wood, 830 m.

Tortula hoppeana (Schultz) Ochyra – Rar. 7. On soil in hummocky dwarf-shrub-herb tundra, 830 m; on soil in nival community, 1100 m. S+.

T. mucronifolia Schwägr. – Rar. 2. On rock outcrops, 300 m. 4. On rocks covered with soil at rock-field, 700 m. S+.

T. muralis var. *aestiva* Hedw. – Rar. 3. On rocks in *Chosenia* flood-plain forest. 300 m. S+.

T. systylia (Schimp.) Lindb. – Rar. 3. On rock outcrops. 300 m. S+.

Warnstorfia exannulata (Bruch et al.) Loeske – Spar. 2, 5, 7. On soil in hummocky dwarf-shrub-herb and sedge-moss tundras, subalpine boggy meadow, in moist depression of rock-field; at lake shore. 800-1000 m.

W. sarmentosa (Wahlenb.) Hedenäs – Spar. 5, 7. On soil and in hollow: hummocky sedge-dwarf-shrub and sedge-moss tundras; at stream banks and lake shores. 800-1250 m.

DISCUSSION

In Bystrinsky Nature Park, 292 moss species and 13 intraspecific taxa were revealed. Among the most rich in species genera *Dicranum* is represented by 19 species, some of them dominate in tundras and mossy forests; species of *Pohlia* (14) and *Bryum* (13) prefer disturbed places; species of *Sphagnum* (13) grow in wet habitats. Nineteen taxa are reported for the territory of Kamchatka for the first time: *Anacamptodon latidens*, *Bryum knowltonii*, *B. salinum*, *Bucklandiella laeta*, *Cnestrum alpestre*, *Dicranella grevilleana*, *Dicranum dispersum*, *D. drummondii*, *Encalypta brevicolla*, *E. microstoma*, *Hedwigia ciliata* var. *leucophaea*, *Herzogiella turfacea*, *Oligotrichum falcatum*, *Polytrichastrum pallidisetum*, *Pseudoleskeella rupestris*, *Psilopilum cavifolium*, *Schistidium liliputanum*, *S.*

tenerum, *Tortula muralis* var. *aestiva*. Presence of several very rare species is confirmed: *Bucklandiella vulcanicola*, *Pohlia cardotii*, *P. tundrae*, *Tetradontium repandum*.

Moss flora of Bystrinsky Nature Park is rather rich, comparatively with some well-investigated floras of nature reserves of the Russian Far East. For example, 217 moss species are known in Usurijsky Reserve, 243 species in Vrangeli Island, 192 species in Sikhote-Alinsky Reserve, 278 species in Bureinsky Reserve, 215 species in Zejsky Reserve (Ignatov et al., 2004). Well-investigated moss flora of the Klyuchevskoy Nature Park in Kamchatka includes 272 species. Chernyadjeva & Ignatova (2007) published 274 species for this territory, but later *Sciuro-hypnum populeum* (Hedw.) Ignatov & Huttunen was excluded from the moss flora of Kamchatka (Ignatov, 2007), and we include *Polytrichastrum norwegicum* (Hedw.) Schljak. into synonymy of *P. alpinum*. The territory of Klyuchevskoy Nature Park is occupied by large group of active volcanoes; lava and scoria fields are widespread there, alternated by volcanogenic rock outcrops which are highly porous, with high air and water permeability, with inclusions of different metals, complex and heterogeneous in chemical composition and physical characteristics.

Moss flora in Bystrinsky park is more rich than in Klyuchevskoy one (292 and 272 species respectively), and they are rather different, having only 193 species in common (Jacckard's coefficient 0.52), despite close proximity of the territories. This sufficient difference between moss floras of an ancient volcanic system and of a young, active one can be explained by the difference in diversity of habitats. In the territory of the old volcanic system of Bystrinsky park grass cover is generally more dense, wet habitats are widespread and open rock outcrops are more rare. In Klyuchevskoy park epilithic species and species of disturbed places are more common, among them *Grimmia* spp., *Schistidium* spp., *Hymenoloma crispulum*, *Niphotrichum canescens*, *N. ericoides*, etc. In Bystrinsky park species of wet habitats are more abundant, i. e. *Bryum pseudotriquetrum*, *Pseudobryum cinclidioides*, *Sphagnum angustifolium*, *Tomentypnum nitens*. *Calliargon cordifolium* is also frequent while it is absent in Klyuchevskoy park.

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