Arctoa (2009) **18**: *217-224*

BRYOPHYTES OF "GORA VAIDA" STATE NATURE MONUMENT (SAKHALIN, RUSSIAN FAR EAST)

МОХООБРАЗНЫЕ ПАМЯТНИКА ПРИРОДЫ "ГОРА ВАЙДА" (САХАЛИН, РОССИЙСКОЙ ДАЛЬНИЙ ВОСТОК)

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Abstract

A list of bryophytes of the State Nature Monument "Gora Vaida" ("The Vaida Mountain"), supplemented by a brief phytogeographic overview, is presented. It includes 57 species of hepatics and 138 of mosses. The flora is predominantly boreal with a number of East Asiatic and arctic-alpine species. The mountain is formed by limestone, which is rare in Sakhalin; so many species have here quite isolated populations. *Sauteria japonica* (Shimizu et S. Hatt.) S. Hatt. is recorded for the first time for Russia. Many northern species, e.g. *Arnellia fennica, Eocalypogeia schusteriana, Tomentypnum nitens, Scorpidium cossonii, Catoscopium nigritum, Meesia uliginosa*, etc. were found new to Sakhalin, occurring at ridge top in mossy tundra-like communities.

Резюме

Приводится список и фитогеографический обзор мохообразных памятника природы "Гора Вайда" (остров Сахалин). Список включает 57 видов печеночников и 138 видов мхов. Ядро флоры составлено бореальными видами, а специфичность обуславливается присутствием восточноазиатских и арктических таксонов. Гора сложена известняками, выходы которых редки на Сахалине, так что для многих видов их местонахождения на Вайде значительно изолированы от основного ареала. *Sauteria japonica* (Shimizu et S. Hatt.) S. Hatt. приводится впервые для России. Северные виды, как например *Arnellia fennica, Eocalypogeia schusteriana, Tomentypnum nitens, Scorpidium cossonii, Catoscopium nigritum, Meesia uliginosa* и др., отмечены впервые для Сахалина; все они найдены в моховых тундрах и тундроподобных сообществах близ вершины горы.

KEYWORDS: Sakhalin, East Asia, hepatics, mosses, bryoflora, disjunctions

Introduction

Mt. Vaida (Japanese name Okada-jama, ca. 49°52'N 143°28'E) represents the largest in the Sakhalin Island ancient rift formation and is a portion of the limestone massif (Bersenev, 1983). Vaida is a two-headed mountain with elevations of 835 m and 947 m. The mountain is designated as a State Nature Monument (ca. six square kilometer) because of numerous caves, as of this moment 24 are known, including one with a remarkable underground glacier ca. 90 m^3 in size (Bersenev, 1983). In spite of a relatively low elevation and position at 49° northern latitude, the permafrost is rather widespread here. The latter

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fact determines the presence of patches of tundra and similar unique vegetation types supported by seepage of cold waters during the summer due to permafrost melting.

VEGETATION

Most of the territory of the Mt. Vaida area is covered by *Abies* forest, at 350-500(-800) m elev.; the principal ground cover is herb-type, with a moderately developed moss carpet. A considerable part of the forest on S-facing slope was recently burned out by crown and creeping fires. Flood valley of the Vitnitsa River (350 m elev.) has mixed forest, which has many moss species not found in other places, but growing here on rotten logs and stumps covered by alluvial deposits that are obviously quite calcareous. *Pinus pumila* communities and *Betula ermanii* elfin forests occur starting from 490 m on more steep slopes and reaching almost the summit, ca 900 m. The mountain tundra is developed in a small summit area, at 800-947 m elev., but a similar types of vegetation occur near the ridge top also at lower elevation, 650-700 m, where steep N-facing slope is strongly wetted, resulting in community composed by *Tomentypnum, Meesia, Catoscopium, Orthothecium, Aulacomnium turgidum, Sphagnum fuscum, S. capillifolium,* etc. Among other specific types of vegetation, there is a small springy mire on steep slope (380 m elev.), which is dominated by *Hamatocaulis* and the rare orchid *Epiphyanthus*. Limestone outcrops are numerous occurring in a variety of light and water conditions.

PHYTOGEOGRAPHY

Sakhalin Island has North-South orientation, with boreal northern part, and temperate southern one. Their limit is at ca. 48°N (cf. Tatewaki, 1933; Krestov, 2006), thus Vaida is situated within the boreal part of the island. Lowlands and broad valleys are covered by expanded monotonous *Pinus* and *Larix* forests, with a large proportion of bogs. Mountains of northern Sakhalin (usually north of 51°N) have mountain tundras with characterisic vascular plants such as *Dryas* and *Arctous*. However, most of Sakhalin lacks calcareous rocks, thus many calciphilous northern species were not known in Sakhalin previously. Our findings of *Orthothecum chryseon, O. strictum, Tomentypnum nitens, Scorpidium cossonii, Catoscopium nigritum, Meesia uliginosa* are the most southern ones in the Far Eastern region of Russia. Among hepatics, the following arctic-boreal mountain species were discovered at the southern edge of their distribution: *Arnellia fennica* (the nearest known locality on the northern coast of the Sea of Okhotsk: Bakalin, 2009b), *Odontoschisma macounii* (the nearest locality in East Kamchatka, Bakalin, 2009a), *Scapania gymnostomophila, Leiocolea badensis* (the nearest locality in South Yakutia, Bakalin, 2003)*, L. bantriensis* (the nearest localities in Heilongjiang and Kamchatka: Bakalin, 2009a; Piippo, 1990)*, L. gillmanii* (the nearest locality in Kamchatka: Bakalin, 2009a); *Blepharostoma trichophyllum* var. *brevirete*, *Orthocaulis quadrilobus* (the nearest localities for these two are in Kamchatka and on the northern coast of the Sea of Okhotsk: Bakalin, 2009a; Bakalin, 2009b), *Eocalypogeia schusteriana* (the nearest localities in Yakutia and Chukotka: Konstantinova & Bakalin, 2009), *Frullania nisqualensis* (the nearest locality is 150 km to the north, in Chamga Mt. of Nabilskij Range), *Radula prolifera* (the nearest locality in Central Kamchatka: Bakalin, 2009a).

There are six hepatic species that have more southern distribution and grows here at their northern limit: *Frullania appendiculata* (widespread in E Asia south to Java and Sumatra)*, Mylia verrucosa* (outside Russian Far East in China and Japan)*, Porella chinensis* (China, NW India)*, P. gracillima* (South Siberia, China, Japan, Korean Peninsula, NW India). In addition two other taxa accepted here at the species level can be added: *Blepharostoma minus* and *Sauteria japonica;* their differentiation from the closely related *B. trichophyllum* and *Sauteria alpina* correspondingly needs further studies. All these taxa are known in the southern part of Sakhalin, 100-200 km to the south from Vaida. None of the listed moss species are found to be of the northernmost occurrence.

LIST OF BRYOPHYTE SPECIES

Our exploration of bryophytes of the Vaida Mt. was conducted on August 20-21, 2006. The following list includes 57 species of hepatics (specimens in VLA) and 138 mosses (specimens in MHA). A voucher specimen of each species is cited at the end of its annotation.

Hepatics

Abbreviations after species name indicate presence of antheridia (anth.), archegonia (arch.), gemmae (gemm.), perianths (per.), sporophytes (sp.), or juvenille sporophytes (sp. juv.).

Apometzgeria pubescens (Schrank) Kuwah. – 600 m – Shaded limestone cliffs on slope in *Abies* forest. In pure mats or with *Frullania appendiculata*, *Leiocolea heterocolpos*, *Porella chinensis*, *P. gracillima*. S-32-8-06.

Arnellia fennica (Gottsche) Lindb. – 600 m – Shaded cliffs in *Betula ermanii-Pinus pumila* community with forb cover. S-32-24-06.

Barbilophozia barbata (Schmid. ex Schreb.) Loeske – 600 m – Shaded cliffs in *Betula ermanii-Pinus pumila* community with forb cover. With *Leiocolea heterocolpos*. S-32-16-06.

Bazzania ovifolia (Steph.) S. Hatt. – 425-900 m – Decaying wood in *Abies* forests on slope to valley; over moss mats in moss tundra on seeping permafrost water. In pure mats or (mainly) with *Blepharostoma trichophyllum* var. *trichophyllum*, *Calypogeia suecica*, *Cephalozia leucantha*, *C. lunulifolia*, *Crossocalyx hellerianus*, *Lophozia guttulata*, *L. silvicola*, *Macrodiplophyllum plicatum*, *Mylia verrucosa*, *Riccardia palmata*, *Sphenolobus minutus*, *Tritomaria exsecta*. S-35-4-06.

B. trilobata (L.) S. Gray – 425 m – Ground cover in *Abies* forest. S-35-3-06.

Blepharostoma minus Horikawa – 600 m – Shaded cliffs in *Betula ermanii-Pinus pumila* community with forb cover. S-32-14a-06.

B. trichophyllum (L.) Dumort. var. *brevirete* Bryhn & Kaal. – 900 m – Over moss mats in moss tundra on seeping permafrost water. With *Tritomaria quinquedentata*. S-32-27a-06.

B. trichophyllum (L.) Dumort. var. *trichophyllum* – 394-481 m – Decaying wood in *Abies* forest on slope to valley; limestone cliffs of stream's bank. With *Bazzania ovifolia*, *Calypogeia suecica*, *Cephalozia leucantha*, *C. lunulifolia*, *Crossocalyx hellerianus*, *Leiocolea* cf. *gillmanii*, *Lepidozia reptans*, *Lophocolea itoana*, *Lophozia guttulata*, *L. silvicola*, *Macrodiplophyllum plicatum*, *Mylia verrucosa*, *Pellia neesiana*, *Riccardia latifrons*, *R. palmata*, *Tritomaria exsecta*. S-32-1-06.

Calypogeia integristipula Steph. – 900 m – Over moss mats in moss tundra on seeping permafrost water. With *Eocalypogeia schusteriana*, *Odontoschisma macounii*, *Sphenolobus minutus*. S-32-31-06.

C. suecica (Arnell & J. Perss.) Müll. Frib. – gemm. – 425-481 m – Decaying wood in *Abies* forests. With *Bazzania ovifolia*, *Blepharostoma trichophyllum* var. *trichophyllum*, *Cephalozia leucantha*, *C. lunulifolia*, *Mylia verrucosa*. S-32-2-06.

Cephalozia leucantha Spruce – per. – 481 m – Decaying wood in *Abies* forest. With *Bazzania ovifolia*, *Blepharostoma trichophyllum* var. *trichophyllum*, *Calypogeia suecica*, *Crossocalyx hellerianus*, *Lophozia guttulata*, *L. silvicola*, *Macrodiplophyllum plicatum*, *Mylia verrucosa*, *Riccardia palmata*, *Tritomaria exsecta*. S-32-2-06.

C. lunulifolia (Dumort.) Dumort. – 425-481 m – Decaying wood in *Abies* forests. With *Bazzania ovifolia*, *Blepharostoma trichophyllum* var. *trichophyllum, Calypogeia suecica*, *Cephalozia leucantha*, *Lepidozia reptans*, *Macrodiplophyllum plicatum*, *Mylia verrucosa*, *Schistochilopsis incisa*. S-32-1-06.

Conocephalum conicum (L.) Underw. – 900 m – Over moss mats in moss tundra on seeping permafrost water. With *Eocalypogeia schusteriana*, *Preissia quadrata*. S-32-34-06.

Crossocalyx hellerianus (Nees) Meyl. – gemm. – 481 m – Decaying wood in *Abies* forest. With *Bazzania ovifolia*, *Blepharostoma trichophyllum* var. *trichophyllum, Cephalozia leucantha*, *Lophozia guttulata*, *Macrodiplophyllum plicatum*, *Mylia verrucosa*, *Tritomaria exsecta*. S-32-3-06.

Eocalypogeia schusteriana (S. Hatt. & Mizut.) R.M. Schust. – 600-900 m – Shaded cliffs in *Betula ermanii-Pinus pumila* community with forb cover; over moss mats in moss tundra on seeping permafrost water. In pure mats or with *Calypogeia integristipula*, *Conocephalum conicum*, *Leiocolea heterocolpos*, *Lophozia ventricosa*, *Odontoschisma macounii*, *Preissia quadrata*, *Sphenolobus minutus*. S-32-18-06.

Frullania appendiculata Steph. – 600-900 m – Shady cliffs in *Betula ermanii-Pinus pumila* community with forb cover; over moss mats in moss tundra on seeping permafrost water. In pure mats or with *Apometzgeria pubescens*, *Macrodiplophyllum plicatum*. S-32-19-06

F. nisqualensis Sull. – 900 m – Over moss mats in moss tundra on seeping permafrost water. S-32-29-06.

Jungermannia borealis Damsh. & Váňa – 394 m – Limestone cliffs along stream in *Abies* forest. S-34-2-06.

J. exsertifolia Steph. – 394 m – Limestone cliffs along stream in *Abies* forest. With *Solenostoma confertissimum*. S-34-3-06.

J. pumila With. – per., anth. – 481 m – Shaded limestone cliffs in *Abies* forest on slope. S-32-7-06.

Leiocolea badensis (Gottsche) Schiffn. – per. – 600-900 m – Shaded cliffs in *Betula ermanii-Pinus pumila* community with forb cover; over moss mats in moss tundra on seeping permafrost water. S-32-23a-06.

L. bantriensis (Hook.) Jørg. – per. – 830 m – Wet moss mats on seeping water in limestone cliff crevices. S-33-2-06.

L. collaris (Nees) Schljakov – 600 – Shaded cliffs in *Betula ermanii-Pinus pumila* community with forb cover. S-32-15-06.

L. gillmanii (Aust.) A. Evans – per., anth. – 394 m – Limestone cliffs along stream. With *Blepharostoma trichophyllum* var. *trichophyllum*, *Lophocolea itoana*, *Pellia neesiana*. S-34-1-06.

L. heterocolpos (Thed. ex Hartm.) H. Buch var. *heterocolpos* – per., gemm. – 481-900 m – Shaded limestone cliffs in *Abies* forest and *Betula ermanii-Pinus pumila* community; over moss mats in moss tundra on seeping permafrost water. In pure mats or with *Apometzgeria pubescens*, *Barbilophozia barbata*, *Eocalypogeia schusteriana*, *Lophozia ventricosa*, *Preissia quadrata*, *Radula* cf. *constricta*, *Radula complanata*, *Scapania gymnostomophila*. S-35-9-06.

Lepidozia reptans (L.) Dumort. – 425-481 m – Decaying wood in *Abies* forests. With *Blepharostoma trichophyllum* var. *trichophyllum*, *Cephalozia lunulifolia*, *Macrodiplophyllum plicatum*, *Mylia verrucosa*, *Schistochilopsis incisa*. S-35-1-06.

Lophocolea itoana H. Inoue – anth. – 394-481 m – Shaded limestone cliffs in *Abies* forest and in full sun on stream bank. With *Blepharostoma trichophyllum* var. *trichophyllum*, *Leiocolea* cf. *gillmanii*, *Pellia neesiana*. S-34-4-06.

Lophozia guttulata (Lindb. & Arnell) A. Evans – 481 m – Decaying wood in *Abies* forest on slope to valley. With *Bazzania ovifolia*, *Blepharostoma trichophyllum* var. *trichophyllum*, *Cephalozia leucantha*, *Crossocalyx hellerianus*, *Macrodiplophyllum plicatum*, *Mylia verrucosa*, *Riccardia latifrons*, *Tritomaria exsecta*. S-32-2a-06.

L. silvicola H. Buch – 481 m – Decaying wood in *Abies* forest on slope to valley. With *Bazzania ovifolia*, *Blepharostoma trichophyllum* var. *trichophyllum, Cephalozia leucantha*, *Riccardia palmata*. S-32-4-06.

L. ventricosa (Dicks.) Dumort. var. *ventricosa* – 600 m – Shaded cliffs in *Betula ermanii-Pinus pumila* community with forb cover. With *Eocalypogeia schusteriana*, *Leiocolea heterocolpos*, *Preissia quadrata*. S-32-18-06.

Macrodiplophyllum plicatum (Lindb.) H. Perss. – gemm. – 425-900 m – Decaying wood in *Abies* forests; over moss mats in moss tundra on seeping permafrost water. In pure mats or with *Bazzania ovifolia*, *Blepharostoma trichophyllum* var. *trichophyllum*, *Cephalozia leucantha*, *Cephalozia lunulifolia*, *Crossocalyx hellerianus*, *Frullania appendiculata*, *Lepidozia reptans*, *Lophozia guttulata*, *Mylia verrucosa*, *Schistochilopsis incisa*, *Sphenolobus minutus*, *Tritomaria exsecta*. S-35-1-06.

Metzgeria furcata (L.) Dumort. – 900 m – Decaying wood in *Betula ermanii-Pinus pumila* community with forb cover. S-32-38-06.

Mylia taylorii (Hook.) S. Gray – 830 m – Wet moss mats on seeping water in crevices of limestone cliff. In pure mats or with *Sphenolobus minutus*. S-33-1-06.

M. verrucosa Lindb. – per., sp. – 425-481 m – Decaying wood in *Abies* forests. With *Bazzania ovifolia*, *Blepharostoma trichophyllum* var. *trichophyllum*, *Calypogeia suecica*, *Cephalozia leucantha*, *C. lunulifolia*, *Crossocalyx hellerianus*, *Lepidozia reptans*, *Lophozia guttulata*, *Tritomaria exsecta*. S-35-1-06.

Odontoschisma macounii (Aust.) Underw. – per., sp. juv. – 830-900 m – Over moss mats in moss tundra on seeping permafrost water and crevices of limestone cliff. In pure mats or with *Calypogeia integristipula*, *Eocalypogeia schusteriana*, *Sphenolobus minutus*. S-32-27b-06, S-33-3-06.

Orthocaulis attenuatus (Mart.) A. Evans – gemm. – 900 m – *Pinus pumila* branch in *Betula ermanii-Pinus pumila* community with forb cover. S-32-39-06.

O. quadrilobus (Lindb.) H. Buch – per. – 900 m – Over moss mats in moss tundra on seeping permafrost water. S-32-27-06.

Pellia neesiana (Gottsche) Limpr. – anth. – 394 m – Limestone cliff on stream bank. With *Blepharostoma trichophyllum* var. *trichophyllum*, *Leiocolea* cf. *gillmanii*, *Lophocolea itoana*. S-34-4-06.

Plagiochila ovalifolia Mitt. – 481 m – Shaded limestone cliffs on slope in *Abies* forest. S-32-11-06.

P. porelloides (Torrey ex Nees) Lindenb. – per. – 394 m – Limestone cliff on stream bank. S-34-5-06.

Porella chinensis (Steph.) S. Hatt. – 481 m – Shaded limestone cliff in *Abies* forest. With *Apometzgeria pubescens*. S-32-10-06.

P. gracillima Mitt. var. *gracillima* – 481-600 m – Shaded limestone cliff in *Abies* forest. With *Apometzgeria pubescens*. S-32-8-06.

Preissia quadrata (Scop.) Nees – sp. – 481-900 m – Wet landslide along roadside; shaded cliffs in *Betula ermanii-Pinus pumila* community with forb cover; over moss mats in moss tundra on seeping permafrost water. In pure mats or with *Conocephalum conicum*, *Eocalypogeia schusteriana*, *Leiocolea heterocolpos*, *Lophozia ventricosa*. S-32-6-06.

Ptilidium pulcherrimum (Weber) Vain. – per. – 425 m – Decaying wood in *Abies* forest with moss cover. S-35-2-06.

Radula cf. *constricta* Steph. – gemm. – 600 m – Shaded cliffs in *Betula ermanii-Pinus pumila* community with forb cover. With *Leiocolea heterocolpos*, *Scapania gymnostomophila*. S-32-26-06.

R. complanata (L.) Dumort. – per., anth., gemm. – 600 m – Shaded cliffs in *Betula ermanii-Pinus pumila* community with forb cover. In pure mats or with *Leiocolea heterocolpos*. S-32-17-06.

R. prolifera Arnell – anth. – 900 m – Over moss mats in moss tundra on seeping permafrost water. S-32-28-06.

Riccardia latifrons (Lindb.) Lindb. – anth., arch. – 481 m – Decaying wood in *Abies* forest on slope to valley.

With *Blepharostoma trichophyllum* var. *trichophyllum, Lophozia guttulata*. S-32-2a-06.

R. palmata (Hedw.) Carruth. – 481 m – Decaying wood in *Abies* forest on slope to valley. With *Bazzania ovifolia*, *Blepharostoma trichophyllum* var. *trichophyllum, Cephalozia leucantha*, *Lophozia silvicola*. S-32-4-06.

Sauteria japonica (Shimizu & S. Hatt.) S. Hatt. – anth., arch. – 600 m – Shaded cliffs in *Betula ermanii-Pinus pumila* community with forb cover. S-32-23-06. – The first record in Russia.

Scapania apiculata Spruce – per., gemm. – 425 m – Decaying wood in *Abies* forest with moss cover. S-35-8-06.

S. gymnostomophila Kaal. – gemm. – 600 m – Shaded cliffs in *Betula ermanii-Pinus pumila* community with forb cover. In pure mats or with *Leiocolea heterocolpos*, *Radula* cf. *constricta*. S-32-14-06.

Schistochilopsis incisa (Schrad.) Konstant. – 425 m – Decaying wood in *Abies* forest with moss cover. With *Blepharostoma trichophyllum* var. *trichophyllum, Cephalozia lunulifolia*, *Lepidozia reptans*, *Macrodiplophyllum plicatum*. S-35-7-06.

Solenostoma pseudopyriforum Bakalin & Vilnet – per. – 394 m – Limestone cliffs along stream bank. With *Jungermannia exsertifolia*. S-34-3-06.

Sphenolobus minutus (Schreb.) Berggr. – per., gemm. – 481-900 m – Shady limestone cliffs and decaying wood in *Abies* forests; over moss mats in moss tundra on seeping permafrost water and crevices in limestone cliff. In pure mats or with *Bazzania ovifolia*, *Calypogeia integristipula*, *Eocalypogeia schusteriana*, *Macrodiplophyllum plicatum*, *Mylia taylorii*, *Odontoschisma macounii*, *Tritomaria exsecta*. S-35-4-06.

Tritomaria exsecta (Schmid. ex Schrad.) Loeske – gemm. – 425-481 m – Decaying wood, over moss mats hanging from limestone cliffs in *Abies* forests. In pure mats or (on decaying wood) with *Bazzania ovifolia*, *Blepharostoma trichophyllum* var. *trichophyllum, Cephalozia leucantha*, *Crossocalyx hellerianus*, *Lophozia guttulata*, *Macrodiplophyllum plicatum*, *Mylia verrucosa*, *Sphenolobus minutus*. S-32-3-06.

T. quinquedentata (Huds.) H. Buch – 900 m – Over moss mats in moss tundra on seeping permafrost water. With *Blepharostoma trichophyllum* var. *brevirete*. S-32-27a-06.

Mosses

Abietinella abietina (Hedw.) M. Fleisch. – 480-900 m – rock outcrops on N-facing slope, on open places as well as in forest. 06-134.

Anomodon longifolius (Brid.) Hartm. – 450-600 m – rocks in *Abies* forest and relatively open cliff base on N-facing slope. 06-130.

A. rugelii (Müll.Hal.) Keissl. – 650 m – open cliff base on N-facing slope. 06-131.

Aulacomnium palustre (Hedw.) Schwägr. – 350-380 m – stream side and hanging bog near springs. 06-79.

A. turgidum (Wahlenb.) Schwägr. – 600-900 m – moss tundra on N-facing slope near summit and ridge top. 06-81.

Barbula convoluta Hedw. — 450 m – on soil in burned forest. 06-54.

B. unguiculata Hedw.–350-450 m – disturbed places and limestone outcrops on N-facing slope. 06-55.

Bartramia pomiformis Hedw. — 350-600 m - soil bank at base of slope to flood valley and side of hummock in flood valley and on rotten log in *Abies* forest on slope. 06-92.

Brachythecium buchananii (Hook.) A. Jaeger — 450-600 m – rock outcrops in open and partially shaded slopes. 06-211.

B. campestre (Müll.Hal.) Bruch et al. – 800 m – rocks among *Pinus pumila* thicket. 06-0608.

B. cirrosum (Schwägr.) Schimp. – 450-900 m – limestone outcrops on open slopes and in summit area, as well as in forest. 06-99.

B. rivulare Bruch et al. – 600 m — stream bed in conifer forest. 06-100.

B. rotaeanum De Not. – 550-600 m – rather dry cliffs and shaded limestone rocks on open slope. 06–239.

Bryoerytrophyllum recurvirostrum (Hedw.) P.C. Chen – 350-930 m – calcareous rock outcrops, occasionally in other habitats, e.g. on stump in flood valley forest. 06-41.

Bryum argenteum Hedw. – 350 m – roadside. 06-90.

B. moravicum Podp. – 600 m – on *Betula* trunk in mixed forest on steep slope of ravine. 06-91.

Callicladium haldanianum (Grev.) H.A.Crum – 350 m – rotten log in flood valley. 06-165.

Calliergonella lindbergii (Mitt.) Hedenäs – 350-450 m – common on bare soil in flood valley forest and along wet ground road. 06-170.

Campyliadelphus chrysophyllus (Brid.) R.S. Chopra – 750 m – dry rocks on S-facing slope. 06-218.

Campylidium cf. *sommerfeltii* (Myrin) Ochyra – 350-600 m – rotten logs and tree bases in forest and moderately open places. 06-213.

Campylium stellatum (Hedw.) C.E.O. Jensen – 380-750 m – springy mire, wet cliffs, and mossy tundra-like community on N-facing slope. 06-124.

Campylophyllum halleri (Hedw.) M. Fleisch. – 450-900 m – on limestone outcrops; very common along the ridge top. 06-121.

Catoscopium nigritum (Hedw.) Brid. – 650-900 m – tundra-like communities near ridge top and on N-facing slope. 06-83.

Ceratodon purpureus (Hedw.) Brid. – 380 m – along a road in open forest; rare. 06-39.

Claopodium pellucinerve (Mitt.) Best – 400-500 m – calcareous rock outcrops: at bases of rocks and in niches. 06-318.

Climacium dendroides (Hedw.) F. Weber & D. Mohr – 350-650 m – flood valley forest and wet fir forests. 06-328.

Cnestrum alpestre (Wahlenb. ex Huebener) Nyholm ex Mogensen – 650 m – near rock outcrop on N-facing slope. 06-420.

Cratoneuron filicinum (Hedw.) Spruce – 350-750 m – on soil in flood valley forest, near springs, on wet cliffs. 06-320.

Cyrtomnium hymenophylloides (Huebener) T.J. Kop. – 550-920 m – on shaded limestone rock, in ridge area rather abundant in caves. 06-82.

Dichodontium pellucidum (Hedw.) Schimp. – 700 m – rocks in stream, not high above water. 06-220.

Dicranella grevilleana (Brid.) Schimp. – 380-400 m – wet road at foothill, abundant at a certain distance. 06-3558.

D. subulata (Hedw.) Schimp. – 600 m – under upturned roots of fallen tree in fir forest. 06-310.

Dicranum acutifolium (Lindb. & Arnell) C.E.O. Jensen – 700 m – mossy tundra-like community of N-facing slope. 06-18.

D. elongatum Schleich. ex Schwägr. – 920 m – mossy tundra-like community in summit area. 06-20.

D. fuscescens Turner – 350-750 m. – rotten logs and stumps and on trunk bases. 06-14.

D. majus Turner – 350-800 m – rather common in forests, including elfin forests, and in tundra-like communities. 06-16.

D. montanum Hedw. – 500 m – rotten logs in conifer forests. 06-19.

Didymodon perobtusus Broth. – cliffs in summit area. 06–3543.

Distichium capillaceum (Hedw.) Bruch et al. – 400-700 m – calcareous rock outcrops. 06-21.

Ditrichum flexicaule (Schwägr.) Hampe – 425-930 m – calcareous rock outcrops, mostly in forest or on N-facing surfaces, and in mossy tundra-like communities. 06-93.

Drepanium recurvatum (Lindb. & Arnell) G. Roth – 450-900 m – on limestone outcrops; along the ridge rather common, often with *Campylophyllum halleri*. 06-169.

Echinophyllum sachalinense (Lindb.) O'Brian – 450 m – cliffs on N-facing slope and on rotten log in fir forest. 06-135.

Encalypta procera Bruch – 450-500 m – limestone outcrop on rather open W- and N-facing slopes. 06-42.

E. rhaptocarpa Schwägr. – 500-925 m – dry limestone outcrops to rather wet rocky tundra in summit area. 06-45.

Entodon concinnus (De Not.) Paris – 480 m – limestone rocks on N-facing slope. 06-166.

Eurhynchiadelphus eustegius (Besch.) Ignatov & Huttunen – 600 m – rock ourcrop in *Abies* forest. 06-221.

Eurhynchiastrum pulchellum (Hedw.) Ignatov & Huttunen – 350-750 m – on rocks in forest, but also on stumps and rotten logs in flood valley (with some alluvium). 06-126.

Fissidens adianthoides Hedw. – 380-700 m – among mosses in springy mire and on wet cliffs in fir forest. 06-53.

Funaria hygrometrica Hedw. – 750 m – the only finding in limestone niche on S-facing slope. 06-87.

Gollania turgens (Müll.Hal.) Ando – 500-700 m – wet mossy tundra-like communities at ridge top on steep N-facing slope and wet limestone outcrops. 06-417.

Grimmia tergestina Tomm. ex Bruch et al. – 550 m – dry limestone rocks on S-facing slope. 06-62.

Gymnostomum aeruginosum Sm. – 450-600 m – not rare on limestone on both open slopes and in fir forest. 06-3604.

Hamatocaulus vernicosus (Mitt.) Hedenäs – 380 m – springy mire on slope. 06-142.

Herzogiella turfacea (Lindb.) Z. Iwats. – 350 m – rotten log in flood valley. 06-163.

Hylocomiastrum pyrenaicum (Spruce) M. Fleisch. – 600 m – limestone outcrops in fir forest. 06-307.

Hylocomium splendens (Hedw.) Bruch et al. – 350-930 m – on soil and rocks in forest and among other mosses in treeless summit vegetation. 06-167.

Hymenostylium recurvirostrum (Hedw.) Dixon – 750 m – S-facing cliffs. 06-78.

Hypnum cupressiforme Hedw. – 650 m – rather dry rocks in upper part of canyon, close to ridge top. 06-115.

Isopterygiopsis muelleriana (Schimp.) Z. Iwats. – 650 m – rocks in wet tundra-like community on N-facing slope. 06-160.

I. pulchella (Hedw.) Z. Iwats. – 650-700 m – calcareous rock outcrops on N-facing slope, on wet rocks and soil at their base. 06-309.

Iwatsukiella leucotricha (Mitt.) W.R. Buck & H.A. Crum – 350-750 m–common in conifer and mixed forests, on *Alnus* and *Abies* trunks (for the latter including crown portion), and especially twigs, occasionally on rotten logs. 06-118.

Leptobryum pyriforme (Hedw.) Wilson – 500-700 m – calcareous rocks. 06-63.

Lescuraea incurvata (Hedw.) E. Lawton – 800 m – rock outcrops in *Pinus pumila* belt. 06-327.

Leucodon pendulus Lindb. – 600 m – on *Abies* twigs on ravine slope (only one finding in the area). 06-164.

Loeskypnum badium (Hartm.) H.K.G. Paul – 700 m – wet tundra-like communitiy of N-facing slope. 06-168.

Meesia uliginosa Hedw. – 450-900 m – wet calcareous cliffs and tundra-like mossy communities on ridge top. 06-66.

Mnium lycopodioides Schwägr. – 350-900 m – on rocks, fallen logs in flood valley, soil banks near streams, mossy tundra-like communities in summit area. 06-210.

M. thomsonii Schimp. – 600 m – on rock outcrops in fir forest. 06-208.

Myurella julacea (Schwägr.) Bruch et al. – 550-900 m – limestone rocks, mossy tundra-like communities and rocky tundra in summit area. 06-111.

M. sibirica (Müll.Hal.) Reimers – 500-650 m – on shaded and rather moist limestone rocks, and also on soil in tundra-like mossy communities near the ridge top. 06-107.

Neckera pennata Hedw. – 350 m – on *Salix* trunk in flood valley. 06-241.

Orthothecium chryseon (Schwägr.) Bruch et al. – 650-700 m – mossy tundra-like community on N-facing slope near the ridge top. 06-144.

O. strictum Lorentz – 650-920 m – in the same place with previous species and among rocks in rocky tundra near summit. 06-147.

Orthotrichum anomalum Hedw. – 650 m – rare, on open rocks among *Pinus pumila*, near ridge top. 06-244.

O. sordidum Sull. & Lesq. – 350 m – on *Salix* in flood valley of the Vitnitza River. 06-224.

Paraleucobrium longifolium (Hedw.) Loeske – 600 m – rock outcrops in fir forest. 06-89.

Plagiomnium ellipticum (Brid.) T.J. Kop. – 750 m – wet fir forest near a stream. 06-421.

P. vesicatum (Besch.) T.J. Kop. – 350 m – side of hummock in flood valley forest. 06-416.

Plagiopus oederianus (Sw.) H.A. Crum & L.E. Anderson – 500-900 m – wet calcareous rocks in forest and tundra-like community near summit. 06-48.

Plagiothecium euryphyllum (Cardot & Thér.) Z. Iwats. – 700 m – on soil bank to stream bed. 06-243.

P. laetum Bruch et al. – 750 m – rotten logs in *Betula* elfin forest. 06-128.

Platygyrium repens (Brid.) Bruch et al. – 500 m – on *Betula* trunk in fir forest. 06-312.

Pleuroziopsis ruthenica (Weinm.) Kindb. ex E. Britton – 600-750 m – sporadic in mossy fir forests in moss carpet and on wet cliffs. 06-171.

Pleurozium schreberi (Brid.) Mitt. – 350-900 m – in conifer and mixed forest on litter, common. 06-3554a.

Pogonatum contortum (Brid.) Lesq. – 380-500 m – along a road in conifer forest and on bank to stream bed. 06-23.

P. japonicum Sull. & Lesq. – 550-700 m – on litter and among moss carpet in mossy fir forests, along small stream in ravine bottom. 06-28.

P. urnigerum (Hedw.) P. Beauv. – 350-500 m – on rock outcrops on slope, along a road in forest, and under roots of fallen trees. 06-27.

Pohlia cruda (Hedw.) Lindb. – 350-930 m – on stump in flood valley, on soil bank and near rock outcrops. 06-69.

P. nutans (Hedw.) Lindb. – 350-650 m – on rotten logs and stumps in fir and mixed forest. 06-67.

Polytrichastrum alpinum (Hedw.) G.L. Sm. – 550-600 m – on soil and rotten logs in conifer forest on steep slope. 06-33.

Polytrichum commune Hedw. – 500 m – soil bank along stream in forest, rare. 06-36.

P. juniperinum Hedw. – 350-750 m – wet N-facing slope. 06-34.

P. piliferum Hedw. – 350-550 m – on soil in disturbed places and eroded slopes in forest. 06-35.

Pseudoleskeella catenulata (Brid. ex Schrad.) Kindb. – 450-750 m – rocks on open S-facing slope. 06-319.

P. rupestris (Berggr.) Hedenäs & L.Söderstr. – 450-600 m – rocks and rotten logs in fir forest. 06-323.

P. tectorum (Funck ex Brid.) Kindb. ex Broth. – 550 m – calcareous cliffs. 06-314.

Ptilium crista-castrensis (Hedw.) De Not. – 350-900 m – common in conifer forests on litter and rotten logs and in mossy tundra-like communities. 06-113.

Pylaisia falcata Bruch et al. – 550 m – on *Betula* in *Abies* forest on slope. 06-245.

P. polyantha (Hedw.) Bruch et al. – 350 m – on *Salix* in flood valley. 06-418.

Racomitrium lanuginosum (Hedw.) Brid. – 650-930 m – on moist soil on N-facing slope near the ridge top. 06-86.

Rhizomnium magnifolium (Horik.) T.J. Kop. – 380-650 m – stream banks. 06-311.

Rhytidiadelphus japonicus (Reimers) T.J.Kop. – 350 m – one finding on wet rotten log in flood valley.

R. triquetrus (Hedw.) Warnst. – 350-900 m – common on litter in conifer forest and *Betula* elfin woods.

Rhytidium rugosum (Hedw.) Kindb. – 600-940 m – sporadic on rather dry limestone cliffs near ridge top. 06-157.

Rigodiadelphus robustus (Lindb.) Nog. — 750-700 m - on fir and *Sorbus* twigs in dense fir forest on steep slope of deep ravine. 06–3603.

Saelania glaucescens (Hedw.) Broth. – 350 m – soil banks in flood valley. 06-61.

Sanionia uncinata (Hedw.) Loeske – 350 m – rotten logs and tree trunk bases in flood valley forest. 06-137.

Schistidium lancifolium (Kindb.) H.H. Blom – 450 m – rocks in fir forest. 06-974.

S. pulchrum H.H. Blom – 750 m – rock outcrops on S-facing slope. 06-975.

S. trichodon (Brid.) Poelt. var. *trichodon* – 600 m – rather wet and shaded rock outcrops. 06-972.

S. trichodon var. *nutans* H.H. Blom – 500-600 m – limestone outcrops, both in rather open dry places and in *Abies* forest. 06-969.

Sciuro-hypnum reflexum (Starke) Ignatov & Huttunen – 750 m – rotten log in *Betula* elfin forest. 06-102.

S. starkei (Brid.) Ignatov & Huttunen – 700 m – soil in *Betula* elfin forest. 06-219.

S. uncinifolium (Broth. & Paris) Ochyra & Żarnowiec – 600 m – limestone outcrop in *Abies* forest. 06-103.

Scorpidium cossonii (Schimp.) Hedenäs – 650 m – wet tundra-like community of N-facing slope. 06-315.

Seligeria campylopoda Kindb. – 450 m – in niche of limestone rocks on rather open slope. 06-38.

Sphagnum capillifolium (Ehrh.) Hedw. – 380-920 m – springy mire on slope, with *Hamatocaulis,* and wet tundra-like community of N-facing slope and in summit area. 06-3602.

S. fuscum (Schimp.) H.Klinggr. – 650-920 m – wet tundra-like community of N-facing slope and in wet tundra in summit area. 06-3606.

S. girgensohnii Russow – 500-600 m – in wet coniferous forest.

S. lenense H. Lindb. ex L.I.Savicz – 920 m – in wet tundra in summit area. 06-3553.

S. russowii Warnst. – 650 m – found as admixture to the previous species. 06-3606a.

Stereodon bambergeri (Schimp.) Lindb. – 600 m – N-facing slope in summit area, within wet mossy carpet. 06-321.

Stereodon plicatulus Lindb. – 600 m – rotten log in *Abies* forest. 06-3547.

S. procerrimus (Molendo) Bauer – 650-900 m – dry calcareous rocks near summit and on S-facing slopes. 06-140.

S. vaucheri (Lesq.) Lindb. ex Broth. – 650-750 m – dry calcareous rocks on S-facing slope. 06-114.

Syntrichia norvegica F. Weber – 750-930 m – sporadic on dry calcareous rocks at ridge top. 06-37.

Tetraphis geniculata Girg. ex Milde – 350-700 m – common on rotten logs in conifer forest. 06-3545.

T. pellucida Hedw. – 550 m – rotten log in conifer forest. 06-88.

Thuidium assimile (Mitt.) A. Jaeger – 450-900 m – calcareous rock outcrops and mossy tundra-like vegetation at ridge top. 06-231.

Timmia bavarica Hessl. – 600 m – limestone outcrops in fir forest. 06-9.

T. comata Lindb. & Arnell – 500-700 m – limestone rocks on N-facing slopes, in rocky tundra-like community on ridge top. 06-7.

Tomentypnum nitens (Hedw.) Loeske – 700-750 m – mossy tundra-like community on ridge top and upper part of N-facing slope. 06-158.

Tortella alpicola Dixon – 750 m – S-facing cliffs. 06-60.

T. tortuosa (Hedw.) Limpr. – 425-750 m – very common along ridge top, on xeric open rock outcrops, occasionally in other places in a broad range of environments, including rather wet rocks in fir forest. 06-59.

Trachycystis flagellaris (Sull. & Lesq.) Lindb. – 350-700 m – quite common on rotten logs in deciduous and conifer forests and on rock outcrops in shady wet places. 06-74.

T. ussuriensis (Maack & Regel) T.J. Kop. – 650 m – dry cliffs in upper part of canyon. 06-76.

Ulota crispa (Hedw.) Brid. – 350-600 m - on *Abies* twigs in mixed and fir forest. 06-84.

U. reptans Mitt. – 350-600 m - on *Abies* and *Alnus*, in fir and mixed forests. 06-3609.

ACKNOWLEDGEMENTS

Authors thank Dr. P.V. Krestov (VLA) for organization of wonderful field trip to Sakhalin Island during summer of 2006 and Ye.I. Kosovich-Anderson for English correction.

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