

BRYOPHYTES – МОХООБРАЗНЫЕ

A contribution to the liverwort flora of Kamchatka (Northwest Pacific)

V. A. Bakalin

Botanical Garden–Institute, Far Eastern Branch of the Russian Academy of Sciences, Vladivostok, Russia

Corresponding author: V. A. Bakalin, vabakalin@gmail.com

Abstract. Research on the liverwort flora of the Kamchatka Peninsula have been active throughout the first quarter of the 21st century. The data discussed here were obtained during a survey of three areas of Kamchatka in the summer of 2005, two of which (the northern macroslope of the Ichinskaya Sopka Volcano and the middle course of the Kikhchik River basin) had previously been only poorly documented. Overall, 110 species and three varieties were revealed in the studied collection. Two species (*Marsupella arctica* and *Mylia taylorii*) are reported in this study for the first time from the Kamchatka Peninsula. Taking these data into account, 239 species are now known in the peninsula flora. Although the number of species new to the Kamchatka liverwort flora revealed here is small, the study of taxonomic diversity is not complete, and the new research will expand our knowledge on the Kamchatka liverwort flora. However, new data likely will not change the general understanding of the flora character.

Keywords: Hepaticae, Kamchatka Territory, Northeast Asia, Northwest Pacific, diversity, liverworts, rare species.

Новые материалы к флоре печеночников Камчатки (северо-западная Пацифика)

В. А. Бакалин

Ботанический сад–институт ДВО РАН, Владивосток, Россия

Автор для переписки: В.А. Бакалин, vabakalin@gmail.com

Резюме. Флора печеночников Камчатки активно исследовалась на протяжении первой четверти 21 века. Обсуждаемые результаты были получены при исследовании трех районов Камчатки летом 2005 года, для двух из которых (Северный макросклон вулкана Ичинская Сопка и среднее течение реки Кихчик) имелось мало сведений. В изученной коллекции выявлено 110 видов и три разновидности печеночников. Два вида (*Marsupella arctica*, *Mylia taylorii*) приводятся для флоры полуострова впервые. С учетом этих данных, во флоре полуострова известно 239 видов. Хотя количество выявленных здесь новых для региональной флоры видов невелико, постижение таксономического разнообразия не закончено и новые исследования позволят пополнить имеющийся список флоры печеночников Камчатки. Новые находки, тем не менее, не изменят общего представления о характере флоры в целом.

Ключевые слова: Камчатский край, Северо-восточная Азия, Северо-западная Пацифика, печеночники, разнообразие, редкие виды.

Within the Russian Far East, the liverwort flora of the Kamchatka Peninsula appears to be relatively well studied. A definitive summary of the Kamchatka liverwort flora was provided by Bakalin (2009), who listed 226 species for Kamchatka (within the peninsula, excluding the Koryak Highlands) and adjacent islands, including the Commander Islands and the Northern Kuril Islands. For the peninsula itself, 218 liverwort species were reported. Moreover, it was suggested that at least 10 additional taxa (5%) could be found on the peninsula. Subsequent research has demonstrated that substantially more than 10 additional species may indeed be found on the peninsula.

After the monograph on the liverwort flora of Kamchatka and adjacent islands had been submitted to the publisher (mid-2008; although the monograph itself was printed the following year;

Bakalin, 2009), new information on the regional liverwort flora was obtained. Potemkin and Dulin (2008) published a report on *Plagiochila arctica* Bryhn et Kaal. in the Tolbachik volcanic massif as new to the Kamchatka Region (as province), which was later merged with the Koryak Autonomous Region and, after this merger and up to the present is known as Kamchatka Territory. The authors erroneously cited it as new to the province, although they referenced the paper by Bakalin and Cherdantseva (2008), who had reported this species from the Commander Islands (administratively part of the Kamchatka Region at that time). The record by Potemkin and Dulin (2008) is therefore new to the peninsula, but not to the province.

Dulin (2009) published the first data on the occurrence of *Scapania sphaerifera* H. Buch et Tuom. in the Kamchatka Peninsula. This species appears

to be common in most regions of northeast Asia but is likely rare in Kamchatka. At least, this species has not been recorded in Kamchatka either before or after the cited study. Several years later, in 2014 (Vyatkina *et al.*, 2014), a synthesis of the vegetation cover of the volcanic plateaus of Central Kamchatka, including the Klyuchevskaya group of volcanoes, was published. Both species mentioned above (*Scapania sphaerifera* and *Plagiochila arc-tica*) were reported there from the same localities and were again treated as the new to Kamchatka. In addition, in the same work, *Lophozia excisa* var. *elegans* (R. M. Schust.) Konstant. et Vilnet was also reported from Kamchatka for the first time. Due to recent research using molecular methods (Konstantinova *et al.*, 2020) this taxon is deeply immersed to *L. excisa* clade and thus may represent an ecological modification. In 2011, data on liverworts from the Uzon caldera (East Kamchatka) were published (Potemkin *et al.*, 2011). The cited paper lists 37 species. The authors do not indicate that any of the taxa were recorded from the peninsula for the first time. However, the paper reports *Solenostoma* cf. *aomorense* Steph., considered a synonym of *Solenostoma fusiforme* (Steph.) R. M. Schust. (= *Protosolenostoma fusiforme* (Steph.) Vilnet et Bakalin; Catalogue of Life, 2025). It remains unclear what was meant by this designation — ‘real’ *Protosolenostoma fusiforme*, or *Metasolenostoma orientale* Bakalin et Vilnet that was described later based, among other things, on Kamchatka material previously published as *Solenostoma fusiforme*, or something else.

Two dozen species are listed in the paper dealing with the vegetation of the Krashennikov Volcano caldera (Pestrov *et al.*, 2013). There are no further additions to the peninsula’s flora. During a revision of ‘*Jungermannia* s. l.’ for the northern Pacific (Bakalin, 2014), *Metasolenostoma ochotense* (Bakalin et Vilnet) Vilnet et Bakalin was reported for the first time for Kamchatka Peninsula. In the same year (Bakalin *et al.*, 2014), *Metasolenostoma orientale* was described and recorded from Kamchatka, replacing previously incorrect reports of *Solenostoma fusiforme* from the peninsula.

In 2015, Bakalin conducted a study on the liverwort flora of the Ganalsky Range, including Bakening Volcano and Nalychevo Nature Park (both in East Kamchatka). Floristic results have so far been published only for the latter (Bakalin and Klimova, 2018). That paper lists 84 species, four of which [*Solenostoma rossicum* Bakalin et Vilnet, *Cordaia flotoviana* Nees (= *Moerckia flotoviana* (Nees) Schiffn.), *Marsupella apertifolia* Steph., and

Riccardia decrescens (Steph.) S. Hatt.] are new to the flora of the Kamchatka Peninsula. Earlier, in 2016, based on the same collection, a new species of *Schistochilopsis* (N. Kitag.) Konstant. (*S. pacifica* Bakalin) was described from the vicinity of Bakening Volcano and Nalychevo Nature Park (Bakalin, Klimova, 2016); its isolated position within the genus was demonstrated later (Bakalin *et al.*, 2020a). In 2017, Klimova undertook a comprehensive study of the Alney–Chachakondzha mountain massif. The results have not yet been published, except for the report of two new species of *Scapania* (Dumort.) Dumort. (*S. magadanica* S. S. Choi *et al.*, *S. spitsbergensis* (Lindb.) Müll. Frib.) for the flora of Kamchatka, both found in very remarkable, apparently unglaciated habitats in the near-summit part of the middle ridge of the Alney–Chashakondzha massif (Klimova, Bakalin, 2017).

Mamontov *et al.* (2019) described a new species, *Gymnomitrium kamchaticum* Mamontov *et al.*, morphologically similar to *G. brevissimum* (Dumort.) Warnst. (the main difference being dioicous versus monoicous inflorescences in the latter). In a paper on the taxonomy of *Marsupella* Dumort., one species (*Marsupella submarginata* Bakalin et Fedosov) was described as new to science from East Kamchatka (Bakalin *et al.*, 2019). In their revision of Radulaceae for the Russian Far East, Bakalin and Klimova (2020) reported *Radula obtusiloba* Steph. for the first time from Kamchatka. In 2021, Potemkin *et al.* (2021) described a new species, *Scapania pseudouliginosa* Potemkin *et al.*; most of the cited specimens are from the Koryak Uplands (northward of the Kamchatka Peninsula), with the exception of one record from the Kikhchik River basin (part of the collection discussed here).

A molecular revision of *Calypogeia* Raddi in Pacific Asia (Bakalin *et al.*, 2022a) excluded *Calypogeia neogaea* (R. M. Schust.) Bakalin from the Kamchatka flora, demonstrating that plants previously referred to this species (Bakalin, 2009) belong to a new-for-science taxon, *Calypogeia kamchatica* Bakalin *et al.* Finally, following a multitask expedition to the South Kamchatka Nature Park, in which Bakalin and Klimova participated, a checklist for the park was published. It lists 132 species (Bakalin *et al.*, 2022b). Of these, six species are reported from the Kamchatka Peninsula for the first time: *Blepharostoma neglectum* Vilnet et Bakalin, *Blepharostoma primum* Vilnet et Bakalin, *Marsupella aleutica* Mamontov *et al.*, *Fossombronina alaskana* Steere et Inoue, *Gymnocolea marginata* (Steph.) S. Hatt. (a taxon with a highly questionable status), and *Scapania parvitexta* Steph.

Thus, taking into account the aforementioned additions, since the publication of the monograph on the liverwort flora of Kamchatka and adjacent islands, the liverwort flora of Kamchatka has been expanded by 19 additional species and one variety, bringing the total liverwort diversity in the peninsula to 237 species.

The present account is based on a collection gathered in 2005 on the Kamchatka Peninsula that remained unpublished until now. Since the data presented here contribute to clarifying the intraregional species distribution, the presentation of this new information is the primary goal of this paper.

Material and Methods

Kamchatka is among the largest peninsulas in the Pacific Asia, covering approximately 270 thousand square kilometers (Kamchatka Krai, 2025). In size, this peninsula is slightly larger than the Malay Peninsula (Malay Peninsula, 2025) and the Korean Peninsula (Korea, 2025), which cover ca. 242 and 223 thousand square kilometers, respectively. The main features of the climate, orography, and vegetation have been described in detail previously (Bakalin, 2009); here we will list only the most important traits.

The Kamchatka Peninsula is connected to the mainland by the narrow, gently sloping isthmus of the Rekinniki Vale near 60–61° N and extends from there for 1200 km south-southwest to the Lopatka Peninsula at approximately 51° N. The main orographic backbone of the peninsula is the Sredinny Range, to the west of which lie peneplained plains and to the east a complex of young ridges with active volcanoes, including Eurasia's highest active volcano, Klyuchevskaya Sopka (4700 m a. s. l.). Modern glaciation is widespread in the mountains above 1500–2000 m a. s. l.

Despite its formal status as a peninsula, Kamchatka is essentially an island, as migration across the gently sloping, marshy, forestless, and narrow isthmus in the north is difficult (historically, this isthmus has often been engulfed by water, turning Kamchatka into a true island).

The eastern and southern parts of Kamchatka lie within the Pacific Ring of Fire and are rich in active volcanoes. Eruptions affect not only adjacent areas but also distant ones, including those hundreds of kilometers away from the vent due to the dispersal of ash. Current volcanic activity creates specific habitats, such as a great variety of thermal outlets (mostly with water rich in sulfur compounds) and strata of travertine.

The entire peninsula is located in the subarctic zone; true coniferous forests [*Larix gmelinii* (Rupr.) Kuzen. and *Picea ajanensis* Fisch. ex Carrière] are found only in depression in the central part of the peninsula *Betula pendula* subsp. *mandshurica* (Regel) Ashburner et McAll. is also found in small areas there, either mixed with the aforementioned conifers or as monodominant stands). Extensive areas are covered by communities dominated by *Betula ermanii* Cham., which forms forests similar to the taiga, including in the species composition of liverworts. Crooked forest communities [*Pinus pumila* (Pall.) Regel, *Alnus fruticosa* Rupr.] occupy an area approximately equal to that of the birch forests and are widespread both at lower elevations (mainly as a consequence of temperature inversions) and at higher elevations. The mountain peaks, and in the north of the peninsula practically extending from the coast, are covered by tundra, which in the upper reaches often grades into rocky wastelands and vegetation of periglacial areas.

All the specimens were collected by the author, V.A. Bakalin, in July–August 2005 in three areas marked as clusters A, B, C in Fig. 1.

Cluster A — Central Kamchatka, the northern slope of Ichinskaya Sopka volcano, a transitional area from mountain tundra to alpine heathland and periglacial zones. Dwarf pine (exclusively *Pinus pumila*) occurs there, but only as scattered clumps in mesorelief depressions in the most wind-protected areas.

Cluster B — West Kamchatka the middle reaches of the Kikhchik River basin, a peneplained plain occupied by tundra and bog communities, occasionally with dwarf pine thickets and birch forests.

Cluster C — South Kamchatka, the Mutnovskaya group of volcanoes, an area of very active contemporary volcanism, is formally located within the mountain tundra belt. However, the complete absence of forests is more likely determined by ongoing volcanic activity than by macroclimatic factors.

All collecting localities are described below and shown on the map (Fig. 1). During collection, the environmental conditions (community type, substrate) for each specimen were recorded, and a GPS receiver was used to obtain the geographic coordinates and absolute altitude of the collection site. The specimens were dried over the several days following collection. Subsequently, a comparative morphological study of all the material was conducted using the equipment of the Cryptogamic

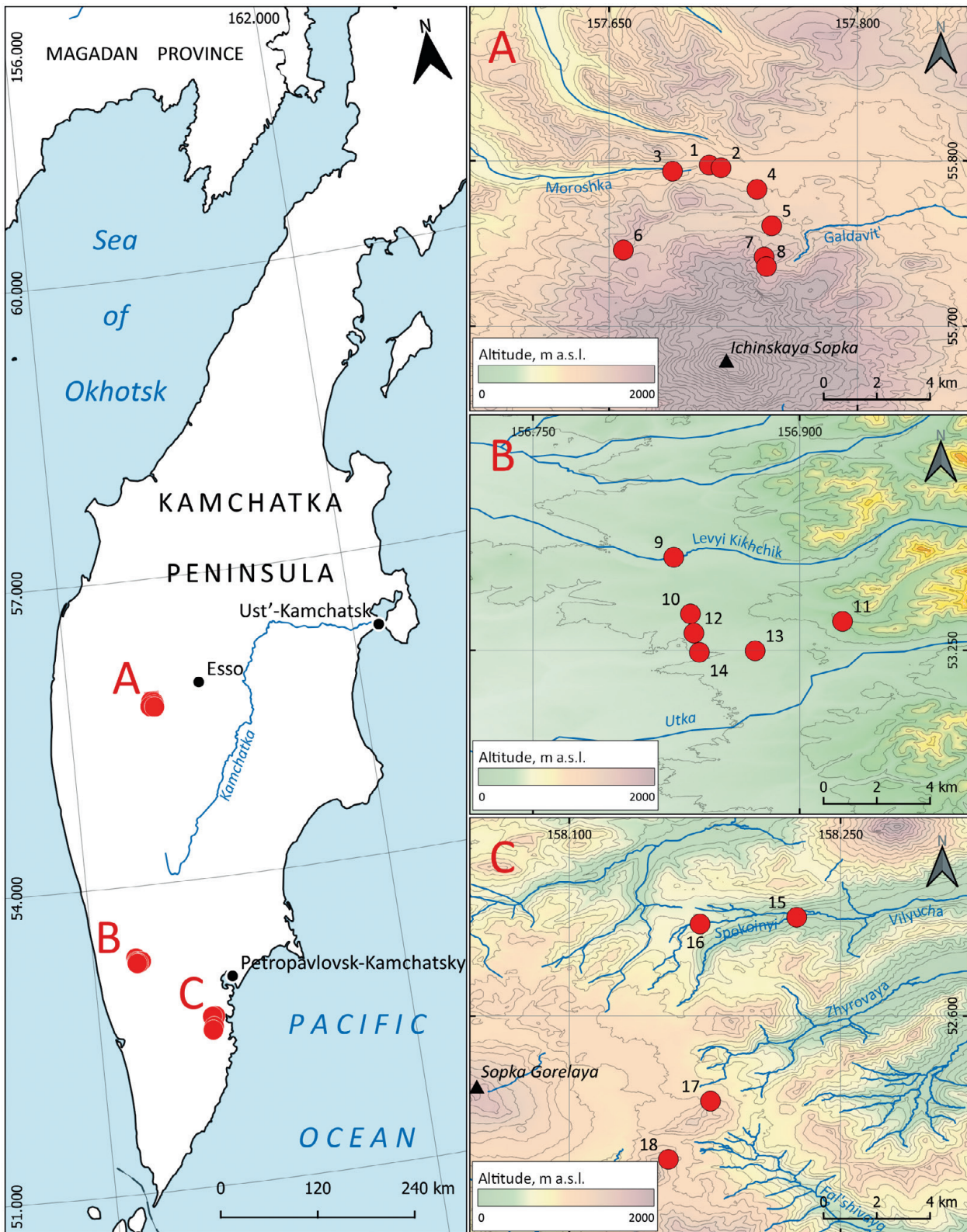


Fig. 1. Collecting localities in Central Kamchatka (cluster A), West Kamchatka (cluster B), South Kamchatka (cluster C), in accordance with Table 1.

Biota Laboratory of the Far Eastern Branch of the Russian Academy of Sciences. The identification results were entered into a specially developed database (Kislov *et al.*, 2017). All input materials, structured by species name, were extracted from

the database in a table. This table was converted into text manually. To save space, and given the novelty of the data obtained, this list includes all species identified in the studied collection, along with a list of collection localities. However, data

on species ecology are provided only for the taxa newly revealed for certain phytogeographic regions of Kamchatka (adopted from Bakalin, 2009) and for the peninsula as a whole. The nomenclature in the list follows the world checklist of liverworts (Söderström *et al.*, 2016), with the exception of the genera *Blepharostoma* (Dumort.) Dumort. (species later described in Bakalin *et al.*, 2020b are accepted), *Marchantia* L. (due to tradition in far-eastern literature, we adopted a narrow species concept, the appropriateness of which, however, can be fairly questioned), and *Pseudolophozia* Konstant. et Vilnet whose generic status is accepted. The description of new records for the flora is structured as follows: collection locality number(s), elevation at which the species was collected, environmental conditions of growth, associated species (if any), and field numbers of specimens. A total of 367 specimens were included in the study (several specimens contain the plants with unclear taxonomic position and still awaits the evaluation). Taxa new to the phytogeographic region are marked with one asterisk, and taxa new for the Kamchatka Peninsula as a whole with two.

The list of collecting localities (the numbers are the same with the Fig. 1). All specimens were gathered by the author and therefore collector name is not provided.

Cluster A, Central Kamchatka: 1 – Ichinskaya Sopka Volcano surroundings, upper reaches of Pravaya Moroshka River, 55.79749°N 157.71048°E, 1100 m a. s. l., 25 VII 2005; 2 – *ibid.*, range along left edge of Goldavit River, swampy *Juncus*-sedge-moss tundra on watershed plateau, 55.79586°N 157.71761°E, 1162 m a. s. l., 25 VII 2005; 3 – *ibid.*, valley of Pravaya Moroshka River about 3 km down of its source, dwarf shrub-lichen-moss tundra, 55.79372°N 157.68833°E, 1055 m a. s. l., 24 VII 2005; 4 – *ibid.*, range along left edge of Goldavit River, hummocky dwarf shrub-lichen-moss tundra with temporary stream, 55.78275°N 157.73933°E, 1263 m a. s. l., 25 VII 2005; 5 – *ibid.*, ridge along right edge of Goldavit River, 55.76078°N 157.74825°E, 1353 m a. s. l., 25 VII 2005; 6 – *ibid.*, pass Gordavit-Nyul-kandya Rivers, source of Levyi Goldavit River, 55.74611°N 157.65861°E, 1511 m a. s. l., 22 VII 2005; 7 – *ibid.*, left edge of right tributary of Goldavit River, moss-lichen stony tundra on slope to Goldavit River, 55.74192°N 157.74369°E, 1616 m a. s. l., 21 VII 2005; 8 – *ibid.*, Severnyi Dlinnyi Glacier, lichen stony tundra on moraine

slope, 55.73614°N 157.74506°E, 1647 m a. s. l., 21 VII 2005;

Cluster B, West Kamchatka: 9 – Levyi Kikhchik River, its middle course, *Chosenia* Nakai -*Salix* L. tallgrass forest, 53.30242°N 156.82922°E, 239 m a. s. l., 18 VII 2005; 10 – upper course of Khomutinsky Stream (basin of Kikhchik River), *Betula ermanii* Cham. forest with herb cover and understory by *Sorbus sambucifolia* (Cham. et Schltdl.) M. Roem., 53.27056°N 156.83861°E, 283 m a. s. l., 16 VII 2005; 11 – *ibid.*, stream in floodplain covered by mosaic combination of *Salix udensis* (Wimm.) Trautv. & C. A. Mey. thickets, forbs-shrub meadow and *Betula* forest with forb cover, 53.26633°N 156.92417°E, 400 m a. s. l., 17 VII 2005; 12 – *ibid.*, talus slope to stream valley in transitional area between sedge-dwarf shrub (*Myrica tomentosa* (C. DC.) Asch. et Graebn.)-moss mire to *Betula* forest, 53.25972°N 156.84056°E, 220 m a. s. l., 16 VII 2005; 13 – *ibid.*, stream in floodplain covered by mosaic combination of *Salix udensis* thickets, forbs-shrub meadow and *Betula* forest with forbs cover, 53.24972°N 156.87500°E, 226 m a. s. l., 17 VII 2005; 14 – *ibid.*, upper course of Khomutinsky Stream (basin of Kikhchik River), *Sphagnum-Carex*-dwarf shrub mire, 53.24889°N 156.84361°E, 203 m a. s. l., 17 VII 2005;

Cluster C, South Kamchatka: 15 – Mutnovsky Volcano surroundings, hot thermal springs area in Vilyucha River, 52.65464°N 158.22583°E, 188 m a. s. l., 09 VIII 2005; 16 – *ibid.*, upper course of Spokojnyj Stream (ca. 7 km to South-West from top of Viluchinskaya Sopka Volcano), 52.65092°N 158.17233°E, 536 m a. s. l., 09 VIII 2005; 17 – *ibid.*, western macroslope of Ostraya Mt., 52.55286°N 158.17814°E, 1172 m a. s. l., 10 VIII 2005; 18 – *ibid.*, 52.52058°N 158.15481°E, 1016 m a. s. l., 10 VIII 2005.

The list of taxa

Aneura pinguis (L.) Dumort. – 5.

Anthelia juratzkana (Limpr.) Trevis. – 3–8, 16, 18.

Barbilophozia hatcheri (A. Evans) Loeske – 6, 12.

Bazzania denudata (Torr. ex Gottsche et al.) Trevis. – 9, 13.

Blasia pusilla L. – 9, 10.

Blepharostoma brevirete (Bryhn et Kaal.) Vilnet et Bakalin – 5.

**Blepharostoma* cf. *neglectum* Vilnet et Bakalin – 3, 5 – 1055, 1353 – In pure mats or associated with *Diplophyllum taxifolium*, *Pellia neesiana*, *Sphenolobus minutus*, *Tetralophozia setiformis* – Mountain tundra belt, fine soil between boulders on slopes and along streams – K-13-22-05, K-14-31-05. Newly

reported for Central Kamchatka, before known for South Kamchatka (Bakalin *et al.*, 2022b). The identification made based on dried plants and due to this is uncertain.

Blepharostoma trichophyllum (L.) Dumort. — 13.

Calycularia laxa Lindb. et Arnell — 5, 9, 16.

Calypogeia integristipula Steph. — 5, 10, 12, 17, 18.

***Calypogeia kamchatica** Bakalin *et al.* — 12 — 220 — Talus slope to stream valley in transitional area between sedge-dwarf shrub (*Myrica tomentosa*-moss mire to *Betula* forest. — K-1-28-05. New for West Kamchatka, before known from South (Bakalin *et al.*, 2022b) and East Kamchatka (Bakalin *et al.*, 2022a).

Calypogeia muelleriana (Schiffn.) Müll. Frib. — 5, 10, 12.

Cephalozia bicuspidata (L.) Dumort. — 2, 4–6, 10, 14, 16–18.

***Cephaloziella elachista** (J. B. Jack) Schiffn. — 10, 12, 14 — 203, 220, 260 — In pure mats or associated with *Calypogeia* sp., *Cephalozia bicuspidata*, *Cladopodiella fluitans*, *Fuscocephaloziopsis lunulifolia*, *Mylia anomala*, *Scapania paludicola* — Hollows in moss-sedge-dwarf shrub oligotrophic mires and sedge-dwarf shrubs tundroid community in low elevation in the floodplain. — K-1-21-05, K-1-22-05, K-1-24-05, -3-7-05, K-4-4-05, K-4-8-05. New for West Kamchatka, before known for South Kamchatka only (Bakalin *et al.*, 2022b).

Cephaloziella varians (Gottsche) Steph. — 5, 17.

Chiloscyphus polyanthos (L.) Corda — 9, 12, 13.

***Cladopodiella fluitans** (Nees) H. Buch — 2, 12, 14 — 203, 220, 1162 — In pure mats or associated with *Cephalozia bicuspidata*, *Cephaloziella elachista*, *Mylia anomala*, *Pseudolophozia sudetica*, *Scapania paludicola* — Hollows in moss-dwarf shrubs-sedge oligotrophic mires and in moist mountain tundra between *Juncus* patches. — K-1-17-05, K-1-18-05, K-1-21-05, K-1-23-05, K-1-24-05, K-16-9-05, K-4-1-05, K-4-2-05, K-4-3-05, K-4-6-05, K-4-7-05, K-4-9-05. New for Central Kamchatka, before known for West, East and South Kamchatka (Bakalin, 2009).

Cryptocolea imbricata R. M. Schust. — 18.

Cryptocoleopsis imbricata Amak. — 17.

Diplophyllum albicans (L.) Dumort. — 1, 3, 4, 6, 17.

Diplophyllum taxifolium (Wahlenb.) Dumort. — 1–9, 13, 16.

Douinia plicata (Lindb.) Konstant. et Vilnet — 3, 5–8.

Frullania austinii J. J. Atwood *et al.* — 9–11.

Fuscocephaloziopsis leucantha (Spruce) Váňa *et* L. Söderstr. — 12.

Fuscocephaloziopsis lunulifolia (Dumort.) Váňa *et* L. Söderstr. — 9, 12, 14.

Fuscocephaloziopsis pachycaulis (R. M. Schust.) Váňa *et* L. Söderstr. — 8.

Fuscocephaloziopsis pleniceps (Austin) Váňa *et* L. Söderstr. — 5, 8–10.

Gymnocolea cf. inflata (Huds.) Dumort. — 18.

Gymnocolea marginata (Steph.) S. Hatt. — 17, 18.

Gymnomitrium brevissimum (Dumort.) Warnst. — 5, 16.

***Gymnomitrium commutatum** (Limpr.) Schiffn. — 5, 8, 17 — 1172, 1353, 1760 — In pure mats or associated with *Cephalozia bicuspidata*, *Diplophyllum taxifolium*, *Lophozia cf. silvicoloides*, *Lophozia cf. ventricosa*, *Pleurocladula albescens* — Crumbling fine soil on slopes, also that between stones in mountain tundra belt. — K-10-3-05, K-14-45-05, K-14-46-05, K-33-11-05, K-33-6-05, K-33-8-05. New for Central Kamchatka, before known for East Kamchatka (Bakalin, 2009).

Gymnomitrium concinnatum (Lightf.) Corda — 3, 4, 6–8, 16–18.

Gymnomitrium corallioides Nees — 5, 7, 8.

***Gymnomitrium kamchaticum** Mamontov *et al.* — 1, 17, 18 — 1016, 1100, 1172 — In pure mats or associated with *Gymnomitrium concinnatum* — Fine soil in snowbed habitats and on slopes, also alluvial volcanic ashes between boulders of gravelly barrens field; all in mountain tundra belt. — K-17-13-05, K-32-22-05, K-33-20-05, K-33-3a-05. New for Central Kamchatka, before known for South Kamchatka (Bakalin *et al.*, 2022b) and East Kamchatka (Mamontov *et al.*, 2019).

***Gymnomitrium pacificum** Grolle — 1, 6 — 1100, 1511 — In pure mats or associated with *Diplophyllum albicans*, *Marsupella apiculata* — merely dry crevices in the cliffs in mountain tundra belt. — K-12-3-05, K-17-15-05. New for Central Kamchatka, before known for North and South Kamchatka (Bakalin, 2009).

Harpanthus flotovianus (Nees) Nees — 1, 12, 16.

Hygrobiella squamosa Bakalin *et* Vilnet — 16.

Isopaches bicrenatus (Schmidel) H. Buch — 12, 18.

Jungermannia eucordifolia Schljakov — 1, 11, 16.

Jungermannia exsertifolia Steph. — 16.

Jungermannia pumila With. — 5.

Lophocolea minor Nees — 9, 13.

Lophozia ascendens (Warnst.) R. M. Schust. — 10, 11.

Lophozia guttulata (Lindb. et Arnell) A. Evans — 4, 10 — Oil bodies not seen.

Lophozia lacerata N. Kitag. — 8.

Lophozia longiflora (Nees) Schiffn. — 3, 7, 12.

Lophozia murmanica Kaal. — 7, 8.

Lophozia cf. savicziae Schljakov — 6 — Oil bodies not seen.

Lophozia silvicola H. Buch — 10, 11 — Oil bodies not seen.

Lophozia silvicoloides N. Kitag. — 5, 12 — Oil bodies not seen.

Lophozia ventricosa (Dicks.) Dumort. — 2, 3, 5, 10, 12, 13, 16.

Lophozia wenzelii (Nees) Steph. — 2.

***Lophozia wenzelii** var. **lapponica** H. Buch *et* S. W. Arnell — 7, 18 — 1016, 1616 — *Anthelia juratzkana* — Over boulders covered with fine soil along small stream and alluvial volcanic ashes between boulders of gravelly barrens field; both in mountain tundra belt. — K-11-5-05, K-32-10-05, K-32-13-05. New for Central and South Kamchatka, before known for North, West and East Kamchatka (Bakalin, 2009).

Lophozia excisa (Dicks.) Konstant. *et* Vilnet — 8.

- Lophozopsis longidens** (Lindb.) Konstant. et Vilnet — 10.
- Marchantia latifolia** Gray (= *Marchantia polymorpha* L. subsp. *ruderalis* Bischl. et Boissel.-Dub.) — 9.
- Marchantia alpestris** (Nees) Burgeff (= *Marchantia polymorpha* subsp. *montivagans* Bischl. et Boissel.-Dub.) — 5.
- ***Marsupella apertifolia** Steph. — 1, 4, 6 — 1100, 1263, 1511 — In pure mats or associated with *Diplophyllum taxifolium*, *Pseudolophozia sudetica* — Stones and alluvial soil along streams and spring outlets, all in mountain tundra belt. — K-12-22-05, K-15-6-05, K-17-10-05. New for Central Kamchatka, before known in South Kamchatka (Bakalin *et al.*, 2022b).
- Marsupella apiculata** Schiffn. — 3, 5–8, 16, 18.
- ****Marsupella arctica** (Berggr.) Bryhn et Kaal. — 5 — 1353 — In pure mats or associated with *Aneura pinguis*, *Blepharostoma brevirete*, *Odontoschisma elongatum* — Small hollows in swampy moss-dwarf shrub tundra at the ridgeline. — K-14-11-05, K-14-6-05, K-14-8-05, K-14-9-05. New for Kamchatka.
- Marsupella boeckii** (Austin) Lindb. ex Kaal. — 3, 4, 6, 7.
- Marsupella condensata** (Ångstr. ex C. Hartm.) Lindb. ex Kaal. — 3–8, 16–18.
- ***Marsupella subemarginata** Bakalin et Fedosov — 3, 4, 6, 9 — 239, 1055, 1263, 1511 — In pure mats or associated with *Anthelia juratzkana*, *Gymnomitrium concinatum*, *Pleurocladula albescens*, *Pseudolophozia sudetica* — Stones and alluvial volcanic ashes along small streams (including nival ones) in mountain tundra belt, or cliffy wall in young *Salix udensis* thickets in low elevation. — K-12-18-05, K-13-16-05, K-13-19-05, K-13-21-05, K-15-5-05, K-8-5-05. New for Central and West Kamchatka, before known in South Kamchatka (Bakalin *et al.*, 2022b) and East Kamchatka (Bakalin *et al.*, 2019).
- ***Metasolenostoma ochotense** (Bakalin et Vilnet) Vilnet et Bakalin — 13, 17 — 226, 1172 — In pure mats or associated with *Scapania praetervisa* — Crumbling fine soil along slope in mountain tundra belt; peaty stream bank shaded by *Salix* in *S. udensis* thickets along river in lower elevation — K-33-5-05, K-33-6a-05, K-5-14-05. New for South Kamchatka, before known for West Kamchatka (Bakalin 2014).
- Mylia anomala** (Hook.) Gray — 14.
- ****Mylia taylorii** (Hook.) Gray — 6 — 1511 — In pure mats or associated with *Douinia plicata*, *Sphenobolus minutus* — Between boulders in rock field in mountain tundra belt. — K-12-26-05. New for Kamchatka.
- Nardia breidlerii** (Limpr.) Lindb. — 3–8, 16–18.
- Nardia geoscyphus** (De Not.) Lindb. — 2, 3, 5, 8.
- Nardia insecta** Lindb. — 5, 7, 12, 13.
- Nardia japonica** Steph. — 5, 10, 11, 16.
- Nardia pacifica** Bakalin — 1, 3, 4–6, 15–17.
- Nardia scalaris** Gray — 5, 6, 12.
- Neorthocaulis attenuatus** (Mart.) L. Söderstr. *et al.* — 12.
- Odontoschisma elongatum** (Lindb.) A. Evans — 2, 5.
- Pellia neesiana** (Gottsche) Limpr. — 3, 4, 6, 12, 13, 16.
- Pleurocladula albescens** (Hook.) Grolle — 3–6, 8, 16–18.
- Preissia quadrata** (Scop.) Nees — 5.
- Protochilopsis grandiretis** (Lindb. ex Kaal.) A. V. Troitsky *et al.* — 5.
- Pseudolophozia debiliformis** (R. M. Schust. et Damsh.) Konstant. et Vilnet — 2, 8, 18.
- Pseudolophozia sudetica** (Nees ex Huebener) Konstant. et Vilnet — 1–6, 8, 9, 13, 16–18.
- Ptilidium californicum** (Aust.) Pears — 11.
- Ptilidium ciliare** (L.) Hampe — 5.
- Ptilidium pulcherrimum** (Weber) Vain. — 9, 10.
- Radula prolifera** Arnell — 5.
- Sandea japonica** Steph. ex Yoshin — 15, 17.
- Scapania curta** (Mart.) Dumort. — 8.
- Scapania hyperborea** Jørg. — 2.
- Scapania irrigua** (Nees) Nees — 5, 8, 9.
- Scapania kaurinii** Ryan — 1, 8.
- Scapania mucronata** H. Buch — 12.
- ***Scapania obcordata** (Berggr.) S. W. Arnell — 2 — 1162 — In pure mats or associated with *Cephalozia bicuspidata*, *Diplophyllum taxifolium*, *Nardia geoscyphus*, *Pseudolophozia debiliformis* — Between *Juncus* patches in swampy *Juncus*-sedge-moss tundra on watershed plateau. — K-16-3-05, K-16-6-05. New for Central Kamchatka, before known for East Kamchatka (Bakalin, 2009).
- Scapania paludicola** Loeske et Müll. Frib. — 2, 12, 14, 16.
- Scapania paludosa** (Müll. Frib.) Müll. Frib. — 1, 12.
- Scapania parvifolia** Warnst. — 8.
- Scapania parvifolia** Warnst. var. **grandiretis** Schljakov — 5.
- Scapania pseudouliginosa** Potemkin *et al.* — 13.
- Scapania praetervisa** Meyl. — 17.
- Scapania subalpina** (Nees ex Lindenb.) Dumort. — 7, 9, 12, 13.
- Scapania cf. tundrae** (Arnell) H. Buch — 2.
- Scapania undulata** (L.) Dumort. — 13.
- Schistochilopsis incisa** (Schrad.) Konstant. — 9.
- ***Schistochilopsis pacifica** Bakalin — 3 — 1055 — In pure mats or associated with *Nardia pacifica*, *Pseudolophozia sudetica* — Between stones of gravelly barrens field in dwarf shrub-lichen-moss tundra. — K-13-26-05. New for Central Kamchatka, before known in South Kamchatka (Bakalin *et al.*, 2022b) and East Kamchatka (Bakalin, Klimova, 2016).
- Schljakovia kunzeana** (Huebener) Konstant. et Vilnet — 2, 10, 12.
- Solenostoma confertissimum** (Nees) Schljakov — 8, 12.
- Solenostoma cf. obscurum** (A. Evans) R. M. Schust. — 12.
- Solenostoma pusillum** (C. E. O. Jensen) Steph. — 8, 17.
- Solenostoma rossicum** Bakalin et Vilnet — 18.
- Solenostoma sphaerocarpum** (Hook.) Steph. — 5, 12.
- Solenostoma sphaerocarpum** (Hook.) Steph. var. **nanum** (Nees ex Flot.) Müll. Frib. — 8.

Solenostoma subellipticum (Lindb. ex Heeg) R. M. Schust. — 1, 3, 9.

Sphenolobus minutus (Schreb.) Berggr. — 5, 6, 8–10, 13.

Tetralophozia setiformis (Ehrh.) Schljakov — 1, 5, 6, 8.

Trilophozia quinqueidentata (Huds.) Bakalin — 3, 5, 8, 13.

Tritomaria exsectiformis (Breidl.) Schiffner ex Loeske — 9.

Discussion

As noted above, 367 specimens were included in the study. A total of 628 identifications were made (most specimens contained more than one species). In total, 110 species and three varieties were revealed in the studied collection.

Based on the scheme of Kamchatka's natural geographic regions (North, West, Central, East, and South) adopted by Bakalin (2009), and on an assessment of the distribution of the identified species within them, a number of taxa were found to be new to these regions. Three species were reported for the first time from West Kamchatka, one species from South Kamchatka, and nine species from Central Kamchatka. New to the flora of the entire peninsula are *Marsupella arctica* and *Mylia taylorii*. According to available data (Konstantinova *et al.*, 2009), the locality of *Marsupella arctica* is the southernmost in Pacific Asia. The data obtained for Central Kamchatka are likely of greatest interest, since the specimens were collected on the northern macroslope of the Ichinskaya Sopka volcano, an area accessible only by helicopter, where hepatic studies are unlikely to be conducted in the coming years.

Among the revealed taxa, four are included in the latest edition of the Red Data of Kamchatka Book (Chernyagina, 2018). *Schistochilopsis pacifica* and *Gymnomitrium pacificum* were found in this research in Central Kamchatka (cluster A); *Metasolenostoma ochotense* was found only in West Kamchatka (cluster B); *Nardia pacifica* was found in all clusters. Apparently, the rarity of *Nardia pacifica* is somewhat overestimated, and the conservation status of this species should be clarified later. Furthermore, *Marsupella arctica* and *Mylia taylorii*, newly revealed in Kamchatka, are likely rare here. Both of these species should be likely included in the new edition of the Red Data Book of Kamchatka.

Therefore, 239 species are currently known from the flora of the Kamchatka Peninsula. It is worth noting that the Kamchatka Peninsula does not comprise the entire Kamchatka Territory,

which also includes the southern part of the Koryak Highlands and the Commander Islands. The area of the peninsula is approximately 270 thousand square kilometers (Kamchatka Peninsula, 2025), whereas the area of the entire territory is over 464 thousand square kilometers (Kamchatka Krai), meaning that the peninsula itself occupies approximately three-fifths of the total territory. Outside the peninsula, there are species not yet recorded within the peninsula.

As was shown earlier (Bakalin, 2009), all the liverwort taxonomic diversity within accepted floristic districts in Kamchatka are closely related to each other, with the exception of the somewhat isolated position of West Kamchatka. The latter can be likely explained by the flat relief and, as a consequence, a somewhat lower landscape diversity. However, despite the internal similarity of diversity (meaning that a “flora core” has been revealed in all areas), the issue of the specificity and state of knowledge for each of the five floristic districts on the peninsula remains unresolved. Taking into account the newly obtained data, added to those summarized in the book on Kamchatka liverworts (Bakalin, 2009), the approximate number of species for each division is as follows. North Kamchatka — 83 (unchanged since 2009), with very low specificity (2 species). West Kamchatka — over 100 species, low specificity (8 species). Central Kamchatka — more than 160 species (at least 30 species are specific). East Kamchatka — more than 150 species, at least 20 are specific. South Kamchatka — 140 species, at least 15 are specific. Since additions can be expected in all areas, exact numbers of known taxa are unlikely to clarify the situation. Obviously, North Kamchatka, characterized by a high landscape diversity under the conditions of mountainous relief and a humid climate, resulting in the widespread occurrence of periglacial areas, houses may be twice more species than in it now known. The vast majority, if not all, of the arctomontane species known in Central Kamchatka may be found here. There is also a high probability of occurrence of some Beringian taxa, currently known in Northeast Asia in the Magadan Region and Chukotka only. As noted above, the number of species known in Kamchatka currently reach 239. Compared to other regions of Russia, this is a relatively high level, but not final. As shows the explorations in some of the most thoroughly studied regions of Russia, such as the Murmansk Region (Konstantinova *et al.*, 2025), even there the new records are constantly being discovered, and their number is increasing. Exploration

of previously unstudied areas of the peninsula and the use of molecular methods for processing the collected material (for the Kamchatka flora, this is more the exception than the rule) should increase the number of species known on the peninsula by at least dozens.

Thus, given the scattered data, the Kamchatka Territory may have one of the richest regional liverwort floras in Russia. Apparently, the closest regions in the Russian Far East in terms of liverwort taxonomic diversity are the Sakhalin Region and Primorye Territory, each containing, according to very rough and preliminary estimates, approximately 250 species.

Overall, the study indicates that our understanding of the liverwort flora of the Kamchatka Peninsula is gradually approaching a plateau on the ‘knowledge curve’ (Bakalin *et al.*, 2021; Beber *et al.*, 2007), at which further discoveries for the region as a whole remain possible, but will be few in number and will not fundamentally alter our perception of the characteristics of the flora. Within Kamchatka, however, different areas have been studied unevenly, and many remain severely data-poor. This is particularly true of the northern part of the Sredinny Range, from the Alney–Chashakondzha Massif and northward of the latter.

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