

MARSUPELLA ALEUTICA – NEW TO RUSSIA LIVERWORT  
FROM COMMANDER ISLANDS (FAR EAST OF RUSSIA)

MARSUPELLA ALEUTICA – НОВЫЙ ДЛЯ РОССИИ ВИД ПЕЧЕНОЧНИКОВ  
С КОМАНДОРСКИХ ОСТРОВОВ (ДАЛЬНИЙ ВОСТОК РОССИИ)

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Abstract

*Marsupella aleutica*, previously known from a single locality on the Aleutian Islands, was found in several specimens from the Mednyj Island (Commander Archipelago, Russia). Male plants, sporophytes and oil bodies are described for the species for the first time. The revealed variability of the species in size, color, and leaf shape is considered and differences from morphologically similar species are discussed.

Резюме

*Marsupella aleutica*, известная ранее из одного местонахождения на Алеутских островах, найдена в нескольких образцах с острова Медный (Командорский архипелаг). Впервые для вида описываются мужские растения, спорофиты и масляные тельца. Рассматривается выявленная вариабельность вида по размерам, окраске, форме листа и обсуждаются отличия от морфологически похожих видов.

KEYWORDS: liverworts, taxonomy, *Marsupella aleutica*, morphology, ITS1-2, *trnL-F*, distribution, ecology

INTRODUCTION

*Marsupella aleutica* Mamontov, Vilnet, Konstant. et Bakalin was recently described based on one specimen collected by W.B. Schofield from Simeonof Island (Mamontov *et al.*, 2019). So far it has been known only from the type specimen (l.c.). During the revision of the specimens of *M. sparsifolia* (Lindb.) Dumort. in the herbarium of Polar-Alpine Botanical Garden Institute (KPABG) and sequencing some of them from different regions it turned out that two of the sequenced specimens from Mednyj (Copper) Island are similar to the recently described *Marsupella aleutica*. Morphological study of seven specimens identified as *Marsupella sparsifolia* from Mednyj Island showed that they all belong to *Marsupella aleutica*. The species has already been described in great detail and the description is published in an open access journal (Mamontov *et al.*, 2019), so we here want to supplement the protologue by focusing on the variability of specimens from different habitats, as well as on the description of some structures (for example, oil bodies, androecia, sporophytes) that were not found before. We consider it useful to pay attention to this species, since it may be found in other regions of the Far East of Russia and Western North America, and provide description of the variability of the species.

MATERIAL AND METHODS

The morphological study is based on a revision of seven specimens collected by V. Bakalin on Mednyj Island (Commander Islands, Far East of Russia). The specimens are preserved in the herbarium of the Polar-Alpine Botanical Garden-Institute, Kirovsk, Russia (KPABG) and two duplicates are stored in the herbarium of the Main Botanical Garden, Moscow (MHA). The plants were studied and photographed using a MVX-10 stereomicroscope equipped with a digital camera Infinity Lumenera 3-6 (Fig. 1A–C, 2A, D, G, I), and a Leitz Wetzlar Orthoplan light microscope equipped with digital cameras Nikon D700 (Fig. 1E, G, H, K) and Canon EOS 1100D (Fig. 1D, F, I, J, L, M, 2B, C, E, F, H, J, K–M). In order to better illustrate the three-dimensional objects, photomicrographs were combined from several optical sections using the stacking software Helicon Focus 8 (Kozub *et al.*, 2008).

Two specimens of *Marsupella*: K-68-1-04 (KPABG 106779) and K-63-03-EM (KPABG 106476) from Mednyj Island were tested from DNA evidence following the protocols for DNA extraction, ITS1-2 nrDNA and *trnL-F* cpDNA amplification and sequencing that were described in Mamontov *et al.* (2019). Both DNA loci were obtained for the specimen K-68-1-04 (ITS1-2 nrDNA GenBank

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accession number OR889476 and *trnL-F* nrDNA GenBank accession number OR900161) and only *trnL-F* (GenBank accession number OR900162) for the specimen *K-63-03-EM*. Both specimens possess identical sequences of *trnL-F*. A Basic Local Alignment Search Tool (BLAST) search (<https://blast.ncbi.nlm.nih.gov/Blast.cgi>) was conducted to assess the molecular similarity of the tested specimens and resolved them up to 99.77% similar to *M. aleutica* by *trnL-F* (MH822632; two single base substitutions in 5'-ends of *trnL* and *trnF*) and up to 99.54% by ITS2 (MH826408; single base deletion and substitution). The level of the obtained sequence variation corresponds with infraspecific variation in other *Marsupella* species (Mamontov *et al.*, 2019).

#### RESULTS AND DISCUSSION

The study of the newly discovered specimens of the species made it possible to supplement the description of the species previously based on a single specimen and expand the understanding of its variability. First of all, male plants and just one old sporophyte were found. Male bracts are intercalary in several pairs, concave, with wide cordate base and very shallow, ca. 0.1 bracts length sinuses, slightly larger than leaves, ca. 0.7–0.8 (0.9) mm wide and 0.5–0.6 mm long, dorsal lobes of bracts are smaller than ventral, lobes wide-rounded, sometimes abruptly ending in uniseriate or superposed 2 cells, cells of apices small, isodiametric, 6–7  $\mu\text{m}$ , antheridia 2–3 per bract, with long, 2 cells wide stalk. In one specimen we found one sporophyte. Unfortunately, no elaters preserved and just a few spores were seen. Spores are light brown and rather large, 12–14  $\mu\text{m}$  in diameter. The only open capsule is deeply brown, 2-, partly 3-stratose, both epidermal and inner layers of wall with rather large nodular thickenings.

Oil bodies were found in some leaves mostly near the base of upper leaves, they are uniformly 2 per cell, finely granulate, rounded, (5) 6–7  $\mu\text{m}$ , or widely ellipsoidal, 5–6 $\times$ 7–9  $\mu\text{m}$ .

In the studied specimens, the species is either in almost pure turf, or mixed with other liverworts, of which *Anthelia juratzkana* (Limpr.) Trevis. is most often its associate. In some specimens *Anthelia juratzkana* dominates and *Marsupella aleutica* plants are covered with an easily removable white cobweb coating of *Fungi* hyphae.

In general, the plants in all specimens are more or less similar, differing slightly in color, size and some other parameters. Some variability of different characteristics revealed are described below.

**The size of plants** vary in different habitats from (0.3)0.5–0.75(0.9) mm wide and 5–10 mm long. In general, plants from Mednyj Island are slightly larger than the holotype.

**Color of plants.** The species was described as olive green to yellow brownish. The color of leaves in the studied specimens varies from green (small young shoots),

golden and warm brown to deep brown in upper part of shoot and dark brown and even blackish brown in the lower parts of some specimens. Margins of leaves sometimes are more dark brown or even blackish in upper leaves but often decolorate but not or slightly erose in the middle of shoot and below. Bases of leaves at least in upper leaves are green.

**Stolons** were not seen in the type specimen according to the description (Mamontov *et al.*, 2019), but ventral stolons occur in at least one sequenced specimen from Mednyj Island.

**Leaves** vary from subquadrate to more often with a width significantly exceeding the length, particularly 0.5–0.7 $\times$ 0.6–0.9 mm, mostly with clearly uneven lobes, of which the ventral is larger than the dorsal.

Bases of leaves are rather strongly asymmetrically rounded, especially in male bracts, cordate ventrally and sometimes with a wide multicellular protrusion at the base dorsally (which was described in the protologue as lobe-like teeth).

**Lobes of leaves** are obtuse or bluntly pointed. Lobes are more distinctly uneven compared to the holotype, dorsal lobes are distinctly smaller than ventral.

**Sinuses** vary from 0.1 leaf length in male bracts to 0.2 (0.25) leaf length in leaves on sterile shoots, from wide obtuse to acuminate and even gamma-shaped.

**Margins** of leaves in some shoots (old?) are decolorated partly or on the whole leaves, in some leaves more deeply colored and look like “old” specimens. However, the young tips of shoots are warm brown.

**Cells** are more or less thick-walled, in the sequenced specimens somewhat larger than in the holotype and vary in one leaf from (13)15–20(22)  $\mu\text{m}$  wide and (13)15–22(24)  $\mu\text{m}$  long, in the middle to 17–22(24) $\times$ 20–25(30)  $\mu\text{m}$  at base, but vary greatly even on one plant.

**Oil bodies** are invariably 2 per cell, rounded, to 5–7  $\mu\text{m}$ , or widely ellipsoidal, 5–6 $\times$ 7–8  $\mu\text{m}$ .

**Differentiation.** Mamontov *et al.* (2019), considered the differences between *M. aleutica* and morphologically similar species in some detail. We will therefore focus here mainly on the differences from species that have not been considered before, as well as on some differences that were not emphasized earlier. In terms of size, *M. aleutica* occupies an intermediate position between small species like *M. sprucei* (Limpr.) Bernet or the Japanese *M. pseudo-funckii* S. Hatt. and the larger *M. sparsifolia*. *Marsupella aleutica* differs from *M. sparsifolia* in 1) distinctly smaller size, usually with shoots not exceeding 0.9 mm wide and 10 mm long vs. 0.8–1.5 mm wide and 8–15 (25) mm long in *M. sparsifolia*; 2) dioicous inflorescence vs. parioicous in *M. sparsifolia*; 3) more shallow bilobed leaves, mostly 0.1–0.2 of leaf length and not exceeding 0.25, whereas in *M. sparsifolia* leaves are bilobed to 0.25–0.35 their length; 4) distinctly uneven lobes vs. equally lobed leaves in *M. sparsifolia*; 5) leaves mostly wider than long vs. as wide as long in *M. sparsifolia*.



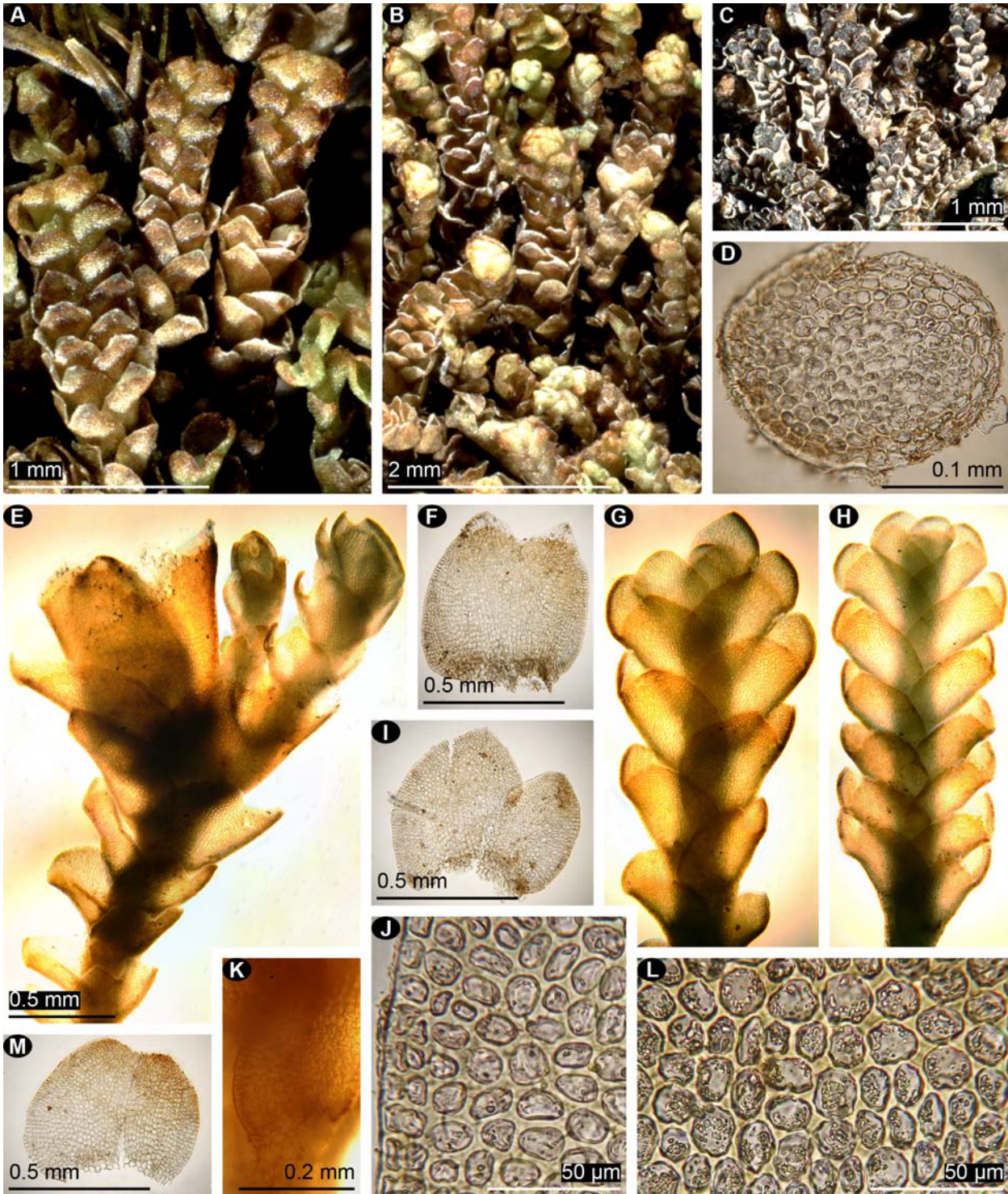


Fig. 1. *Marsupella aleutica* (A, B, D, E–M from KPABG-106476, C from KPABG-106679): A–C: dry habit; D: stem cross section; E: perianthous shoot fragment with two subfloral innovations (dorsal view); F, I, M: leaves; G: gynoeical shoot fragment (dorsal view); H: sterile shoot fragment (lateral view); J, L: median leaf cells; K: shoot sector showing leaf insertion (dorsal view).

From *Marsupella sprucei* complex similar to *M. aleutica* in size and habitat, the latter differs in slightly larger size, 0.5–0.7 mm wide and up to 0.8 mm high vs. 0.3–0.45(0.5) mm wide and 5 mm high in *M. sprucei* s.lat.; not enlarged to the top of shoot leaves vs. distinctly enlarged in *Marsupella sprucei* complex; in color varying

from green to golden and warm brown or blackish brown, vs. mostly fuscous to dark blackish brown; dioicous inflorescence vs. always paroicous or heteroicous in *M. sprucei* complex; larger, ca. 12–14 µm, spores vs. 7–9 µm in *M. sprucei* complex.



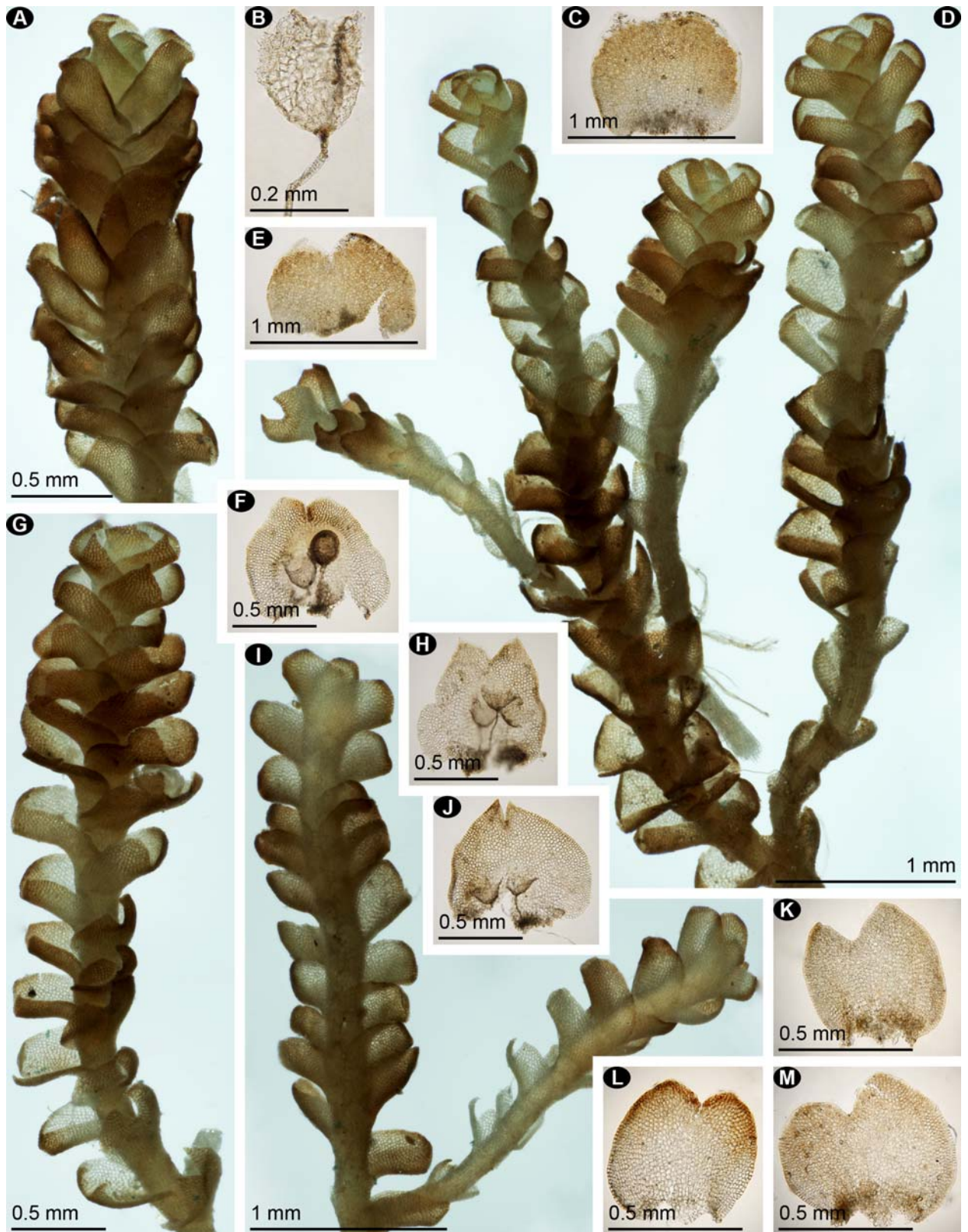


Fig. 2. *Marsupella aleutica* (A, B, D, F–J from KPABG-106779, C, E, K–M from KPABG-106476): A: androecial shoot; B: opened antheridium with biserial stalk; C, E: gynoecial bracts; F, J, H: male bracts; D, G: sterile shoots showing *Plagichila*-type intercalary branching (dorsal view); I: same (ventral view); K–M: leaves.

Leaves with clearly unequal and slightly folded lobes, the dioicous inflorescence, relatively large spores make *M. aleutica* look like the Japanese *M. pseudofunckii*. But the latter species differs clearly in much stronger uneven, up to 0.3–0.5 leaf length bilobed and conduplicate leaves with relatively distinct keel.

**Ecology.** The species has been collected both in the southern and northern parts of the island. It occurs from almost sea level (10 m alt.) to 268 m alt. among the pebbles on fine earth in gravelly wastelands, on fine earth on edge of path in low shrub lichen mountain tundra, on a cliff to the sea, and on moist sandy loam landslide. Its commonest associate is *Anthelia juratzkana*, which is present in most studied specimens. In several specimens *Cephalozia ambigua* C.Massal., *Plagiochila porelloides* (Torr. ex Nees) Lindenb. and a small *Scapania* sp. occur as admixture. It seems that the species is not rare in Mednyj Island.

**Specimens studied:** Russia, Commander's Archipelago, Mednyj Island: watershed ridge, ca 2 km to the NW from the top of Stolbovaya Mount, 54°43'40"N, 167°39'40"E, 152 m a.s.l., 1.VII.2004 V. Bakalin, [KPABG 106582], Southern slope of Stolbovaya Mount, rocky wetland with cliffs, 54°43'20"N, 167°40'00"E, 247 m a.s.l., in crevices among rocks, on fine earth 1.VII.2004 V. Bakalin, K-29-3-04 [KPABG 106587]; Gladkovskoe Lake, tuff ridge with steep and dry cliffs, in crevices 54°45'30"N, 167°40'10"E, 14 m a.s.l., 5.VII.2004 V. Bakalin K-68-1-04 [106779]; south part of island, near South-East village, low shrub-lichen tundra on path, 5.VIII.2003 E. Mamaev K-63-03 EM [106476]; cliff to the sea 1100 m EEN of the mouth of the Preobrazhenka River 54°46'45"N, 167°35'00"E, 268 m a.s.l., 2.VII.2004 V. Bakalin K-52-2-04 [106680], on waterlogged sandy loam landslide; cliff to the sea 1100 m EEN of the mouth of the Preobrazhenka River 54°46'45"N, 167°35'00"E, 268 m a.s.l., 2.VII.2004 V. Bakalin K-52-1-04 [106679], on waterlogged sandy loam landslide; the mouth of

the Peschanka River (Peschanaya Bay). wet scree sliding down from seaside cliffs, 54°48'20"N, 167°32'10"E, 10 m a.s.l., 3.VII.2004 V. Bakalin K-61-2-04 [106753], on fine-grained soil.

#### CONCLUSION

This discovery demonstrates the close connection of the Commander and Aleutian Islands as well as the northern parts of Western North America and Eurasia and the fact that we still know too little about the phytogeography and, moreover, the phylogeography of liverworts. Numerous new data that being revealed as a result of enhanced study of liverworts in poorly studied regions can significantly change the prevailing ideas on diversity and phytogeography of liverworts.

#### ACKNOWLEDGEMENTS

A. Hagborg is gratefully acknowledged for valuable comments and linguistic corrections. We sincerely thank V. Bakalin for the review and some comments. The study was carried out within institutional research project of the Avrorin Polar-Alpine Botanical Garden-Institute, RAS NN № 1021071612832-8-1.6.11, and using large scale research facilities "Herbarium of the Polar-Alpine Botanical Garden-Institute (KPABG)", reg. No. 499397. The Ministry of Higher Education and Science of Russia is thanked for grant 075-15-2021-678 supporting Center of Common Use «Herbarium MBG RAS».

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Received 29 November 2023 Accepted 14 December 2023