

*FRULLANIA HAMATILOBA*, A LIVERWORT SPECIES NEW FOR RUSSIA  
FOUND IN SAKHALIN

*FRULLANIA HAMATILOBA*, НОВЫЙ ДЛЯ РОССИИ ВИД ПЕЧЕНОЧНИКОВ  
НАЙДЕН НА САХАЛИНЕ

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Abstract

*Frullania hamatiloba* is recorded for the first time for Russia from Sakhalin. It is a northernmost locality for this species, for which was previously known from Japan (Hokkaido, Honshu, Shikoku, and Kyushu), Taiwan, China (Anhui, Guangdong) and the Korean Peninsula. The species is distinguished by (1) relatively large, shallowly bilobed (up to 0.26 the length) underleaves with obtuse to acute lobes and mostly angulate sinus, (2) characteristic leaf lobules which are transversely to longitudinally elongated (when well-developed), with incurved rostral portion, and (3) tuberculate perianth with three keels. Description and photomicrographs of *F. hamatiloba* from Sakhalin are provided together with discussion on its ecology and differentiation from having much in common *F. fauriana*, *F. kagoshimensis*, *F. pedicellata*, *F. taradakensis* and *F. usamiensis*.

Резюме

Новый для России вид печеночников *Frullania hamatiloba* выявлен на Сахалине. Это наиболее северная находка данного вида, который ранее был известен только в Японии (Хоккайдо, Хонсю, Сикоку и Кюсю), на Тайване, в Китае (провинции Аньхой, Гуандун) и в Республике Корея. Для *F. hamatiloba* характерна следующая комбинация признаков: (1) амфигастрии крупные, неглубоко (до 0.26 длины) двулопастные, в основном с угловатой вырезкой и тупыми или заостренными лопастями, в нижней половине часто с сильно отвороченными краями; (2) брюшные лопасти от продольно до поперечно удлинённых, в основном с изогнутой и вытянутой вниз ростральной областью; (3) периантий с тремя выступающими киями и бородавчатой до пластинчатой поверхностью. Приводятся описание и микрофотографии *F. hamatiloba*, а также обсуждение экологии, варибельности и отличий этого вида от морфологически сходных видов *F. fauriana*, *F. kagoshimensis*, *F. pedicellata* и *F. usamiensis*.

KEYWORDS: *Frullania hamatiloba*, liverworts, Russia, Sakhalin

INTRODUCTION

During the revision of *Frullania* Raddi collections from Sakhalin, a characteristic species of this genus, *F. hamatiloba* Steph., was discovered for the first time for Russia. This species was described by Stephani (1910: 401) with the only formal description of the locality “Japonia, Formosa”. Kamimura (1961) lectotypified this species by the specimen from the north of Honshu, Japan (Miyagi Prefecture), while the syntype of *F. hamatiloba* in G herbarium (G00067447!) having the mark “Formosa” (Taiwan) on the label was considered to have been collected in Korea (l.c.: 34). Nevertheless, the species has been discovered in Taiwan, as well as continental China (Piippo, 1990), and noted for the Korean Peninsula in Hong (1997). In Japan, *F. hamatiloba* was reported as rather common in the deciduous broad-leaved and coniferous forests at altitudes from 500 to 1300 m a.s.l.

(Kamimura, 1961), while in Sakhalin it was collected at much lower altitude (ca. 160 m a.s.l.) in the vicinities of Yuzhno-Sakhalinsk City, although in the deciduous floodplain forest. The description and photomicrographs of *F. hamatiloba* from Sakhalin together with discussion on its differentiation from having much in common *F. fauriana*, *F. kagoshimensis*, *F. pedicellata* and *F. usamiensis* are provided below.

MATERIALS AND METHODS

Description is based upon the studied specimen from Sakhalin. Photomicrographs were obtained with an Olympus MVX-10 stereomicroscope (Fig. 1A) and a Leitz Wetzlar Orthoplan light microscope (Fig. 1B, C, 2) equipped with digital cameras Lumenera Infinity 3-6 and Nikon D90, respectively. In order to better illustrate the three-dimensional objects, photomicrographs were combined from several optical sections using the stacking

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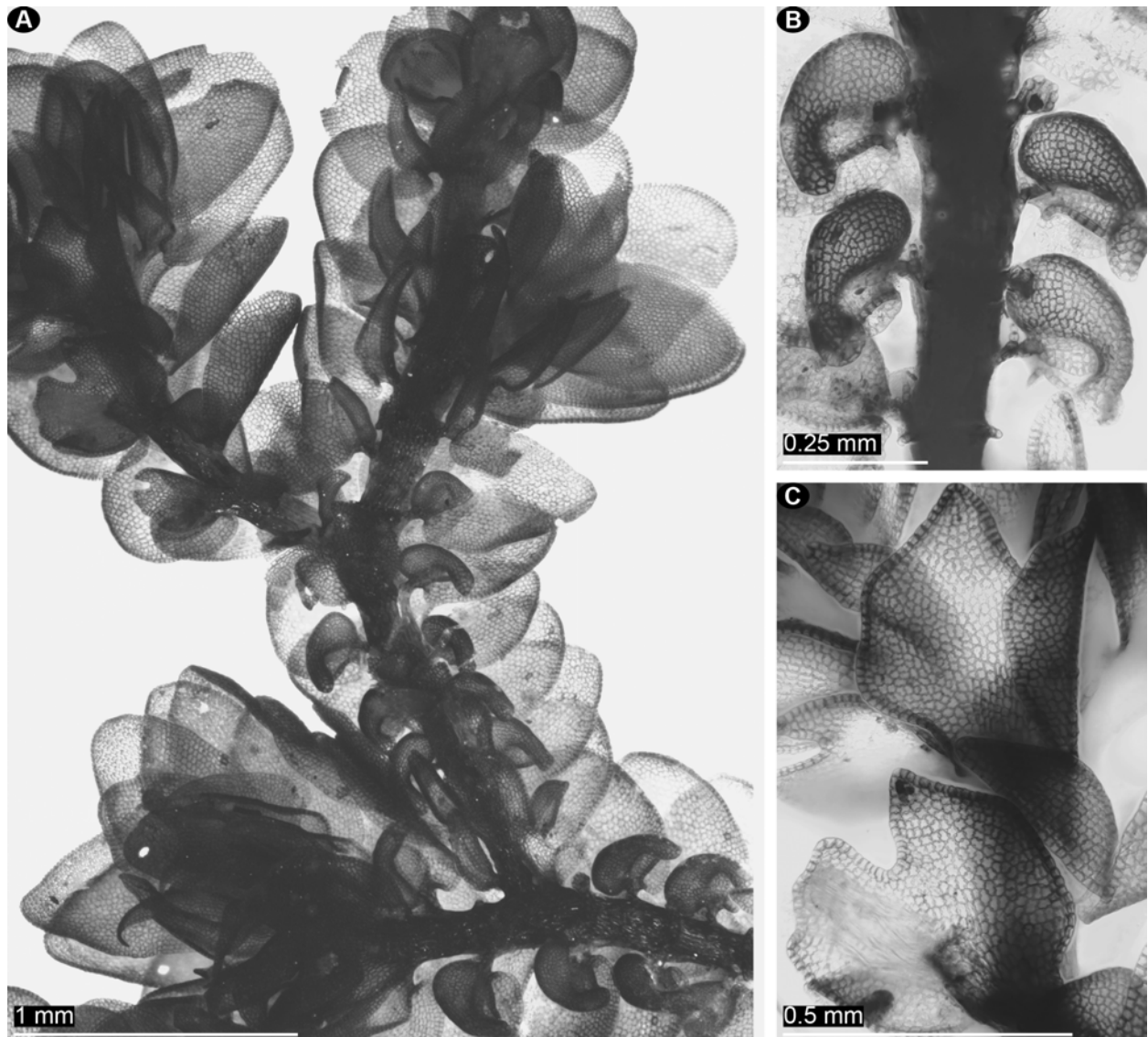


Fig. 1. *Frullania hamatiloba* (all from Ezhkin 240, MHA 9088498): A: portion of gynoecial shoot with unfertilized gynoecia; B, C: sterile shoot fragments showing leaf lobules and underleaves, respectively.

software HeliconFocus 8 (Kozub *et al.*, 2008). The descriptions of androecia and perianths in square brackets are based upon the syntypes of *F. hamatiloba* preserved in G herbarium (G-00280791 and G-00280788, respectively).

#### TAXONOMY

***Frullania hamatiloba*** Steph., Sp. Hepat. 4: 400. 1910. (Fig. 1, 2).

Plants in thin dense mats, yellowish to deep dark brown, loosely adhering to substrate, irregularly branched; shoots to 1.5 cm long and 0.9–1.3 mm wide. Stems rounded, 140–190  $\mu\text{m}$  in diameter, light to dark or almost blackish brown. Dorsal leaf lobes slightly concave and imbricate (in view from above), widely reniform to widely obovate, 650–850  $\mu\text{m}$  long, 460–630  $\mu\text{m}$  wide, ca. 1.34–1.55 $\times$  as long as wide; antical base mostly not auriculate or only weakly so (but sometimes bear an ovate appendage of ca. 0.5–1.0 of the lobule size), extending

ca. stem-width across and beyond the farther edge of stem, postical base not cordate; apex of lobes broadly rounded; margins entire. Lobules inflated or explanate, when inflated 0.1–0.15 of the size of the lobes, transversely (Fig. 2C, D, H) to longitudinally elongated, 200–250  $\mu\text{m}$  high, 160–310  $\mu\text{m}$  wide, ca. 0.7–1.5 $\times$  as high as wide; the lobules widely cucullate, their upper part distinctly saccate, inflated to the substrate, antero-upper part inclined or inflated, postero-upper part inflated, the rostral portion distinct, tubular; the lobule beak distinct, well-developed, nearly straight or incurved toward both lobule base and substrate, short to rather long (up to 1/2 of the lobule width, Fig. 2H), rounded to obtuse, hoof- to gouge-shaped, without apical hollow; the mouth convex or truncate or nearly straight, compressed, the dorsal valve more or less wrapped up inside the mouth to form a fold (Fig. 2D), the ventral valve nearly plane to slightly reflexed postically, the mouth opening to the substrate, the keel ca. 0.2–0.3 of the lobule width. Stylus indistinct, filiform, 1(–2)

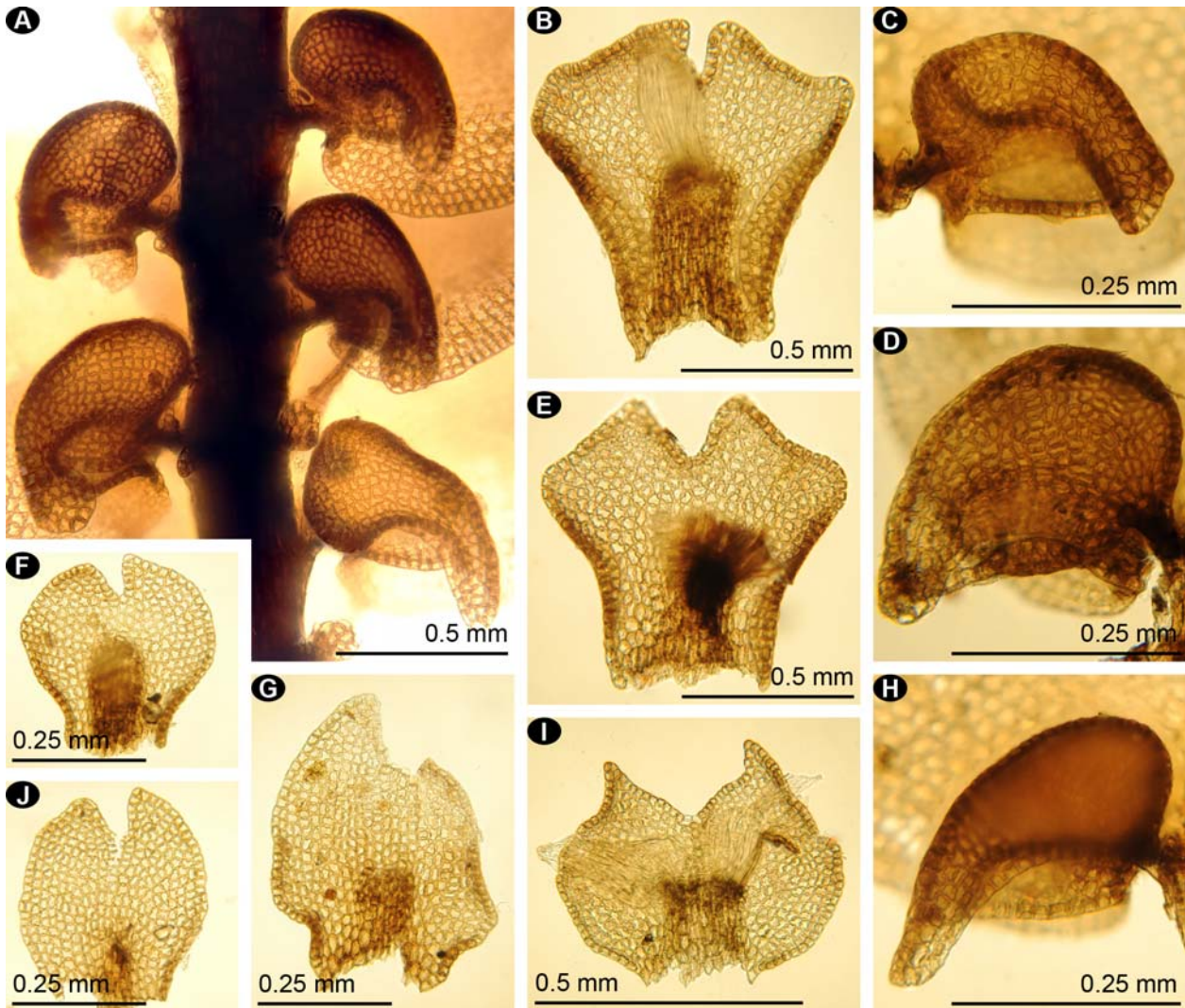


Fig. 2. *Frullania hamatiliba* (all from *Ezhkin 240*, MHA 9088498): A: sterile shoot fragments showing leaf lobules; B, E, F, G, I, J: underleaves; C, D, H: enlarged leaf lobules.

cells wide at base, 3–5 cells long, sometimes ending by slime papilla. Cells in the lobe middle rounded hexagonal, with medium to rather large, usually convex (rarely concave) trigones and with intermediate thickenings; near the lobe apex the trigones somewhat smaller and the intermediate thickenings rarely present; median cells ca.  $23\text{--}29\text{--}(35)\times 20\text{--}25\text{--}(29)\ \mu\text{m}$ , marginal cells smaller, nearly quadrate or slightly elongated,  $14\text{--}19\text{--}(22)\times 11\text{--}17\text{--}(23)\ \mu\text{m}$ ; cells near the base larger,  $27\text{--}35\text{--}(46)\times 24\text{--}30\text{--}(36)\ \mu\text{m}$ . Oil-bodies not seen. Ocelli lacking. Underleaves nearly transversely inserted,  $(370\text{--})400\text{--}600\ \mu\text{m}$  long,  $(350\text{--})410\text{--}550\text{--}(690)\ \mu\text{m}$  wide,  $0.75\text{--}1.25\times$  as long as wide,  $1.8\text{--}3.7\text{--}(4.4)$  times as wide as the stem, widely reniform or obovate or orbicular, widest mostly in the upper third, rarely near the middle, the lower half often obtuse, with the margins widely reflexed to revolute postically, in upper half the margins not revolute, entire or with an angulation on both sides; the underleaves almost undecurrent or somewhat decurrent (Fig. 2G), with line of insertion straight to slightly arched; the apex bi-

lobed ca.  $0.18\text{--}0.26$  of the length, sinus mostly acute, rarely rectangular, margins straight to concave, entire; the lobes obtuse to acute at apex, the outer margins nearly straight to convex in less-developed underleaves, but concave in well-developed ones (Fig. 1C, 2B, E, I). Asexual reproduction unknown.

Dioecious. Androecia not seen [in terminal on short lateral branches, usually subglobose (button-shaped), compact, of 4–5 pairs of densely imbricate bracts. Bracts subequally bilobed, lobules near the middle or in upper third with small, filiform stylus 1–2 cells at base and up to 4 cells long. Bracteoles free, with entire to angulate margins; upper bracteoles very small and sling-shaped,  $130\text{--}150\ \mu\text{m}$  long,  $60\text{--}120\ \mu\text{m}$  wide, bifid ca.  $0.7$  of the length, with rectangular sinus, with the lobes filiform, consist of conical base  $2\times 2$  cells and a uniceriate tip 5–7 cells long; the bracteoles near the base almost rectangular,  $320\text{--}360\ \mu\text{m}$  long,  $80\text{--}140\ \mu\text{m}$  wide, bifid ca.  $0.31\text{--}0.39$  of the length, with acute lobes and acute-angled sinus.] Unfertilized gynoecia terminal on main shoots or

on lateral branches. The bracts in three gyres, unequally bilobed, with entire margins, innermost bracts divided 0.75–0.85 of the length; lobes more or less concave, broadly oval to ovate, 970–1110 µm long, 550–700 µm wide, apex rounded; lobules long lanceolate, strongly canaliculate to involute postically, 600–700 µm long, 120–200 µm wide, apex acute to acuminate; stylus at base of lobules, filiform, 2 cells at base and 4–6 cells long, ending by slime papilla; an additional cilium identical to the stylus also present in the base of each lobule, just near the stylus. Bracteoles free from bracts, 450–600 µm long, 220–350 µm wide, at base with 1–3 cells cilia, bilobed 0.6–0.88 of the length, sinus acute-angled, lobes narrowly triangular, but strongly canaliculate to involute, entire margined, lobes divergent from, or crossing, each other, ± strongly curved postically, apex acute to apiculate. [Perianth exerted from 1/2 to 2/3 of the length, obovate to obpyriform, 1380–2510 µm long, 1030–1130 µm wide, with two lateral keels and one high and sharp ventral keel; the surface tuberculate mostly in lower two thirds; the apex subtruncate or ± retuse, with the beak 98–145 µm long; the beak apex crenulate.]

**Distinction.** Among *Frullania* species known in Russia, *F. hamatiloba* is rather remarkable due to transversely to longitudinally elongated lobules, shallowly bilobed underleaves and tuberculate perianth surface. However, since the species was found in Sakhalin without perianths, the comparison between *F. hamatiloba* and other similar species is provided below to include features of sterile plants only. The species *F. kagoshimensis* Steph., *F. taradakensis* Steph. and *F. usamiensis* Steph. (two latter are known in the south of the Russian Far East) are similar to *F. hamatiloba* in rather large shoots, the shape of transversely elongated leaf lobules and the shape of underleaves in some phases. However, in the former three species the underleaves are broader in relation to the stem width (usually 4–5 times) than in *F. hamatiloba*. Moreover, in *F. taradakensis* the well-developed underleaves are cordate at base, widest at most below the middle, gradually narrowed to the apex, while the underleaf margins are entire, plane or only slightly reflexed in lower 1/4 of rather less-developed underleaves (Kamimura, 1961: Fig. XVII: 15, 16). In *F. usamiensis*, the underleaves are usually less deeply bilobed than in *F. hamatiloba*, that is emarginate or bilobed to 0.13 of the length. Moreover, in both *F. kagoshimensis* and *F. usamiensis* the underleaf margins are entire (without distinct angulation) and usually plane (not revolute or reflexed postically in lower half). The species *F. fauriana* Steph. and *F. osumiensis* (S. Hatt.) S. Hatt., known from Japan, also resemble *F. hamatiloba* in the shape of transversely elongated leaf lobules and shallowly bilobed underleaves; however, both former species differ from *F. hamatiloba* by the underleaves dentate in upper half and the underleaf margins neither revolute or distinctly reflexed in lower half. The species *F. pedicellata* Steph. is similar to *F. hamatiloba*

in the shape of longitudinally elongated leaf lobules, however, it easily differs from the latter by the underleaf margins mostly plane (not or slightly reflexed) in lower half, and toothed in upper third of relatively well-developed underleaves (Kamimura, 1961: Fig. 5: 1–4, 10, 13–15, 28).

**Distribution.** Japan: Hokkaido, Honshu, Shikoku, Kyushu including Yakushima I. (Kamimura, 1961; Yamada, Iwatsuki, 2006); Republic of Korea (Kamimura 1961, Hong, 1997); China: Anhui, Guangdong, Taiwan (Piippo, 1990); Russia: Sakhalin (present study).

**Ecology.** According to Kamimura (1961), *F. hamatiloba* occurs on bark of deciduous broad-leaved and coniferous trees, rarely on rocks or decayed logs, in the deciduous broadleaved forest zone, at altitudes of 500–1300 m.s.m., associated with other *Frullania* and species of the genera *Cheilolejeunea*, *Lophocolea*, *Porella*, *Radula*. In Sakhalin, *F. hamatiloba* was collected on bark of *Ulmus* sp. in deciduous forest, in pure mat about 10 cm<sup>2</sup>.

**Specimens examined:** **Russia:** Sakhalin Region, Sakhalin Island, vicinity of Yuzhno-Sakhalinsk City, the valley of Rogatka River, 46°58'5.707"N, 142°47'49.03"E, 160 m a.s.l., floodplain forest with *Populus maximoviczii* and *Ulmus* sp., on bark of *Ulmus* sp., 19.V.2014, A.K. Ezhkin 240 (MHA 9088498, gynoecial plants with unfertilized gynoecia). **Japan:** Honshu: Shiga Prefecture, Kanzaki-gun, Eigenji-cho, Mt. Fujiwara, 5.IV.1952, N. Takaki 13560 (MHA 9088499). Miyagi Prefecture, Tenshudai, Sendai, 20.X.1907, E. Jishiba 6 (G-00280791, syntype of *F. hamatiloba*, androecial plants). Iwate Prefecture, Morioka, 20.X.1907, 18.VIII.1999, K. Sawada 38 (G-00280788, syntype of *F. hamatiloba*, gynoecial plants with perianths and sporophytes). Niigata Prefecture, Kitanbaragan, Sasagamimura, Deyu, 11.VI.1961, Y. Ikegami 63458 (NICH 71706, holotype of *F. hamatiloba* var. *latistipula* S.Hatt.).

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