

Synonymy, taxonomic notes, and range extensions for several noteworthy Asian liverworts

Qiong He^{1,2}, Ling-Juan Liu³, Chao-Xin Liu³, Guo-Long Liu³, Yi Ma³, De-Lu Gao³, Yu-Mei Wei¹, Rui-Ping Shi^{1,4}, Lei Shu¹, Rui-Liang Zhu¹

¹School of Life Science, East China Normal University, Shanghai, China, ²Ningbo Binhai Education Group Ltd, Ningbo, China, ³Fengyangshan National Nature Reserve, China, ⁴Shanghai Science and Technology Museum, Shanghai, China

Several noteworthy liverworts are reported from China, including *Bazzania horridula* Schiffn. and *Riccardia tamariscina* (Steph.) Schiffn. new to China, and five species new to mainland China. *Cololejeunea dozyana* (Sande Lac.) Schiffn. and *Leptolejeunea udarii* M.Dey & D.K.Singh are reported new to Thailand. *Chiloscyphus yunnanensis* C.Gao & Y.H.Wu, previously known only from the type locality, is proposed to be synonymous with the tropical Asian *Chiloscyphus ciliolatus* (Nees) J.J.Engel & R.M.Schust. SEM observations reveal that the wax-like projections on the thallus surface of *Riccardia tamariscina* do not belong to surface wax. Two types of oil bodies in *Bazzania* are illustrated. It is suggested avoiding the use of the term '*Bazzania*-type' when oil bodies are described.

Keywords: *Bazzania horridula*, *Bazzania*-type oil bodies, *Chiloscyphus ciliolatus*, *C. yunnanensis*, *Lepicolea yakusimensis*, *Riccardia tamariscina*

Introduction

China is a rich and important country for bryophyte diversity. Over 1000 species of liverwort and hornwort are known in this country, constituting the richest and most diverse liverwort and hornwort flora in the world. Our examination of recent collections made from China and Thailand reveals that several noteworthy liverworts have extended ranges. *Chiloscyphus yunnanensis* C.Gao & Y.H.Wu, previously known only from the type locality, is proposed to be synonymous with the tropical Asian *Chiloscyphus ciliolatus* (Nees) J.J.Engel & R.M.Schust.

In addition, oil body characters in *Bazzania angustistipula* N.Kitag. are characterized, and the surface wax-like projections in *Riccardia tamariscina* (Steph.) Schiffn. are investigated.

Materials and Methods

Observations were made on various recent collections, as well as older herbarium material. All specimens cited in the present article are kept in the herbarium of the East China Normal University (HSNU), unless otherwise indicated.

Materials of *Riccardia tamariscina* for scanning electron microscope (SEM) studies were air-dried, mounted on metal stubs with double adhesive tape, and then coated with gold. SEM micrographs were made with a Hitachi S-4800 SEM. In order to determine whether or not surface wax was present, thalli from the same plants were examined by SEM following washing of the thalli in chloroform for 3–5 minutes prior to coating. Field images were made with a digital camera (Canon G11). Micrographs were made with a Zeiss Imager A1 microscope.

Taxonomic Notes and Range Extension

Aneura maxima (Schiffn.) Steph., Sp. Hepat. 1: 270. 1899.

Aneura maxima is a rather rare species in China where the only record is from Taiwan (Piippo, 1990). It is newly reported for mainland China. Recently, *Aneura maxima* has also been found in Thailand (Frahm *et al.*, 2009), Poland (Buczowska & Bączkiewicz, 2006), and Romania (Ștefănuț, 2012). The total range of this species includes Asia (China, India, Indonesia, Japan, Nepal, Thailand), Europe (Belgium, Czech Republic, Poland, Romania, Slovakia), Eastern North America, and Oceania (New Caledonia, Vanuatu) (Grolle & Long, 2000; Furuki, 2002; Mierzeńska & Vončina, 2010; Thouvenot *et al.*, 2011).

Correspondence to: Rui-Liang Zhu, Department of Biology, School of Life Science, East China Normal University, 3663 Zhong Shan North Road, Shanghai 200062, China. Email: lejeunea@163.com

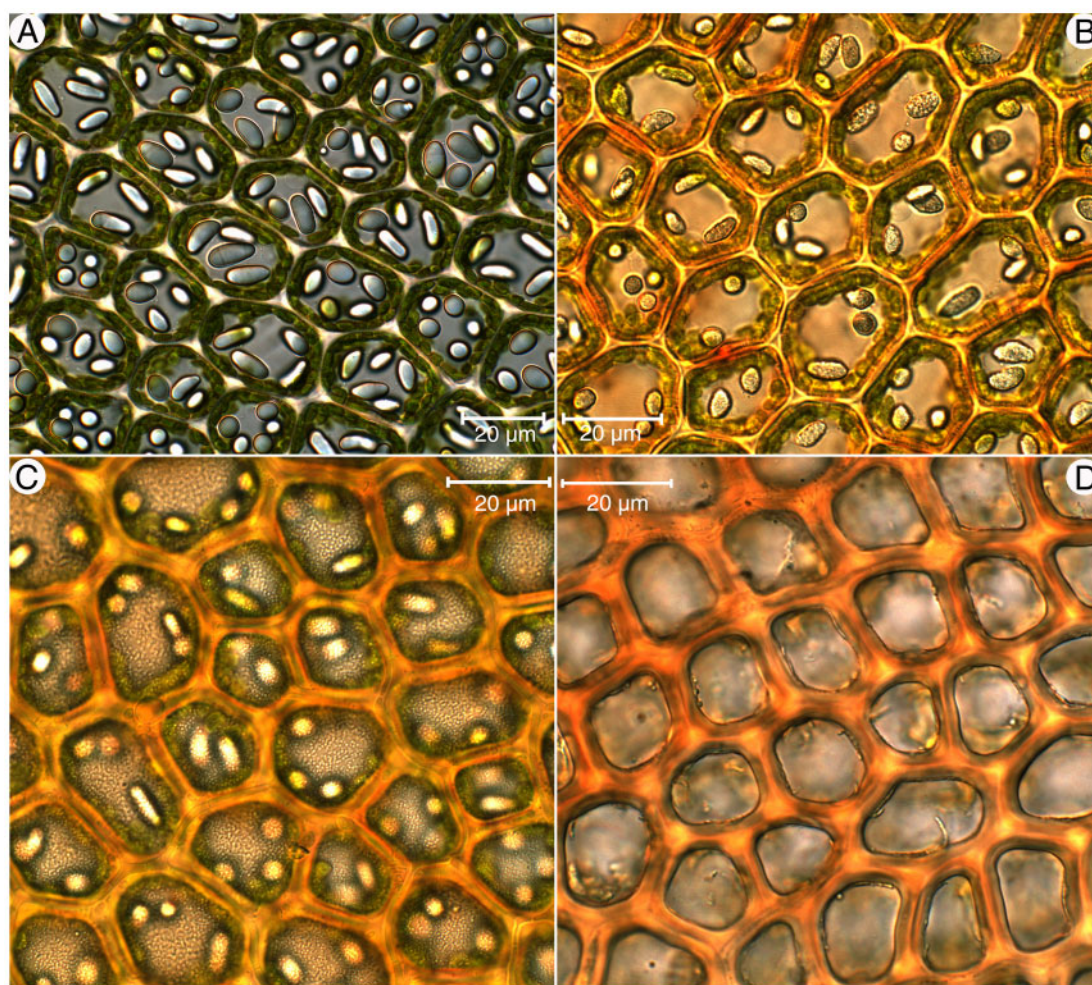


Figure 1 (A) *Bazzania himalayana* (Mitt.) Schiffn., showing typical (homogeneous or weakly 1–4 segmented) oil bodies of *Bazzania*. (B–D) *Bazzania angustistipula*: (B) finely granular oil bodies; (C) verrucose cuticle of median leaf cells; (D) smooth cuticle of median leaf cells. A from R.-L. Zhu 20111220-27 from Thailand, B and C from R.-L. Zhu 20111220-13B from Thailand, D from R.-L. Zhu et al. 20100826-68b from China.

Specimen examined: China. Guangxi, Fangchenggang City, Shangsi Co, Pinglongshan, 21°51'389"N, 107°51'675"E, on wet soil, 525 m, 21 August 2010, R.-L. Zhu, Y.-M. Wei & Q. He 20100821-29.

Bazzania angustistipula N.Kitag., J. Hattori Bot. Lab. 30: 268. 1967.

Bazzania angustistipula was first described by Kitagawa (1967) from Doi Inthanon National Park, northern Thailand. It is a Himalayan species which has previously been known from China (Bapna & Kachroo, 2000), India (Bapna & Kachroo, 2000), Nepal (Hattori, 1975), Thailand, and Vietnam (Pócs, 1969). Recently, Zhou et al. (2012) reported its occurrence in Sichuan and Yunnan, China. *Bazzania angustistipula* is here reported as new to Guizhou, China. All known populations of this species in China, Nepal, Thailand, and Vietnam grow on tree trunks and branches in alpine forests at 1800–3700 m.

As noted by Kitagawa (1967), *Bazzania angustistipula* is well characterized and readily recognized by the caducous leaves and underleaves, the slender reddish brown plants, the triangular-ovate leaves

with an acuminate (sometimes bilobed) apex, and the patent often bilobed underleaves. Further diagnostic characters include its finely granular oil bodies (Figure 1B), which are not usual in *Bazzania* species. Previously described species had homogeneous, or 1–4 segmented oil bodies (Figure 1A) (Gradstein et al., 1977, 2001) which have therefore been described as ‘*Bazzania*-type’. Given the newly reported variation in oil-body type in *Bazzania*, use of the term ‘*Bazzania*-type’ oil-body is no longer appropriate and should be avoided. In the local specimens cited below the cuticle of leaf cells is smooth (Figure 1D), but in the samples from the type locality the cuticle is densely punctate under the light microscope (Figure 1C).

Specimens examined: China. Guizhou, Leigongshan Nature Reserve, along the road from the peak to Jianzhu Garden, 26°23'329"N, 108°11'925"E, 2090 m, on dead branches, 26 August 2010, R.-L. Zhu et al 20100826-68B. Thailand. Chiang Mai, Chom Thong, Doi Inthanon National Park, summit, *Sphagnum*. L bog, 18°58'914"N, 98°48'566"E, on tree trunk and

branch of *Rhododendron* L., 2539 m, 20 November 2011, R.-L. Zhu 20111220-13B.

Bazzania horridula Schiffn., Nova Acta Acad. Caes. Leop.-Carol. German. Nat. Cur. 60: 258. 1893.

Bazzania horridula was described as a new species from Ambon by Schiffner (1893). As noted by Kitagawa (1967), *B. horridula* is well characterized and easily recognized by the reflexed underleaves, denticulate leaf and underleaf margins, and thick-walled cells with a distinct papilla. This species has previously been known from Ambon, Borneo, Java, New Guinea, Thailand, and the Philippines (Kitagawa, 1967; Grolle & Piippo, 1984; Lai et al., 2008). This is the first record of *B. horridula* for China. Hainan Island is thus by far the northernmost locality of this species. In China, *B. horridula* occurs on tree trunks associated with two lepidoziaecous taxa, *Acromastigum divaricatum* (Nees) A. Evans and *Bazzania vittata* (Gottsche) Trevis., in the moist tropical monsoon rain forests in the Diaoluoshan Nature Reserve in the southeastern part of Hainan Island. Chinese plants agree with the plants outside China.

Specimen examined: China. Hainan, Diaoluoshan Nature Reserve, Erbiandao, 900 m, on tree trunks, 5 September 2005, R.-L. Zhu et al. 20050905-37B.

Chiloscyphus ciliolatus (Nees) J.J. Engel & R.M. Schust., Nova Hedwigia 39: 413. 1985[1984].

Chiloscyphus yunnanensis C. Gao & Y.H. Wu, Acta Bot. Yunn. 28(2): 119. 2006. **Type:** China. Yunnan. Bijiang Co., Gaoligongshan Mt., Pianmayakou, on stone, 2 August 1978, M. Zang 5849A (holotype: IFP!); *syn. nov.*

Detailed observations on tropical Asian specimens of *Chiloscyphus ciliolatus* reveal that *C. ciliolatus* is somewhat variable in trigone and leaf tooth characters. Most specimens of Chinese plants have small trigones and 0–3 teeth on the ventral leaf margin. Examination of the type material of *Chiloscyphus yunnanensis* from Yunnan, China (Gao & Wu, 2006) indicates that *C. yunnanensis* is conspecific with *C. ciliolatus*. The known range of *C. ciliolatus* (*Lophocolea ciliolata*) includes Borneo, Hawaii, Java, Malaya, Papua New Guinea, Sri Lanka, Sulawesi, Sumatra, Thailand (Kitagawa, 1979; Piippo, 1985, 1989). In China, it has previously been known only from Taiwan (Gao & Wu, 2010; Wang et al., 2011).

Specimens examined: China. Hainan. Bawangling Nature Reserve, 1000 m, on decaying logs, 28 November 2003, R.-L. Zhu et al. 03371, 03370, 03112802, 20031128-37; Diaoluoshan Nature Reserve, on tree trunks, 930 m, 2 September 2005, R.-L. Zhu et al. 20050902-36B.

Cololejeunea dozyana (Sande Lac.) Schiffn., Consp. Hepat. Arch. Ind.: 242. 1898.

Cololejeunea dozyana has previously been known from China (Taiwan, Yunnan), India (Sikkim) (Dey &

Singh, 2011), Nepal (Zhu & Long, 2003), the Philippines, Indonesia, and Malaysia (Zhu & So, 2001). It is newly recorded for Thailand. This species is easily recognized by the slightly falcate, obovate leaves usually with several remote irregular marginal teeth (Zhu & So, 2001). It is highly possible that it also occurs in Oceania and other regions of southeastern Asia.

Specimen examined: Thailand. Chiang Mai. Chom Thong District, Doi Inthanon National Park, summit, 18°58'912"N, 98°48'560"E, on branches of *Rhododendron*, 2528 m, 20 December 2011, R.-L. Zhu 20111220-80D.

Lepicolea yakusimensis (S.Hatt.) S.Hatt., J. Hattori Bot. Lab. 10: 42. 1953.

Lepicolea yakusimensis was described as a new species from Japan by Hattori (1948 as *Lepicolea scolopendra* (Hook.) Dumort. ex Trevis. var. *yakusimensis* S.Hatt.). It is considered to be an endangered species (Iwatsuki et al., 2008). In China, it has previously been reported only for Taiwan (Piippo, 1990; Lin, 2000; Yang, 2011). Its occurrence in Hainan confirms its contiguous distribution from Sri Lanka to Japan. The total range of this species includes Borneo, China (Hainan, Taiwan), Japan, Malaya, Sri Lanka, and Thailand (cf. Kitagawa, 1978).

Specimen examined: China. Hainan, Bawangling Nature Reserve, on trunks in forest, 1050 m, December 1989, R.-L. Zhu 89993B.

Leptolejeunea udarii M. Dey & D.K. Singh, Taiwaniana 55: 359. 2010.

Leptolejeunea udarii is a recently described species known only from India (Sikkim) where it is epiphyllous. The status of the species is somewhat doubtful, because it is extremely similar to the Himalayan *Leptolejeunea latifolia* Herzog known from Bhutan, China, India, and Nepal (Zhu & Long, 2003), and none of the characters listed in the discussion in Dey & Singh (2010) is unique to *Leptolejeunea udarii*. A comparison with other *Leptolejeunea* species at molecular level is necessary to resolve these doubts.

Specimen examined: Thailand. Chiang Mai. Chom Thong, Doi Inthanon National Park, summit, 18°58'912"N, 98°48'560"E, on branches of *Rhododendron*, 2528 m, 20 December 2011, R.-L. Zhu 20111220-80B.

Mnioloma fuscum (Lehm.) R.M. Schust., Fragm. Florist. Geobot. 40: 848. 1995.

Mnioloma is a small pantropical genus, containing ca 13 species, 11 of which are restricted to the Neotropics and mostly occur in northern South America (Engel, 2006). *Mnioloma fuscum* is a paleotropical species, but in China the species has previously been known only from a single specimen collected from Yuanyanghu Nature Reserve, Taiwan (Gao et al., 2002). The collection cited below is the

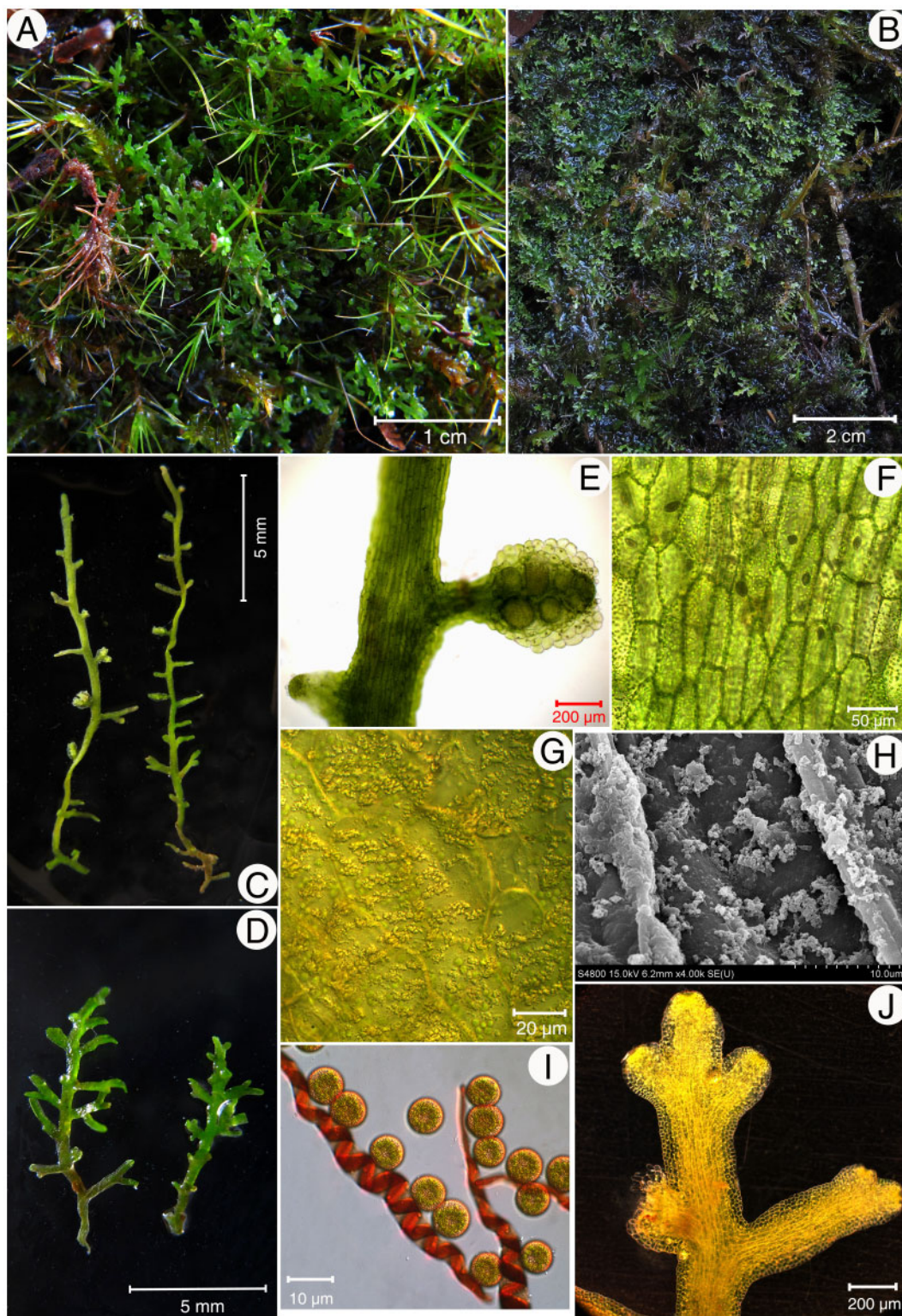


Figure 2 *Riccardia tamariscina* (A–B) Habits. (C) Male thalli. (D) Sterile thalli. (E) Male branch. (F) Dorsal epidermal cells of median part of ultimate pinnule, showing oil bodies. (G) Irregularly verrucose surface of thalli. (H) SEM micrograph showing surface projections of the thallus. (I) Spores and elaters. (J) Ultimate thallus showing a wide unistratose alar portion. B from R.-L. Zhu & Y.-M. Wei 20110417-97, C and D from R.L. Zhu, Q. He & L. Shu 20100711-14, F from R.-L. Zhu & Y.-M. Wei 20110420-33, I from R.-L. Zhu & Y.-M. Wei 20110417-28A, the others from R.L. Zhu, Q. He & L. Shu 20100711-54C.

first locality of the species in mainland China where *M. fuscum* is associated with *Cheilolejeunea osumiensis* (S.Hatt.) Mizut., *Cheilolejeunea trapezia* (Nees) Kachroo & R.M.Schust., and *Radula oyamensis* Steph.

Specimens examined: China. Guangdong. Nanling Nature Reserve, Babaoshan protection station, waterfalls, along stone steps, on tree trunks, 1035 m, 21 September 2009, J. Wang et al. 20090921-17B; Taiwan. Xinzhu Co., Yuanyang Lake Nature Reserve,

on rotten log, 1670 m, 19 October 1998, C. Gao & T. Cao 98044 (JE).

Riccardia tamariscina (Steph.) Schiffn., Consp. Hepat. Arch. Ind.: 58. 1898.

Riccardia tamariscina was first described from Java. It is well characterized by the bi- to tripinnately branched thalli, the ultimate pinnules with a wide unistratose alar portion (Figure 2J), and the irregularly verrucose surface of thalli giving the appearance of being covered with minute dust (Furuki, 1991). The last character is unique in *Riccardia* and not found in any other species of this genus (Furuki, 1999). The peculiar rough surface is visible even with the light microscope (Figure 2G). It is irregularly verrucose (Figure 2H) which looks similar to the surface wax seen in some leafy liverworts (Heinrichs et al., 2000; Heinrichs & Reiner-Drehwald, 2012). SEM observations reveal that the thallus surface is covered by irregular verrucae and sometimes membranous platelets (Figure 2H). All the surface projections in *R. tamariscina*, however, do not belong to surface wax projections because they could not be removed with chloroform. *Riccardia tamariscina* has previously been known from Japan and Java (Furuki, 1991, 1998; Furuki et al., 2001). It is newly reported for China. In China, *R. tamariscina* occurs on wet soil or rocks in the evergreen broadleaved forests and the mixed needle and broad-leaved forests at altitudes of 600–1550 m. Chinese plants are somewhat atypical. Thalli are usually scarcely branched, and most plants are only bi-pinnately branched (Figure 2A–D). Male branches are 0–2 branched, with 2–5 pairs of antheridial chambers (Figure 2E). Elaters are linear, brownish red, 135–330 µm long, 11–17 µm wide at middle, with a single spiral band of thickenings (Figure 2I). Spores are brown, 14–16 µm in diameter, minutely papillose on the surface (Figure 2I).

Specimens examined: China. Zhejiang. Fengyangshan Nature Reserve, Datianping, 27°54.538'N, 119°10.367'E, on soil, 1283 m, 11 July 2010, R.-L. Zhu, Q. He & L. Shu 20100711-22B; *ibid.*, 27°54.872'N, 119°10.185'E, on soil, 1230 m, 11 July 2010, R.-L. Zhu, Q. He & L. Shu 20100711-54C; Zhejiang. Qingyuan, Baishanzu Nature Reserve, Wulingkeng, 27°32'838"N, 119°03'723"E, on cliff, 627 m, 20 April 2011, R.-L. Zhu & Y.-M. Wei 20110420-33. Japan. Kyushu, Miyazaki-ken, Minaminaka-gun, Kitago, Inohae Gorge, 80–200 m, 3 March 1998, T. Furuki 7299.

Saccogynidium muricellum (De Not.) Grolle, J. Hattori Bot. Lab. 36: 80. 1972.

Saccogynidium muricellum is distributed in Australia, China (Taiwan), Indonesia, Malaysia, New Caledonia, Papua New Guinea, the Philippines, and Thailand (Kitagawa, 1979; Piippo, 1985; Gao et al.,

2001; McCarthy, 2003; Lai et al., 2008; Thouvenot et al., 2011). Previously known only from Taiwan (Piippo, 1990; Gao et al., 2001; Gao & Wu, 2010), *Saccogynidium muricellum* is here reported for the first time for mainland China. Locally it seems to be very rare, with only three specimens collected in the evergreen broadleaved forests and tropical monsoon rain forests in Fujian and Hainan. *Saccogynidium muricellum* is very similar to *S. rigidulum* (Nees) Grolle, which shares the same range. The latter species, however, differs mainly in the larger trigones and much taller papillae of the leaf cells.

Specimens examined: China. Fujian, Ningde, Zhiti Mt., 700 m, 13 September 1999, J. Zhu 1128; Hainan, Diaoluoshan Nature Reserve, on rocks, 950 m, 2 September 2005, Zhu et al. 20050902-23b; 970 m, 3 September 2005, Zhu et al. 20050903-15b.

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Taxonomic Additions and Changes: *Chiloscyphus ciliolatus* (Nees) J.J.Engel & R.M.Schust. (*Chiloscyphus yunnanensis* C.Gao & Y.H.Wu *syn. nov.*)

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