

# New records of *Cololejeunea* (Lejeuneaceae, Hepaticae) for China and Vietnam

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**Abstract.** *Cololejeunea bhutanica* Grolle & Mizut. and *C. ceylanica* Onr., two little known species known previously only from Bhutan and Sri Lanka, respectively, are newly found in Guangxi and Xizang, respectively. *Cololejeunea horikawana* (S. Hatt.) Mizut. previously reported only for Japan is now found in Yunnan. *Cololejeunea horikawana* is similar to *C. goebelii* (Gottsche ex Schiffn.) Schiffn., however differs in the morphology of the stylus and position of the hyaline papilla. Pantropical *Cololejeunea wightii* Steph. is newly found in Guangxi and Hainan. *Cololejeunea tenella* Benedix is reported for the first time for Taiwan. It is readily separated from the other *Cololejeunea* species of Taiwan by its falcate leaves, ± hooked first tooth of the leaf lobule, and the presence of ocellus-like basal cells in leaf lobe. *Cololejeunea pseudoplagiophylla* P.C. Wu & J.S. Lou is newly reported for Vietnam. Detailed illustrations of *Cololejeunea bhutanica*, *C. tenella*, and *C. wightii* are provided.

**Keywords:** China; *Cololejeunea*; Distribution; Epiphyllous liverworts; Lejeuneaceae; New records; Taiwan; Taxonomy; Vietnam.

## Introduction

*Cololejeunea* is the largest known genus of the Lejeuneaceae in China. Piippo (1990, 1992) listed 51 species. Since 1992, three new species, *Cololejeunea dinghuiana* R.L. Zhu & Y.F. Wang, *C. hainanensis* R.L. Zhu and *C. latistyla* R.L. Zhu, have been described (Zhu and Wang, 1992; Zhu et al., 1994b; Zhu, 1995), and 12 new records have been added to the Chinese *Cololejeunea* flora (Zhu et al., 1994a, b; Zhu, 1995; Zhu and Lu, 1995; Ji and Wu, 1997; Zhu and So, 1998a, b). *Cololejeunea yoshinagana* (S. Hatt.) Mizut. was excluded from the Chinese *Cololejeunea* flora (Zhu and Wang, 1992). *Cololejeunea roselloides* P.C. Wu & P.J. Lin from Hainan was treated as a synonym of *C. verrucosa* Steph. (Zhu, 1995). Li (1997) published a new variety, *Pedinolejeunea himalayensis* (Pandé & Misra) P.C. Chen & P.C. Wu var. *fukiensis* D.K. Li, from Fujian. Thus a total of 59 species and 3 varieties have been recorded in China.

During our recent examination of Southeast Asian specimens of Lejeuneaceae, we found several new records of the genus *Cololejeunea*. In this paper we report four new records for China, *Cololejeunea bhutanica* Grolle & Mizut., a rare species known previously only from Bhutan, now found in Guangxi; *C. ceylanica* Onr., known previously only from Sri Lanka,

now found in Xizang; *C. horikawana* (S. Hatt.) Mizut., known previously only from Japan, now collected from Yunnan, and *Cololejeunea wightii* Steph., a pantropical species, found from Guangxi and Hainan. *Cololejeunea tenella* Benedix and *C. pseudoplagiophylla* P.C. Wu & J.S. Lou were newly found in Taiwan and Vietnam, respectively.

***Cololejeunea bhutanica*** Grolle & Mizut., J. Bryol. 15: 281. 1988.—TYPE: BHUTAN. Tongsa District, W slopes below Yuto La, small valley in moist *Quercus* forest, 2,960 m, Long 7986 (holotype: E; isotypes: JE!, NICH). Figure 1

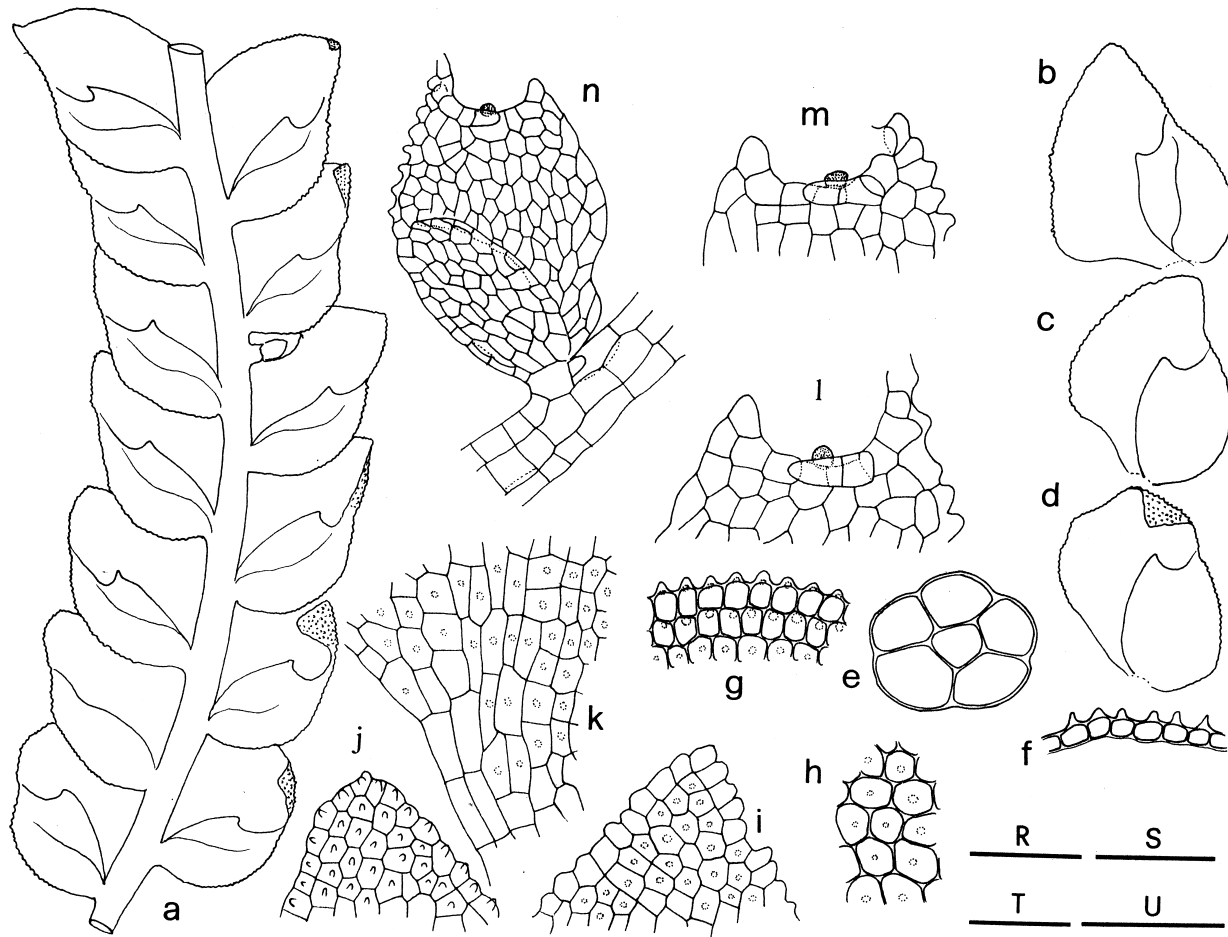
*Illustration.* Grolle (1988): p. 282, Fig. 1.

*Additional specimen examined.* CHINA. GUANGXI: Miaoershan, grasslands at peak of mountain, Gao & Zhang 1696 (HSNU, IFP-0013775, JE).

*Distribution.* Bhutan, China (Guangxi).

*Notes.* *Cololejeunea bhutanica* is well characterized and easily recognized by the (1) scarcely branched stems, (2) strongly revolute, asymmetrical leaves with acute to obtuse apices, (3) large, strongly inflated lobules, (4) presence of small, conical papillae on dorsal surface of cells, (5) smooth ventral surface of leaf lobule, (6) 1-2-celled first tooth positioned horizontally (Figure 1: l, m), (7) small hyaline papilla partially covered by the first tooth and situated at the middle of apical free margin of leaf lobule, (8) 1-celled stylus, and (9) absence of ocelli and vitta. Compared with the type material, the leaves are

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**Figure 1.** *Cololejeunea bhutanica* Grolle & Mizut. a, Portion of plant, ventral view; b–d, Leaves, ventral view; e, Transverse section of stem; f, Portion of transverse section of leaf; g, Marginal cells of leaf lobe; h, Median cells of leaf lobe; i–j, Apices of leaf lobes; k, Basal cells of dorsal margin of leaf lobe; l–m, Apices of leaf lobules; n, Leaf lobule and portion of stem, ventral view. All drawn from Gao & Zhang 1696 from Guangxi. Line scales: R=0.05 mm (e–h); S = 0.1 mm (n); T = 0.05 mm (i–m); U = 0.3 mm (a–d).

only slightly falcate, and the leaf apex is often obtuse in Chinese specimens, as shown in Figure 1.

As noted by Grolle (1988), *Cololejeunea bhutanica* is easily separated from the other species of the genus by the apex of its leaf lobule and the unique position of the hyaline papilla. *Aphanolejeunea contractiloba* (A. Evans) R.M. Schust. somewhat resembles *Cololejeunea bhutanica* in the position of the hyaline papilla, but the latter differs in its large size of plant, the gyrothecal branching, and the large leaves with narrowing dorsal margin toward the base.

*Cololejeunea bhutanica* seems to be a rare species. Only one specimen from Bhutan was cited by Grolle (1988). In China it is known only at the locality cited above on the basis of one sterile specimen.

***Cololejeunea ceylanica*** Onr., Acta Bot. Acad. Sci. Hung. 25: 107. 1979.—TYPE: SRI LANKA. Galle district, Hiniduma, Kanneliya Forest Reserve, forêt

dense, ombrophile, alt. ca 150 m, *Onraedt 77.L.4191* (holotype: Hb. Onraedt!; isotypes: EGR, JE, NICH).

*Illustration.* Onraedt (1979): p. 108, Fig. 1.

*Additional specimens examined.* CHINA. XIZANG: Motuo, Bangushan, epiphyllous [together with *Cololejeunea longifolia* (Mitt.) Benedix], collector unknown, no. 6 (HSNU); Motuo, Beibeng, collector unknown, no. 11 (HSNU). SRI LANKA. Galle district, Hiniduma, Kanneliya Forest Reserve, forêt dense, ombrophile, alt. ca 150 m, *Onraedt 77.L.4254* (paratype, JE).

*Distribution.* China (Xizang), Sri Lanka.

*Notes.* As noted by Onraedt (1979), *Cololejeunea ceylanica* is most closely related to *C. goebelii* (Gottsche ex Schiffn.) Schiffn. These two species are extremely similar in the structure of leaf lobule and the morphology of stylus and perianth. According to our observations, *Cololejeunea ceylanica* differs from *C. goebelii* in hav-

ing an apiculate apex of leaf lobe. The leaf lobe apex is not always apiculate, but sometimes obtuse to rounded-obtuse in type specimens and Chinese materials. The stylus also varies from one to five cells long in Chinese materials. Dorsal papillae are usually present in marginal cells of leaf lobe as in the type material; however, sometimes they occur in the median-upper cells of leaf lobe in Chinese materials. In *Cololejeunea goebelii*, dorsal papillae are sometimes present in marginal cells of leaf lobe, never in median-upper ones. Until now, *Cololejeunea ceylanica* was found growing only on living leaves.

**Cololejeunea horikawana** (S. Hatt.) Mizut., J. Hattori Bot. Lab. 24: 254. 1961.

*Leptocolea horikawana* S. Hatt., J. Jap. Bot. 18: 653. 1942.—TYPE: JAPAN. Kagoshima Pref. (Prov. Osumi), Yakushima I., Kosugidani, *Hattori 6717* (holotype: TNS!).

*Illustrations.* Hattori (1942): p. 653, Fig. 14 as *Leptocolea horikawana*; Mizutani (1961): p. 253, Fig. XXXI, 9–19.

*Specimen examined.* CHINA. YUNNAN: Xishuangbanna, epiphyllous, *Li 3029* (HSNU).

*Distribution.* China (Yunnan), Japan.

*Notes.* *Cololejeunea horikawana* is most closely related to *C. goebelii* (Gottsche ex Schiffn.) Schiffn. As pointed out by Mizutani (1961), *Cololejeunea horikawana* differs from the latter by its larger stylus (at least 2–3 cells wide at base) and the position of the hyaline papilla (at the proximal side of the third or fourth cell [from the tip] of the first tooth of leaf lobule). In *Cololejeunea goebelii*, however, the stylus is always one cell wide, and the hyaline papilla is situated at the proximal side of the second cell (from the tip) of the first tooth of leaf lobule. In China, only one scanty epiphyllous specimen was available for our study. Compared with *Cololejeunea goebelii*, *C. horikawana* appears to be rather rare in China. *Cololejeunea horikawana* was previously known only from Japan. Now Xishuangbanna (Yunnan) can be regarded as the southernmost locality for this species.

**Cololejeunea pseudoplagiophylla** P.C. Wu & J.S. Lou, Acta Phytotax. Sin. 16: 106. 1978.—TYPE: CHINA. XIZANG: Motuo (Meto), beside the lake of Si-kong, on the leaves of Piperaceae, Lauraceae and *Coelogyne longipes* Lindb., 8 Sep 1974, *Group of Vegetation 3164* (holotype: PE)

*Illustrations.* Wu and Lou (1978): p. 107, Fig. 4; Srivastava and Srivastava (1990): p. 128, Fig. 4.

*Specimens examined.* CHINA. HAINAN: Wuzhishan, epiphyllous, 650 m, *Li 05512* (HSNU, SHM); Diaoluoshan, epiphyllous, 1,040 m, *Li 05558* (HSNU, SHM); XIZANG: Motuo, Labanglashan, epiphyllous, *Su 4599* (HSNU, IFP, KUN); YUNNAN: Dulong River, No.

41 Jiebei, 1,240 m, epiphyllous, *Zang 2291* (HSNU, IFP, KUN, JE, NY). VIETNAM. Ninh Binh, 250 m, *Pócs 3139/6* (PC).

*Distribution.* China (Hainan, new to Yunnan, Xizang), India (Srivastava and Srivastava, 1990), new to Vietnam.

*Notes.* This is a distinct species readily recognized by its asymmetric leaves, minute dorsal papillae of leaf lobe, and its leaf lobule, which is not entirely attached to the leaf lobe margin by its keel. The dorsal papillae of the leaf cells are sometimes poorly developed. The species to which *Cololejeunea pseudoplagiophylla* may be related is *C. tranninhiana* Tixier, a Vietnamese species (Tixier 1974, 1985). However, the differences between the two await further examination of the type of *Cololejeunea tranninhiana*.

*Cololejeunea pseudoplagiophylla* is often loosely appressed on the surface of living leaves. In Vietnam, it was found associated with *Leptolejeunea balansae* Steph. Although rare in Yunnan, *Cololejeunea pseudoplagiophylla* is a common epiphyllous *Cololejeunea* species in Hainan.

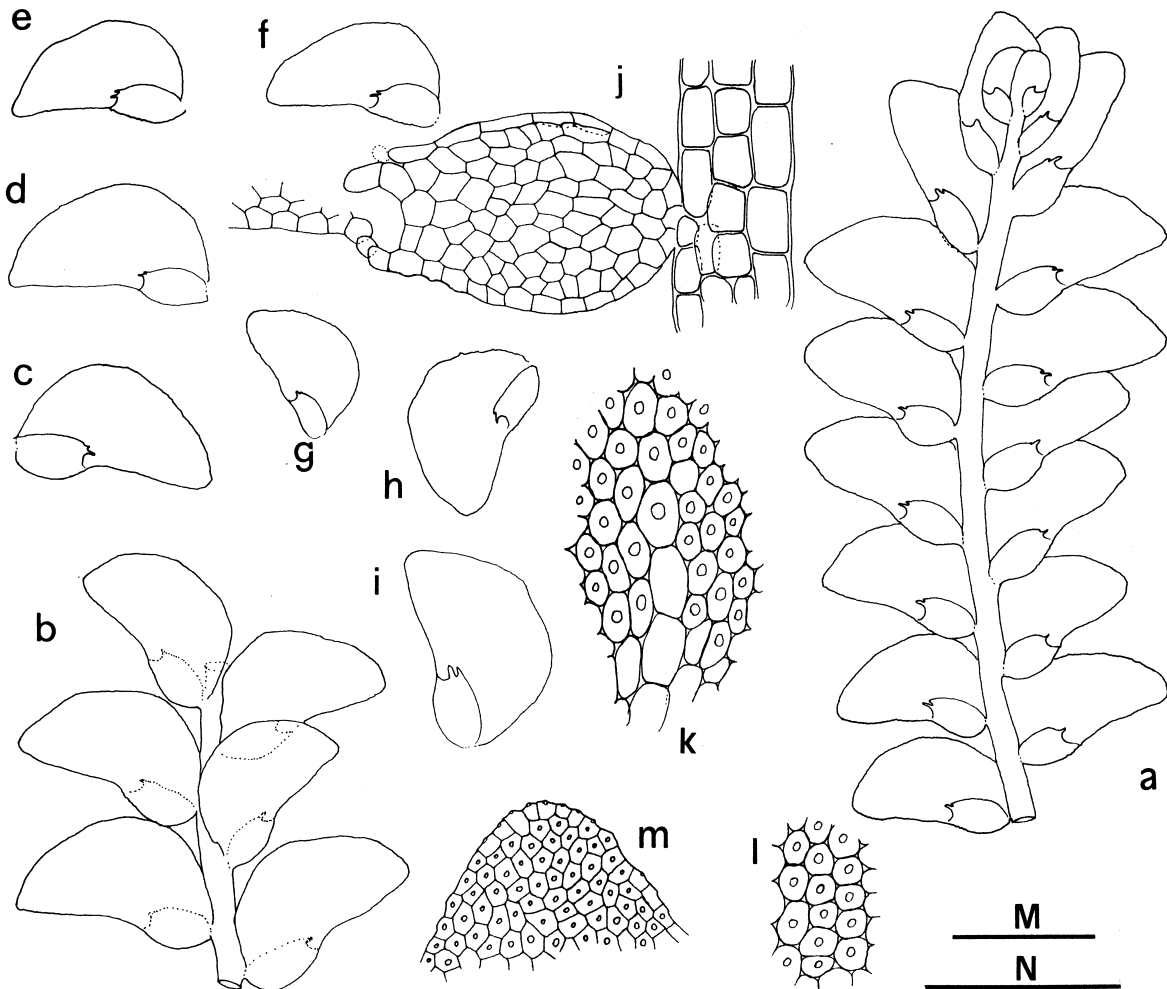
**Cololejeunea tenella** Benedix, Feddes Rept. 134: 55. 1953.—TYPE: INDONESIA. Java. G. Salak, on leaves, 800 m, *Schiffner 3328* (holotype: JE!). Figure 2

*Illustrations.* Benedix (1953): Pl. 17; Tixier (1985): p. 210, Fig. 11; Thiers (1988): p. 117, Pl. 1.

*Additional specimens examined.* CAMBODIA. Sré Ambel, epiphyllous en forêt Dégradée, *Tixier 3713-3714-3715* (FH). CHINA. FUJIAN: Wuyishan, on leaves, 900 m, *Li 06282* (HSNU, SHM); GUANGXI: Longshen, Sanmen, on tree-trunks, *Wu & Lin 824* (HSNU, IBSC); GUIZHOU: Maolan Nature Reserve, Dongyang, on tree-trunks, 660 m, *Zhu 98865* (HSNU); HAINAN: Wuzhishan, on tree-trunks, 850 m, *Li 04494* (HSNU, SHM); XIZANG: Motuo, Nanyoula, collector unknown (HSNU). YUNNAN: Daweishan Nature Reserve, epiphyllous, *Zhu 88429* (HSNU); ZHEJIANG: Baishanzu Nature Reserve, Wulingken, epiphyllous, 710 m, *Zhu 90679* (HSNU). SRI LANKA. Galle dist., epiphyllous, ca 1,500 m, *Onraedt 77.L.4723* (Herb. Onraedt). TAIWAN. NANTOU HSIEN: Chito, on bark of *Prunus* sp., 1,200 m, together with *Cheilolejeunea longiloba* (Hoffm.) Kachroo & R.M. Schust., *Yamada 14017* (HSNU, Herb. Yamada), Nantou, Chito, on leaves, 1,200 m, together with *Leptolejeunea follicola* Steph., *Yamada 14036* (HSNU, Herb. Yamada).

*Distribution.* Australia (Thiers, 1988), Cambodia, China (Anhui, Fujian, Guizhou, Hainan, new to Guangxi, Taiwan, Xizang, Yunnan, Zhejiang), Indonesia, Malaysia, Sri Lanka, Rwanda (Tixier, 1995).

*Notes.* *Cololejeunea tenella* is readily separated from other *Cololejeunea* species by its falcate leaves, ± hooked first tooth of the leaf lobule, the presence of ocellus-like basal cells in leaf lobe, and strongly papillose leaf cells. It is most closely related to *Cololejeunea dinghuiana* R.L. Zhu & Y.F. Wang which was known only



**Figure 2.** *Cololejeunea tenella* Benedix. a, Portion of plant, ventral view; b, Portion of plant, dorsal view; c–i, Leaves, ventral view; j, Leaf lobule and portion of stem, ventral view; k, Basal cells of leaf lobe; l, Median cells of leaf lobe; m, Apex of leaf lobe. e, f drawn from Schiffner 3328 from Java (holotype of *Cololejeunea tenella*); the others from Yamada 14036 from Taiwan. Line scales: M = 0.3 mm (a–i); N = 0.1 mm (j–m).

from Guangdong, China. However, the latter is readily distinguished by its reduced leaf lobules, large papillae of leaf cells, and non falcate leaves. *Cololejeunea tenella* is also similar to *C. platyneura* (Spruce) A. Evans, which differs in its small and low dorsal papillae of leaf cells, absence of ocellus-like basal cells and non-falcate leaves with a rounded apex.

The leaves from Taiwan *Cololejeunea tenella* are wider than those in the type from Java, as shown in Figure 2. Yamada et al. (1981, 1986) reported some liverworts from Chito's Experimental Forest of the National Taiwan University. Recently we re-examined some of their voucher specimens of the Lejeuneaceae, and found *Cololejeunea tenella* among two specimens, which were reported by Yamada et al. (1981, 1986) as *Cheilolejeunea longiloba* and *Leptolejeunea follicola*, respectively. *Cololejeunea tenella* is commonly found on living leaves, decaying logs, and tree-trunks in tropical and sub-

tropical regions of mainland China. It is here reported for the first time for Taiwan, bringing the total number of *Cololejeunea* species in Taiwan to 32 (Zhu and So, 1998a).

***Cololejeunea wightii*** Steph., Hedwigia 34: 253. 1895.—TYPE: MALAYA. Dulopenang, Wallich s.n. & s.d. (holotype: G-22054!). Figure 3

*Physocolea cuspidata* Steph., Spec. Hep. 5: 889. 1916.—TYPE: NEW CALEDONIA, Ile des Pins, June 1909, Le Rat s.n. (holotype: G-14991!).

*Physocolea wightii* (Steph.) Steph., Spec. Hep. 5: 909. 1916.

*Cololejeunea cuspidata* (Steph.) R.M. Schust., J. Hattori Bot. Lab. 26: 241. 1963.

*Illustrations.* Miller et al. (1963): Pl. 21; Miller (1968): p. 254, Fig. 37; Tixier (1979): p. 759, Fig. 20 as

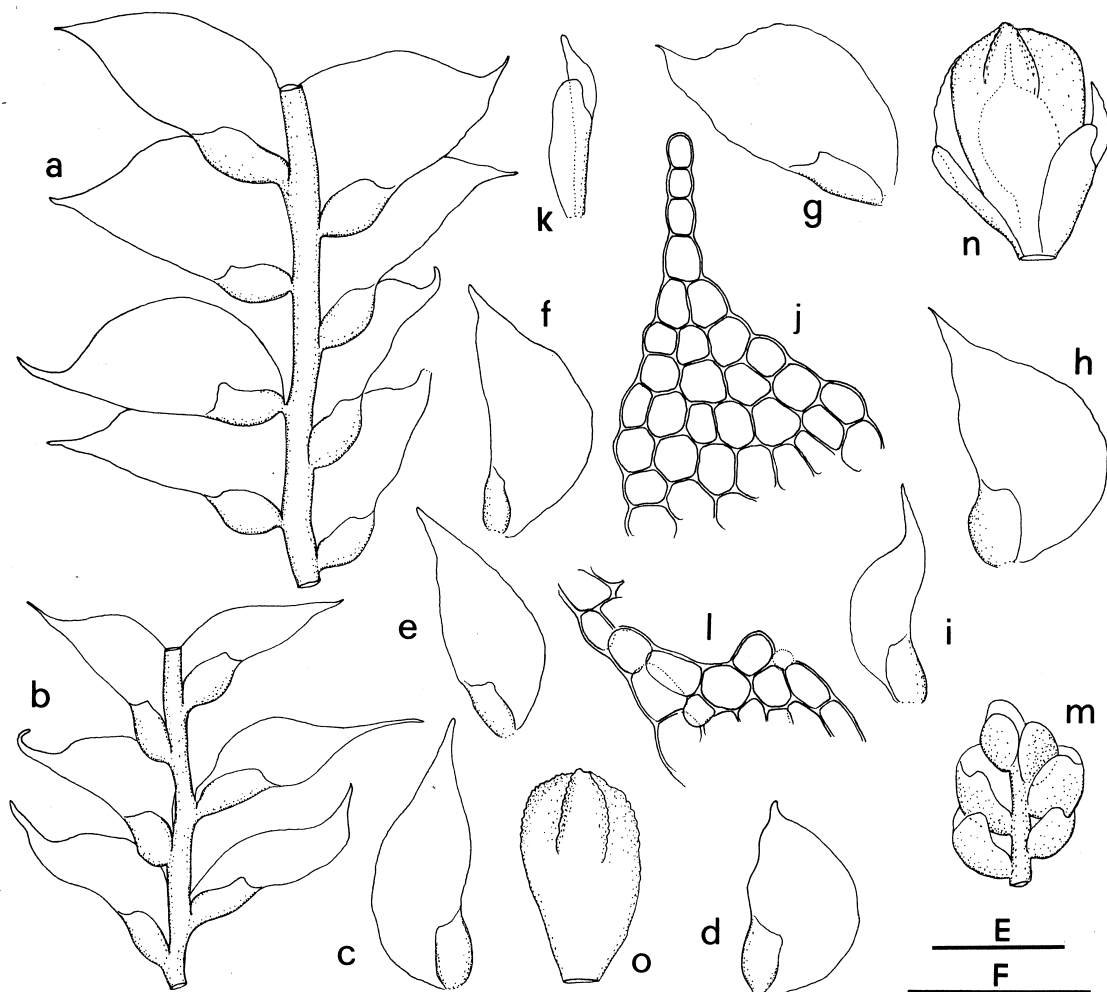
*Cololejeunea cuspidata* Steph.; Tixier (1985): p. 249, Fig. 31 as *C. wightii*, p. 250, Fig. 32 as *C. cuspidata*; Thiers (1988): p. 136, Pl. 9.

*Additional specimens examined.* CHINA. GUANGXI: Shangsi, Hongqilinchang, *Gao 1819* (HSNU, IFP); HAINAN: Jianfengling, *Chen et al. 57* (HSNU, IBSC-05046). TONGA. Tafahi, between the village of Tafahi and the landing place Faihavanui, on dead tree in secondary forest, 100 m, mixed with *Lejeunea anisophylla* Mont., *Hürlimann T 955a* (HSNU, Herb. Hürlimann).

*Distribution.* Pantropical.

*Notes.* As noted by Kitagawa (1972) and Thiers (1988), *Cololejeunea wightii* is easily recognized by the ovate leaves with long acuminate apices, the flat, indistinct first tooth, the  $\pm$  crenulate leaf margins, and the smooth leaf surface. It resembles *Cololejeunea acuminata* Mizut., *C. drepanolejeuneoides* (Horik.) R.

M. Schust. and *C. salgadoi* Onr. These four species are characterized by the ovate leaves with an acuminate apex and  $\pm$  crenulate leaf margins. As mentioned by Mizutani (1970), *Cololejeunea acuminata* is readily separated from the other *Cololejeunea* species by its roughened dorsal leaf face. *Cololejeunea drepanolejeuneoides* is recognized by its 2-celled,  $\pm$  curved first tooth, the compressed perianths with 2 wing-shaped lateral keels, and the absence of innovation. The differences between *Cololejeunea wightii* and the Philippine *C. salgadoi* lie in the morphology of the leaf lobule apex. In *Cololejeunea wightii* the second tooth is reduced, and the hyaline papilla is at the proximal side of first tooth. However, in *Cololejeunea salgadoi* the second tooth is distinct, and hyaline papilla is on the inner surface of the base of first tooth. Though Kitagawa (1972) regarded *Cololejeunea wightii* and *C. cuspidata* (Steph.) R.M. Schust. as conspecific, Tixier (1979, 1985) regarded



**Figure 3.** *Cololejeunea wightii* Steph. a–b, Portions of plant, ventral view; c–i, Leaves, ventral view; j, Apex of leaf lobe; k, Female bract, ventral view; l, Apex of leaf lobule; m, Male inflorescence, ventral view; n, Female inflorescence, ventral view; o, Perianth, ventral view. a–b, g–n from *Chen et al. 57* from Hainan; c from *Wallich s.n. & s.d.* (G-22054, holotype of *Cololejeunea wightii* Steph.) from Malaya; d from *Gao 1819* from Guangxi; e from *Le Rat s.n.* (G-14991, holotype of *Cololejeunea cuspidata* Steph.) from New Caledonia; f, o from *Hürlimann T 955a* from Tonga. Line scales: E = 0.3 mm (a–i, k, m–o); F = 0.1 mm (j, l).

them as separate species, based on the size of leaf lobule. Our observations show no distinct differences between them. Although leaf lobules in *Cololejeunea cuspidata* are sometimes relatively small, they are also quite variable in size in *C. wightii* (Figure 3: c–i). *Cololejeunea cuspidata* is here treated as a synonym of *C. wightii* following Kitagawa (1972). In the Chinese specimens examined, the keels of perianth are usually smooth, rarely slightly mammillose (Figure 3: n). But they are usually distinctly mammillose in several specimens from Tonga and New Caledonia (Figure 3: o). The hyaline papilla is always at the proximal side of the first tooth of leaf lobule in all material examined by us. It is, however, on the inner surface of the first tooth (distal tooth) in Australian material, based on Thiers' (1988) observation. Trigones are very variable in Chinese materials of *Cololejeunea wightii*. In most cases they are not distinct, but sometimes moderately large. Chinese material examined by us is totally autoecious.

Although *Cololejeunea wightii* has been known from Africa (Kis and Pócs, 1997, as *C. cuspidata*), Australia (Grolle, 1982; Thiers, 1988), Cambodia, Malaysia, Thailand (Tixier, 1985), Melanesia (Kitagawa, 1972; Grolle and Piippo, 1984), Micronesia (Miller et al., 1963), and New Caledonia, it is reported for the first time for China. In China it grows on tree-trunks and decaying logs, and it seems to be rare; only two specimens cited above were available for our study.

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## 中國和越南疣鱗苔屬（苔綱，細鱗苔科）新記錄植物

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稀少知道的不丹疣鱗苔(新擬) *Cololejeunea bhutanica* Grolle & Mizut. 和錫蘭疣鱗苔(新擬) *Cololejeunea ceylanica* Onr. 原分別分布於不丹和斯里蘭卡，最近我們發現它們各自分布在廣西和西藏。以前僅日本有報導的堀川疣鱗苔(新擬) *Cololejeunea horikawana* (S. Hatt.) Mizut. 亦分布於雲南。堀川疣鱗苔與單體疣鱗苔 *Cololejeunea goebelii* (Gottsche ex Schiffn.) Schiffn. 相似，但副體的大小和透明疣的位置不同。泛熱帶分布的魏氏疣鱗苔(新擬) *Cololejeunea wightii* Steph. 亦發現分布在廣西和海南。南亞疣鱗苔 *Cololejeunea tenella* Benedix 為台灣新記錄種。依據鐮刀狀的葉子，或多或少<sup>2a</sup>狀的中齒以及油胞狀葉基部細胞的存在，南亞疣鱗苔易與其它台灣產的疣鱗苔屬植物區分。原分布於印度，中國西藏及海南的擬斜葉疣鱗苔 *Cololejeunea pseudoplagiophylla* P.C. Wu & J.S. Lou 為越南新記錄植物。本文也提供不丹疣鱗苔，南亞疣鱗苔和魏氏疣鱗苔的詳盡圖解。

**關鍵詞：**中國；疣鱗苔屬；分布；葉附生苔類植物；細鱗苔科；新記錄種；台灣；分類；越南。