

Two epiphyllous liverworts, *Cololejeunea dozyana* (Sande Lac.) Schiffn. and *Cololejeunea sigmoidea* Jovet-Ast & Tixier (Hepaticae, Lejeuneaceae), new to Taiwan

Rui-Liang Zhu¹ and May Ling So

Biology Department, Hong Kong Baptist University, 224 Waterloo Road, Hong Kong, China

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Abstract. Two epiphyllous species of the genus *Cololejeunea* (Hepaticae, Lejeuneaceae), *C. dozyana* (Sande Lac.) Schiffn. and *C. sigmoidea* Jovet-Ast & Tixier, are reported for the first time from Taiwan. *Cololejeunea dozyana* is related to *C. macounii* (Spruce ex Underw.) A. Evans, whereas *C. sigmoidea* is similar to *C. formosana* Mizut. and *C. rotundilobula* (Wu & Lin) Piippo. A distribution map of *C. dozyana* and *C. sigmoidea* and distinctions from related species are provided. Descriptions and illustrations of the two species based on local specimens are also presented.

Keywords: *Cololejeunea dozyana*; *Cololejeunea sigmoidea*; Epiphyllous liverworts; Hepaticae; Lejeuneaceae; Taiwan.

Introduction

Cololejeunea has been variously treated by different authors. Spruce (1884–1885), Evans (1911), Stephani (1912–1917), Zwickel (1933), Horikawa (1936), Hattori (1947), Jones (1953a, b, 1954), Chen and Wu (1964), and Tixier (1974) separated such genera as *Leptocolea* (Spruce) A. Evans, *Physocolea* (Spruce) Steph., *Taeniolejeunea* Zwickel, *Pedinolejeunea* (Benedix ex Mizut.) Chen et Wu, *Boninoleptocolea* Horik., *Campylolejeunea* S. Hatt. and *Jovetastella* Tixier. Now these equivalent genera of this genus have been reduced to a subgeneric or even lower level under *Cololejeunea* (Spruce) Schiffn. (Benedix, 1953; Grolle, 1983; Mizutani, 1961; Schuster, 1980). Here we follow Schuster's (1963, 1980) classification of this genus. The genus *Cololejeunea* is well characterized and easily recognized by 1) the cross-section of stem with five cortical cells and one medullary cell, 2) the absence of underleaves, 3) the very narrow insertion of leaf lobule to stem, 4) usually with two teeth at apex of leaf lobule, and 5) the presence of discoid gemmae in most species.

Cololejeunea is a large hepatic genus of subtropical and tropical regions, where most species of this genus are epiphyllous. Pócs (1996) reported 389 epiphyllous species in the whole genus. It is also the largest genus of epiphyllous liverworts in China. Scattered reports of the *Cololejeunea* flora in Taiwan have been made during the past 60 years, notably by Chen and Wu (1964), Herzog and Noguchi (1955), Horikawa (1931, 1932, 1934, 1955), Kuo and Chiang (1988), Mizutani (1961), Piippo (1990), and Zhu (1995). Twenty nine species of *Cololejeunea* have

been reported from Taiwan (Piippo, 1990), which is also the type locality of 6 *Cololejeunea* species, including *C. formosana* Mizut., *C. magnilobula* (Horik.) S. Hatt., *C. ocellata* (Horik.) Benedix, *C. ocelloides* (Horik.) Mizut., *C. pseudofloccosa* (Horik.) Benedix and *C. schwabei* Herzog. During our studies on Chinese *Cololejeunea*, we found *C. dozyana* (Sande Lac.) Schiffn. and *C. sigmoidea* Jovet-Ast & Tixier from the epiphyllous specimens deposited in the herbarium of Hiroshima University (HIRO). These two species are new to Taiwan, bringing the total number of *Cololejeunea* species in Taiwan to 31.

1. *Cololejeunea dozyana* (Sande Lac.) Schiffn., Hedwigia 39: 199. 1900. (Figure 1)

Lejeunea dozyana Sande Lac., Syn. Hep. Java.: 63. 1856.

Physocolea dozyana (Sande Lac.) Steph., Spec. Hep. 5: 891. 1916.

Autoicous. Plants ± delicate, pale yellow in dried condition. Stems 3–8 mm long, 0.056–0.08 mm in diameter, 1.2–1.54 mm wide with leaves, irregularly branched, transverse section of stem 3 cells in diameter, cortical cells 5, medullary cell 1. Ventral merophyte of the stem one cell wide. Rhizoids numerous, fasciculate. Leaf lobes imbricate to contiguous, spreading at an angle of about 45°–60°, obovate, ± falcate, 0.62–0.85 mm long, 0.43–0.65 mm wide, usually widely rounded at apex; margin entire, usually with 1–5 minute teeth; marginal cells subquadrate, 4.5–8 × 7–12 μm; median cells hexagonal, 18–30 × 15–20 μm, thin-walled, trigones large, intermediate thickenings distinct; basal cells oblong, 32–40 × 10–17 μm; papillae short-cylindrical, 5–8 μm in diameter, 4–7 μm high, 1 per cell of leaf lobe, absent in basal part of leaf lobe; ocelli absent. Leaf lobules large, oblong, 1/2–2/3 as long as the lobe, usually slightly inflated, free lateral margin usually

¹Corresponding author. Fax: 852-23361400; E-mail: c6402830@hkbu.edu.hk

slightly inrolled, apex obliquely truncate, with 2 teeth, the second tooth triangular, (1-) 2-3 cells long and 1-2 cells wide at base, more or less curved toward the keel, the first tooth 2-celled, with the terminal cell usually large and roundate; hyaline papilla subspherical roundate, ca. $20 \times 13 \mu\text{m}$, on the inner surface of leaf lobule at base of first tooth; keel slightly arched and smooth. Stylus unicellular, $28-32 \mu\text{m}$ long and $10-32 \mu\text{m}$ wide. Underleaves absent.

Gemmae not seen. Androecium on lateral short branch, bracts 3 pairs. Gynoecium terminal on short branch, always with 1 innovation; bract lobes long-obovate, ca. $1/2-3/4$ as long as perianth, $0.7-0.83 \text{ mm}$ long, $0.32-0.4 \text{ mm}$ wide, apex rounded, margin entire to slightly dentate; bract lobules $1/2-2/3$ as long as the lobe, oblong, margin entire, sometimes with a tooth at apex, keel $3/4-4/5$ as long as bract lobule; bracteoles absent; perianth obovate, ca. 0.75

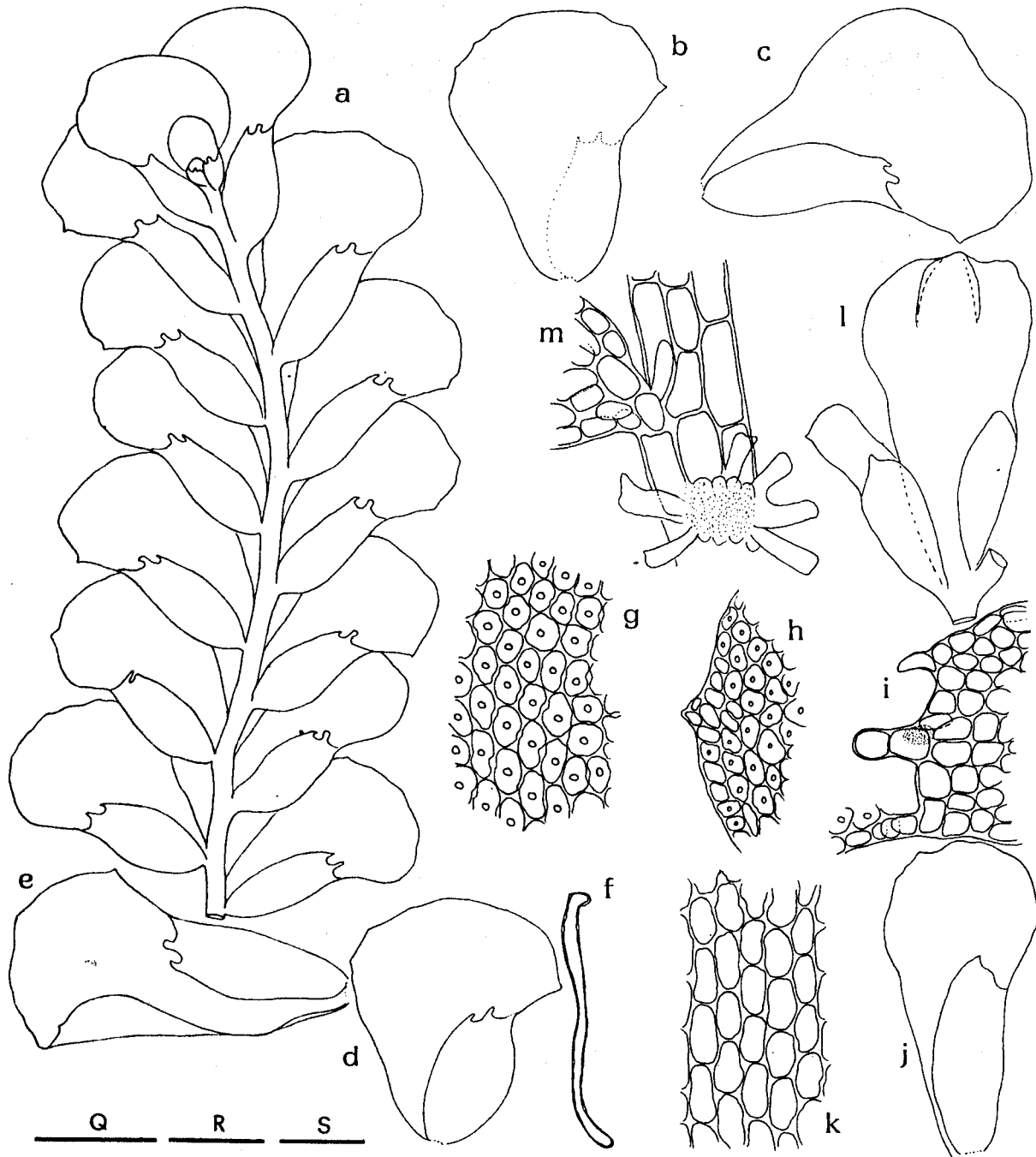


Figure 1. *Cololejeunea dozyana* (Sande Lac.) Schiffn. a: Plant, ventral view; b-e: Leaves; f: Elater; g: Median cells of leaf lobe; h: Marginal cells of leaf lobe; i: Apex of leaf lobule; j: Female bract, ventral view; k: Basal cells of leaf lobe; l: Female inflorescence, ventral view; m: Portion of stem showing stylus and insertion of leaf lobule on stem. Line scales: Q = 0.3 mm (b-e, j, l), R = 0.3 mm (a), S = 0.05 mm (f-i, k, m). All drawn from *Horikawa 10766* (HIRO).

mm long and 0.4 mm wide, 5-keeled, surface nearly smooth, beak short, 1 cell high; elaters linear, nearly hyaline, ca. 160 μm long and 7–8 μm wide, walls \pm sinuately thickened; spores not seen.

Specimens examined. **TAIWAN.** Taito, between Shinsuiei and Shucho-kyoukai, *Horikawa 10766* (HIRO); Taito, Mt. Chipon, Kiri-yama, Chipon-san, 1932, *Horikawa 10431* (HIRO).

Distribution. *Cololejeunea dozyana* was known from Borneo (Benedix, 1953; Menzel, 1988; Mizutani, 1977), Java (type locality, Benedix, 1953; Sande Lacoste, 1856; Mizutani, 1977; Tixier, 1985), Malaysia (Benedix, 1953; Mizutani, 1977; Tixier, 1985), Seram Island (Mizutani, 1986), Sumatra (Benedix, 1953; Mizutani, 1977), West Irian (Grolle and Piippo, 1984), Philippines (Mizutani, 1977; Tan and Engel, 1986; Tixier, 1985).

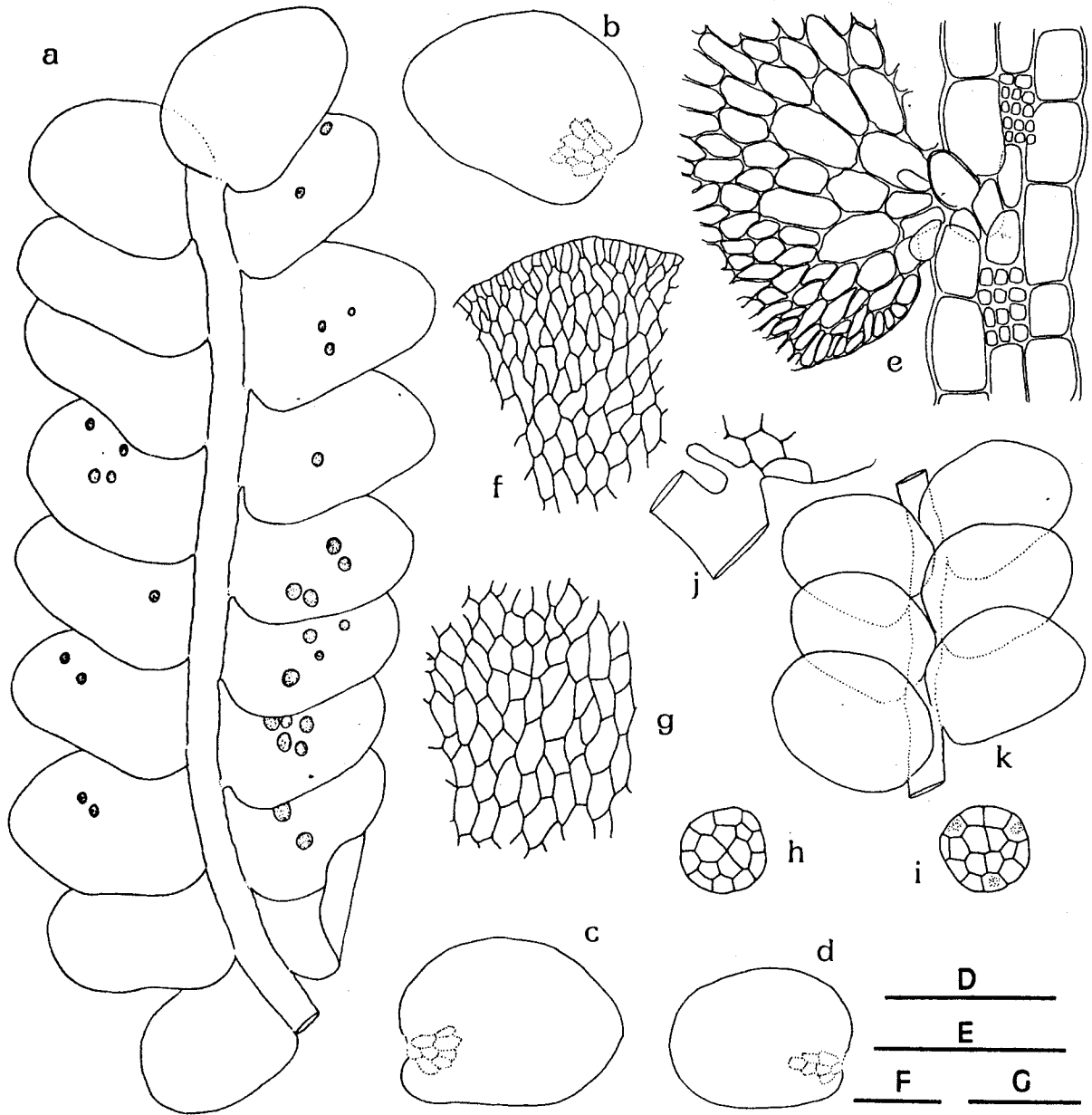


Figure 2. *Cololejeunea sigmoidea* Jovet-Ast & Tixier. a: Plant, ventral view; b–d: Leaves; e: Portion of stem and basal cells of leaf lobe; f: Marginal cells of leaf apex; g: Median cells of leaf lobe; h, i: Gemmae; j: Portion of young branch showing stylus, ventral view; k: Portion of plant, dorsal view. Line scales: D = 0.1 mm (e–g), E = 0.1 mm (h–j), F = 0.2 mm (a, k), G = 0.2 mm (b–d). All drawn from Herb. Horikawa no. 6202 (HIRO).

Notes. The important features of *Cololejeunea dozyana* are 1) ocelli absent, 2) leaf lobe long-obovate, entire or usually with 0–5 minute teeth, 3) perianth nearly smooth, with a very short beak, 4) short cylindrical dorsal protrusions of leaf cells only present in the upper half of leaf lobe, 5) median tooth more or less hammer-shaped median tooth of leaf lobule, 6) leaf lobule large, 1/2–3/4 as long as the leaf lobe, and 7) keel of leaf lobule smooth. *Cololejeunea dozyana* is somewhat similar to *C. macounii* (Spruce ex Underw.) A. Evans. However, *C. dozyana* has nearly smooth perianths; long obovate leaf lobes; and leaf margin entire to serrulate, never crenulate as in *C. macounii* because of papillae of marginal cells. *Cololejeunea dozyana* belongs to the subgenus *Cololejeunea* due to the absence of ocelli and the presence of papillae in the median cells of leaf lobe.

Cololejeunea dozyana is often loosely appressed on the surface of living leaves. Only two specimens were seen in Y. Horikawa's collection from Taiwan in the 1930's. The previously known northernmost locality for this species is the Philippines. Now Taiwan is the northernmost locality of this species, as shown in Figure 3.

2. *Cololejeunea sigmoidea* Jovet-Ast & Tixier, Rev. Bryol. Lichenol. 31: 27. 1962. (Figure 2)

Plants rather delicate, nearly hyaline in dried condition, strongly appressed on living leaves. Stems 2–5 mm long, 0.064–0.088 mm in diameter, 0.5–0.9 (-1) mm wide with leaves, scarcely branched, transverse section of stem 3 cells in diameter, cortical cells 5, medullary cell 1. Ventral merophyte of stem one cell wide. Rhizoids numerous, fasciculate, nearly hyaline. Leaf lobes imbricate, flat, spreading at an angle of about 50°–75°, ovate, 0.32–0.46 mm long and 0.24–0.38 mm wide, rounded at apex, margin entire; marginal cells linear-flexuous, 8–18 × 3–5 μm; median cells rhombic to rectangular, 19–37 × 6–16 μm, walls thin, trigones indistinct, intermediate thickenings

usually absent, rarely minute; basal cells rectangular, 32–54 × 16–32 μm, trigones distinct; cuticle smooth; ocelli absent. Leaf lobules strongly reduced, usually 1-celled. Stylus unicellular, hyaline, 22–30 μm long and 6–10 μm wide. Underleaves absent. Gemmae numerous, discoid, 16-celled, on ventral surface of leaf lobe, rhizoid-initial cells 3. Sexual reproductive organs not seen.

Specimen examined. **TAIWAN.** Taihoku, Urai, A. Noguchi, July 1928, Herb Horikawa no. 6202 (HIRO).

Distribution. *Cololejeunea sigmoidea* was reported from Borneo (Tixier, 1970, 1971; Mizutani, 1966, 1970; Menzel, 1988), Cambodia (Tixier, 1970), French Guiana (Tixier, 1980, 1989), India (Udar et al., 1987), Java (Tixier, 1970), Ryukyu (Mizutani, 1978), Thailand (Tixier, 1971) and Vietnam (type locality, Jovet-Ast and Tixier, 1962).

Notes. *Cololejeunea sigmoidea* is characterized by the presence of linear-flexuose marginal cells of leaf lobe and extremely reduced leaf lobule which is almost absent or only unicellular. It is closely related to *Cololejeunea rotundilobula* (Wu & Lin) Pippo, which is endemic to mainland China, both having linear-flexuose marginal cells of leaf lobe. However, *C. rotundilobula* is separated from *C. sigmoidea* by its asymmetric broadly ovate leaf lobes which are somewhat wider than long, and the presence of large and orbicular leaf lobules. Moreover, the keels of leaf lobes are strongly arched in *C. rotundilobula*, but slightly arched or straight in the latter. Based on Schuster's (1963) classification, *C. sigmoidea* and *C. formosana* Mizut. clearly belong to the subgenus *Chlorocolea* R.M. Schust. because of the presence of peculiar sigmoid cells at the distal portion of leaves. The two species were placed in the subgenus *Pedinolejeunea* Benedix ex Mizut. by Tixier (1985).

In Taiwan, *Cololejeunea sigmoidea* was found within the type specimen of *C. formosana*. Although the two species are present on the surface of the same leaf, *C.*

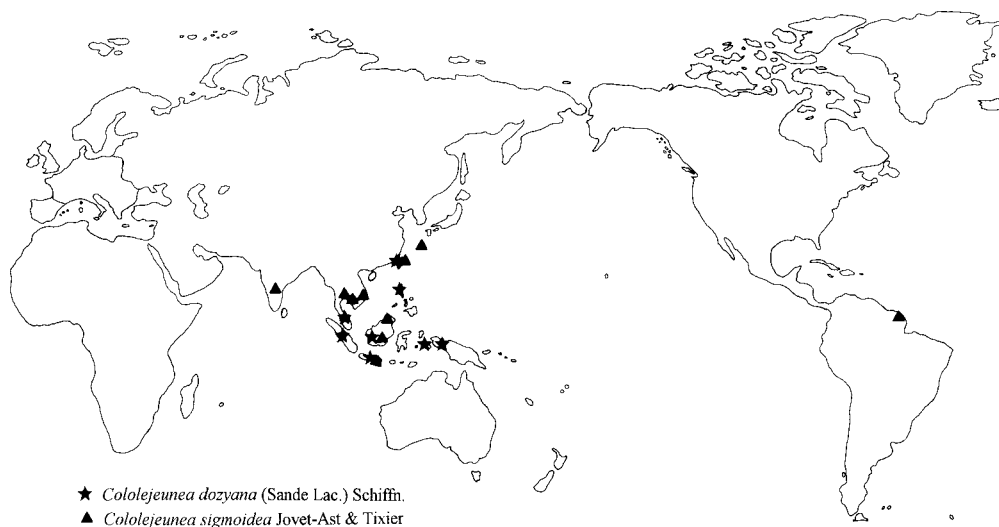


Figure 3. Distribution of *Cololejeunea dozyana* (Sande Lac.) Schiffn. and *C. sigmoidea* Jovet-Ast & Tixier.

sigmoidea can be distinguished from *C. formosana* by the nearly hyaline plants, smaller size, symmetric leaf lobes, and extremely reduced leaf lobules. According to our observation, Taiwan material of *C. sigmoidea* agrees well with that outside Taiwan. *Cololejeunea sigmoidea* is an obligately epiphyllous liverwort. It bears many adaptations to epiphyllous such as strongly flattened perianths, numerous rhizoids in tufts, thin stems, and rich gemmae. Sexual reproductive organs are very rare in this species. It is interesting to note the very disjunctive distribution of *C. sigmoidea* (Figure 3). Only a single record from French Guiana, South America, is available.

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