

# Range extension and description for the rare *Cheilolejeunea chenii* (Lejeuneaceae, Marchantiophyta), with reference to the *Cyrtolejeunea* clade

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Among the 24 members of *Cheilolejeunea* recognized in China (Zhu *et al.*, 2002; Ye & Zhu, 2010; He & Zhu, 2011), *Cheilolejeunea chenii* R.L.Zhu & M.L.So is one

of the most mysterious and interesting, not only because it is known to be endemic to China, but also for the remarkably few samples that have been collected. *Cheilolejeunea chenii* was reported based on two sterile epiphyllous herbarium specimens from Fujian, China (Chen & Wu, 1964). It is well distinguished from other *Cheilolejeunea* species by its very long and unicellular lobule tooth, obliquely spreading spatulate leaves, and small underleaves with apex varied from very shortly bifid to emarginate (Zhu *et al.*, 1999). Meanwhile, however, no fertile material was available for *C. chenii*, leaving the specific circumscription incomplete. Moreover, the type of oil body for this species was also unknown. Our revision on the genus *Cheilolejeunea* led us to a specimen of *C. chenii* from Yunnan with both female and male plants, and during a field survey to northern Thailand in December 2011, a fresh sample of *C. chenii* was also found. Finally, this gave us the chance to examine the oil bodies of *C. chenii* and to reveal the completed definition of this poorly known species.

***Cheilolejeunea chenii*** R.L.Zhu & M.L.So, Taxon 48: 663. 1999 (Figures 1 and 2).

≡ *Neurolejeunea fukiensis* P.C.Chen & P.C.Wu, Acta Phytotax. Sin. 9: 227. 1964 [non *Cheilolejeunea fukiensis* (P.C.Chen & P.C.Wu) Piippo, J. Hattori Bot. Lab. 68: 133. 1990]. Type: China, Fujian, Wu-Yi Shan, on leaves of *Symplocos*, 19 April 1955, P.C. Chen & *al.* 840 (holotype: PE).

**Autoicous.** Plants delicate, becoming yellowish brown in herbarium material, 5–9 mm long. Shoots 0.3–0.7 mm wide, seldom irregularly branched, branching of the *Lejeunea*-type, leaf sequence of vegetative branches lejeuneoid. Stem 44–78 µm in diameter, in transverse section with 7 cortical cells and 5 medullary ones; ventral merophytes 2 cells wide. Rhizoids at base of underleaves, few or numerous, usually hyaline, rhizoid disc absent. Leaves remote, sometimes contiguous or slightly imbricate, diverging from stem at an angle of *ca* 45°(–55°), weakly interlocking dorsally; leaf lobe ovate-spatulate, asymmetric, slightly falcate, 0.25–0.41 mm long, 0.16–0.20 mm wide, apex mostly broadly rounded, rarely obtuse, usually incurved, margin entire, dorsal margin usually arched at middle, the ventral margin straight or slightly arched; leaf lobule triangular to ovate-oblong, strongly inflated,  $\frac{1}{2}$ – $\frac{3}{5}$  (– $\frac{2}{3}$ ) as long as the lobe, lateral free margin flattened, bordered by 4(–5) rectangular marginal cells, apex connected to the leaf lobe by only a single cell, strongly constricted, with 2 teeth, first tooth obsolete, second tooth 1 cell long, spinose, slightly curved toward the apex of the leaf, keel straight to arched, hyaline papilla spherical, *ca* 6.5 µm in diameter, situated on the distal side of second tooth. Cells of leaf lobe moderately thick-walled with small to

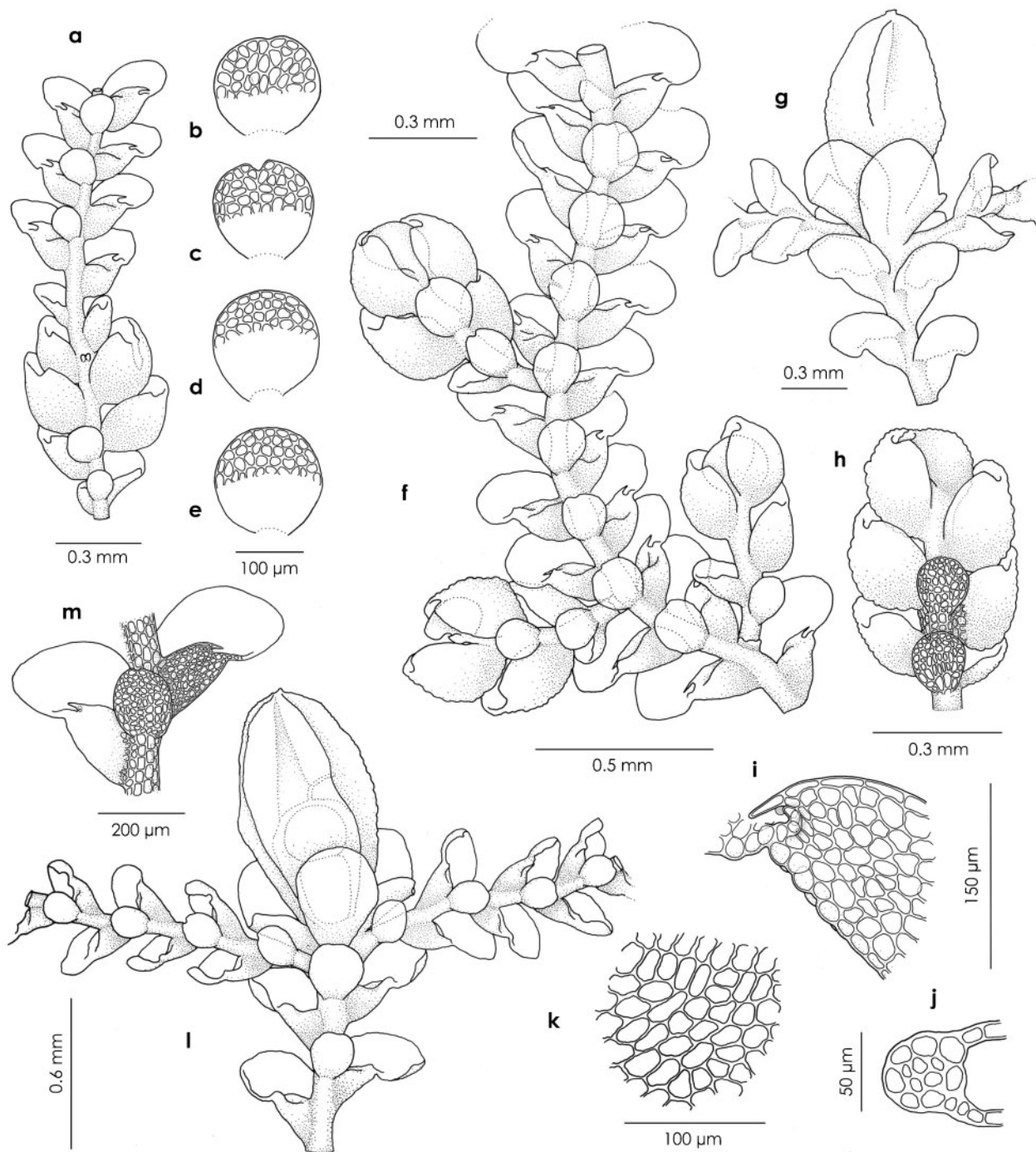
median trigones, intermediate thickenings absent or sometimes slightly developed, at margin quadrate to rectangular, 7.2–14.4 × 12–26.4 µm, in middle hexagonal to rectangular, 8.4–16.8 × 12–28.8 µm, near base similar to median ones in shape, 14.4–25.6 × 16.8–28.8 µm. *Vitta* and *ocelli* absent. *Oil bodies* of the *Jungermannia*-type, 2–4 per median cell of leaf lobe, mostly ellipsoid to subglobose, 4.0–21.0 × 1.8–4.2 µm, finely segmented, forming small granules at the surface. *Underleaves* distant, transversely inserted, usually very shallowly bifid to emarginate, sometimes entire, orbicular, 0.10–0.14 mm long, 0.11–0.13 mm wide, 1.5–2 times as wide as stem, margins entire. *Gemmae* absent.

**Androecia** intercalary on main branches, or terminal on very short lateral branches, bracts in 2–3 pairs, hypostatic, strongly concave and inflated, shortly and sub-equally bifid, lobe 0.22–0.30 mm long, 0.13–0.19 mm wide, apex rounded or rounded-obtuse, lobule similar, but slightly shorter, antheridia 2 per bract, bracteoles 1–2, present only at the base of the androecium, similar to ordinary underleaves. **Gynoecea** on main stems, almost always with 2 innovations, leaf sequence of innovation pycnolejeuneoid; bracts shortly and unequally bifid, lobe orbicular, 0.25–0.54 mm long, 0.18–0.33 mm wide at middle, margin entire, ventral margin somewhat incurved, apex mostly obtuse, lobule oblong, *ca*  $\frac{3}{4}$  as long as bract lobe, apex obtuse, keel almost straight; bracteole free or nearly so, suborbicular to orbicular, somewhat convex postically, 0.32–0.46 mm long, 0.34–0.59 mm wide, margin entire. **Perianth** exerted, obovoid, 0.75–0.98 mm long, 0.45–0.58 mm wide, inflated, rounded at apex, with 5 obtuse keels (2 lateral keels, 1 dorsal one, and 2 ventral ones) in upper  $\frac{3}{4}$  portion, keels and rest of surface of perianth usually weakly mammillose, beak short, 2–3 cells high, cells subquadrate. Mature sporophyte not observed, asexual reproductive organs not seen.

**Habitat:** on living leaves or on tree trunks, and sometimes growing on rocks.

**Distribution:** China (Fujian, Taiwan, and Yunnan) and new to Thailand.

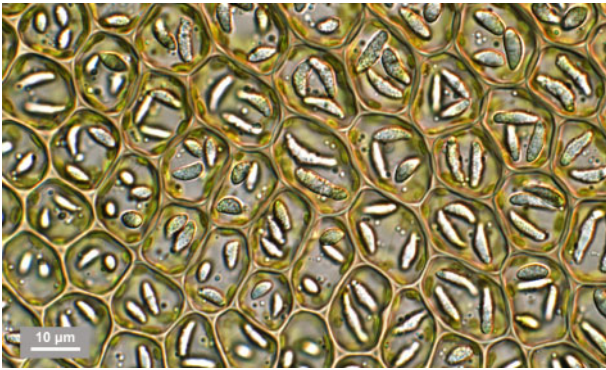
**Specimens examined:** China. Taiwan, Xinzhu Co., Yuanyanghu Nature Reserve, 1679 m, epiphyllous, 19 October 1998, T. Cao & Q. Gao 980783 (HSNU); Yunnan, Gongshan County, Dulong Xiang, west slope of Gaoligong Shan, Irrawadi catchment, Qiqi trail above San Dui between Shu Gung Qiao (Stone Arch Bridge) and Xishaofang, 27°42′45.1″N, 98°25′38.1″E, large ravine at margin of *Tsugal Rhododendron* forest with mossy rock outcrops and scrub on banks, on mossy rock slab on cliff. alt. *ca.* 2767 m, 30 October 2004, D.G. Long 33756 (E, HSNU). Thailand. Chiang Mai Province, Doi Luang Chiang Dao, 19°39′247″N, 99°98′034″ E, on tree trunk, 2010 m, 19 December 2011, R.-L. Zhu 20111219-21A (HSNU).



**Figure 1** *Cheilolejeunea chenii* R.L.Zhu & M.L.So. (a) Intercalary androecium, ventral view. (b–e) Underleaves. (f) Portion of plant, with terminal androecia, ventral view. (g) Gynoecium with two innovations, dorsal view. (h) Androecium, ventral view. (i) Lobule, ventral view. (j) Transverse section of stem. (k) Median cells. (l) Gynoecium with two innovations, ventral view. (m) Portion of stem showing underleaf and leaves. All drawn from *D.G. Long 33756*.

As a species previously known only from around the Tropic of Cancer and considered endemic to China, the discovery of *Cheilolejeunea chenii* from Gaoligong Shan, Yunnan proclaims its existence in the Sino-Himalayan region, which is one of the richest and most diversified hotspots in the world for bryophytes. At the same time, it marks the highest known altitudinal occurrence of *C. chenii* at 2767 m. The national new record in Thailand, on the other hand, represented the southernmost locality of this species. Although only a single collection of *C. chenii* in Northern Thailand was

available, the recent discovery of new species and new records of bryophytes from northern Thailand (He *et al.*, 2012) reveal that northern Thailand is an important area for bryophyte diversity investigation. More localities of *C. chenii* are expected to be found there. Judging from the current distribution pattern of *C. chenii*, the potential occurrence of it in other countries of Indochina is highly likely. The Sino-Himalaya, although relatively well investigated for liverworts (Zhu & Long, 2003), still deserve more intensive study.



**Figure 2** Median cells from lateral leaf of *Cheilolejeunea chenii*, showing the *Jungermannia*-type oil bodies (taken from R.-L. Zhu 20111219-21A).

*Cheilolejeunea chenii* resembles the neotropical *C. holostipa* (Spruce) Grolle & R.L.Zhu and *C. insecta* Grolle & Gradst., both formerly placed within *Cyrtolejeunea* (= *Cheilolejeunea*) (Grolle *et al.*, 2002), on account of the short-bifid small underleaves, the spinose unicellular lobule tooth, and the *Jungermannia*-type oil bodies. Morphologically *Cheilolejeunea holostipa* can be separated from *C. chenii* by its dioicous condition, and by having entire underleaves except for those serving as female bracteoles. *Cheilolejeunea insecta* differs from *C. chenii* mainly by being dioicous, and having male bracteoles borne throughout the androecium. The Asian *Cheilolejeunea obtusifolia* (Steph.) S.Hatt. is also very similar to *C. chenii*, but differs in its strongly squarrose, asymmetrically ovate leaf lobes, strongly incurved free lateral margin of the leaf lobule, shortly bilobed underleaves (Zhu *et al.*, 1999), and male bracteoles present along the entire androecium.

The recent discovery of *Cheilolejeunea ulugurica* Malombe, Eb.Fisch. & Pócs, a species known only from Tanzania, gave the first record of a *Cyrtolejeunea*-like species in Africa. As stated in the original paper, *Cheilolejeunea ulugurica* is closest to *C. chenii*, but differs from the latter mainly by 'having a longer and narrower lobule, which forms a narrow sinus with postical lobe margin. Also the free margin of the lobule is flat, bordered by about 10 elongated cells (7–8 in *C. chenii*). The truncate lobule apex is only 2–3 cells wide (6–8 cells wide in *C. chenii*). The inner base of lobule forms a conspicuous fold (which can be mistaken to a vitta) running diagonally towards the apex almost to join the keel' (Malombe *et al.*, 2010). Our examination of the type specimens of *Cheilolejeunea ulugurica* revealed that its lobule apex is consistently 4–5 cells wide, with the first two cells that sit next to the apical tooth significantly longer and larger than the others. The number of bordering cells of the lobule varies in *Cheilolejeunea chenii* from 4 (Yunnan material) to 7–8 (Taiwan material). The same type of inflated lobule also appears in *C. chenii* (Fig. 2, Zhu

*et al.*, 1999, Fig. 1). Unfortunately, the sole collection of *Cheilolejeunea ulugurica* does not contain fertile shoots and there is no oil body data. Furthermore, only several pairs of leaves are presented in the holotype, which thus makes study of the variation among gametophytes impossible. Owing to the state of the type material, we suggest that until further collections are available, the possibility that *C. ulugurica* is conspecific with *C. chenii* cannot be totally ruled out.

*Cheilolejeunea chenii*, together with *C. obtusifolia*, were placed within subg. *Cheilolejeunea* (Zhu *et al.*, 2002). In spite of the fact that the type of oil bodies would suggest *Cyrtolejeunea* to be a separate section (or subgenus) of *Cheilolejeunea*, Grolle *et al.* (2002) were reluctant to clearly state to which subgenus *C. holostipa* and *C. insecta* belong. Molecular phylogenetic studies placed *Cheilolejeunea chenii*, *C. holostipa*, *C. insecta*, and *C. obtusifolia* within a well supported clade, but their systematic relationship with subg. *Cheilolejeunea* is not completely resolved (Ye *et al.*, unpublished data). Therefore, *Cheilolejeunea chenii*, *C. holostipa*, *C. insecta*, *C. obtusifolia*, and *C. ulugurica* are considered here as a *Cyrtolejeunea* clade within *Cheilolejeunea*, and separated in the following key:

Key to species in *Cyrtolejeunea* clade

1. Distributed in neotropics, plant dioicous . . . . . 2
1. Distributed in palaeotropics, plant autoicous . . . . . 3
2. Apex of underleaves entire on sterile shoots, male bracteoles present only at the base of androecium . . . . . *C. holostipa*
2. Apex of underleaves shortly bifid, male bracteoles present throughout the androecium . . . . . *C. insecta*
3. Apex of underleaves bifid to 0.4–0.5 of their length, leaf lobes asymmetrically ovate . . . . . *C. obtusifolia*
3. Apex of underleaves very shortly bifid to emarginate, leaf lobes obovate to slightly spatulate . . . . . 4
4. Leaf lobule *ca.* ½ long as the leaf lobe, forms an angle of *ca.* 135–150° with the free lateral margin . . . . . *C. chenii*
4. Leaf lobule longer, forms a narrow sinus with the free lateral margin . . . . . *C. ulugurica*

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