

Research paper

Taxonomy notes on Vandaeae (Orchidaceae) from China: Five new species and two new records

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ABSTRACT

Five new species (*Gastrochilus yei*, *Gastrochilus minimus*, *Luisia simaoensis*, *Taeniophyllum xizangense*, *Tuberolabium subulatum*) and two newly recorded species (*Cleisostoma tricornutum*, *Luisia inconspicua*) of Vandaeae (Orchidaceae) from China are described and illustrated. *Gastrochilus yei* is similar to *G. affinis* and *G. nepalensis*, but differs from them by having an epichile not lobed, the apex of the hypochile not bilobed, and a tine on the apex of the leaf. *Gastrochilus minimus* is similar to *G. acinacifolius*, but can be distinguished from the latter by having a flabellate epichile that is densely hirsute on the adaxial surface and an inconspicuous central cushion; in addition, the hypochile of *G. minimus* has a keel that extends to the apex of the epichile. *Taeniophyllum xizangense* is similar to *T. stella* and *T. radiatum*, but it is distinguished from them by having much bigger flowers, inflorescences densely covered with short-bristly hairs, papillae on the external surface of sepals, and bigger triangular-ovate viscidium. *Luisia simaoensis* is similar to *L. magniflora* and *L. ramosii*, but can be easily distinguished from them by having lateral sepals longer than dorsal sepals and petals, lip with irregular and wavy margins, and lip with bilobed apex. *Luisia inconspicua* is moved from *Gastrochilus* to *Luisia* based on phylogenetic analyses of plastid matK sequence data. *Tuberolabium subulatum* is similar to *T. carnosum*, but it can be easily distinguished from the latter by having an inflorescence much shorter than the leaves, yellow sepals and petals, and many small papillae outside the lip lobes.

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1. Introduction

The orchid family is among the largest families of angiosperms, with approximately 200 genera and 1650 species in China (Jin et al., 2019). In 2019, The Orchid Survey of China was initiated by the

Chinese National Forestry and Grassland Administration. This survey will cover all provinces, autonomous regions, and municipalities in China. During our botanical survey in south and southwest China between 2019 and 2020, many little known or unknown orchid species were discovered. The results of morphological comparison indicate that five species belonging to Vandaeae are new to science and two are new records in China. Here we describe these new discoveries to the flora of China.

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2. Material and methods

Specimens were collected and deposited at the Herbarium (HITBC) of Xishuangbanna Tropical Botanical Garden and in the Herbarium (KUN) of the Kunming Institute of Botany, Chinese Academy of Sciences. Flowers were also preserved in formalin-acetic acid-alcohol (FAA) and DNA samples were preserved in a freezer for further study. Specimens were studied in the laboratory under a stereomicroscope.

The phylogenetic position of one new record, *Luisia inconspicua*, is confusing due to its morphological characters, i.e., terete leaves, short inflorescence, raceme with several flowers and saccate hypochile. It has previously been placed in *Cymbidium*, *Gastrochilus*, *Luisia*, *Luisiopsis*, and *Saccolabium*. To determine its phylogenetic position, we analyzed two markers, plastid *matK* and nrITS. Thirty species of *Gastrochilus*, *Holcoglossum* and *Luisia* were included for phylogenetic analysis. *Calanthe sieboldii* was selected as outgroup. Total DNA was extracted from dry leaves using a TIANGEN DNA secure Plant Kit (TIANGEN BIOTECH (BEIJING) CO., LTD) following the manufacturer's instructions. Phylogenetic analyses were performed using IQ-TREE multicore v.1.6.10 for Windows 64-bit (Schrempf et al., 2019) with 1000 bootstrap replicates. Newly sequenced markers of *L. inconspicua* have been deposited in GenBank (Table 1).

3. Taxonomic treatment

3.1. *Tuberolabium Yamam.*

Tuberolabium is a small genus comprising about 11 species, mainly distributed in India, China, Thailand, Peninsular Malaysia, the Philippines, Indonesia, New Guinea, and Australia (Pridgeon et al., 2014). *Tuberolabium* is an epiphytic herb with few leaves, characterized by a pendulous inflorescence with many flowers and a spurred, 3-lobed lip (Chen and Wood, 2009; Kocyan and Schuiteman, 2013; Ormerod and Juswara, 2019).

Table 1
Taxa and GenBank accession numbers of each species and outgroup in *matK* sequence analyses.

Species	Accession no.
<i>Gastrochilus acinacifolius</i>	KJ733569.1
<i>G. calceolaris</i>	MK357135.1
<i>G. formosanus</i>	KJ733573.1
<i>G. guangtungensis</i>	KJ733574.1
<i>G. intermedius</i>	MK357151.1
<i>G. japonicus</i>	KJ733575.1
<i>G. linii</i>	MK357152.1
<i>G. minutiflorus</i>	MK357153.1
<i>G. rantabunensis</i>	MK357155.1
<i>G. raraensis</i>	KJ733577.1
<i>G. tianbaoensis</i>	MK357157.1
<i>G. yunnanensis</i>	MK357158.1
<i>G. zhenyuanensis</i>	MK357146.1
<i>Holcoglossum lingulatum</i>	EU558949.1
<i>H. omeiense</i>	HQ452917.1
<i>H. omeiense</i>	JN106346.1
<i>H. quasipinifolium</i>	HQ452924.1
<i>H. tsii</i>	AB217732.1
<i>Luisia amesiana</i>	KJ733580.1
<i>L. cordata</i>	KJ733581.1
<i>L. filiformis</i>	KF421852.1
<i>L. inconspicua</i>	MW169039
<i>L. longispica</i>	KJ733582.1
<i>L. magniflora</i>	KJ733583.1
<i>L. trichorrhiza</i>	EF655800.1
<i>L. zeylanica</i>	JN004496.1
<i>Calanthe sieboldii</i>	KF673815.1

Tuberolabium subulatum Jian W. Li & X. H. Jin, sp. nov. (勐腊管唇兰 *Meng La Guan Chun Lan*). Figs. 1 and 2: A–D.

Type: — CHINA. Mengla County, Yunnan Province. Epiphytic on tree in tropical seasonal rain forests in Yiwu State Nature Reserve, alt. 900 m, 4 May 2016, J.W. Li (holotype: HITBC!).

Diagnosis: Epiphytic herbs. Stems 3–5 cm long, base with several fleshy roots. Leaves 3–9, distichous, leaf blade oblong-lanceolate, 3.0–6.0 × 0.7–1.5 cm, mid-vein slightly concave adaxially, convex abaxially, apex unequally bilobed, lobes acute; base sheathing, jointed and twisted, almost lying in one plane. Inflorescence axillary, 1–5, descending, 1.0–2.5 cm long, ca. 1.5 mm in diam.; peduncle 0.5–1.0 cm long, with 2–4 sheaths, sheath triangular, ca. 1 × 3 mm; rachis 0.5–1.5 cm long, slightly flattened, with 2–7-flowered, 1–2 opening at same time. Sepals and petals orange-yellow, lip white with yellowish apex and several yellow spots at mouth of tube; pedicel and ovary 7–8 mm long, white. Dorsal sepal ovate-oblong, 7.0–7.2 × 4.0–4.2 mm, apex obtuse and mucronulate, 5-veined; lateral sepals oblique ovate, 7.0–7.2 × 4.8–5.0 mm, apex obtuse and mucronulate, 5-veined. Petals ovate-oblong, 6.0–6.2 × 2.5–2.6 mm, apex obtuse, 3-veined. Lip immovably attached to end of column foot, spurred, 4.2–4.3 mm long, 3-lobed; outside of lobes with many small papillae; mid-lobe very small, triangular, ca. 1.0 × 1.4 mm, apex obtuse; lateral lobes triangular, ca. 2.5 × 1.4 mm, apex bilobed, upper lobelet oblong, ca. 1.5 × 0.7 mm, apex rounded, lower lobelet equilateral triangular, ca. 0.5 mm, apex obtuse; spur conical, 4.0–4.2 mm long, ca. 2 mm in diam., apex obtuse. Column stout, ca. 2 mm long, column wings enlarge, ca. 0.2 mm high; rostellum 2, linear, ca. 1 mm; column foot ca. 2.5 mm long, anther cap triangular, pollinia 2, viscidium equilateral triangular, ca. 0.5 mm long; stipe triangular, ca. 1.0 × 0.4 mm. Capsule cylinder, slender.

Phenology. Flowering from April to May.

Distribution and habitat. *Tuberolabium subulatum* was found in Mengla County, Yunnan Province, P. R. China, at the border between China and Laos. It is epiphytic on trees under tropical seasonal rain forests at elevations of 850–1000 m.

Etymology. The specific epithet ‘*subulatum*’ refers to the shape of spur.

Relationships. Morphologically, *Tuberolabium subulatum* is similar to *T. carnosum* Seidenf., but it can be easily distinguished from the latter by having an inflorescence much shorter than the leaves (vs. inflorescence as long as or longer than leaves), yellow sepals and petals (vs. sepals and petals whitish-green), many small papillae outside the lip lobes, very small, triangular mid-lobe, triangular lateral lobes, bilobed apex, oblong upper lobus, apex rounded apex, and equilateral triangular nether lobus (vs. lip with mid-lobe fleshy, with a very small triangular tip; lateral lobes fleshy, triangular, apex rounded, near front edge inside with a pair of squarish flanges meeting at base).

Conservation status. For the time being, *Tuberolabium subulatum* is only known from the type locality in a Nature Reserve. Accurate data on abundance and distribution is lacking; we here consider it as “Data Deficient (DD)” (IUCN 2012).

3.2. *Gastrochilus D. Don*

Gastrochilus comprises about 65 species mainly distributed in China, India and Sri Lanka through eastern Asia and southern Japan to southeast Asia (Liu et al., 2016; Wu et al., 2019). *Gastrochilus* is characterized by having the lip divided into a semi-globose to saccate hypochile and broadly triangular or flabellate, often hairy or papillose epichile (Tsi et al., 1996; Pridgeon et al., 2014; Liu and Gao, 2018).

3.2.1. *Gastrochilus yei* Jian W. Li & X.H. Jin, sp. nov. (叶氏盆距兰 *Ye Shi Pen Ju Lan*). Fig. 2: E–F; Fig. 3: A–E.

Type: — CHINA. Jingdong County, Yunnan Province, epiphytic on trees in broad-leaved evergreen forests, E: 100.77°, N: 24.39°, alt. 1900 m, 24 Apr. 2020, J.W. Li 5464 (Holotype: HITBC!, Isotype: HITBC!)

Diagnosis: Morphologically, *Gastrochilus yei* Jian W. Li & X.H. Jin is similar to *Gastrochilus affinis* Schlechter and *Gastrochilus nepalensis* Raskoti, but differs from them by having epichile not lobed, apex of hypochile not bilobed, apex of leaf with a tine.

Epiphytic herb, creeping, 3–8 cm long. Roots several, come out from nodes of stem, 1.3 mm in diameter; stem 1.1 mm in diameter. Leaves distichous, leaf blade lanceolate, green with purple spots, 1.5–3.0 × 0.4–0.8 cm, apex acute, with a tine; base jointed amplexicaul-sheathing, twisted and almost lying in one plane; mid-vein slightly concave adaxially, slightly convex abaxially. Inflorescences 1–5 arising from nodes of stem, 1.0–1.5 cm long, rachis 0.3–0.7 mm long, raceme 2–6-flowered, flower yellowish-green, with purple spots, inside surface of petals and sepals purple with green margin. Floral bracts triangular, 0.9 × 1.0 mm, apex acute. Pedicel and ovary 0.7–1.0 cm long. Dorsal sepal oblong, 3.3 × 1.9–2.0 mm, apex rounded; lateral sepals oblong, 3.9–4.0 × 1.8–1.9 mm, apex obtuse. Petals oblong, 3.5 × 1.8 mm, apex rounded. Lip with an epichile and a saccate hypochile; epichile semi-rounded, 2.0–2.2 × 4.0–4.2 mm, glabrous, with a thickened central, rugose cushion, tint with purple, margin irregularly denticulate; hypochile subconical, 3 mm tall, 3 mm in diameter, apex rounded. Column stout, 1.5 mm long; rostellum bilobed; pollinia 2, viscidium peltate, stipe filiform. Capsule cylinder, 14 mm long, 4 mm in diameter, with 5 ridges.

Phenology. Flowering from April to May.

Distribution and habitat. *Gastrochilus yei* is only known from the type locality in Wuliangshan National Nature Reserve. *G. yei* is epiphytic on tree trunks in mossy broad-leaved evergreen forests at an elevation of 1850–2000 m.

Etymology. The specific epithet 'yei' is in honor of De-Ping Ye, who found this species.

Relationships. Morphologically, *Gastrochilus yei* is mostly similar to *G. affinis* Schltr. and *G. nepalensis* Raskoti, which share green leaves with purple spots, as well as the inside surface of sepals and petals purple with green margin. *G. yei* can be easily distinguished from *G. affinis* and *G. nepalensis* by having an acute leaf apex with a tine (vs. apex of leaf acute, with 2–3 denticulate in *G. affinis*; apex of leaf acute, without tine in *G. nepalensis*); rounded saccate apex (vs. apex of saccate bilobed both in *G. affinis* and *G. nepalensis*); semi-rounded epichile, with a thickened central, rugose cushion, and irregularly denticulate margin (vs. epichile triangular, central with 2 ridges ranging from base to apex, basal part of margin denticulate, apex slightly bilobed in *G. affinis*; epichile 3-lobed, lateral lobes subauriform, margin entire, midlobe suborbicular, base with rugose callus, margin entire in *G. nepalensis*).

Conservation status. *Gastrochilus yei* is only known from the type locality. In total, 150 individuals have been documented during our investigation. However, the habitat of this new species is widespread in the Jingdong Natural Reserve. We here tentatively consider it "Data Deficient (DD)" (IUCN 2012).

3.2.2. *Gastrochilus minimus* Jian W. Li, D.P. Ye & X.H. Jin, sp. nov. (小盆距兰 *Xiao Pen Ju Lan*). Fig. 3: F–H.

Type: — CHINA. Yixiang township, Simao District, Yunnan Province, epiphytic on trees near riverside in subtropical mixed coniferous broad-leaved forests, E: 100.97°, N: 22.79°, alt. 1287 m, 13 Sep. 2020, D.P. Ye (Holotype: HITBC!, Isotype: HITBC!)

Diagnosis: Epiphytic herb, small plant, 1.5–2.0 cm tall, stem ca. 1 mm in diameter. Roots several, ca. 1 mm in diameter. Leaves 3–6, ovate-lanceolate, 1.5–2.5 × 0.5–0.8 cm, apex acute, base jointed and amplexicaul-sheathing, twisted and almost lying in one plane, mid-vein concave adaxially, convex abaxially, green on both surfaces, sometimes tinted purple adaxially. Inflorescences come out from nodes from lower middle part, 0.5–0.9 cm long, ca. 1 mm in diameter, base with 1–2 sheaths, membranous, ca. 1 mm long, apex acute. Rachis 0.2–0.5 cm long, raceme 2–4-

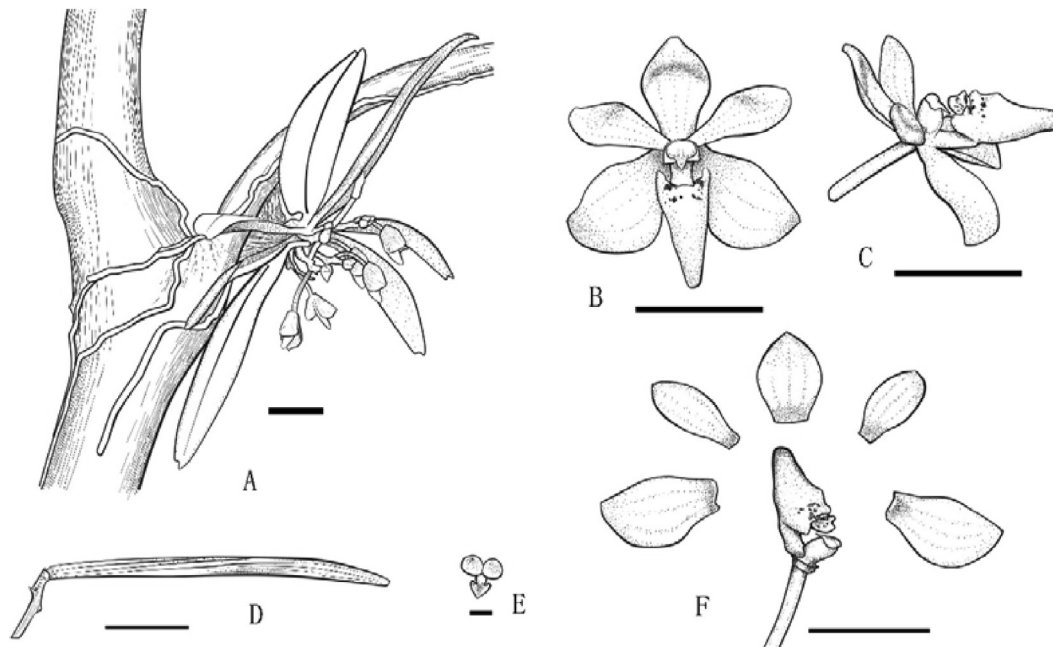


Fig. 1. Line drawings of *Tuberculolabium subulatum* Jian W. Li & X.H. Jin, sp. nov. (A) Plant, bar = 1 cm. (B) Flower (face view), bar = 5 mm. (C) Flower (side view), bar = 5 mm. (D) Capsule, bar = 1 cm. (E) Pollinia, bar = 1 mm. (F) Dissection of flower, bar = 5 mm. (Draw from type specimen by Bo Pan).

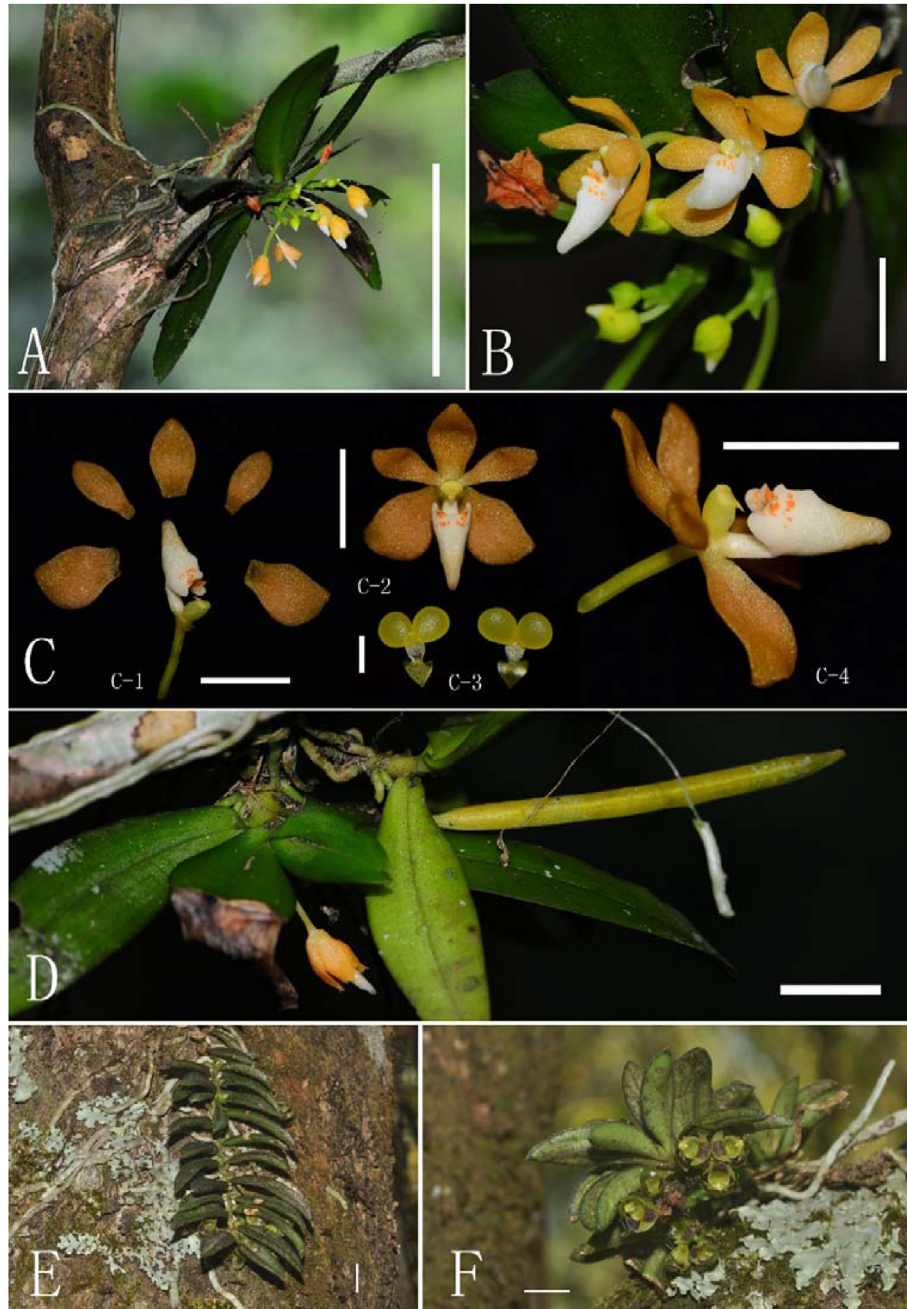


Fig. 2. (A–D): *Tuberolabium subulatum* Jian W. Li & X.H. Jin, sp. nov. (A) Plant, bar = 5 cm. (B) Flowers, bar = 5 mm. (C) (C-1. Dissection of flower, bar = 5 mm; C-2. Face view of flower, bar = 5 mm; C-3. Pollinia, bar = 1 mm; C-4. Side view of flower, bar = 5 mm). (D) Plant with capsule, bar = 1 cm. (E–F): Plant of *Gastrochilus yei* Jian W. Li & X.H. Jin. (A–D photographed by Jian-Wu Li, E–F photographed by De-Ping Ye).

flowered, flowers yellowish-green, inside surface of sepals and petals with 2 longitudinal red-purple stripes, lip tinted red-purple spots. Floral bracts triangular, 0.9×0.9 mm, apex acute. Pedicel and ovary ca. 3 mm long. Dorsal sepal spatulate, concave, 3.2×1.7 mm, apex rounded; lateral sepals oblong-lanceolate, 3.5×1.2 mm, apex rounded, keel slightly convex abaxially. Petals oblanceolate, 2.8×1.4 mm, apex rounded, keel slightly convex abaxially. Lip with an epichile and a saccate hypochile; epichile flabellate, $2.0\text{--}2.2 \times 4.0\text{--}4.2$ mm, adaxially densely hirsute and inconspicuously with a central cushion, slightly reflexed; hypochile subconic, ca. 2 mm tall, ca. 2 mm in diameter, abaxially with a keel, extending to apex of epichile. Column stout,

ca. 1.2 mm long; rostellum bilobed with acuminate tip; pollinia 2; viscidium oblong, ca. 0.3 mm long, stipe filiform, ca. 0.6 mm long.

Phenology. Flowering from July to September.

Distribution and habitat. *Gastrochilus minimus* was found in Simao District, Pu'er City, Yunnan Province, P.R. China. It is epiphytic in mixed coniferous broad-leaved evergreen forests at elevations between 1200–1300 m.

Etymology. The specific epithet ‘*minimus*’ refers to smallest species in *Gastrochilus* s.l.

Relationships. Morphologically, *Gastrochilus minimus* is the smallest plant in *Gastrochilus* s.l. It is similar to *G. acinacifolius* Z.H. Tsi, but can be easily distinguished from the latter by being much

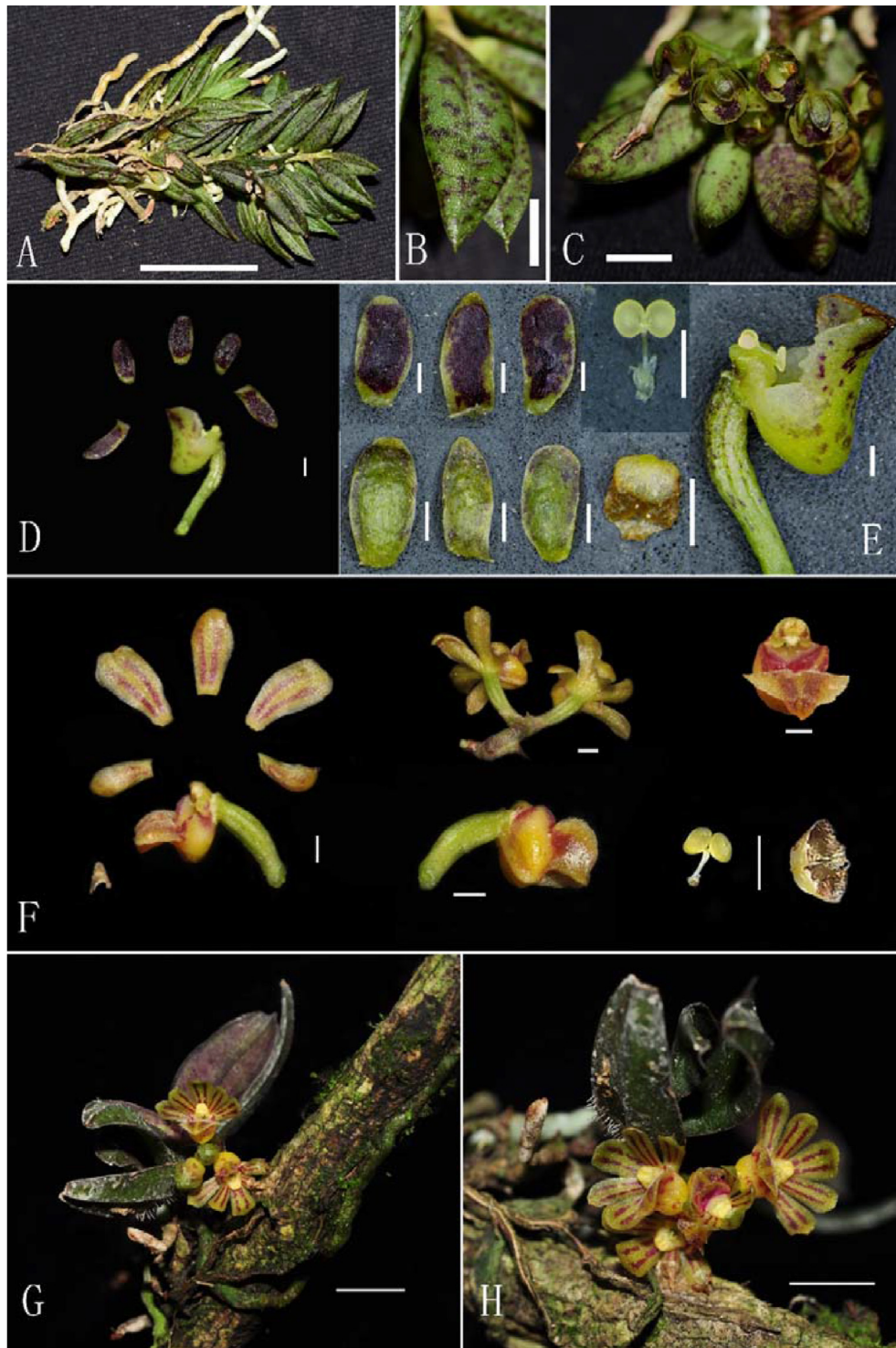


Fig. 3. (A–E) *Gastrochilus yei* Jian W. Li & X.H. Jin, sp. nov. (A) Plants, bar = 5 cm. (B) Leaves, bar = 1 cm. (C) Plant with flower, bar = 1 cm. (D–E) Dissection of flower, bar = 1 mm. (F–H) *G. minimus* Jian W. Li, D.P. Ye & X.H. Jin sp. nov. (F) Dissection of flower, bar = 1 mm. (G) Plant with flowers, bar = 1 cm. (H) flowers, bar = 1 cm. (A–E) photographed by Jian-Wu Li, F–H photographed by De-Ping Ye).

smaller (1.5–2.0 cm tall in *G. minimus*. vs. 8–15 cm tall in *G. acinacifolius*); having yellowish-green flowers, with 2 longitudinal red-purple stripes on the inside surfaces of sepals and petals (vs. sepals and petals yellow with purplish red spots in *G. acinacifolius*); and an adaxially flabellate epichile that is densely hirsute and has an inconspicuous central cushion, which is slightly

reflexed; a hypochile with a keel, on the abaxial surface that extends to apex of epichile (vs. epichile transversely oblong, adaxially sparsely papillate-hairy except on central cushion, margin irregularly denticulate, hypochile abaxially with 3 ridges).

Conservation status. *Gastrochilus minimus* was found only from the type locality. The habitat is in mixed coniferous broad-leaved

evergreen forests along a river. Its habitat was greatly disturbed by plantations and deforestation. We estimate that the suitable habitat of *G. minimus* is less than 500 ha. In total, approximately 200 individuals were documented. Following IUCN (2012) guidelines we consider the conservation status of the new species Critically Endangered (CR: criteria B1ab(iii) + B2ab(iii)).

Notes. This species was included in the Wild Orchis in Yunnan (Xu et al., 2010) as *Gastrochilus pumilus* H. Jiang & D.P. Ye, *sp. nov. ined.* However, it was not validly published because the specific epithet 'pumilus' was already published as *Gastrochilus pumilus* Kuntze (1891), and also as *Gastrochilus pumilus* Hayata, which is now transferred to *Holcoglossum pumilum* (Hayata) X.H. Jin. According to the *International Code of Nomenclature for algae, fungi and plants* (Shenzhen Code) (Turland et al., 2018), it has no status in the Code. It may not be later homonym. Therefore, we proposed *G. minimus* Jian W. Li, D.P. Ye & X.H. Jin as a replaced name.

3.3. *Taeniophyllum Blume*

Taeniophyllum is a leafless and epiphytic genus with short stems and four divided pollinia (Carr, 1932). *Taeniophyllum* was divided into two subgenera based on having sepals and petals that are connate or free at the base; these subgenera were further subdivided into six sections (Schlechter, 1913a). Recent molecular studies indicated that leafy *Microtatorchis* is nested within *Taeniophyllum* and that *Microtatorchis* should be included in *Taeniophyllum* (Zou et al., 2015). *Taeniophyllum* s.l. comprises ca. 236 species widely distributed from tropical Africa (only one species) through tropical Asia to Australia and the Pacific islands (POWO, 2019); there are 4 species in China, with one *Microtatorchis* species (Chen and Wood, 2009).

3.3.1. *Taeniophyllum xizangense* J.D. Ya & C. Liu, *sp. nov.* (西藏带叶兰 *Xi Zang Dai Ye Lan*). Fig. 4.

Type: CHINA. Xizang Autonomous Region: Mêdog County, subtropical evergreen broad-leaved forest, 2000 m, 28 May 2019, J.D. Ya & C. Liu (Holotype: KUN!)

Diagnosis. Epiphytic herb. Roots up to 40, strongly flattened, 2–10 cm or longer, 1.5–2.0 mm in diameter. Inflorescences 3–7, erect, muricate, dense short-bristly hairs, 6–16 mm long, 1–3-flowered; peduncle filiform, 0.5–0.8 mm in diameter; bracts distichous, dense short-bristly hairs, broadly ovate-triangular, ca. 2.0 mm. Flowers open singly and widely, yellowish-green, sepals externally with papillae, peduncle and ovary ca. 4.0 mm long, sparse short-bristly hairs. Sepals and petals connate at the base into a tube ca. 2.0 mm long. Dorsal sepal narrowly lanceolate, obtuse, ca. 10.0 × 1.5 mm, incurved; lateral sepals narrowly lanceolate, obtuse, ca. 10.0 × 1.8 mm. Petals narrowly lanceolate, obtuse, ca. 8.0 × 1.8 mm, base clawed, apex acuminate. Labellum thick fleshy, narrowly lanceolate in outline, 10.0–11.0 mm × ca. 1.7 mm, with a transverse V-shaped lamella and shallowly saccate at the base of disk, with an inflexed spine ca. 0.25–0.35 mm long at the tip, base with retrorse square septum over spur entrance; spur subglobose, ca. 1.5 mm. Column short, steldia rounded, ca. 1.4 × 1.4 mm. Anther cap white, ca. 0.75 × 0.65 mm, with 2 prominent humps. Pollinia 4, in two pairs, pale yellow, ovoid, ca. 0.4 × 0.3 mm; stipe white, ca. 0.5 mm long; viscidium large, white, triangular-ovate, ca. 0.9 × 0.6 mm.

Phenology. Flowering from May to June (based on cultivated material in the greenhouse).

Distribution and habitat. *Taeniophyllum xizangense* is currently known only from the type locality Mêdog County, Xizang, China. It is epiphytic on trunks under evergreen broadleaf forest at an elevation of 1350 m.

Etymology. The specific epithet 'xizangense' refers to the type locality where the new species occurs, Xizang, China.

Relationships. *Taeniophyllum xizangense* is similar to *T. stella* Carr and *T. radiatum* J.J. Sm. in morphological structure and shape of the flowers (Smith, 1918; Carr, 1932), but can be easily distinguished from them by having much bigger flowers, longer inflorescences densely covered with short-bristly hairs, sepals with papillae on the external surface, and bigger triangular-ovate viscidium (see Table 2).

Conservation status. During our 2-week field survey, only one population was found; thus, we regard its status as "Data Deficient (DD)" (IUCN, 2012).

3.4. *Luisia Gaudich.*

Luisia comprises about 40 species distributed through Sri Lanka, India, Bhutan, China, Southeast Asia, to Japan, New Guinea, the Pacific Islands and Australia (Khurajam and Roy, 2015; Karuppusamy and Ravichandran, 2019; Mishra et al., 2020a, b). There are eleven species in China, five of which are endemic.

3.4.1. *Luisia simaoensis* D.P. Ye & H. Jiang, *sp. nov.* (裂唇钗子股 *Lie Chun Chai Zi Gu*). Fig. 5.

Type: CHINA. Sigangli village, Ximeng County, Pu'er City, Yunnan Province, epiphytic on trees in Karst region, alt. 1700 m, 30 Aug. 2011, Jianwu Li 897 (Holotype: HITBC!, Isotype: HITBC!)

Diagnosis. Epiphytic herb, stem suberect, or pendulous and ascending, rigid, simple or sometimes basally branched, 10–50 cm tall, 0.6–0.7 cm in diameter, internodes 1.5–2.0 cm long, perennial covered with persistent leaf sheath, brownish. Roots several, basally, slightly depressed, ca. 5 mm in diameter. Leaves several on upper part of stem, nearly distichous, obliquely upward, 1.5–2.0 cm apart from each other, terete, 10–14 × ca. 0.4 cm, apex acute, base enlarged into amplexicaul-sheathing, sheath 1.5–2.0 cm long. Inflorescence 1–5 came out from nodes of stem, penetrating leaf sheath, 0.7–1.0 cm long, base with 2–3 annular sheaths, sheath 2–3 mm long, apex acute; rachis 3–5 mm long, raceme 2–5-flowered, sepals and petals whitish, outside tinged with purplish-red, lip yellowish-green, dense dark purple spots. Flora bracts triangular, 5.0–5.5 × 6.5–7 mm, apex sharp contractive and acuminate. Pedicel and ovary 1.7 cm long. Dorsal sepal ovate-elliptic, 8.5–9.0 × 5.0–5.2 mm, 7-veined, apex rounded; lateral sepals oblong, slightly oblique, 12 × 5 mm, 5-veined, abaxially with a keel, heightening gradually towards tip, forming an awn, 1.1 mm tall at tip, apex acute; petals oblong, 10 × 5 mm, 5-veined, apex obtuse. Lip broadly oblong, 1.5 cm long, middle strongly constricted and forming hypochile and epichile, with a distinct boundary between hypochile and epichile; epichile subcordate, 9 × 11 mm, margin irregular waved, apex bilobed, with a sinus 2 mm deep, apex of lobus rounded and irregular waved; hypochile transverse ovate, 6 × 14 mm, with lateral lobes ascending and embracing column, apex rounded. Column 7 mm long, anther cap galeiform, pollinia 2, viscidium rounded, ca. 2 mm in diameter, stipe lorate, 2 × 1.2 mm, rostellum lorate, ca. 1 mm long.

Phenology. Flowering from August to September.

Distribution and habitat. *Luisia simaoensis* was found in Pu'er City, Yunnan Province, P.R. China. It is an epiphytic herb, epiphytic on trees in karst regions at elevations between 1100–1800 m.

Etymology. The specific epithet 'simaoensis' refers to the type locality of this species, Liushun Township, Simao District, Pu'er City, Yunnan Province, P.R. China.

Relationships. Morphologically, *Luisia simaoensis* is similar to *L. magniflora* Z.H. Tsi & S.C. Chen and *L. ramosii* Ames. All three share lateral sepals with a keel on the abaxial surface, a lip with a distinct boundary between hypochile and epichile, a hypochile in which the lateral lobes embrace the column. *L. simaoensis* can be easily

Table 2
Differences between *Tainiophyllum xizangense*, *T. stella* and *T. radiatum*.

Characters	<i>Tainiophyllum xizangense</i>	<i>T. stella</i>	<i>T. radiatum</i>
Roots in diam.	1.5–2.0 mm	0.5 mm	2.5–3.5 mm
Inflorescences	6.0–16.0 mm long, 1–3-flowered, densely short-bristly hairs	4.0–8.0 mm long, many flowered, muriculate	5.0–6.0 mm long, many flowered, papillosa
Bracts	ca. 2.0 mm, densely short-bristly hairs	ca. 0.7 mm, minutely muriculate	ca. 0.7 mm, minutely muriculate
Flowers	yellowish green	pale yellowish white to bright yellow or salmon pink	pale orange or pale salmon pink
Sepals	10.0 × 1.5 mm, externally with papillae	5.5 × 1.0 mm, externally without papillae	5.8–7.6 × 1.0–1.3 mm, externally without papillae
Petals	ca. 8.0 × 1.8 mm	ca. 5.5–7.5 × 1.0–0.75 mm	ca. 5.0 × 0.9 mm
Labellum	10.0–11.0 × ca. 1.7 mm, with an inflexed spine at the tip, disk without keel	ca. 7.0 × 1.8 mm, without spine at tip, keeled in the disk	ca. 5.5–8.0 × 1.3 mm, with an inflexed spine at the tip, disk without keel
Pollinia	ovoid	pyriform	oblique obovoid
Viscidium	triangular-ovate, 0.9 mm	oval	lanceolate, 0.7 mm

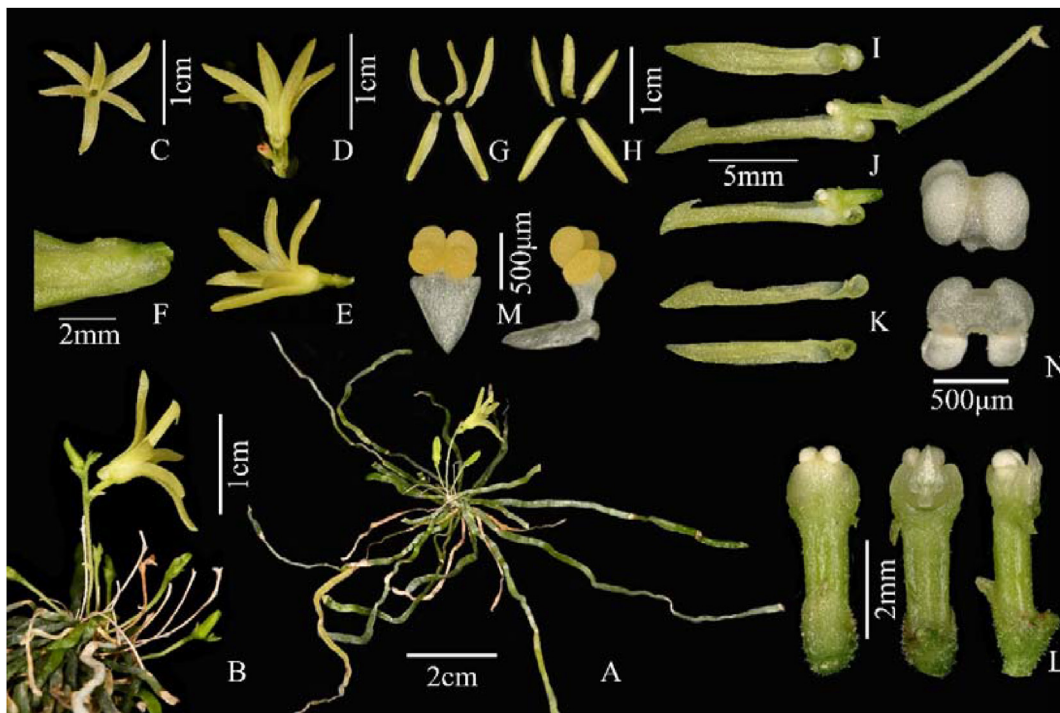


Fig. 4. *Tainiophyllum xizangense* J.D. Ya & C. Liu, sp. nov. (A) Plant. (B) Inflorescence. (C) Front view of flower. (D) Dorsal view of flower. (E) Lateral view of flower. (F) Papillae on external surface of the sepals. (G) Adaxial sepals and petals. (H) Abaxial sepals and petals. (I) Front view of labellum. (J) Lateral view of column and labellum. (K) Lateral view of labellum (rip cutting). (L) Ovary and column. (M) Pollinarium. (N) Anther cap. (Photographed by Ji-Dong Ya).

distinguished from these species by having a lateral sepals longer than the dorsal sepals and petals (Dorsal sepal ovate-elliptic, 8.5–9.0 mm long; lateral sepals oblong, slightly oblique, 12 mm long; petals oblong, 10 mm long. vs. dorsal sepal ovate-oblong, 9–12 mm long, lateral sepals suboblong, 10–12 mm long, margin incurved and embracing epichile, petals subelliptic, 10–11 mm long in *L. magniflora*; Dorsal sepal elliptic, 5 mm long, lateral sepals oblong, slightly oblique, 6 mm long, petals ovate, 6.2 mm long in *L. ramosii*); margins of lip irregular waved (vs. margins entire, recurved in *L. magniflora*; margins entire in *L. ramosii*), apex of lip bilobed (vs. apex of lip emarginate in *L. magniflora*; apex of lip obtuse in *L. ramosii*).

Luisia simaoensis is also similar to *L. teres* (Thunb.) Blume, but differs from the latter by having a lip with a distinct boundary between hypochile and epichile, a subcordate epichile, 9 × 11 mm, and an irregular waved margin.

Conservation status. *Luisia simaoensis* was found in Simao district, Lancang County, Ximeng County, Yunnan Province. Although it is distributed in several counties, the number of populations and range of distribution are still not clear. We here consider *L. simaoensis* as “Data Deficient (DD)” (IUCN, 2012).

Additional specimens examined (Paratypes). CHINA. Laba Township, Lancang County, Pu'er City, Yunnan Province, epiphytic on trees near riversides in karst regions, alt. 1230, 13 Sep. 2020, D.P. Ye 1923 (HITBC!, PE!)

Notes. Xu et al. (2010) published an inedita name as *Luisia simaoensis* D.P. Ye & H. Jiang, sp. nov. ined. in the *Wild Orchids in Yunnan*; however, only a diagnosis was provided, no type specimens designated. According to the *International Code of N. for algae, fungi and plants* (Shenzhen Code) (Turland et al., 2018), it is an invalid name (Art. 40.1, Turland et al., 2018). Here, the name of *L. simaoensis* is validly published. In addition, an illustration with

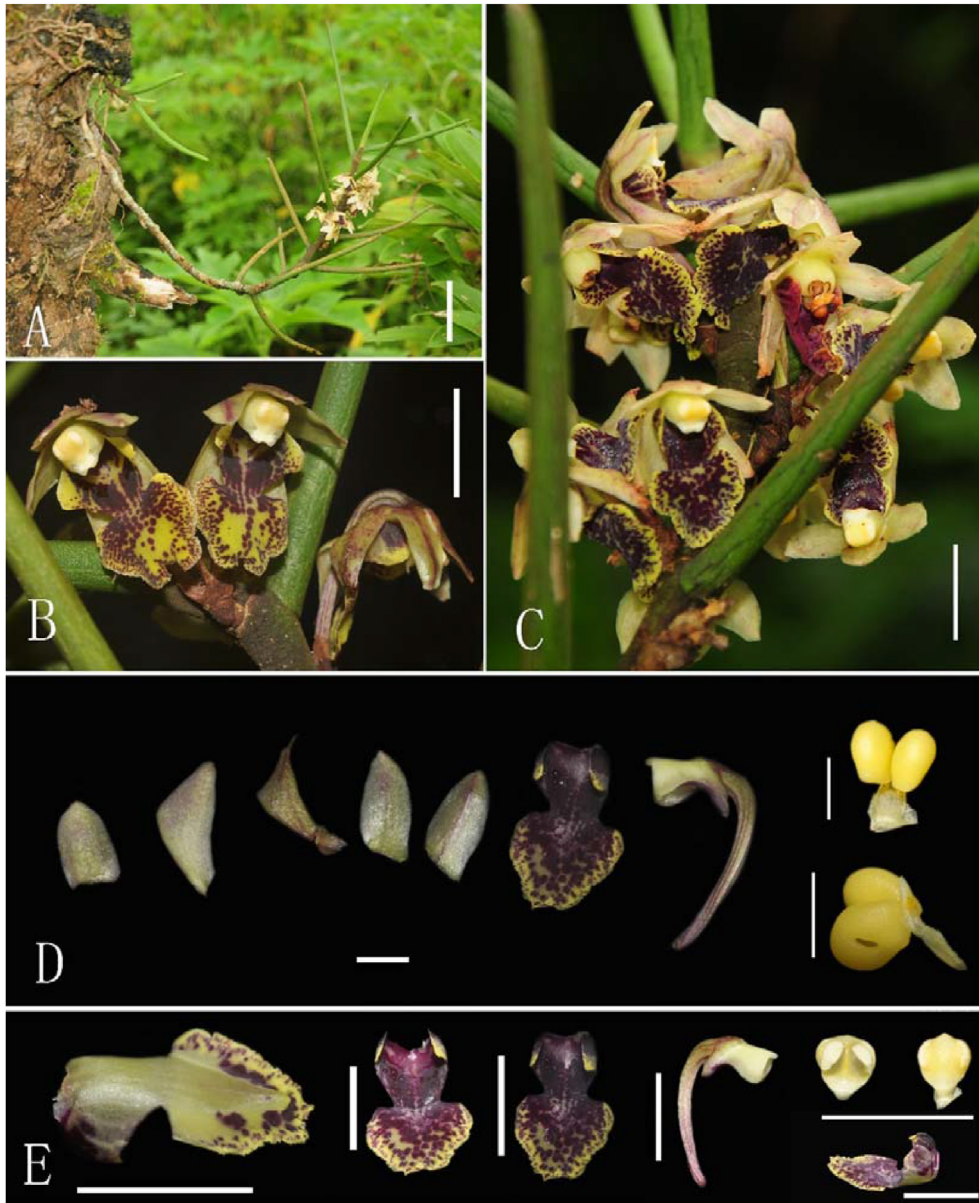


Fig. 5. *Luisia simaoensis* D.P. Ye & H. Jiang ex Jian W. Li & D.P. Ye, sp. nov. (A) Plant, bar = 5 cm. (B–C) Flowers, bar = 1 cm. (D–E) Dissection of flower (D. bar = 5 mm; E. bar = 1 cm). (A–C photographed by Jian-Wu Li, D–E photographed by De-Ping Ye).

color photos, distribution, IUCN conservation status and description are provided.

3.4.2. *Luisia inconspicua* (Hook.f.) King & Pantl., in *Ann. Roy. Bot. Gard. (Calcutta)* 8: 203. 1898. (兜唇钗子股 *Dou Chun Chai Zi Gu*). **Fig. 6:** A–C.

— *Cymbidium inconspicuum* Wall. ex Hook.f., *Ann. Roy. Bot. Gard. (Calcutta)* 5(1): 46. 1895; *Gastrochilus inconspicuus* (Hook.f.) Kuntze. *Revis. Gen. Pl.* 2: 661. 1891; *Luisiopsis inconspicua* (Hook.f.) Sath. Kumar & P.C.S. Kumar, *Rheedea* 15(1): 48. 2005; *Saccolabium inconspicuum* Hook.f., *Fl. Brit. India.* 6(17): 56. 1890.

Epiphytic, stems erect, rare ramose, branched at base and tufted, 5–15 cm tall, 0.3 cm in diameter, with internodes 0.5–0.7 cm long, perennial stems covered by persistent leaf sheaths, brownish, base with several roots, root depressed, 1.5–2.0 mm in diameter. Leaves

several on upper part of stem, obliquely upward, irregular distichous, 6–9 mm apart from each other. Leaf blade terete, 2–5 cm long, ca. 2 mm in diam., base jointed and sheathing, 6–9 mm long, apex acute. Inflorescences come out from node of stem, penetrating leaf sheaths, green to dark purple, 1–3 every stem, 4–6 mm long, with 2–3 sheaths, sheath triangular, 1.3 × 3.0 mm, apex obtuse. Rachis 2–3 mm long, 4–5-flowered, flowers pale green. Flora bracts triangular, 2 × 2 mm, apex acute. Pedicel and ovary 5–6 mm long. Dorsal sepal oblong, 2.5 × 1.8 mm, apex obtuse to rounded; lateral sepals ovate-oblong, 3.2–3.4 × 1.5–1.6 mm, mid-vein slightly raised abaxially, apex acute. Petals oblong, 2.8–3.0 × 1.3–1.5 mm, apex obtuse to rounded. Lip ovate-oblong, slightly fleshy, with an epichile and a saccate hypochile, dense with purple spots abaxially; epichile subtriangular, recurved, 1.8 × 2.5 mm, apex obtuse and inconspicuous emarginate; hypochile nearly subglobose-cucullate,

2 mm tall, 1.5–2.0 mm in diam., lateral edges with an semicircular lobe above the oral area, ca. 0.9 mm tall, fleshy at bottom of saccate. Column stout, ca. 2.2 mm long, purple; rostellum bifid; anther cap cucullate; pollinia 2, ovate-orbicular; viscidium oblong, 0.5 × 0.1 mm; stipe linear, ca. 1 mm long.

Distribution. China (Yunnan), India, Nepal and Bhutan.

Phenology. Flowering from July to September.

Habitat. Epiphytic on trees in karst regions.

Specimens Examined. CHINA. Yunnan, Jinping County, Jinshuihe Town, alt. 400 m, 11 Aug. 2020, epiphytic on trees in karst regions. J.W. Li 6085 (HITBC!).

Note. Our phylogenetic analyses indicate that *Luisia inconspicua* belongs to *Luisia* with high support (Fig. 7). *L. inconspicua* is sister to *Luisia amesiana*.

3.5. *Cleisostoma Blume*

Cleisostoma comprises approximately 110 species widely distributed from mainland tropical and subtropical regions of Asia, Malaysia, Indonesia, and the Philippines to Japan, Western Pacific islands and Australia (Ponert et al., 2016). There are 18 species in China four of which are endemic (Huang et al., 2020).

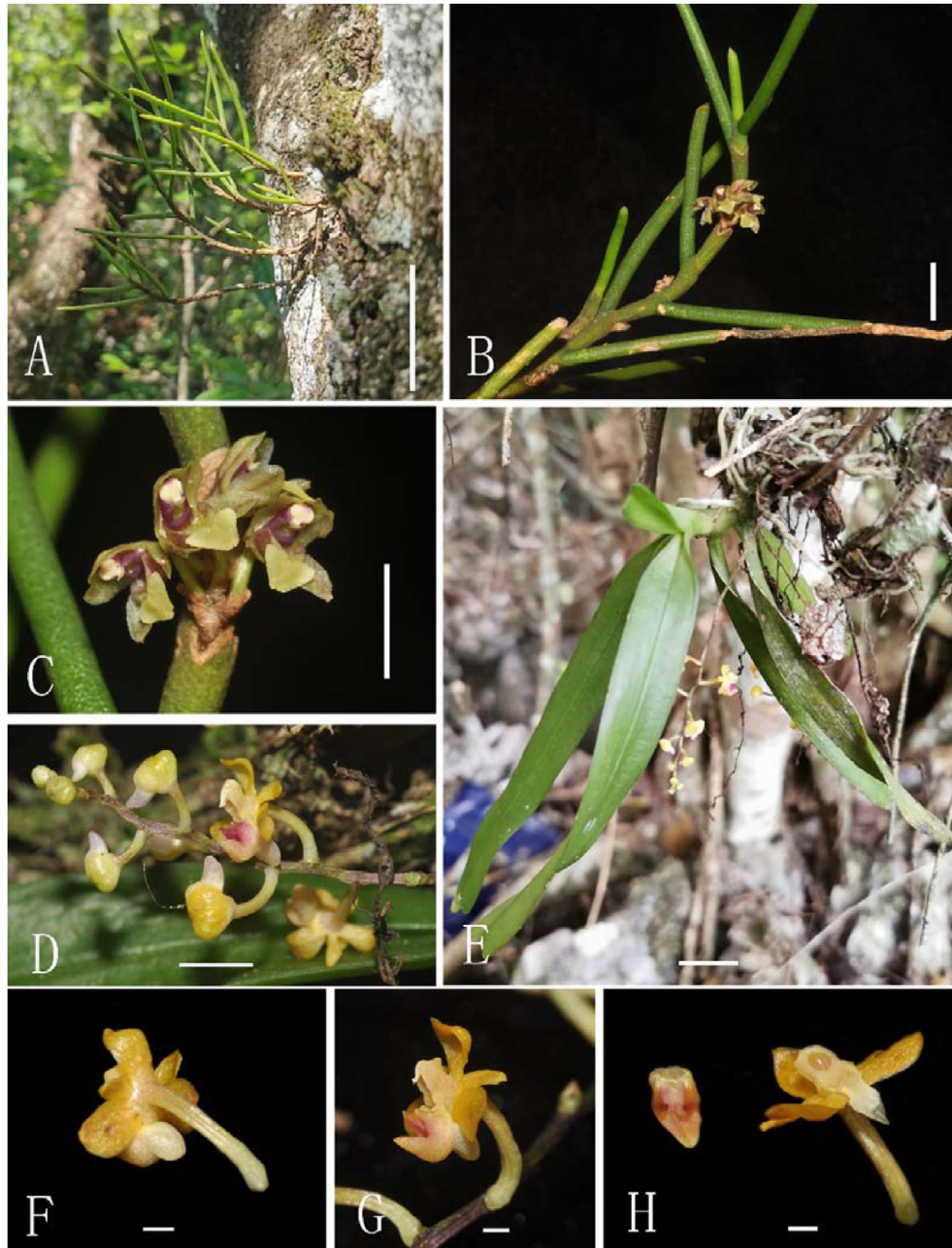


Fig. 6. (A–C): *Luisia inconspicua* (Hook.f.) King & Pantl. (A) Plant, bar = 5 cm. (B) Plant with flowers, bar = 1 cm. (C) Flowers, bar = 1 cm. (D–H) *Cleisostoma tricorutum* Aver. (D) Inflorescence, bar = 1 cm. (E) Plant, bar = 1 cm. (F) Back view of flower, bar = 1 mm. (G) Side view of flower, bar = 1 mm. (H) Dissection of flower, bar = 1 mm (A photographed by Jian-Wu Li, B–H photographed by De-Ping Ye).

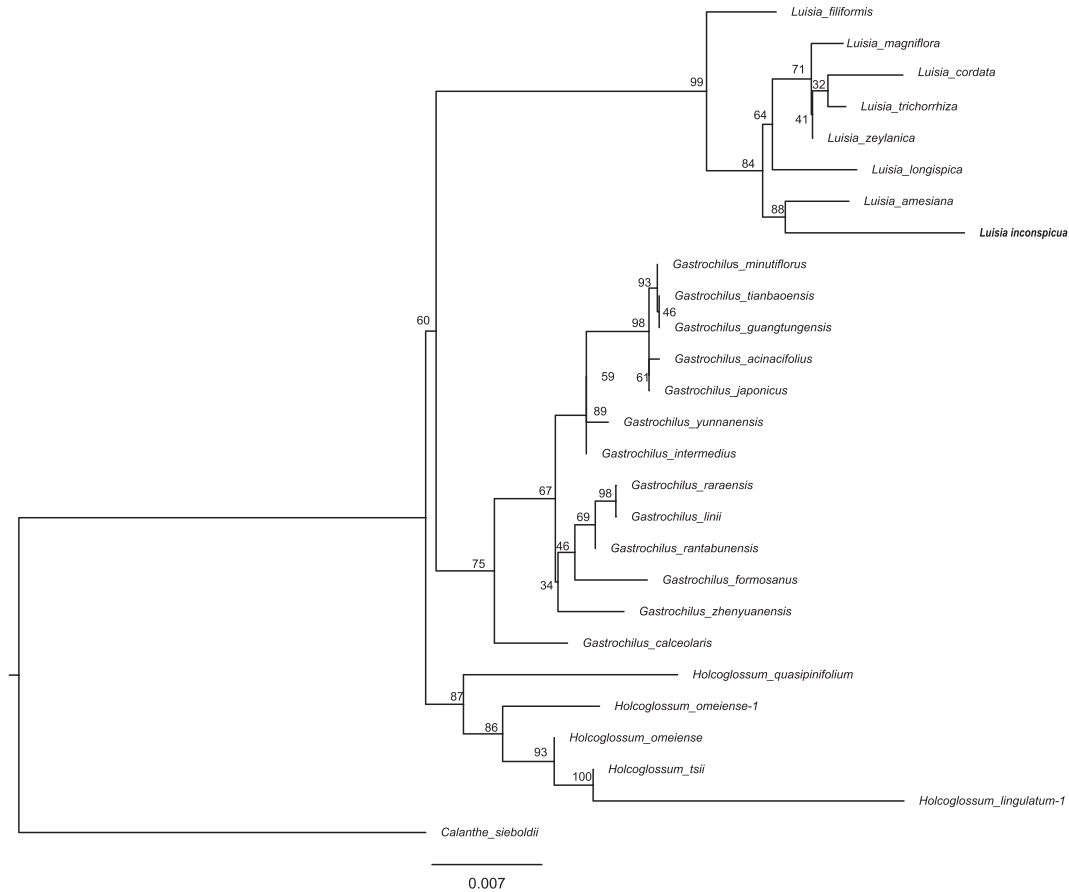


Fig. 7. Bayesian tree obtained from analysis of the combined data set showing the detailed relationships of *Luisia inconspicua*.

3.5.1. *Cleisostoma tricornutum* Aver. in *Taiwania* 60 (3): 108. 205. (角状隔距兰 *Jiao Zhuang Ge Ju Lan*). Fig. 6: D–H.

—Type: Vietnam: Thanh Hoa Province, Thuong Xuan district, Van Xuan municipality, Hang Cao village, Xuan Lien Natural Reserve. 8 Nov. 2013, remnants of primary and secondary broad-leaved evergreen forest on highly eroded rocky limestone hills, Averyanov et al. CPC 6894 (Holotype: LE!)

Epiphytic herb. Roots several, basal, terete, ca. 1 mm in diameter. Stem pendulous and ascending, 1–6 cm tall, ca. 3 mm in diameter. Leaves several, distichous, flat, slightly V-shape, 9–18 × 1.1–2.0 cm, leathery, apex unequally bilobed, lobes acute to rounded, base jointed and amplexicaul-sheathing. Inflorescence 1–5, come out from basal axillary, unbranched, slender, 5–30 cm long, ca. 0.9 mm in diameter, with 1–4 cannular sheaths, sheath membranous, 2–3 × 1–2 mm, apex acute; rachis 4–18 cm long, slightly zig-zag curved, sparsely with many flowers, flower yellowish-white, lip with purple lateral lobes. Flora bracts triangular, 0.5–0.7 × 0.7–1.0 mm, apex acute. Pedicel and ovary 5–6 mm long. Dorsal sepal oblong, 4.0–4.5 × 1.3–1.5 mm, apex obtuse, slightly cymbiform, 5-veined; lateral sepals broadly ovate, 3.5–3.7 × 2.5–2.6 mm, apex obtuse, 5-veined; petals slightly oblique spatula, 2.6–2.8 × 1.1–1.2 mm, apex obtuse, 1-veined. Lip spurred, 3-lobed, lateral lobes erect, narrowly conic, parallel and forward protruding, ca. 1.0 × 1.5 mm, apex acute; mid-lobe sagittate-triangular, 2.5–2.6 × 1.9–2 mm, apex obtuse, central with a longitudinal groove, disc with 3 fleshy low indistinct keels, median slightly longer; spur conical, 1.6–1.7 mm long, apex rounded, inside with longitudinally septate. Back-wall callus globrous, simple. Column stout, 2.2–2.3 mm long, base slightly papillate, wings inconspicuous; anther cap beaked, pollinia 4, in 2 pair; rostellum

filiform, ca. 1 mm long; viscidium oblong, ca. 0.3 mm long, stipe filiform, 1.6 mm long.

Distribution. China (Yunnan), Vietnam.

Phenology. Flowering from August to October.

Habitat. Epiphytic on trees or lithophytic on rocks in karst regions in tropical seasonal rain forests, at elevations between 100–1600 m.

Specimens Examined. CHINA. Tukahe village, Qushui township, Jiangcheng County, Yunnan Province, epiphytic on tree trunks in karst regions in tropical seasonal forest. E:102.28, N: 22.59, alt. 370 m, 8 Oct. 2019, *Jianwu LI 5121* (HITBC!).

Notes. Averyanov et al. (2015) described flowers “not widely opening”. We observe that this species has flowers slightly spreading. It seems that plants and flowers are larger.

Declaration of competing interest

None declared.

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