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**Hanguana podzolicola** (Hanguanaceae), a new record for Singapore

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ABSTRACT. *Hanguana podzolicola* (Hanguanaceae) is newly recorded for Singapore. Detailed colour plates are given alongside the main characters for distinguishing this species from the two most similar species in Singapore, *Hanguana rubinea* and *H. triangulata*. The seeds of *Hanguana podzolicola* are described for the first time. A local conservation assessment is given. As no original material of *Hanguana podzolicola* could be traced, a neotype is designated here. Following a recent clarification of several historical *Hanguana* names it is noted here that the correct name for the large helophytic stoloniferous species often cultivated in Singapore under the name *Hanguana malayana* is *Hanguana anthelminthica*. An updated key to *Hanguana* species in Singapore is provided.

Keywords. Central Catchment Nature Reserve, *Hanguana anthelminthica*, *H. malayana*, *H. pantiensis*, IUCN conservation assessment, Johor, neotypification, Peninsular Malaysia

Introduction

In a recent overview of *Hanguana* Blume in Singapore, Leong-Škorničková & Boyce (2015) recognised four native, one introduced, and one cultivated species. Since the publication of this paper, fieldwork on Hanguanaceae has continued and a survey of all populations of *Hanguana*, along with a systematic survey of the primary forest habitats of Zingiberales in Singapore, has been undertaken (Niissalo et al., 2017). During these surveys we found a population of a species that has not been previously reported from Singapore.

We have compared our material to all seven *Hanguana* species so far described from Peninsular Malaysia (Jack, 1820; Siti Nurfazilah et al., 2010; Leong-Škorničková & Kiew, 2016). The plants in Singapore are similar to two species described from Johor, *Hanguana podzolicola* Siti Nurfazilah et al. and *H. pantiensis* Siti Nurfazilah et al., in their leaf characters, small fruits and strongly obliquely positioned stigmas, although, of these two, the spreading, long inflorescence branches of the Singaporean plant
better fit *H. podzolicola*. We have not seen individuals with particularly pronounced aerial stems in Singapore, but based on our observations in Singapore and Peninsular Malaysia, we believe that this character has little taxonomic value, as it is regularly seen in many taxa and is likely an indication of an old individual. Siti Nurfasilah et al. (2010) only reported female plants and, likewise in Singapore, only female plants have been collected. We provide a full description, including the previously undescribed seeds, and photographic illustrations of the species based on the Singapore population to aid future taxonomic work.

The type specimens and all paratypes for the five names published in Siti Nurfasilah et al. (2010) were never deposited in KEP. The whereabouts of these materials, including those of *Hanguana podzolicola*, remain unknown. There are no morphologically well-matched specimens of *Hanguana podzolicola* from the type locality or nearby areas in any of the herbaria we have examined (E, K, KEP, L, P, SING). A single sheet of *Hanguana podzolicola* was found at USM (Mohd Fahmi Bin Abu Bakar et al. 59; Sofiman Othman, pers. comm), but this collection is not mentioned in the protologue and it is not from the type locality. The specimen consists of a young female inflorescence, but it has no leaves or fruits and therefore does not allow for unambiguous identification of the species. As the population in Singapore appears to be morphologically inseparable from the plants from the type locality illustrated by Siti Nurfasilah et al. (2010), we designate a neotype from a fully ripe female specimen collected in Singapore.

We consider the two specimens, Corner s.n. from Mandai Road and Ridley 170 from Seletar, previously cited with caution as *Hanguana rubinea* Škorničk. & P.C.Boyce by Leong-Škorničková & Boyce (2015), to rather be *H. podzolicola* as they match the living material seen in all aspects, most prominently in the large size of the female inflorescences. The ripe fruit on Corner s.n. also matches *Hanguana podzolicola* in the strongly obliquely positioned stigmas and seed structure.

The vegetative parts of this species, especially the corrugated leaves and fairly prominent flocculose indumentum, are very similar to those of *Hanguana triangulata* Škorničk. & B.C.Boyce. Our preliminary results from genetic analyses of Singapore’s *Hanguana* populations (Niissalo et al., manuscript in preparation) suggest that the sterile specimen from Upper Seletar originally cited by Leong-Škorničková & Boyce (2015) under *H. triangulata* (Leong-Škorničková, J. & Thame, A. JLS-3036), is genetically part of the same population as our collections of fertile *H. podzolicola*. We therefore correct its identification to *Hanguana podzolicola* here. The only surviving populations of *Hanguana triangulata* are therefore in Bukit Timah Nature Reserve and, as confirmed by the preliminary results of our analyses, all plants with corrugated leaves in the northern parts of the Central Catchment Nature Reserve are *H. podzolicola*. In the fruiting stage these two taxa are not easily confused as *Hanguana podzolicola* has much longer and more slender inflorescence branches (to c. 30 cm), smaller pink fruits (c. 5–7 mm in diam.) that turn translucent green-dull pink to green-brown as they ripen, and strongly obliquely positioned and rounded stigma lobes (compared to short and almost perpendicular branches to 8 cm long, larger cream-white fruits 9–10 mm in diam., a stigma which is terminal or slightly
oblique, and stigma lobes which are connate at base and with sharp apices forming an equilateral triangle in *H. triangulata*). In addition the seed has a single, broadly and bluntly acute appendage (compared to the seed appendage bluntly bilobed in *H. triangulata*). *Hanguana podzolicola* is also similar in stature and inflorescence details to *H. rubinea*, but differs from it by its prominently corrugated leaves and abaxially more thickly flocculose indumentum (compared to the almost flat lamina with a sparse indumentum in *H. rubinea*). They also differ in inflorescence branch length, fruit, and seed details (in *Hanguana rubinea* branches are up to 11 cm long, fruits are larger, 9–10 mm in diam., and turn ruby-red as they ripen, stigma is terminal or only slightly oblique, stigma lobes are similar to *H. podzolicola*, except larger, and the seed appendage is triangular). *Hanguana podzolicola* has the largest female inflorescences of any native *Hanguana* in Singapore.

With the recent work on *Hanguana* in Singapore (Niissalo et al., 2014; Leong-Škorničková & Boyce, 2015), the current paper brings the number of native *Hanguana* species in Singapore to five. *Hanguana malayana* (Jack) Merr., the name provisionally applied to the cultivated massive helophyte by Leong-Škorničková & Boyce (2015; see Fig. 1 & 11–12), is here updated to *Hanguana anthelminthica* (Blume ex Schult. & Schult.f.) Masam. to reflect a recent clarification of the old names of *Hanguana* (Leong-Škorničková & Niissalo, 2017). *Hanguana malayana* is a solitary forest species that is so far only known from Penang and has never been collected from Singapore, whereas *Hanguana anthelminthica* is the widespread massive helophyte that is also widely cultivated in the tropics, including in Singapore. An updated key to all *Hanguana* species in Singapore is provided.

**Hanguana podzolicola** Siti Nurfazilah et al. – TYPE: Singapore, Mandai Road, 24 Aug 2015, Leong-Škorničková, J. HAN-76 (neotype SING [mounted over 2 sheets and including fruits preserved in spirit as part of a single specimen], here designated). (Fig. 1, 2)

*Herbaceous, dioecious mesophyte* to c. 1.6 m tall; stem terete, to 3 cm in diam., basally semi-ascending, with age becoming leafless, terminally ascending with crown of up to 20 leaves; *stolons* absent. **Leaves** to 170 cm long, spreading then arching, bases imbricate margins hyaline (young leaves), turning erose-marcescent with age; *pseudopetiole* 60–70 cm long, c. 10–14 mm wide, accounting for 1/3–1/2 of entire leaf length, roundly channelled with sharp margins, strigose; *leaf blade* 80–105 × 14–17 cm, narrowly elliptic, base attenuate, tip long, narrowly attenuate with apicule c. 4 mm, leathery, irregularly corrugated, adaxially mid to dark green, sparsely hairy (silky appressed hair; falling off in older leaves), abaxially lighter green when fresh, prominently flocculose (falling off in older leaves); *midrib* weakly impressed, of the same colour as the rest of the lamina adaxially, round-raised, lighter green, almost glabrous and shiny abaxially. **Male inflorescences** not observed, female inflorescences erect at anthesis. **Female inflorescence/infructescence** erect, comprising up to 9 partial, whorled, alternate-secund, thyrsoid infructescences plus a terminal spike;
Fig. 1. *Hanguana podzolicola* Siti Nurfaizilah et al. A. Lower side of the lamina showing flocculose indumentum. B. Upper side of the lamina. C. Habit (inset: detail of the petiole). D. Detail of young fruits (photographed on 29 Apr 2015) E. Detail of ripe fruits (photographed from the same individual on 24 Aug 2015). F. Infructescence. From Leong-Škorničková, J. HAN-76. (Photos: Jana Leong-Škorničková)
**Fig. 2.** *Hanguana podzolicola* Siti Nurfazilah et al. A. Side view detail of fruit attached to a branch showing tepals tightly clasping the base of the fruit. B. Detail of inner tepals, staminodes and staminodial scales. C. Detail of stigma. D. Cross section of fruit showing single seed and two empty locules. E. Longitudinal section of fruit. F. Fruit in top view, showing asymmetrically placed stigma. G. Seed (side view, appendage facing camera). H. Seed (side view, appendage to the right). I. Seed (top view, appendage to the left). From Leong-Škorničková, *J. HAN*-76. (Photos: A–F: Jana Leong-Škorničková; G–I: Matti A. Niissalo)

*partial inflorescences* spreading almost perpendicularly to rachis (lowermost 2 ascending); *peduncle and rachis* together up to 90 cm tall, green when fresh, conspicuously pale brown-grey flocculose, visible portion of peduncle up to 30 cm long; one sterile bract per peduncle, foliaceous, persistent, narrowly ovate with a basal claw, c. 95 (incl. 30 cm long claw/pseudopetiole) × c. 11 cm; *bract subtending partial inflorescences* similar to sterile bracts, diminishing in size and becoming narrowly triangular distally along the infructescence, the bract supporting basal-most partial
inflorescences c. 50 × 10 cm (incl. 6 cm claw), fully reduced in uppermost partial inflorescences; partial inflorescences each comprising up to 17 branches at basal levels (occasionally two branches connate at base; fewer towards the apex of the inflorescence), branches arising simultaneously from the axil of the subtending bract, lateral branches progressively shorter in length (outermost lateral branches 1/2–2/3 of the median branch), median branches at basal levels usually further branched, 20–30 cm long (10–25 cm long in upper levels). **Female flowers** scattered, solitary or in pairs, sessile, all with an associated minute bract and bracteole; perianth composed of 6 tepals in two whorls tightly clasping ovary/fruit in fresh material, all tepals with prominent bulbous thickening at base (more prominent in outer whorl), light green, margin c. 0.2–0.3 mm wide, hyaline translucent white; outer tepals broadly ovate, 2.5–3 mm long, c. 2.8–3 mm broad, connate at base (only 0.3 mm), sparsely arachnoid; inner tepals almost circular, c. 3 mm long, 3–3.2 mm broad, free to base, almost glabrous; staminodes 6, in two whorls, pale green to cream white, triangular, outer staminodes, 0.3–0.4 mm long, 0.2–0.3 mm broad at base, inner staminodes longer, narrowly triangular, c. 1 mm long, 0.2–0.3 mm at base, each basally sheathed with a broad narrow scale (often shallowly bilobed), c. 0.8–0.9 mm long, and c. 1.2 mm broad, brown with translucent margin, stigma 3-lobed, c. 1.5 mm in diam., each lobe 0.8–1 mm long (fruiting material), broadly ovate with round apex, lobes connate basally, with points of connation seen as grooves, matte dark brown (fruiting stage); position of stigma in ripe fruits strongly oblique (only a single seed ever develops). **Ripe fruit** with pink blush externally (ripe fruit appears dirty-pink or green-brown as the dark seed colour is visible through the increasingly translucent pulp), globose, 5–7 mm diam.; pulp 0.7–1 mm thick, pale yellow, fairly hard, ripening from cream-white with bright pink blush, to dirty pale yellow with dull pink tinge; seeds 1 per fruit (2 seeds in a single fruit have not been observed), c. 5 × 4 mm, brown, deeply bowl-shaped with slightly incurved margins, with a small broadly bluntly acute appendage positioned on the distal part of the rim, cavity filled with placental tissue.

**Distribution.** Both the historic and recent collections of this species in Singapore are from the northern parts of the Central Catchment Nature Reserve or locations immediately adjacent to it. The species is now only found in the Nee Soon Freshwater Swamp-forest (NSFS). One historic collection locality, Seletar, has likely been deforested, but the locality name was used for a larger swamp-forest complex that was once connected to NSFS (O’Dempsey & Chew, 2013). In Peninsular Malaysia the species has been recorded from two localities in Johor, Hutan Simpanan Lenggor, Mersing and Hutan Lipur Panti, Kota Tinggi (Siti Nurfazilah et al., 2010).

**Ecology & phenology.** In Singapore *Hanguana podzolicola* is strictly a swamp-forest species, occurring in locations with permanently wet or flooded soil in NSFS. The only other species recorded there, *Hanguana rubinea*, occurs in drier locations. The two are only occasionally sympatric at the edges of the swamp forest (Upper Seletar and southern end of NSFS). Based on historical collections and our observations, the species flowers early in the year (c. March) and fruits ripen by July–August.
**Provisional IUCN conservation assessment.** The known Extent of Occurrence of *Hanguana podzolicola* is c. 500 km$^2$ and the species is currently only known from three localities, with an estimated Area of Occupancy of c. 10 km$^2$. Two of the known localities are in protected areas, but the third is highly susceptible to forest loss. The species should therefore be considered to be Endangered globally, EN B1ab(iii) (IUCN, 2012). In Singapore there are c. 50 stems, all solitary, and the majority of them are found within a small area (c. 1/2 ha) of particularly wet, low-lying forest, with only very few or single stems elsewhere in NSFS. Given the small number of stems, small total area of occupancy and the highly clustered distribution, the species should be considered Critically Endangered (CR C2) nationally using the slightly amended national categories of Davison et al. (2008).


**Notes:** The fruit colour develops in an unusual way in this species, and the fruits illustrated in Siti Nurfazilah et al. (2010) are not yet fully ripe. In the fruits we have observed, the fruits have nearly reached their mature size by late April. At this point the fruits have a bright pink coloration, but they remain unripe and the seeds remain soft. The fruits ripen very slowly and become more translucent over time. As the seeds ripen dark brown, the fruits appear dirty greenish-dull pink or even green-brown when the seeds are fully developed. This ripening stage lasts for about five months after the fruits have their final size (Fig. 1), bringing the total flowering and fruiting process to last 7–8 months.

Singapore plants overall agree closely with measurements from Malaysia (Siti Nurfazilah et al., 2010), but the petioles we measured are proportionally longer (1/3 of leaf length in Malaysia, up to 1/2 of leaf length in Singapore), and the outer whorls of petals are also slightly larger in Singapore than in the Malaysian plants (1 × 1.8 mm in Malaysia, 2.5–3 × 2.8–3 mm in Singapore). However, when comparing photographs of the fruits of both Malaysian and Singapore collections, the proportional dimensions of outer and inner tepals compared to diameter of the fruits appears to be identical.

Leong-Škorničková & Boyce (2015) discussed the taxonomic importance of oblique stigmas in *Hanguana* and, as they mention, oblique stigmas can occur in many *Hanguana* species when only a single seed develops inside the fruit. However, in *Hanguana podzolicola* (and apparently *H. pantiensis*) the stigma is very strongly oblique, even closer to the base of the fruit than the apex, and such a strongly oblique stigma is an unmistakable character of taxonomic significance. It is also well preserved in dry material. The species is also characterised by the thick, flocculose indumentum, but this character is often lost on old herbarium specimens and also on the older leaves of live plants and therefore unreliable for herbarium-based taxonomy.
Updated key to *Hanguana* in Singapore

1a. Large stoloniferous colonial herbs ................................................................. 2
1b. Solitary or clumping herbs lacking stolons ..................................................... 3

2a. Leaves stiffly erect with acute apex; lamina more or less flat or weakly irregularly
corrugate, semi-matt green; staminodial scales composed of lobes without
a hyaline margin; stigma lobes large, flat, connate at base, forming a bluntly
triangular to clover-leaf shape, almost obscuring the apex of ovary ..............
.......................................................... *H. anthelminthica*

2b. Leaves weakly arching, with long-attenuate apex; lamina prominently corrugate,
shiny green with a visible pattern of lighter and darker green (best observed on
young and medium aged leaves); staminodial scales entire with a hyaline margin;
stigma lobes small, erect, separate, teardrop-shaped to obovate .............. *H. nitens*

3a. Leaves green on both sides .................................................................................. 4
3b. Leaves dark emerald-green above and dark red-purple underneath ...... *H. corneri*

4a. Large herbs over 1 m in height; leaves arching; ripe fruits cream-white, dull pink
or ruby red; seeds bowl-shaped, more or less hemispherical ....................... 5
4b. Medium sized herbs not exceeding 0.8 m in height; leaves spreading (not arching);
ripe fruits black; seeds 3/4 globose to ovoid with wedge-shaped opening ........
...................................................................................................... *H. neglecta*

5a. Lamina almost flat, abaxially with evenly distributed silky indumentum; ripe
fruits ruby-red; stigma lobes connate basally (sometimes imperfectly), with
round apices ........................................................................................................... *H. rubinea*
5b. Lamina more or less corrugate, abaxially with unevenly distributed
flocculose indumentum, ripe fruits cream-white or dull pink ...................... 6

6a. Ripe fruits cream-white, 9–10 mm in diam.; stigma lobes with sharply acute
apices, forming sharply triangular structure; seed appendage bluntly bilobed ..... 
......................................................................................................................... *H. triangulata*
6b. Ripe fruits dull pink, 5–7 mm in diam.; stigma lobes connate basally (sometimes
imperfectly), with round apices, forming bluntly triangular structure; seed
appendage single, broadly bluntly acute ...................................................... *H. podzolicola*

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**References**


Two new records of *Litsea* (Lauraceae) from Singapore and the lectotypification of twenty-two names from several Lauraceae genera

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Keywords. *Beilschmiedia*, *Cinnamomum*, *Cryptocarya*, *Lindera*, *Litsea*, Singapore

Introduction

Recently several genera of Lauraceae have been revised for the *Flora of Singapore* (*Beilschmiedia* Nees, *Cinnamomum* Schaeff., *Cryptocarya* R.Br., *Lindera* Thunb. and *Litsea* Lam.). The Lauraceae (Laural Family) are of major ecological and economic importance in Southeast Asia as they comprise a major part of many forests in the region. In particular, species of the genus *Cinnamomum* are important as sources of various spices and several species have been introduced into Singapore for this purpose. In Singapore, there are two species of *Beilschmiedia* (de Kok, 2016a), five of *Cinnamomum* (de Kok, in prep.), seven of *Cryptocarya* (de Kok, 2015, 2016b), one of *Lindera* and eighteen of *Litsea* (de Kok, in prep.). These will be enumerated in the forthcoming *Flora of Singapore*. No species is endemic to Singapore. Unlike in the Lamiaceae (de Kok et al., 2016), it is relatively easy to determine if a species is native or naturalised in Singapore. Two species are recorded from Singapore for the first time: *Litsea tomentosa* Blume, and *L. spathacea* Gamble. Both species are common in the lowland forests of Peninsular Malaysia and their occurrence in Singapore is therefore not a surprise.
The revisions of Lauraceae from Singapore are based on herbarium collections made in Singapore and now housed at the Natural History Museum, London (BM), the Royal Botanic Gardens, Kew (K and K-W), the Forest Research Institute of Malaysia (KEP) and the Singapore Botanic Gardens (SING). Type material not available at those institutions was studied online via JSTOR (https://plants.jstor.org/plants) and accessed in July 2017. In addition to the new records for *Litsea*, twenty-two names from all of the genera revised need to be lectotypified. Barcode information is given for all specimens where available.

**New species records for Singapore**


Tree or shrub 4.5–15 m tall; dbh 7–30 cm. Twigs slender to stout 2.7–9 mm thick, grey (brown), angled to round in cross-section, densely hairy, glabrescent; hairs appressed, yellowish; terminal leaf bud 2–6.3 mm long, lanceolate to ovate, apex acute, velutinous. Leaves alternate. Leaf blade elliptic to oblanceolate or obovate, 11–29 × 4–12 cm, apex (broadly) acute, base cuneate, margins straight, blade membranous to thinly leathery, secondary veins 9–14 pairs, curving near margin and sometimes brochidodromous, tertiary veins scalariform-reticulate; upper surface glossy, dark green, glabrous with a few hairs on midrib, midrib sunken, secondary veins raised, tertiary veins distinct; lower surface green with yellowish midrib, glaucous, glabrous to sparsely hairy, always some hairs present on midrib, midrib and secondary veins raised, tertiary nerves distinct. Petiole slender to slightly swollen, half-terete, 10–25 mm long, sparsely hairy. Inflorescence 1–4 cm long, formed of clusters of umbels in axils of leaves or along branchlets, umbels 6–7.5 mm in diam., pale yellow-green or greenish white; bracts 5, usually imbricate, (sub)orbicular, concave, 5–6.5 × 5–6 mm, velutinous outside. Male flowers white, 6–8 in each umbel; tepals 5–6, elliptic-lanceolate, subequal, 1.5–4 × 0.8–1 mm, hairy; stamens 8–14, unequal; filaments 1–5 mm long, a few hairs present; anthers 0.5–1.5 mm long, yellow. Female flowers 3–6 in each umbel; tepals 5–6, elliptic-lanceolate, subequal, 2–3 × 0.9–3 mm, sparsely hairy; staminodes 7–12, linear, 0.5–3 mm long, glabrous; ovary ovoid, 0.5–1 mm in diam., glabrous; style 1–2 mm long; stigma peltate. Infructescence of 1–3 fruits. Fruits globose to elliptic 15–20 × 11–14 mm, smooth, glabrous, red or purplish when mature; cupule shallow, 13–15 mm in diam., 6–7.2 mm high, glabrous, margin entire or undulate, surface smooth; fruiting pedicel 5–10 mm long, slightly thickened, 1.7–2.6 mm thick.
Distribution. Peninsular Malaysia and Singapore. In Singapore, it is only reported from two specimens both without a locality or date (Cantley’s Collector s.n. (SING); Unknown s.n. (BM)).

Ecology. In the rest of its range growing in lowland and hill forests, sometimes along rivers, from 90–975 m altitude. Flowering all year round; fruiting from February to March.

Conservation. Least Concern (LC) globally, this species is widespread and has been collected over a wide area in the last 20 years (see also IUCN, 2017). In Singapore, it has been collected only twice, in the late 19th or early 20th century, and must, therefore, be considered to be nationally extinct.

Notes. There are eleven different gatherings, which are usually duplicated in several herbaria, available for lectotypification for this name. As Gamble was working at K when he wrote his paper (Gamble, 1910), the K specimen of the gathering: L. Wray 2286 (K000797118) is designated here as the lectotype.

As mentioned above, it is only known from Singapore by two specimens, one at SING, collected by Cantley’s Collector, without a collection number, while a specimen with no collector’s name and number is housed at BM. Cantley worked in Peninsular Malaysia and Singapore in the 1880’s. During this time, he had a collector (M.V. Alvins) who also made collections for him from the same area, Alvins’ labelling is said to be inadequate (only giving the state for localities) and sometimes incorrect (Van Steenis-Kruseman, 1950: 100). The label on the BM collection is from the early 20th century. It seems likely, therefore, that both these specimens where collected in the period between 1880 and 1900, with a question mark about the accuracy of the locality of Cantley’s Collector (M.V. Alvins). The species is common in the lowlands of Peninsular Malaysia, but is not known from open vegetation. It is, therefore, not surprising that it used to grow in Singapore and that it now no longer does. However, the species is difficult to recognise as it is morphologically similar to the very common Litsea umbellata (Lour.) Merr. and could, therefore, have been overlooked in surveys.


Tree 6–40 m tall; dbh 7–40 cm, buttresses extending out to 60 cm; bark smooth, lenticellate, greyish or light brown to black, inner bark red brown, wood yellow. Twigs slender to stout 3.8–12 mm thick, round or angular in cross-section, velutinous, glabrescent; hairs appressed to patent, yellowish; terminal leaf bud 5.5–8.3 mm
long, ovate, apex acuminate, velutinous. **Leaves** spiral, crowded toward the apices of the branchlets. **Leaf blade** elliptic to oblancoolate, 8–40 × 4–16 cm, apex acute to obtuse, base cuneate to rarely rounded, sometimes asymmetric, margins straight, blade chartaceous, secondary veins 11–16 pairs, curving and sometimes brochidodromous, tertiary veins scalariform-finely reticulate; upper surface green, glabrous with densely hairy midrib and secondary veins, midrib raised to sunken, secondary veins shallowly sunken, tertiary veins faint; lower surface glaucous, sparsely hairy to densely so on major veins, midrib and secondary veins raised, tertiary veins distinct. Petiole half-terete, 10–55 mm long, velutinous, glabrescent; hairs appressed to patent, yellowish. **Inflorescence** 1.5–3 cm long, formed of clusters of umbels along branchlets, velutinous, umbels 12–20 mm in diam.; bracts 4–5, suborbicular or broadly ovate, concave, 5–6 × 4–5 mm, velutinous outside. **Male flowers** 5–6 in each umbel; tepals 9–12, lanceolate, unequal, 4–6 × 1.5–2 mm, sparsely hairy; stamens 24–30, unequal; filaments 2–5 mm long, sparsely hairy; anthers 1–1.5 mm long. **Female flowers** 5–6 in each umbel, tepals 8–12, lanceolate, 2–3.1 × 1–1.3 mm, densely hairy; staminodes 26–30, linear, 1.5–3.8 mm long, sparsely hairy; ovary ovoid, 1–1.5 mm in diam., glabrous; style 1.5–2 mm long; stigma peltate. **Fruits** (sub)globose, 1.6–2.2 × 2–2.1 cm, smooth, glabrous, glossy, red when mature; cupule shallow, 11–15 × 1.5–3 mm, sparsely hairy, margin entire, surface warty; fruiting pedicels 7–9.6 mm long, not swollen, 4.3–5.8 mm thick, sparsely hairy.

**Vernacular names.** Medang taudok (Malay).

**Distribution.** Peninsular Thailand, Malaysia (Peninsular and Borneo), Singapore, Indonesia (Borneo, Sumatra and Java) and the Philippines. In Singapore, it has been collected only once, at Tanglin (H.N. Ridley s.n., Upper Tanglin, behind barracks, 1893).

**Ecology.** Throughout its range in open areas in disturbed lowland forests, between 0–750 m altitude. Flowering from February to June; fruiting from September to December.

**Conservation.** Least Concern (LC) globally, this species is widespread and has been collected over a wide area in the last 20 years. In Singapore, it has only been collected once, in the late 19th century, and must therefore be considered to be nationally extinct.

**Notes.** This species has not previously been recorded for Singapore, where it is only known from a single specimen, collected by H.N. Ridley in 1893, from upper Tanglin, behind the barracks. The species is common in the lowlands of Peninsular Malaysia and on the islands of the Sunda shelf and can occur in open areas as well as in disturbed forests. It is, therefore, not surprising that it used to grow in Singapore, but given that it can adapt to open vegetation, it is perhaps surprising that it no longer does. The species is very distinctive with its broad hairy leaves which are crowded near the apex of the young twigs. It is unlikely that it has been overlooked in botanical surveys.
Lectotypifications


At least two gatherings are mentioned in the original description of *Beilschmiedia curtisii* Gamble (Gamble, 1910: 148): *C. Curtis 1015* and *H.N. Ridley 8075*. As Curtis numbered species rather than gatherings, there is no guarantee that all *Curtis 1015* specimens are from the same collection event, despite all having the same locality: Government Hill. The Curtis collections are, therefore, not selected for lectotypification. As Gamble was working at Kew at the time he described this species, the K specimen of *H.N. Ridley 8075* is designated here as the lectotype.


Several gatherings are mentioned in the original description of *Beilschmiedia perakensis* Gamble (Gamble, 1910: 149): *B. Scortechini s.n.* and *King’s Collector 8489*, 10026 and 10432, which are all very similar. Of these, one of the K specimens of *King’s Collector 10026* [K000768677] is designated here as the lectotype.

**Cinnamomum subavenium** Miq., Fl. Ned. Ind. 1: 90 (1858). – TYPE: [Indonesia] Sumatra, Solok, J.E. Teijsmann s.n. (lectotype U [U0002677], designated here; isolectotypes BO, U [U0002678]).

Only one gathering is mentioned in the original description of *Cinnamomum subavenium* Miq. (Miquel, 1858: 90): *Teijsmann, Sumatra, Solok ‘Madang koelit manis’*. At U, two sheets collected by Teijsmann have this locality and the same local name and sheet number, *HB1037*. One specimen has a few flowers and a very young fruit, while the other is sterile. The fertile specimen, U0002677, is therefore designated here as the lectotype.

Only one gathering was mentioned in the original description of *Cryptocarya argentea* Gamble (Gamble, 1910: 144–145): *King’s Collector* 7966. As Gamble was working at Kew at the time he wrote this article, one of the two K specimens is selected as the lectotype. As sheet K001084384 has more immature fruits than K001084383, it is designated here as the lectotype.


In the original description, Blume (1856) mentioned only the F.A.C. Waitz gathering, of which there are three sheets available at L for lectotypification. One sheet, L0036159, has one whole immature fruit and a further dissected immature one, the second sheet, L0036158, has only an immature fruit, and the last sheet, L0036157, is sterile. The first specimen is designated here as the lectotype.


In the original decription, Blume (1851) mentioned two different gatherings: one from the mountain Patuhae on Java and one from South Borneo. In L, two specimens of the former can be identified, L0036276 and L0036277, and one possible one from Borneo, L0036282. The specimen L0036276 has an old (but not original) label clearly stating that it was collected at Patuhae, while the second specimen, L0036277, is much smaller than the first and its label is more recent. The Borneo specimen has no collection data. The specimen from Java with the older label is designated here as the lectotype [L0036276].


In the original description, Blume (1826) only mentioned that the type specimen came from Java. Several gatherings from Java are present at L which Blume saw and which could be used for lectotypification (L0036495, L0036496, L0036497, L0036498, L0036499, L0036500, L0036501, L0036502). One of these is almost sterile, L0036495, while the others have several inflorescences with flowers. Sheet L0036501 bears an original handwritten note with the local name, which is also mentioned in the original description and so this specimen is designated here as the lectotype.

Several gatherings are mentioned in the original description of *Lindera malaccensis* Hook.f. (Hooker, 1886: 183): *W. Griffith [Kew Distribution no. 4297]; A.C. Maingay 1988 [Kew Distribution no. 1257]; A.C. Maingay 3095 [Kew Distribution no. 1257]; A.C. Maingay 1781 [Kew Distribution no. 1257]; A.C. Maingay, [Kew Distribution no. 1272]. As Hooker worked at Kew, the K specimens are most suitable for lectotypification. Of these, only the *Griffith* specimen *[Kew Distribution no. 4297]* has the characteristic card with flower dissections, notes and signature of Gamble and it is designated here as the lectotype.


In the original description of *Tetranthera accedens* Blume (Blume, 1851) no mention is made of any collectors or numbers but two localities are given: Borneo and Celebes. It appears that he was referring to the following gatherings: *Korthals s.n.* from Borneo [U0002782] and *Forsten s.n.* from Tondano (now in Sulawesi Utara), collected in July 1840 [L0036568, L0036569, L0036570]. Most of these collections are sterile. The one Forsten gathering with flowers, L0036569, is designated here as the lectotype.


There are ten gatherings mentioned in the original description of *Litsea amara* Blume var. *attenuata* Gamble (Gamble, 1912: 142): *H.N. Ridley 2265, 9473, 13781; King’s Collector 4614, 8750, 10142; Burn-Murdoch 4; A.C. Maingay 1266, 1278; R. Derry 990. These are all very similar to one another and as Gamble was working at K the time, the K specimen of *R. Derry 990* is designated here as the lectotype.

There are two sheets at K of the one gathering cited in the original description of *Litsea gracilis* Gamble (Gamble, 1910: 317). The sheet bearing a card with notes, dissections and the signature of Gamble, K000797038, is designated here as the lectotype.


In the original description of this name, only one gathering, with male flowers, was cited: *W. Griffith [Kew Distribution no. 4311]* from Malacca (Hooker, 1886: 159–160). In K, two specimens of this gathering are present, K000797136 and K000797135, and the one with the dissection of male flowers and notes on the sheet, K000797135, is designated here as the lectotype.


In the original description of this name, many Peninsular Malaysian, Singaporean and Sumatran gatherings are mentioned: *Burn-Murdock 282 (Ridley 14284), Forbes 1762, W. Griffith [4285], King’s Collector 5865, 8573, King & Hullett s.n., Maingay 12521, Ridley 4823, 5569, and Wray 2757* (Gamble, 1912: 187–188). The gathering from the Reservoir Woods in Singapore, *Ridley 4823*, housed at K, is designated here as the lectotype.


In the original publication of this name, Blume (1851: 367) gave the collection data only ‘in Java’. There are two possible sheets available at U for lectotypification, one only has a single sterile leaf [U0002823] and the other has a twig with several leaves and a few small inflorescences [U0002822]. The latter is designated here as the lectotype.

In their paper dealing with the species of *Litsea* from Thailand, Ngernsaengsaruaray et al. (2011: 70) selected Ridley 4706 at K as the lectotype of *L. machilifolia*. However, six years before, Ng (2005: 238), in his paper dealing with the species from Borneo, had already selected a different specimen (Penang, *Curtis* 795 at SING) as the lectotype for this name. There are, however, two sheets at SING with this number and locality: Penang, Moniot Road, April 1886, *Curtis* 795 [SING 0055932] with flowers, and Penang, Moniot Road, July 1886, *Curtis* 795 [SING 0068773] with fruits. As only one of these can serve as the type, and as fruits are more important than flowers in species recognition within *Litsea*, the fruiting specimen is designated here in a second step lectotypification (see McNeill et al., 2012: Art. 9.17, Ex. 12).


In his description of this variety, Gamble (1912: 172) mentioned thirteen very similar separate gatherings, for which there are often duplicates in several other herbaria. As Gamble was working at K when he wrote his paper, the K specimen of *King’s Collector* 6815 is designated here as the lectotype.


Twenty very similar gatherings, for which there are often duplicates in several herbaria, were cited by Gamble when he published the name *Litsea megacarpa* (Gamble, 1910: 364–365): *Curtis* 2511; Wray 2337, 2730; Scortechini 265, 270, 589; *King’s Collector* 3697, 6076, 6124, 6155, 6237, 6409, 6567, 6613, 6689, 6774, 6866, 7204; Ridley 6455 and 7621. As Gamble was working at K when he wrote this paper, the K specimen of the gathering from Singapore, Toas, 1894, *Ridley* 6456 is designated here as the lectotype.


Several morphologically very similar gatherings were mentioned in the original description of *Litsea pustulata* by Gamble (1910: 359–360): *King’s Collector* 2544, 3418 and 5140. The specimen with the most fruits of *King’s Collector* 5140 housed at K is designated here as the lectotype.

In the original description of Litsea sarawacensis Gamble (Gamble, 1910: 365–366), several morphological very similar gatherings were cited: Ridley 4817; Beccari 905, 1475, 1708, 1796; Haviland 3077 and 3646. The K sheet of the gathering from Singapore, Ridley 4817, is designated here as the lectotype.


Numerous gatherings were mentioned in the original description of Litsea singapurensis by Gamble (1910: 358): H.N. Ridley 2118, 3372, 3894, 4135, 4826, 5065, 5736, 5738, 9075 and R.W. Hullett 5738. I was unable to locate two of these (H.N. Ridley 2118 and R.W. Hullett 5738). As Gamble was working at Kew at the time he wrote this article, the K specimen of H.N. Ridley 4135 is designated here as the lectotype.


Two sheets of type material of Hexanthus umbellatus are extant at BM. One has flowers, leaves and twigs [BM000951060] and the other has several loose leaves, a twig and some flowers [BM000951061]. The first sheet is designated here as the lectotype.

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References


Novitates Bruneienses, 9. A synopsis of *Epirixanthes* (Polygalaceae) in Brunei Darussalam and notes on species elsewhere

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ABSTRACT. The genus *Epirixanthes* Blume is revised for Brunei Darussalam. Four species are recognised for the country: *Epirixanthes cylindrica* Blume, *E. elongata* Blume, *E. kinabaluensis* T.Wendt and *E. papuana* J.J.Sm., with the two latter species being newly recorded for the Brunei flora. A single collection from Brunei that was formerly identified as *Epirixanthes pallida* T.Wendt is now confirmed as *E. papuana*. A revised key for the genus is included.

Keywords. Distribution, herbs, Malesia, mycoheterotrophic plants, north-western Borneo, taxonomy, understorey

Introduction

*Epirixanthes* Blume is a species-poor genus of holomycorrhizal herbaceous plants from the family Polygalaceae which inhabit the understorey of tropical rainforests (Van der Meijden, 1988; Merckx et al., 2013). It is sister to the autotrophic genus *Salomonia* Lour. with which it shares several synapomorphies such as spike-like terminal inflorescence and three anteseudal stamen primordia (Van der Meijden, 1988; Mennes et al., 2015). Members of the genus are generally tiny plants with reduced bract-like leaves and dense spike-like inflorescences (Van der Meijden, 1988). Due to the reduction of vegetative organs as a result of mycoheterotrophy, the set of morphological characters useful for species determination is very limited and includes mostly reproductive organs (i.e., bracts, bracteoles, sepals and fruits). Currently, only seven species of *Epirixanthes* are recognised worldwide, and all of them are endemic to Indo-Malesia (Van der Meijden, 1988; Pendry, 2010; Tsukaya et al., 2016). The centre of its taxonomic diversity lies in Borneo where six of the species co-occur, with one of them apparently endemic to the island (Fig. 1). In the Checklist of the Flowering
Fig. 1. Global distribution and diversity of *Epirixanthes* with number of species for each region and number of endemic species in parentheses.

*Plants and Gymnosperms of Brunei Darussalam* (Coode et al., 1996), three species of *Epirixanthes* are reported from the country, namely *E. cylindrica* Blume, *E. elongata* Blume and *E. pallida* T.Wendt. During our recent ecological research activities in Kuala Belalong (Ulu Temburong National Park, Temburong district), we frequently encountered *Epirixanthes* plants in the lowland dipterocarp forest understorey. However, some of the observed plants did not match with any of the three species reported from Brunei Darussalam by Coode et al. (1996), indicating they possibly belong to unrecorded species. We therefore decided to clarify the taxonomic status of these plants and present a revision of *Epirixanthes* in the country.

**Material and methods**

We examined specimens deposited in BRUN (Brunei National Herbarium) as well as our field collections from Brunei Darussalam deposited in OL (Herbarium of the Department of Botany at Palacký University in Olomouc). Available duplicates kept in K (Royal Botanic Gardens Kew) and AAU (Science Museums, Aarhus University)
were also seen. The identification of each specimen was checked and the identifications updated when necessary. All cited specimens have been seen. Bruneian localities from herbarium labels are sorted below according the current administrative districts of Brunei Darussalam.

Results

Four species of *Epirixanthes* were found to occur in Brunei Darussalam, namely *E. cylindrica*, *E. elongata*, *E. kinabaluensis* T.Wendt and *E. papuana* J.J.Sm. The two former species were previously known from the country while the two latter species are new additions to the country’s flora. *Epirixanthes pallida* should be excluded from the Brunei checklist as all three duplicates (deposited in BRUN, K, and AAU) of the single collection (*Poulsen 3*) cited in Coode et al. (1996) consist of misidentified plants of *E. papuana*. All four species co-occur in the Lowland Mixed Dipterocarp forest of the Ulu Temburong National Park in the Temburong district, which further highlights the floristic and conservation significance of this area.

The *Epirixanthes* species of Brunei Darussalam

1. *Epirixanthes cylindrica* Blume, Cat. Gew. Buitenzorg 82 (1823). (Fig. 2A)

*Global distribution.* Its range includes Myanmar, Sumatra, Java, Borneo and New Guinea (Van der Meijden, 1988).

*Distribution in Brunei Darussalam.* It is documented only from the Temburong district in a few localities in Kuala Belalong – Bukit Belalong area. Its known elevational range in Brunei Darussalam is from c. 100 m a.s.l. up to 850 m a.s.l.


*Notes.* This species is distinguished by a rather short and thick inflorescence. The apex of the inflorescence is covered by imbricate bracts. As most of the specimens come from middle altitudes this species seems to be rare in true lowlands.

2. *Epirixanthes elongata* Blume, Cat. Gew. Buitenzorg 82 (1823). (Fig. 2B)

*Global distribution.* The species range extends from eastern India and southern China to the Moluccas (Van der Meijden, 1988; Chen et al., 2008).

*Distribution in Brunei Darussalam.* It is documented from various locations across the Temburong district. Outside Temburong, it has only been collected from a single locality around Labi in the Belait district. Its known elevational range in Brunei Darussalam is from c. 40 m a.s.l. up to 420 m a.s.l.
Epirixanthes in Brunei Darussalam

Specimens examined. BRUNEI DARUSSALAM: Belait: Labi, Sungai Rampayoh, ca. 3.5 km above road towards Waterfall No. 2, 9 Jan 1994, Coode 7784 (BRUN). Temburong: Batu Apoi Forest Reserve, ridge W of Kuala Belalong Field Studies Centre, in Danish Plot, mixed dipterocarp forest, 1991, Poulsen 224 (AAU, BRUN); Kuala Belalong, E ridge of Sungai Belalong, ca. 1.5 km SE from its confluence with Sungai Temburong, depression NW of ecological plot 2, 13 Feb 2015, Hédi & Chudomelová RH132015 (OL); Kuala Belalong, E ridge of Sungai Belalong, ca. 0.9 km ESE from its confluence with Sungai Temburong, ecological plot 1, 13 Jan 2014, Dančák 2014/6 (OL); ibidem, 13 Jan 2014, Dančák 2014/125 (OL); ibidem, 13 Jan 2014, Dančák 2014/160 (OL); ibidem, 13 Jan 2014, Dančák 2014/180 (OL); ibidem, 4 Feb 2015, Hroneš & Kobrolová 702015 (OL); Sungai Temburong at Kuala Belalong, 23 Jun 1989, Dransfield 1007 (BRUN); Apan, ridge to the north of the river, 13 Jul 1993, Sands 5786 (BRUN); Amo, southeast of LP 297 Bkt. Lutut, 6 Apr 2004, Ariffin et al. BRUN 20797 (BRUN); Labu, Peradayan F. R., 5 Feb 2002, Ariffin et al. BRUN 19913 (BRUN).

Notes. This is the most common species of Epirixanthes. It is locally abundant elsewhere in Borneo, and is presumably also common in Brunei Darussalam. In Kuala Belalong it is almost ubiquitous and by far the most abundant species of Epirixanthes. This species is easily recognised among Bruneian Epirixanthes as its bracts are shed well before the flowers open and the inflorescence is very long and narrow. One of the specimens studied (Hroneš & Kobrolová 702015) is a very pale-coloured plant conspicuously different from the typical brownish-purple plants of E. elongata. Such pale ivory individuals are known to occur within populations of E. elongata and they were described from West Kalimantan as E. elongata f. alba Tsukaya & H.Okada (Tsukaya & Okada, 2012).

3. Epirixanthes kinabaluensis T.Wendt, Fl. Males., Ser. 1, Spermat. 10(3): 491 (1988). (Fig. 2C)

Global distribution. The species is found in Sumatra and Borneo (Van der Meijden, 1988).

Distribution in Brunei Darussalam. It is known only from two locations in the immediate vicinity of the Kuala Belalong Field Studies Centre in the Temburong district. Its known elevational range in Brunei Darussalam is very narrow as it is recorded only from altitudes around 100 m a.s.l., even though its type locality, the slopes of Mt. Kinabalu in Sabah, lies at around 900–1200 m a.s.l. We have observed the species in the Kelabit Highlands of Sarawak up to c. 1300 m a.s.l.

Specimens examined. BRUNEI DARUSSALAM: Temburong: Kuala Belalong, Sungai Esu valley, at its confluence with Sungai Belalong, 9 Jan 2014, Dančák 2014/162 (OL); ibidem, 18 Jan 2014, Dančák 2014/343 (OL); Kuala Belalong, Sungai Esu, clayey bank near its confluence with Sungai Belalong, 21 Jan 2017, Dančák 2017/46 (BRUN); Kuala Belalong, Earthwatch ecological plot ca. 0.3 km W from the Kuala Belalong Field Studies Centre, 28 Jan 2016, Dančák 2016/292 (OL).
Notes. This species is the most robust of all Bruneian *Epirixanthes*, although *E. elongata* is usually taller. It has a rather thick inflorescence with long bracts which sometimes persist on the axis of the inflorescence after the fruits are shed.

4. *Epirixanthes papuana* J.J.Sm., Repert. Spec. Nov. Regni Veg. 10: 486 (June 1912). (Fig. 2D)

Global distribution. It is distributed throughout Malesia from Sumatra to the Solomon Islands (Van der Meijden, 1988).

Distribution in Brunei Darussalam. It is known only from a few locations immediately surrounding the Kuala Belalong Field Studies Centre in Temburong district and one locality in the Bukit Sawat area in Belait district. However, its actual distribution in the country could be much more extensive. Like most of the other species of *Epirixanthes*, this species is likely to be overlooked by collectors and therefore poorly represented in herbaria. Its known elevational range in Brunei Darussalam is rather narrow, reaching from c. 20 m a.s.l. up to 180 m a.s.l. However, the species might potentially also occur at higher elevations because the type collection from New Guinea comes from altitudes from 500 m a.s.l. up to 1800 m a.s.l.


Notes. This species is distinguished by its paler colour (creamy brownish) and the rather short and narrow inflorescence with patent bracts that are turned-up at their apices.

Notes on other species of *Epirixanthes*

*Epirixanthes pallida* T.Wendt, Fl. Males., Ser. 1, Spermat. 10(3): 492 (1988). (Fig. 2E)

Global distribution. The species is found in Borneo and Sulawesi (Van der Meijden, 1988).
Notes. The species was included in the Brunei Checklist (Coode et al., 1996) based on a single collection (Poulsen 3) originally identified as *Epirixanthes pallida* but which has been reidentified as *E. papuana*. Therefore *Epirixanthes pallida* should be excluded from the flora of Brunei Darussalam. *Epirixanthes pallida* is readily distinguished from the Bruneian species by large and very early caducous whitish or pinkish bracts. It seems that *Epirixanthes pallida* is a highland species and thus probably does not grow in lowland rainforests. Its known altitudinal range is from c. 600 m a.s.l. at the type locality up to c. 1200 m a.s.l. in the Kelabit Highlands of Sarawak. As its type locality (slopes of Gunung Api in Sarawak, Malaysia) is just a few kilometres from Brunei’s borders, it might potentially occur at higher altitudes in the Temburong district. It is, however, unlikely that *Epirixanthes pallida* occurs in the Tutong and Belait districts because of the generally lower terrain in these areas. Even though the type locality is on a limestone bedrock, we have observed the species in the Kelabit Highlands in Sarawak at several localities on sandstone bedrock.

**Epirixanthes confusa** Tsukaya et al., Phytotaxa 266(2): 147 (2016).

*Global distribution.* It is endemic to Borneo (Tsukaya et al., 2016).

*Notes.* This species is a recent addition to the genus and was described from Imbak Canyon in Sabah, Malaysia (Tsukaya et al., 2016). It undoubtedly belongs to the group of species with free sepals and wide fruits which also includes *Epirixanthes elongata*, *E. pallida* and *E. compressa* Pendry, but differs by its long-persistent bracts. So far it is known only from the type locality.


*Global distribution.* It is endemic to Thailand (Pendry, 2010).

*Notes.* This biogeographically remarkable species is narrowly distributed in southeastern Thailand (Chanthaburi Province) and is, therefore, the only member of the genus which does not occur in Malesia. Like the previous species, it belongs to the group of *Epirixanthes* with free sepals and wide fruits.

**Key to the species of Epirixanthes**

The following key is adapted from Van der Meijden (1988), Pendry (2010) and Tsukaya et al. (2016).

1a. Sepals free; fruit wider than long ................................................................. 2
1b. Sepals connate for ¼–¾; fruit longer than wide or equal .................................. 5
2a. Bracts caducous before the flowers open ................................................. 3
2b. Bracts persistent at least until the fruits mature .................................... 4

3a. Both leaves and bracts hairy with glandular hairs; inflorescence apex ± pointed, not fully covered by bracts; bracts narrowly triangular, c. 1.2 mm long and 0.5 mm wide, brown with central purple stripe .................................................. E. elongata
3b. Both leaves and bracts glabrous; inflorescence apex ± rounded, completely covered in imbricate bracts; bracts ovate, 2–3 mm long and 1–1.5 mm wide, whitish or pinkish .................................................. E. pallida

4a. Bracts glabrous, some of them persistent after the fruits have fallen; inflorescence elongate, 2–6 cm long; corolla caducous; endemic to Sabah .................. E. confusa
4b. Bracts minutely ciliate, all of them shed with fruits; inflorescence shortly cylindrical, up to 2.5 cm long; corolla persistent; endemic to Thailand .......... ................................................................................................................. E. compressa

5a. Each flower subtended by a bract and pair of subulate bracteoles; bracts ± patent during anthesis, linear with sharply upturned obtuse apex; fruit longer than wide, much shorter than sepals .................................................. E. papuana
5b. Each flower subtended only by a bract, bracteoles absent; bracts ± erect during anthesis, with straight acute or slightly curved apex; fruit as long as wide, as long as sepals or longer .................................................. 6

6a. Bracts lanceolate, 2–2.5 mm long and 0.5–0.6 mm wide, brown with purple central stripe, usually persistent after the fruits have fallen; inflorescence apex not completely covered by bracts; fruit as long as sepals ............... E. kinabaluensis
6b. Bracts ovate, 1.5–2 mm long and 0.8–1.2 mm wide, brown with basal purple patch, usually shed with fruits; inflorescence apex completely covered by imbricate bracts; fruit longer than sepals .................................. E. cylindrica

**Conservation status of Epirixanthes**

The forests of Borneo, including Brunei, Sabah and Sarawak, harbour the highest diversity of *Epirixanthes*. Six species have so far been reported from this island (Van der Meijden, 1988; Coode et al., 1996; Tsukaya et al., 2016). Similar to other mycoheterotrophic plants, all species of *Epirixanthes* are closely tied to primary or very lightly logged forests and as such are threatened by continuing deforestation. However, published data on their distribution and ecology are very scarce and most of the species are poorly represented in herbaria. For these reasons, we propose that all species of *Epirixanthes* in this study be evaluated as data deficient (DD, IUCN Standards and Petitions Subcommittee, 2016) which emphasises the need for further study and sampling.
ACKNOWLEDGEMENTS. We are very grateful to the staff of the Kuala Belalong Field Studies Centre and the Brunei National Herbarium for their service and support. We are indebted to Salwana Jaafar, Hazimah Din and a group of Universiti Brunei Darussalam students for field assistance and logistical arrangements. We also thank Radim Hédl, Markéta Chudomelová, Michal Sochor, Lucie Kobrovlá and Ondřej Popelka for their field assistance. We thank Universiti Brunei Darussalam and the Brunei Forestry Department for permission to conduct research at KBFSC and in the Ulu Temburong National Park respectively, and the Biodiversity Research and Innovation Centre (BioRIC) for granting our export permit. Researchers from Palacký University were supported by project no. CZ.1.07/2.2.00/28.0149.

References


A new species of Zingiber (Zingiberaceae) east of Wallace’s Line

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ABSTRACT. Zingiber Mill. is distributed from India to the Pacific but only a few species are known from east of Wallace’s Line, whereas the area to the west is rich in species. A recent collection from limestone at Bantimurung, South Sulawesi, Indonesia represents a new eastern species, Zingiber ultralimitale Ardiyani & A.D.Poulsen, which is described, illustrated, and barcoded using three of the four barcoding loci (rbcL, trnR-psbA and ITS). Placement of this species using morphological evidence is ambiguous but a combination of evidence from morphology, pollen anatomy and molecular analysis indicates that it belongs to Zingiber sect. Zingiber.

Keywords. Bantimurung, DNA barcode, Indonesia, limestone, Sulawesi, Wallacea

Introduction

Species of Zingiber Mill. occur from India in the west, through Malesia to the western Pacific, and those east of Wallace’s Line are poorly known. There are about 180 species of Zingiber in the world (Zingiberaceae Resource Centre, 2017). Of the 45 species and six varieties of Zingiber occurring in Indonesia west of Wallace’s Line (Ardiyani et al., unpublished), four cross Wallace’s Line, all of them cultivated (Z. officinale Roscoe, Z. montanum (J.Koenig) A.Dietr., Z. odoriferum Blume, Z. zerumbet (L.) Sm.), indicating that their occurrence to the east may be anthropogenic.

Zingiber is currently classified into four sections based on the habit of the inflorescence (Baker, 1894; Schumann, 1904; see Table 1). Most Zingiber species occurring in Malesia belong to Zingiber sect. Zingiber.

Theilade et al. (1993) studied the pollen morphology of a range of species and found that it was not congruent with the division of the genus into sections. Their study showed that in Zingiber sect. Zingiber and Zingiber sect. Dymczewiczia (Horan.) Benth. & Hook. the pollen grains are spherical with cerebroid sculpturing, whereas in Zingiber sect. Cryptanthium Horan. they are ellipsoidal with spiro-striate sculpturing. For this reason, Theilade et al. suggested that Zingiber sect. Dymczewiczia should be included in Zingiber sect. Zingiber.
The molecular study of Theerakulpisut et al. (2012) supports the classification of *Zingiber* into four sections although *Zingiber* sect. *Zingiber* and *Zingiber* sect. *Dymczewiczia* are only weakly supported. This weak support does not, therefore, necessarily refute Theilade’s conclusion that *Zingiber* sect. *Dymczewiczia* should be included in *Zingiber* sect. *Zingiber*. These two sections are more closely related to each other than to *Zingiber* sect. *Cryptanthium* and *Zingiber* sect. *Pleuranthesis* Benth. & Hook. (Theerakulpisut et al., 2012).

Plants of an unidentified *Zingiber* were collected from limestone at Bantimurung, South Sulawesi in 2009. When they were first encountered, several individuals could be seen from the road but they were not easy to reach. At first the sterile plants were thought to be a species of *Globba* L. different from the only other species known to occur east of Wallace’s Line, *G. marantina* L. As this would be a biogeographically exciting discovery, we decided to try to collect sterile plants for cultivation. Despite some difficulty because the roots were deeply anchored in cracks in the limestone, we managed to collect 10 plantlets that were exported to Java, half of which were deposited in Bogor Botanic Gardens and the other half in the Royal Botanic Garden Edinburgh (accession numbers 20092015–20092019). Some of the plants flowered in Edinburgh, enabling us to conclude that it is an undescribed species which we here name *Zingiber ultralimitale*, and to make a full description including floral details and pollen morphology. In addition to describing this species formally, we investigate the sectional placement of this geographically unusual find using palynological data and molecular systematic analyses.

<table>
<thead>
<tr>
<th>Section</th>
<th>Geography</th>
<th>Inflorescence</th>
<th>Pollen morphology</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Zingiber</em></td>
<td>India, China, Indo-China, Thailand, Peninsular Malaysia, Sumatra, Borneo, Java, Cultivated</td>
<td>Borne on radical, erect peduncle or borne apically on a leafy stem</td>
<td>Spherical with cerebroid exine sculpturing</td>
</tr>
<tr>
<td><em>Cryptanthium</em></td>
<td>India, Thailand, China, Indo-China</td>
<td>Borne on a radical, procumbent peduncle</td>
<td>Ellipsoidal with spiro-striate sculpturing</td>
</tr>
<tr>
<td><em>Dymczewiczia</em></td>
<td>India, China, Indo-China, Thailand, Java, Papua New Guinea</td>
<td>Borne apically on a leafy stem</td>
<td>Spherical with cerebroid exine sculpturing</td>
</tr>
<tr>
<td><em>Pleuranthesis</em></td>
<td>China (Yunnan), Vietnam</td>
<td>Arising from the side of the leafy stem</td>
<td>Spherical with cerebroid exine sculpturing</td>
</tr>
</tbody>
</table>
Material and methods

Detailed studies of the morphology were made using living collections grown in the greenhouse of the Royal Botanic Garden Edinburgh. Measurements were made using a ruler and a calibrated eye piece under a dissecting microscope.

For the DNA barcoding, three barcoding regions were successfully sequenced, namely \textit{rbcL}, \textit{trnH-psbA} and the nuclear Internal Transcribed Spacer (ITS). The fourth barcoding region, \textit{matK} could not be sequenced. Extraction, amplification and sequencing followed Kress et al. (2002) and Kress & Erickson (2007). The material sequenced was from Poulsen et al. 2767. GenBank accession numbers for the three barcoding regions are summarised in Table 2. A phylogenetic analysis based on ITS sequences was performed using additional sequences from NCBI GenBank after BLAST was done. GenBank has very few records of \textit{rbcL} and \textit{trnH-psbA} so it was not possible to run an analysis using these regions to address the affiliation of \textit{Zingiber ultralimitale}. \textit{Kaempferia parviflora} Wall. ex Baker and \textit{K. elegans} (Wall.) Baker were chosen as the outgroup following Theerakulpisut et al. (2012) (Table 3). Sequence alignment and Maximum Likelihood analysis were conducted using MEGA version 6 (Tamura et al., 2013).

Table 2. Voucher information and Genbank accession numbers.

<table>
<thead>
<tr>
<th>Species</th>
<th>Gene region</th>
<th>Genbank accession number</th>
<th>Material (Herbarium location)</th>
</tr>
</thead>
<tbody>
<tr>
<td>\textit{Zingiber ultralimitale}</td>
<td>\textit{rbcL}</td>
<td>KU891637</td>
<td>Poulsen et al. 2767</td>
</tr>
<tr>
<td></td>
<td>\textit{trnH-psbA}</td>
<td>KU891638</td>
<td>(BO, E)</td>
</tr>
<tr>
<td></td>
<td>\textit{ITS}</td>
<td>KU891639</td>
<td></td>
</tr>
</tbody>
</table>

For the palynological study, material was collected from a living plant growing at the Royal Botanic Garden Edinburgh (acc. no 20092015 A) and fixed in FAA for at least 24 hours. Mature but unopened flowers were selected. For SEM, anthers were dissected from the flowers, put into tiny chambers and dehydrated for 45 minutes in 50%, 70%, 95%, and 100% ethanol, ten minutes in acetone (two changes of five minutes each). Critical point drying was carried out in an Emitech K850 dryer and samples were sputter-coated with platinum and examined using a Zeiss Supra 55VP SEM.

Results and discussion

Most of the \textit{Zingiber} species of western Malesia have tightly imbricate bracts, long or very short peduncles, and lateral staminodes joined to the labellum, although \textit{Zingiber
Table 3. Species of *Zingiber* and outgroups obtained from NCBI GenBank.

<table>
<thead>
<tr>
<th>No</th>
<th>Species</th>
<th>Distribution/Section</th>
<th>GenBank Acc. No. (ITS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><em>Z. barbatum</em> Wall.</td>
<td>Thailand/Zingiber</td>
<td>DQ064578</td>
</tr>
<tr>
<td>2</td>
<td><em>Z. bradleyanum</em> Craib</td>
<td>Thailand/Cryptanthium</td>
<td>DQ064579</td>
</tr>
<tr>
<td>3</td>
<td><em>Z. capitatum</em> Roxb.</td>
<td>India, Himalaya/Zingiber</td>
<td>KM983532</td>
</tr>
<tr>
<td>4</td>
<td><em>Z. capitatum</em></td>
<td>India, Himalaya/Zingiber</td>
<td>KM983536</td>
</tr>
<tr>
<td>5</td>
<td><em>Z. citriodorum</em> Theilade &amp; Mood</td>
<td>Thailand/Zingiber</td>
<td>DQ064591</td>
</tr>
<tr>
<td>6</td>
<td><em>Z. coloratum</em> N.E.Br.</td>
<td>Borneo/Zingiber</td>
<td>AF414498</td>
</tr>
<tr>
<td>7</td>
<td><em>Z. corallinum</em> Hance</td>
<td>Thailand, China/Zingiber</td>
<td>AF254460</td>
</tr>
<tr>
<td>8</td>
<td><em>Z. corallinum</em></td>
<td>Thailand, China/Zingiber</td>
<td>DQ064587</td>
</tr>
<tr>
<td>9</td>
<td><em>Z. ellipticum</em> (S.Q.Tong &amp; Y.M.Xia) Q.G.Wu &amp; T.L.Wu</td>
<td>Yunnan-China/Pleuranthesis</td>
<td>AF478799</td>
</tr>
<tr>
<td>10</td>
<td><em>Z. fragile</em> S.Q.Tong</td>
<td>Indochina, Java, Sumatra/Zingiber</td>
<td>DQ064581</td>
</tr>
<tr>
<td>11</td>
<td><em>Z. gramineum</em> Noronha ex Blume</td>
<td>Indochina, Java, Sumatra/Zingiber</td>
<td>DQ064577</td>
</tr>
<tr>
<td>12</td>
<td><em>Z. gramineum</em></td>
<td>Indochina, Java, Sumatra/Zingiber</td>
<td>AF478800</td>
</tr>
<tr>
<td>13</td>
<td><em>Z. isanense</em> Triboun &amp; K.Larsen</td>
<td>Thailand/Zingiber</td>
<td>DQ064586</td>
</tr>
<tr>
<td>14</td>
<td><em>Z. junceum</em> Gagnep.</td>
<td>Thailand/Zingiber</td>
<td>DQ064588</td>
</tr>
<tr>
<td>15</td>
<td><em>Z. junceum</em></td>
<td>Thailand/Zingiber</td>
<td>AY424774</td>
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<tr>
<td>16</td>
<td><em>Z. longipedunculatum</em> Ridl.</td>
<td>Borneo/Zingiber</td>
<td>AB097254</td>
</tr>
<tr>
<td>17</td>
<td><em>Z. montanum</em> (J.Koenig) Link ex A.Dietr.</td>
<td>Cultivated/Zingiber</td>
<td>KJ872221</td>
</tr>
<tr>
<td>18</td>
<td><em>Z. montanum</em></td>
<td>Cultivated/Zingiber</td>
<td>DQ064585</td>
</tr>
<tr>
<td>19</td>
<td><em>Z. neesanum</em> (J.Graham) Ramamoorthy</td>
<td>India, Indochina/Zingiber</td>
<td>KJ872228</td>
</tr>
<tr>
<td>20</td>
<td><em>Z. neesanum</em></td>
<td>India, Indochina/Zingiber</td>
<td>KJ872226</td>
</tr>
<tr>
<td>21</td>
<td><em>Z. neotruncatum</em> T.L.Wu, K.Larsen &amp; Turland</td>
<td>India, China/Zingiber</td>
<td>DQ064589</td>
</tr>
<tr>
<td>22</td>
<td><em>Z. newmanii</em> Theilade &amp; Mood</td>
<td>Thailand/Zingiber</td>
<td>DQ064575</td>
</tr>
<tr>
<td>23</td>
<td><em>Z. odoriferum</em> Blume</td>
<td>Cultivated/Zingiber</td>
<td>KF304561</td>
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<tr>
<td>24</td>
<td><em>Z. odoriferum</em></td>
<td>Cultivated/Zingiber</td>
<td>KF304562</td>
</tr>
<tr>
<td>25</td>
<td><em>Z. officinale</em> Roscoe</td>
<td>Cultivated/Zingiber</td>
<td>DQ064590</td>
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<td>26</td>
<td><em>Z. orbiculatum</em> S.Q.Tong</td>
<td>Thailand/Cryptanthium</td>
<td>DQ064573</td>
</tr>
<tr>
<td>27</td>
<td><em>Z. ottensii</em> Valeton</td>
<td>Cultivated/Zingiber</td>
<td>DQ064582</td>
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<tr>
<td>28</td>
<td><em>Z. ottensii</em></td>
<td>Cultivated/Zingiber</td>
<td>AJ388298</td>
</tr>
<tr>
<td>29</td>
<td><em>Z. parishii</em> Hook.f.</td>
<td>Thailand/Zingiber</td>
<td>KF304567</td>
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<tr>
<td>30</td>
<td><em>Z. parishii</em></td>
<td>Thailand/Zingiber</td>
<td>DQ064576</td>
</tr>
<tr>
<td>31</td>
<td><em>Z. pellitum</em> Gagnep.</td>
<td>Thailand/Dymczewiczia</td>
<td>DQ064574</td>
</tr>
<tr>
<td>32</td>
<td><em>Z. purpureum</em> Roscoe (syn. of <em>Z. montanum</em>)</td>
<td>Cultivated/Zingiber</td>
<td>HM236153</td>
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<tr>
<td>33</td>
<td><em>Z. rubens</em> Roxb.</td>
<td>Thailand/Cryptanthium</td>
<td>DQ064580</td>
</tr>
<tr>
<td>34</td>
<td><em>Z. spectabile</em> Griff.</td>
<td>Sumatra, Malay Peninsula/Zingiber</td>
<td>AF414499</td>
</tr>
<tr>
<td>35</td>
<td><em>Z. sulphureum</em> Burkill ex Theilade</td>
<td>Sumatra, Malay Peninsula/Zingiber</td>
<td>AF478801</td>
</tr>
<tr>
<td>36</td>
<td><em>Z. wrayi</em> Prain ex Ridl.</td>
<td>Sumatra, Malay Peninsula, Thailand/Zingiber</td>
<td>AF478802</td>
</tr>
<tr>
<td>37</td>
<td><em>Z. wrayii</em></td>
<td>Sumatra, Malay Peninsula, Thailand/Zingiber</td>
<td>DQ064583</td>
</tr>
</tbody>
</table>
Table 3. Continued.

<table>
<thead>
<tr>
<th>No</th>
<th>Species</th>
<th>Distribution/Section</th>
<th>GenBank Acc. No. (ITS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>38</td>
<td><em>Z. zerumbet</em> (L.) Roscoe ex Sm.</td>
<td>Cultivated/Zingiber</td>
<td>KC582863</td>
</tr>
<tr>
<td>39</td>
<td><em>Z. zerumbet</em></td>
<td>Cultivated/Zingiber</td>
<td>DQ064584</td>
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<tr>
<td>40</td>
<td><em>Z. ultralimitale</em> Ardiyani &amp; A.D.Poulsen</td>
<td>Sulawesi/Zingiber</td>
<td>KU891639</td>
</tr>
<tr>
<td>41</td>
<td><em>Z. ultralimitale</em></td>
<td>Sulawesi/Zingiber</td>
<td>KU891639</td>
</tr>
<tr>
<td>42</td>
<td><em>Kaempferia elegans</em> (Wall.) Baker</td>
<td>China, Indochina, Malesia</td>
<td>AY424764</td>
</tr>
<tr>
<td>43</td>
<td><em>K. parviflora</em> Wall. ex Baker</td>
<td>India, Indochina</td>
<td>DQ064592</td>
</tr>
</tbody>
</table>

*Zingiber ultralimitale* Ardiyani & A.D.Poulsen, sp. nov.

This species is distinct from all others by the following combination of characters: narrow long loose green bracts, bright yellow flowers, and large free yellow lateral staminodes.—TYPE: Indonesia, originally collected from South Sulawesi Province, Bantimurung NP, along Jalan Poros Maros–Soppeng, and cultivated as RBGE 20091017*A, flowering material vouchered on 12 June 2013 as Newman, M.F. 2552 (holotype BO; isotype E). (Fig. 2, 3)
Fig. 1. Phylogenetic tree of *Zingiber* based on Maximum Likelihood analysis using the Internal Transcribed Spacers data (ITS). Bootstrap values (based on 1000 replicates) are presented above the branches. Only Bootstrap values higher than 50% are shown.
Lithophytic herb. **Rhizome** branching profusely, 5–8 mm across, brown externally, yellowish internally, tasting like *Zingiber officinale* but very bitter; roots with irregular ellipsoid tubers to $2.5 \times 1.5$ cm, white in cross-section, tasting like potato. **Leafy shoots** in a loose clump of up to five pseudostems, 2–4 cm apart, to 40–75 cm tall, with 9–12(–20) leaves. **Base of leafy shoot** to 9 mm diam., white to yellowish brown. **Sheaths** light green to mid-green, ± finely hairy especially near margin and apex. **Ligule** to 8 mm long, membranous, emarginate at least for half its length, with scattered, appressed hairs, pale green. **Petiole** 2–9 mm long, channelled above, appressed villose abaxially, especially in lower half. **Lamina** ovate to narrowly ovate, 9–18 $\times$ 3.5–5.5 cm, slightly plicate, yellowish green and glabrous above, pale green and sparsely appressed villose beneath especially near midrib, base rounded when fresh, cuneate to truncate when dried, apex long acuminate. **Inflorescence** erect, to 16 cm long, arising close to the base of leafy shoot, with 9–12 flowers, one flower open at a time in late morning. **Peduncle** 3–6 cm long with 4 peduncular bracts, upper one to 4.5 cm long, being the longest, with scattered fine hairs. **Spike** to 10.5 cm long. **Bracts** laxly arranged at an angle to the rachis, c. 5 mm apart exposing the mid-green rachis, each subtending a single flower, lowermost bract c. $4.5 \times 1.7$ cm, translucent pale green, slightly darker towards apex, with visible cross-veins and hyaline margins, apex of lower bracts acuminate.

Fig. 2. Pollen of *Zingiber ultralimitale* (acc. no 20092015 A). SEM made by Zou Pu.
upper bracts with apex recurved, subulate appendages 6–8 mm long (reminiscent of a reduced lamina), finely ciliate especially near margin and apex, glabrous inside. **Bracteoles** ± as long as bracts, longer than calyx, to 4.6 × 1.3 cm (when flattened), split to base, margins supervolute, translucent cream at base becoming green towards apex, with scattered hairs near margin and along veins, glabrous inside. **Calyx** c. 2.6 cm long, tubular with one incision in upper half, membranous, translucent cream, minutely three-toothed at the apex, pubescent at apex. **Corolla tube** c. 3.5 cm long, white at base, becoming pale yellow apically; dorsal corolla lobe narrowly ovate, slightly hollow, c. 3.4 × 1.2 cm, pale orange-yellow; lateral corolla lobes narrowly ovate, c. 2.5 × 0.7 cm, adnate c. 3 mm to base of labellum, pale orange-yellow. **Labellum** obovate, c. 3.5 × 3–3.5 cm, central lobe c. 3.5 × 2–2.5 cm, bifid, incision c. 8 mm, the two halves slightly divergent and recurved, glabrous throughout, pale orange-yellow. **Lateral staminodes** (side lobes) petaloid, c. 2 × 0.8 cm, paler than labellum, and free from it. **Stamen** c. 3 cm long, filament distinct, c. 0.3 cm long, pale orange-yellow, anther c. 1.5 cm, crest 1.3–1.6 cm long (when stretched), wrapped around style, incurved, pale orange. Anther thecae open along their entire length, ± white. **Style** pale yellow. **Stigma** tubular with a downwards-facing, ciliate ostiole which holds a droplet, held by anther crest; epigynous glands 2, subulate, 4 mm long, pale yellow. **Ovary** c. 4 × 3 mm, trilocular, sometimes incompletely so, with axile placentation, ovules c. 25–30, pale yellow-green. **Fruit** not seen.

**Distribution.** Only known from the type locality in South Sulawesi.

**Etymology.** The specific epithet *ultralimitale* means ‘on the other side of the border’, referring to the occurrence of this species east of Wallace’s Line.

**Ecology and habitat.** Limestone cliffs and boulders in forest, lowlands at c. 300 m. During the first year of cultivation in Edinburgh, it was discovered that the species has a dormancy period during which it survives entirely underground.

**Phenology.** Flowering in May–June in cultivation. Our field assistant, Firdaus, checked the populations at the type locality in June 2016 and found no leafy shoots. From this we infer that the onset of the dry season had already resulted in the plant becoming dormant.

**Conservation status.** Vulnerable VU B1ab(iii) (IUCN, 2001). Abundant at one locality along the road inside a national park but the extent of occurrence is estimated as <20,000 km². It is known from <10 locations and there is a decline in extent and quality of the limestone habitats in Sulawesi.

**Additional specimens examined.** INDONESIA: **South Sulawesi:** Bantimurung National Park, along Jalan Poros Maros–Soppeng, 5°2'32.4"S 119°44'9.4"E, 340 m, 23 January 2009, A.D. Poulsen et al. 2767 (BO, E); Bantimurung National Park, along Jalan Poros Maros–Soppeng, 5°2'32.4"S 119°44'9.4"E, 340 m, 23 January 2009, living collection of Poulsen, A.D., Marlina
Notes. The rhizome branches and forms large clumps in cultivation, which explains why it was almost impossible to remove it from the cracks in the limestone boulders of its natural habitat. The leafy shoots collected in the field were much longer than those of cultivated plants (75 vs. 40 cm) and had up to 20 leaves per shoot (vs. up to 12) which were narrower. In 2015, only one of the plants in the glasshouses produced an inflorescence, which contained a total of 12 flowers usually opening late morning. Only one flower opened per day but sometimes there would be a day without flowers in between.

ACKNOWLEDGEMENTS. The Davis Expedition Fund, Augustinus, and Blaxall Valentine Awards sponsored the expedition in Indonesia in 2009 during which the plant was discovered. The Sibbald Trust funded A.D. Poulsen as a Davis Research Fellow. The State Ministry of Research and Technology (RISTEK) issued the necessary permit. We are indebted to Helen Yeats, RBGE for keeping the plants alive, thereby enabling us to study the flowers and describe the species, and for making additional collections for herbaria. The Royal Botanic Garden Edinburgh (RBGE) is supported by the Scottish Government’s Rural and Environmental Science and Analytical Services Division. We thank J.F. Veldkamp and Philip Oswald for help in Latinising the epithet, Zou Pu for letting us include her pollen photos, Firdaus for travelling to the type locality to check the phenology, and Ida Theilade, Pramote Triboun, Bai Lin, John Mood and Jana Leong-Škorničková for useful discussions. We also thank Susila and Hani Kharismandari for helping us in the Molecular Lab, Herbarium Bogoriense, Research Center for Biology, LIPI. Last but not least, the first author would like to thank the Sibbald Trust of the Royal Botanic Garden Edinburgh which allowed her to examine the herbarium specimens of *Zingiber* at E and K after the 10th Flora Malesiana Symposium.

References


**Syzygium jiewhoei** (Myrtaceae), a new endemic tree from Western New Guinea, Indonesia

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ABSTRACT. *Syzygium jiewhoei* Hambali, Sunarti & Y.W.Low, a new species from Western New Guinea, Indonesia, is described and illustrated. It is closely related to *Syzygium recurvovenosum* (Lauterb.) Diels but differs in a range of vegetative and reproductive morphological characteristics.

**Keywords.** East Malesia, Papua Province, Sahul shelf, *Syzygium recurvovenosum*

**Introduction**

New Guinea, the largest tropical island in the world, is located in the Malesian region with an area of approximately 800,000 km². Politically, it is divided into two roughly equal halves: to the east is Papua New Guinea and to the west is Indonesian New Guinea, comprising the provinces of Papua and West Papua. Biogeographically, New Guinea is part of the Sahul shelf, that also includes Australia and Tasmania, and these regions share similar floristic elements that are distinct from those on the Sunda shelf (Gressitt, 1982; Pieters, 1982). Hence, the phytogeography of the Malesian region has been a focus of research by tropical botanists (Van Steenis, 1950; Van Welzen et al., 2011; Crayn et al., 2015). A comprehensive Flora of New Guinea is still lacking. However, efforts by various botanical institutions have led to checklists, guides and monographs of selected plant groups, such as the orchids (Schuiteman & de Vogel, 2001, 2002, 2005, 2006, 2008; Schuiteman et al., 2010), palms (Heatubun, 2002; Baker & Dransfield, 2006; Heatubun et al., 2012), and alpine plants (Van Royen, 1979a, 1979b, 1982, 1983; Johns et al., 2006), etc.

*Syzygium* Gaertn. is one of the largest genera in the world, with about 1200–1800 species occurring principally in the Old World (Frodin, 2004; Parnell et al., 2007; *Syzygium Working Group*, 2016). A recent analysis reveals that *Syzygium* is
the genus with the largest number of tree species, about 1069 species in all (Beech et al., 2017). *Syzygium* diversity in New Guinea is expected to be extremely rich, with species occurring from the lowlands to the highlands (Craven, 2006), but identification of *Syzygium* species has always been difficult due to a lack of good morphological diagnostic characters, resulting in an accumulation of unidentified materials in many herbaria (Hartley & Perry, 1973; Craven, 2006; Craven & Biffin, 2010).

Among the earliest botanists to examine New Guinean *Syzygium* was Carl Lauterbach (Van Steenis-Kruseman, 1950). He described many new species, including some under segregate genera that are now considered synonyms of *Syzygium*, such as *Aphanomyrtus* Miq. and *Jambosa* Adans. (Lauterbach, 1910, 1912). Later, Friedrich Diels (see Van Steenis-Kruseman, 1950) described many more *Syzygium* species for New Guinea, some of them under *Jambosa* (Diels, 1922; Diels et al., 1929). Merrill & Perry (1939a, 1942a, 1942b) meticulously examined the enormous volume of material of New Guinean *Syzygium* gathered during the Archbold Expeditions. It was Merrill & Perry (1939b), in a treatment of *Syzygium* in Borneo, who synonymised *Jambosa*, and also a few other segregate genera in the *Syzygium* alliance, under *Syzygium*. Later, Hartley & Perry (1973) attempted to revise the by-then much larger *Syzygium* diversity of Papuasia. They recognised 138 species and also listed 69 species of unknown status or which were to be excluded from Papuasia, citing lack of materials for close examination while preparing the account. A recent enumeration in the *World Checklist of Myrtaceae* recorded 195 species of *Syzygium* for New Guinea (Govaerts et al., 2017).

In 1993, while assisting Freeport to establish a plant nursery at Timika under the Incubator Project, the first author stumbled upon several attractive juvenile plants of an unidentified *Syzygium* species with exceptionally long pendulous leaves in the forested area of Kuala Kencana. Ten years later, the first author visited Timika again and this provided an opportunity to procure seeds and seedlings of the peculiar Kuala Kencana *Syzygium* species for cultivation. From these materials, one of the plants was successfully established and is growing vigorously in the garden of Mr Tan Jiew Hoe in Singapore. The tree in Singapore eventually produced flowers and fruits, providing us with sufficient materials to examine for this study. The unidentified Kuala Kencana *Syzygium* is closely related to *Syzygium recurvovenosum* (Lauterb.) Diels but is distinct based on the suite of morphological characters listed in Table 1. It is concluded that the attractive Kuala Kencana *Syzygium* is an undescribed novelty from Western New Guinea and is named here as *Syzygium jiewhoei* Hambali, Sunarti & Y.W.Low.

**Material and methods**

A review of all New Guinean *Syzygium* species was conducted, based on herbarium specimens preserved in BO, K and SING (herbarium acronyms follow Thiers, 2017, continuously updated). Conventional methods employed in herbarium taxonomy were applied in this study. All measurements were taken from dried herbarium specimens. Photographic documentation is of the living specimen growing in Mr Tan Jiew Hoe's
**Table 1.** Comparison of morphological characteristics between *Syzygium jiewhoei* Hambali, Sunarti & Y.W.Low and *S. recurvovenosum* (Lauterb.) Diels.

<table>
<thead>
<tr>
<th></th>
<th><em>Syzygium jiewhoei</em></th>
<th><em>Syzygium recurvovenosum</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Young twigs</td>
<td>Prominently quadrangular and winged</td>
<td>Prominently quadrangular</td>
</tr>
<tr>
<td>Lamina</td>
<td>Slightly bullate</td>
<td>Unknown</td>
</tr>
<tr>
<td>Secondary veins</td>
<td>90–100 pairs</td>
<td>Up to 55 pairs</td>
</tr>
<tr>
<td>Inflorescence</td>
<td>c. 14–16 cm long</td>
<td>Up to 9 cm long</td>
</tr>
<tr>
<td>Peduncle</td>
<td>c. 13–15 mm wide</td>
<td>Up to 3.5 mm wide</td>
</tr>
<tr>
<td>Style</td>
<td>c. 8–18 mm long</td>
<td>c. 4 mm long</td>
</tr>
<tr>
<td>Fruits</td>
<td>Ovoid to broad-ellipsoid, 4–6 cm long, maturing salmon-pink</td>
<td>Pyriform, 2.3 cm long, red (immature)</td>
</tr>
</tbody>
</table>

garden in Singapore, from which the material for the herbarium was taken. Type materials of *Syzygium* species at BO, K and SING were examined, including type images of all Malesian *Syzygium* species available on JSTOR® Global Plants website (http://plants.jstor.org). Provisional conservation assessments are made using the methodology proposed by IUCN (2012).

**Taxonomy**

*Syzygium jiewhoei* Hambali, Sunarti & Y.W.Low, **sp. nov.**

Similar to *Syzygium recurvovenosum* (Lauterb.) Diels but differs in having 90–100 pairs of secondary veins (vs up to 55 pairs of secondary veins in *S. recurvovenosum*), 14–16 cm long inflorescences with 13–15 mm wide peduncles (vs up to 9 cm long and c. 3.5 mm wide in *S. recurvovenosum*), and 8–18 mm long styles (vs 4 mm long in *S. recurvovenosum*). – **TYPE:** Native to Indonesia, Western New Guinea, Papua, Timika, Kuala Kencana, living collection cultivated in Mr Tan Jiew Hoe’s garden in Singapore, vouchered on 3 July 2016 as *Hambali, G.G. s.n.* (holotype BO; isotype SING). (Fig. 1, 2)

**Tree** up to 9 m tall, diameter at breast height c. 20 cm, without buttresses. Bark papery, peeling, greyish brown. **Branchlets** glabrescent, green, prominently quadrangular and winged when young, becoming terete on older branches. **Leaves** purple when young, opposite and decussate on erect shoots, becoming secondarily distichous on lateral branches; blades narrowly elliptic to broadly linear, 60–105 × 14–25 cm, with hardly visible minute oil glands; margin entire; base cordate, apex long-acuminate; midrib and secondary veins on lower surface prominent, midrib flat and secondary veins sunken on upper surface; secondary veins 90–100 pairs, rather abruptly curving out from the midrib, intramarginal vein c. 2 mm from the leaf margin; glabrous on
Fig. 1. Syzygium jiewhoei Hambali, Sunarti & Y.W.Low. A. Young leaves. B. Cauliflorous habit with many inflorescences at various stages. C. Close-up of inflorescences showing flowers at anthesis. D. Close-up of infructescence. All from type Hambali, G.G. s.n. (Photos: G.G. Hambali)
Fig. 2. *Syzygium jiewhoei* Hambali, Sunarti & Y.W.Low. A. Young leafy branch showing winged and angular stem. B. Close-up of cordate leaf base and numerous almost parallel secondary veins arranged very closely together. C. An immature inflorescence. D. Close-up of a mature flower showing the numerous stamens. E. Close-up of a longitudinal section of a mature flower depicting the arrangement of stamens along the rim of the hypanthium. F. A mature fruit. G. Longitudinal section of a mature fruit showing echinate testa intrusions into the cotyledons. Drawn by Subari from holotype, *Hambali, G.G. s.n.* (BO).
both sides; upper surface green, drying dark brown, lower surface pale green, drying brown; petiole c. 7–10 mm long, 6–13 mm wide, leaves appearing subsessile due to length of blades. **Inflorescences** developing on the stem (cauliflorous), compound cymes 14–16 cm long with up to c. 250 flowers; peduncle dark brown, 3.5–6.5 cm long, 13–15 mm wide, branching to 4 orders, bearing flowers usually in triads at their tips; bracteoles rudimentary, caducous. **Flowers** bisexual, white, 18–24 mm long, hypanthium turbinate, 12–14 mm long, 3–4 mm wide at the top; sepals rudimentary; petals roundish, 3–4 mm across, pale green, caducous at anthesis. **Stamens** numerous, up to 76; filaments 6–10 mm, white; anthers c. 0.3 mm long, dirty white. **Pistil** persistent, green; style 8–18 mm long; ovary inferior. **Fruits** 4–6 × 4.5–5 cm, ovoid to broad-ellipsoid, slightly grooved longitudinally, salmon-pink and sour when fully ripe. **Seeds** 3.5 × 2.8 cm.

**Etymology.** We are pleased to name this handsome tree, with foliage very much resembling that of *Anthurium veitchii* Mast. (Araceae), after Mr Tan Jiew Hoe, a benefactor of science who has a great interest in natural history, particularly in the fields of botany and horticulture (see Kurzweil & Lwin, 2014; Kiew et al., 2015; Leong Škorničková & Newman, 2015; Lamb & Rodda, 2016).

**Distribution and habitat.** *Syzygium jiewhoei* is so far known only from the lowland forests around the vicinity of Timika, Papua Province, Indonesian New Guinea. However, the species has now been introduced for cultivation as an ornamental tree in Bogor (Java, Indonesia) and Singapore (Fig. 3).

**Provisional IUCN conservation assessment.** Data Deficient DD, following the guidelines in IUCN (2012). *Syzygium jiewhoei* is known only from Kuala Kencana, Timika, Papua Province, Indonesian New Guinea. As the distribution of this species is inadequately known, we propose a status of Data Deficient (DD). As for all species given this status, reassessment will be required as more data is gathered to document the flora of New Guinea. One current initiative is the Tropical Important Plant Areas-Indonesian New Guinea programme (TIPAs Indonesian New Guinea), led by the Royal Botanic Gardens, Kew in collaboration with Universitas Papua (UNIPA), Manokwari, to identify important areas for plant conservation with an emphasis on the Bird’s Head Peninsula, West Papua Province based on a set of criteria proposed by a team of plant conservationists (Darbyshire et al., 2017; Royal Botanic Gardens Kew, 2017).

**Notes.** *Syzygium jiewhoei* is a majestic free-flowering tree with a somewhat broad conical crown, which makes it a highly desirable ornamental tree. At maturity it produces showy inflorescences on its trunk. Flowers of *Syzygium jiewhoei* produce copious nectar for up to three days after anthesis, thereby attracting large numbers of the Asian honey bee (*Apis cerana*) and stingless bee (*Trigona laeviceps*). The mature salmon-pink fruits of *Syzygium jiewhoei* range from ovoid to broad-ellipsoid and somewhat oblong.
It’s worth noting that there is a solitary tree of *Syzygium jiewhoei* growing beside the road at the back of PT Freeport’s Environmental Department building in Kuala Kencana. It was previously erroneously identified as *Syzygium versteegii* (Lauterb.) Merr. & L.M.Perry. *Syzygium versteegii* differs from *Syzygium jiewhoei* in having terete branchlets and oblong leaves with only 15 pairs of secondary veins.

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References


Syzygium jiewhoei, a new species from Western New Guinea


A revision of *Microchirita* (Gesneriaceae) in Thailand

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Keywords. Chirita, Didymocarpoideae, Flora of Thailand, Gesneriads, new species, taxonomy

Introduction

Generic delimitation in Asian Gesneriaceae has been the focus of much recent research and has led to considerable change (Wei et al., 2010; Möller et al., 2011, 2014, 2016; Puglisi et al., 2011, 2016; Wang et al., 2011; Weber et al., 2011a, 2011b; Middleton & Möller, 2012; Middleton et al., 2014, 2015). This research, much of it based on the results of DNA sequence data, has resulted in an overall reduction in the number of genera but also the description of new genera to accommodate new species which were found to belong to previously unknown lineages (Middleton & Triboun, 2012; Middleton et al., 2015), and the splitting up of genera found to be polyphyletic (Weber et al. 2011a; Möller et al., 2014). Although there are still many questions to address, a relative degree of stability in the delimitation of Asian Gesneriaceae genera has been reached.

The genus *Chirita* Buch.-Ham. is one of the genera that was split up as a consequence of molecular phylogenetic research which found the genus to be polyphyletic (Wang et al., 2011; Weber, 2011a). *Chirita* was characterised by the presence of a “chiritoid” stigma (a two-lipped stigma with the upper lip reduced and the lower bilobed) but was otherwise extremely morphologically diverse. The genera into
which it has been divided are *Damrongia* Kerr ex Craib, *Henckelia* Spreng. (including *Chirita* itself), *Liebigia* Endl., *Microchirita* (C.B.Clarke) Yin Z.Wang and *Primulina* Hance (Weber et al. 2011a). Each of these genera is much more morphologically coherent than was *Chirita*. *Primulina* continues to grow in the number of species and is in need of revision, *Liebigia* has been revised as a section of *Chirita* (Hilliard, 2004), *Damrongia* has been revised for Thailand, its centre of diversity (Puglisi & Middleton, 2017), *Henckelia* is being investigated by a number of research groups (Møller, pers. comm.; Sirimongkol, pers. comm.), and *Microchirita* is the subject of this paper.

*Microchirita* is found in India, Myanmar, southern China, Thailand, Vietnam, Laos, Cambodia, Peninsular Malaysia, Sumatra, Java and Borneo, almost exclusively in limestone habitats. As part of his revision of *Chirita*, Wood (1974) included 18 species in *Chirita* sect. *Microchirita* C.B.Clarke. Of these, *Chirita elata* Ridl. has since been removed to the genus *Codonoboea* Ridl. (Rafidah et al., 2011) and eleven additional species have been described (Punekar & Lakshminarasan, 2009; Middleton & Triboun, 2013; Rafidah & Haron, 2013; Puglisi et al., 2016). This brings the total to 28 species of which 22 have been recorded for Thailand (Wood, 1974; Burtt, 2001; Middleton & Triboun, 2013; Puglisi et al., 2016), one mistakenly (*Chirita caerulea* R.Br. by Wood, 1974), leaving 21 species. This clearly makes Thailand the centre of diversity of the genus with ⅞ of the known species in the genus found there. The lectotype of the genus is *Microchirita hamosa* (R.Br.) Yin Z.Wang.

The most characteristic morphological feature of many species of *Microchirita* is the cristate inflorescence consisting of a single row of flower pairs (Fig. 1A). The young flowers develop against the base of the lamina. Subsequently the pedicels straighten to an upright position when the flowers reach maturity, and bend backwards towards the main stem at the fruiting stage. The series of flower pairs appears as a crest along the petiole, and often there is tissue melding together the peduncles at the base. Wood (1974) interpreted this crest as a single inflorescence whose peduncle is fused with the petiole. Weber (1975) instead supported the idea of a system of multiple inflorescences generated by an enlarged meristem which is displaced from the axil onto the petiole. No attempt was made to characterise the inflorescence in this study, and for merely practical reasons we have chosen to refer to a “cristate inflorescence” when applicable, without implying the acceptance of Wood’s theory over Weber’s. Some species (e.g. *Microchirita involucrata* (Craib) Yin Z.Wang) have inflorescences which do not appear cristate. They consist of one or few well-developed peduncles arising from the axillary end of the petiole, each topped by paired bracts (free or fused), and culminating in a subumbellate cluster of pedicels (Fig. 1B).

The species of *Microchirita* are annual or short-lived. The stems are often fleshy and green, tinged with purple-brown. Another characteristic feature of *Microchirita* is the leaf arrangement: the basal leaf, the macrocotyledon, is single, although sometimes the paired leaf, the much reduced microcotyledon, persists. The subsequent leaves are opposite. This general structure may not be apparent in *Microchirita mollissima* (Ridl.) A.Weber & D.J.Middleton and most Malaysian species (Rafidah, 2017). In these the internodes are shorter and the leaves more crowded, thereby obscuring the phyllotaxis. Also, the inflorescences develop at the axillary end and are less dense. Some species
may flower when only the macrocotyledon has developed and can be mistakenly interpreted as unifoliate, a common state in *Microchirita hamosa* for example. Generally this is very variable, even within a single population, with a mixture of plants flowering at different sizes and stages of development. The macrocotyledon can be much larger than the paired leaves, leading to broad ranges of leaf size and number of secondary veins.

Much variation can be observed in the corolla of *Microchirita*. The tube is generally narrow at the base, often bent downwards, and widens more or less abruptly, into a campanulate, funnel-shaped or tubular upper corolla. The colour of the corolla varies substantially from pure white to a lilac-purple-blue palette, or to a pale yellow-yellow-dark orange range. The colour is rarely uniform throughout the corolla. Some species (e.g. *Microchirita albocyanea* C.Puglisi) have lobes of a different shade from the tube; most species (e.g. *M. tubulosa* (Craib) A.Weber & D.J.Middleton) have a ventral yellow line running from the base of the ventral lobe to the throat; many species (e.g. *M. bimaculata* (D.Wood) A.Weber & D.J.Middleton) have lines or spots either at the base of the lateral lobes or at the base of the upper lip; finally, in few taxa (e.g. *M. rupestris* (Ridl.) A.Weber & Rafidah), the venation of the petals is visible in the form of fine purple lines running along the lobes and anastomosing terminally. The colour and patterning of the corolla are taxonomically significant. Some species appear to have a purple/blue form and a white equivalent (e.g. *M. hypocrateriformis* C.Puglisi). Where this variation was not substantiated by allopatry or further morphological differentiation, no taxonomic distinction is made.

Anthers of *Microchirita* species can be free, coherent face-to-face, or apically joined by a ligament. Furthermore, anthers can be glabrous or bear an indumentum, especially dorsally at the filament insertion. The indumentum is usually of long, somewhat woolly, eglandular hairs, but in some species additional, shorter and straight hairs are seen.

In this account, *Microchirita* in Thailand is revised and 29 species, two of which have three varieties each, are recognised. Of these, eight species and three varieties are newly described.

**Material and methods**

This revision is based on a study of the specimens from the herbaria A, AAU, ABD, BK, BKF, BM, CMU, CMUB, E, K, KEP, L, P, PSU, QBG, SING, US (Thiers et al., 2017, continuously updated), and Mahidol University, Kanchanaburi Campus (MUCA). All specimens have been seen unless otherwise noted. Measurements of all but the floral parts were taken from dry specimens. Flower measurements are from rehydrated or pickled flowers. When no additional material of the recently published species (Middleton & Triboun, 2013; Puglisi et al., 2016) was obtained, we give measurements from the original descriptions. Measurements of the flowers were taken with a microruler and should be considered accurate to 0.05 mm.

Conservation assessments follow the guidelines laid out in IUCN (2012).
The authors have seen more than half of the species in this revision in the field. Field characters have been instrumental in gaining a better understanding of the species to aid in species delimitation. In particular it becomes quite obvious in the field that plants flowering as early as the macrocotyledon stage are completely mixed into populations of much larger plants and that previous taxonomic distinctions based on plant size are untenable. We have not seen living plants of some of the species in the Northeast of Thailand but have been greatly aided by photographs taken by collectors. Many species of *Microchirita* are rather similar when pressed and dried and we urge collectors to ensure good collection notes, especially in corolla colour and colour variation characters, and to take photographs of the living plants. The species are presented in alphabetical order.

**Taxonomic treatment**


Annual or semipernennial herbs, often with succulent stems. *First leaf* (macrocotyledon) often persistent and single (not paired), second cotyledon rudimentary or suppressed; all other leaves in opposite pairs, sessile or petiolate. *Inflorescences* axillary or epiphyllous, often crested (see Introduction above); peduncles normally developed in axillary inflorescences, reduced and sometimes fused with each other in crested inflorescences; bracts present in axillary inflorescences, divided or somewhat fused; flowers 5-merous. *Calyx* lobes divided almost to base or short tube present. *Corolla* of a narrow lower tube, a wider upper tube and a bilabiate limb, upper lip 2-lobed, lower lip 3-lobed, variable in shape and colour. *Stamens* 2, filaments straight or bent, anthers often densely hairy and joined by a ligature; staminodes 3. *Disk* present, often annular, occasionally partial, or absent. *Ovary* unilocular with parietal placentation, mostly fusiform; style distinct; stigma chiritoid (see Introduction above); ovules many. *Fruit* a narrow, bivalved capsule. Seeds many.

**Key to Microchirita species in Thailand**

1a. Inflorescence with distinct bracts in inflorescence, bracts free or fused together .......................................................... 2

1b. Inflorescence without distinct bracts in inflorescence ........................................... 6

2a. Glandular hairs present on pedicels and/or peduncles ........................................ 3

2b. Glandular hairs not present on pedicels and/or peduncles .................................... 4
3a. Bracts fused at the base; leaves with dense short glandular hairs and long eglandular hairs .......................................................... 6. M. glandulosa
3b. Bracts free; leaves with only eglandular indumentum .......... 11. M. involucrata

4a. Corolla 32–45 mm long, lobes orange .................................. 16. M. marcanii
4b. Corolla 16.5–33 mm long, lobes white to purple or blue ............. 5

5a. Leaves sessile to shortly petiolate, ≤ 2.5 cm long; leaf blades 2.2–7.2 times as long as wide, with a silvery white “soft” indumentum; stems with indistinct internodes .......................................................... 18. M. mollissima
5b. Leaves with petioles 2–10 cm long; leaf blades 1.5–2.7 times as long as wide, with a hispid “rough” indumentum; stems with well-defined internodes .......... .......................................................... 22. M. rupestris

6a. Glandular hairs present on pedicels and/or peduncles in addition to any eglandular indumentum .................................................. 7
6b. Glandular hairs not present on pedicels and/or peduncles in addition to any eglandular indumentum ........................................ 10

7a. Corolla lobes pale yellow; calyx lobes 14–17 mm long .......... 15. M. luteola
7b. Corolla lobes blue or purple; calyx lobes 4.5–15 mm long ........... 8

8a. Corolla with two spots inside the lateral lobes; calyx lobes 13–15 mm long ...... ..................................................................... 3. M. aratriformis
8b. Corolla without spots inside the lateral lobes; calyx lobes 4.5–8.5 mm long .... 9

9a. Corolla tubular, widening abruptly; upper lobes dark purple at base ...................... .......................................................... 26. M. thailandica
9b. Corolla with a narrow lower tube which broadens into a campanulate upper tube; upper lobes without a dark patch ................................................. 14. M. limbata

10a. Anthers glabrous ........................................................................ 11
10b. Anthers hairy ............................................................................ 15

11a. Corolla ≥ 18 mm long, with a patch of elongated glands internally between the upper lobes .......................................................... 18. M. mollissima
11b. Corolla ≤ 15 mm long, without a patch of elongated glands between the upper lobes (but sometimes with shorter and more evenly distributed glands on the upper lobes) ........................................................................ 12

12a. Corolla with a broadly campanulate upper tube, lobes very pale lilac .................. ......................................................................... 13. M. lilacina
12b. Corolla with an upper tube which is not campanulate, lobes (at least the lower) pure white ........................................................................ 13
13a. Corolla personate, upper lip greenish white and much smaller than lower lip .... 20. M. personata
13b. Corolla not personate, upper lip pure white and of similar size to lower lip .... 14

14a. Corolla curved downwards and trumpet-shaped; fruit 2–5 cm long, sparsely hairy ................................................................. 1. M. albiflora
14b. Corolla not curved downwards and tubular; fruit 1.2–2 cm long, densely hairy .................................................................................. 7. M. hamosa

15a. Corolla with obvious dark markings either at the base of the lateral lobes, at the base of the upper lobes, or deeper inside the throat ........................................ 16
15b. Corolla without obvious dark marking and fairly uniform in colour ............ 27

16a. Calyx with glandular hairs outside ................................................. 9. M. huppatatensis
16b. Calyx without glandular hairs outside ............................................. 17

17a. Corolla lobes lilac, violet, purple or blue ........................................... 18
17b. Corolla lobes white, yellow or orange ............................................... 20

18a. Elongated glands present inside sinus of upper corolla lobes; anthers coherent but not apically joined by a connective [Peninsular Thailand] ....... 28. M. viola
18b. Elongated glands absent inside sinus of upper corolla lobes; anthers apically joined by a connective [SE, N and NE Thailand] ................................................. 19

19a. Corolla tube gradually flaring, not abruptly widening, lobes spreading, predominantly whitish, pale yellow or blue [N & NE Thailand] ... 25. M. tetsanae
19b. Corolla tube of a distinct narrow lower tube and abruptly widening into a campanulate upper tube, lobes not spreading, predominantly dark purple [Chanthaburi] .......................................................... 21. M. purpurea

20a. Corolla bright yellow with an obvious dark ring inside the throat .................. 19. M. oculata
20b. Corolla lobes white, yellow or orange without a dark ring in throat ............. 21

21a. Corolla 32–45 mm long, lobes orange ........................................... 16. M. marcanii
21b. Corolla 12–30 mm long, lobes white or pale to bright yellow ....................... 22

22a. Corolla lobes predominantly bright yellow ......................................... 23
22b. Corolla lobes predominantly white to very pale yellow or cream ............ 24

23a. Ventral corolla lobe 8–10 × 6.5–10 mm; filaments geniculate or twisted so as to appear divided into two halves ........................................ 5. M. elphinstonia
23b. Ventral corolla lobe 2.3–5.2 × 2.5–7.5 mm; filaments straight and uniform ....... 4. M. bimaculata
24a. Corolla with dark spots at the base of the upper lobes .......... 25. *M. tetsanae*
24b. Corolla with dark spots at the base of the lateral lobes ......................... 25

25a. Corolla ventral lobe < 5 mm long, overall corolla length 12–18 mm long, lobes white ................................................................. 12. *M. karaketii*
25b. Corolla ventral lobe ≥ 5 mm long, overall corolla length 17–25 mm long, lobes white or yellow-white ................................................................. 26

26a. Corolla with yellow-white lobes and yellowish throat in addition to the ventral yellow line and lateral markings; anthers with a strongly dimorphic indumentum ................................................................. 29. *M. woodii*
26b. Corolla with pure white lobes and white in throat in addition to the ventral yellow line and lateral markings; anthers with only one type of hairs ................................................................. 27. *M. tubulosa*

27a. Anther indumentum of two distinct hair types ........................................... 28
27b. Anther indumentum of a single hair type .................................................. 30

28a. Filaments glabrous ................................................................. 2. *M. albocyanea*
28b. Filaments eglandular hairy ................................................................. 29

29a. Calyx 7.5–13 × 1.2–1.7 mm, apex acute; corolla yellow ...... 17. *M. micromusa*
29b. Calyx 4.5–8 × 1–1.2 mm, apex acuminate; corolla white or purple-blue ........... 25. *M. tetsanae*

30a. Corolla pale yellow ................................................................. 24. *M. tadphoensis*
30b. Corolla white, lilac, purple or blue ..................................................... 31

31a. Corolla with a ventral yellow or orange stripe ........................................ 32
31b. Corolla without a yellow ventral stripe ............................................... 33

32a. Corolla with a narrow tube abruptly opening up into spreading lobes, corolla white or blue, with a fringe of glandular hairs at the base of the upper lobes [Chaiyaphum, Loei] ........................................ 10. *M. hypocrateriformis*
32b. Corolla broadly campanulate, white to pale lilac except at very base of tube, with short stalked glands not forming an obvious fringe [Kanchanaburi] ........................................ 8. *M. hemratii*

33a. Corolla 18–33 mm long; leaves softly tomentose [Peninsular Thailand] ........ 18. *M. mollissima*
33b. Corolla 10–13 mm long; leaves sparsely eglandular hairy [Northern Thailand] ................................................................. 23. *M. suddeei*
1. *Microchirita albiflora* D.J.Middleton & Triboun, Thai Forest Bull., Bot. 41: 19 (2013). – TYPE: Thailand, Chiang Rai, Mae Fa Luang District, Road to Doi Tung Royal Residence, 1000 m alt., 23 September 2008, *Middleton, D.J.*, *Karket, R.*, *Triboun, P.*, *Kawatkul, U.* & *Meeboonya, R.* 4567 (holotype BKF; isotypes BK, E [E00629491], K, P [P00966762], QBG, SING [SING0229831]). (Fig. 2A–C)

Caulescent herb to 50 cm tall, with internodes to c. 10 cm, unbranched. **Stems** fleshy, glabrescent or with very sparse short eglandular hairs, pale green or sometimes purple-brown at the base. **Leaves** opposite, except for the basal leaf; petioles 0.2–1.7 cm long, basal leaf often sessile, glabrescent; blades mid-green above, pale green beneath, ovate, 2.6–23 × 1.7–11 cm, 1.5–2.2 times as long as wide, base cordate, apex acute to shortly acuminate, eglandular tomentose above, hispid beneath, margin entire, 7–12 pairs of secondary veins, tertiary venation laxly reticulate. **Inflorescences** cristate, peduncles reduced or emerging to 1–3 mm long, fused with each other, glabrous, bracts absent; pedicels 5–10 mm long, glabrous or sparsely eglandular hairy. **Calyx** green, bilabiate; tube 0.5–3.7 mm dorsally, c. 0.2 mm ventrally, lobes narrowly lanceolate to ligulate, upper lobes 5–7.8 mm long, lower lobes 4–7.8 × 0.5–1.2 mm, sparsely eglandular pubescent especially on midrib and tip, glabrous inside, apex acuminate. **Corolla** 7–15 mm long, white, sometimes with a ventral yellow line, tube curved downwards, trumpet-shaped, lobes not spreading, outside glabrous basally, eglandular tomentose above, inside glabrous, with a glandular patch below the upper lobes; tube 6.5–13 mm long, equal dorsally, laterally and ventrally; lobes broadly orbicular, upper lobes 1.6–1.9 × 2.2–3.1 mm, lateral lobes 1.6–2.7 × 2–3 mm, lower lobe 1.4–2 × 2.6 mm. **Stamens** arising 2.7–4.7 mm above the corolla base, filaments straight, minutely glandular (glabrous in protologue), 2.1–3.1 mm long, 0.2–0.5 mm wide; anthers glabrous, 0.6–1.1 × 1–2 mm, free or coherent by a weak ligature, thecae divergent; lateral staminodes c. 0.6 mm long, arising near the corolla base, central staminode c. 0.4 mm long, arising near the corolla base. **Disk** partial, ventral, lobed, 0.3–0.7 mm. **Pistil** c. 12 mm long; ovary 4.7–6 mm long, c. 0.6 mm diameter, glabrous or papillose in lower 2/3, densely pubescent in upper 1/3, many ovules; style c. 4 mm long, densely pubescent; stigma deeply bilobed, 0.7–1 mm long. **Fruit** green, 2–5 cm long, 1–1.7 mm diameter, with sessile glands at base, then becoming sparsely eglandular hairy, curved. **Seeds** dark brown, elliptic, 0.6–0.7 × 0.3–0.4 mm.

**Distribution.** Northern Thailand. India, (Myanmar?), Laos.

**Habitat.** On rocks in mixed forest.

**Provisional IUCN conservation assessment.** Near Threatened NT. In Middleton & Triboun (2013) this species was given a conservation status of Endangered. Since then specimens have also been identified from NE India and Myanmar. From the known localities, the AOO is still within the threshold for an Endangered assessment but large swathes of territory within the large EOO, particularly in Myanmar, have not been adequately explored to base an assessment on this. As limestone areas throughout the
region are threatened by mining and tourism an updated assessment of Near Threatened is appropriate.


Notes. This northern Thai species is recognisable by the white corolla and the glabrous anthers. It is most easily confused with Microchirita hamosa, from which it differs in the longer and more markedly broadened upper portion of the corolla (shorter and tubular in M. hamosa), and in the much longer and narrower capsule, which is also very sparsely hairy (densely hairy in M. hamosa). It differs from Microchirita suddeei D.J.Middleton & Triboun in the glabrous anthers and in being pure white (not pale lilac). The floral measurements reported were largely extracted from Middleton & Triboun (2013) as not much new material was available for dissection.

2. Microchirita albocyanea C.Puglisi, sp. nov.
Most similar to Microchirita limbata C.Puglisi in the overall shape of the corolla and in colour, but differs in not having a glandular indumentum and in the much longer corolla and larger calyx. – TYPE: Thailand, Loei, Pha Khao, Wat Phu Phang, 447 m, 5 November 2014, Tetsana, N. et al. 876 (holotype BKF; isotype SING). (Fig. 2D–F)
Caulescent herb to 30 cm tall, internodes 3–5 cm. Stem succulent, sparsely eglandular hairy; not branching. Leaves opposite, apart from the basal leaf; petioles 0.1–1 cm long, sparsely eglandular hairy; blades mid green above, paler beneath, ovate to elliptic, 3.5–14.2 × 1.5–8 cm, 1.5–3 times as long as wide, base shortly attenuate to obtuse, apex acute to acuminate, eglandular pubescent above and beneath, margin finely serrulate, 4–13 pairs of secondary veins, venation sunken above and raised beneath in fresh material, flat in dry specimens, tertiary venation seldom visible in dry specimens. Inflorescences cristate, 2–15-flowered; peduncles reduced and shortly fused with each other, eglandular pubescent; bracts absent; pedicels pale green, 1–18 mm long, eglandular pubescent. Calyx greenish white, succulent at the base, tube c. 0.5 mm long, lobes narrowly lanceolate, c. 10–14 × 1.6–2.5 mm, apex acuminate and thickened, margin entire, with eglandular hairs outside especially along the midrib and the margin, glabrous inside. Corolla 21–25 mm long, tube white, throat white with a yellow patch at the base of the filaments, lobes purple-blue, tube narrow at the base, then becoming wider, not curved or only slightly so, lobes almost equal, glabrous at the base, then becoming progressively hairier, eglandular hairy outside, glabrous inside;
tube 17–19 mm long dorsally, 18–22 mm ventrally, 16–20 mm laterally between lips; lobes elliptic, upper lobes 2.5–3.7 × 5–6.5 mm, lateral lobes 4.5–5 × 5–7.5 mm, ventral lobe 4.5–5 × 4.5–7 mm. **Stamens** arising 8.5–9 mm above the corolla base; filaments geniculate, yellow, glabrous, 2–3 mm long, 0.5–0.6 mm wide; anthers white, with a woolly orange indumentum dorsally and at base, and short appressed orange hairs around the apex, c. 1.5–2 × 3 mm, apically coherent and joined by a short ligature, thecae divergent; lateral staminodes 1.5–3 mm long, arising 6–7 mm above the corolla base, central staminode 0.3–0.5 mm long, arising c. 6 mm above the corolla base. **Disk** annular, margin entire or cleft dorsally, 0.1–0.4 mm high. **Pistil** (immature) 15–17 mm long; ovary 8–9 mm long, 1.2–1.7 mm diameter, glabrous around the base, then densely eglandular hairy; style c. 4 mm long, eglandular hairy, more sparsely towards the stigma; stigma bilobed, lobes elliptic, 0.5–2 × 0.5 mm. **Fruit** green, 2.3–5 cm long, 1–1.7 mm diameter, eglandular hairy, straight or slightly curved. **Seeds** light brown, narrowly elliptic, tri-tetrangular, mucronate, 0.2–0.5 × 0.1–0.5 mm.

**Distribution.** Northeastern Thailand (Loei).

**Habitat.** On limestone, in shade.

**Provisional IUCN conservation assessment.** Critically Endangered CR B1ab(iii). Although only known from a single collection the plant was collected from a limestone outcrop which has a total potential area suitable for the growth of *Microchirita* species of around 14 km² and which is not in a protected area. There has been development within the limestone range and agricultural land encroaches right to the base of the outcrop with the potential for changes in microclimate.

**Notes.** The epithet refers to the colour of the corolla tube and lobes.


Caulescent herb to 60 cm tall, branching, internodes to c. 7 cm. **Stem** green, slightly fleshy, with a mixed indumentum of glandular and eglandular hairs. **Leaves** opposite except for the basal leaf; petioles 0.5–3 cm long, eglandular hairy; blades green above, paler beneath, lanceolate to elliptic, 4.8–10(−13+) × 2.5–10 cm, 1.6–2.1 times as long as wide, base acute to shortly acute or subcordate, apex acute to acuminate, sparsely eglandular hispid above and beneath, margin entire, 8–14+ pairs of secondary veins (basal leaf not seen), tertiary venation not visible. **Inflorescences** cristate, 4–10-flowered; peduncles 1–17 mm long, fused with each other, eglandular hairy; bracts absent; pedicels 15–20(−31 reported in literature) mm long, glandular
and eglandular hairy. **Calyx** green, lobes divided almost to base, lanceolate, 13–15 × 1.2–1.5 mm, apex acuminate, glandular and eglandular hairy outside, especially along margins and midrib, glabrescent inside. **Corolla** c. 23 (−28 reported in literature) mm long, white at base, turning purple above, lobes purple inside and outside, throat with a yellow ventral line and lateral dark patches, tube slightly curved, broadening into a pouched upper corolla, indumentum outside sparsely eglandular hairy, densely so by the lobes, inside glandular hairy. Stamens with hairy anthers. Disk not seen. Pistil enantiostyious, white to pale purple, ovary densely hairy. Fruit 2.1–9.5 cm long, 1.2–1.8 mm diameter, densely eglandular hairy, straight or slightly curved. Seeds brown, elliptic, 0.6–0.7 × 0.2–0.3 mm.


**Habitat.** On limestone rock in shade.

**Provisional IUCN conservation assessment.** Endangered EN B2ab(iii). This species is quite widespread but only known from rather few collections in Thailand and Vietnam. It is likely to also occur in Laos but the distribution is fragmented and the likelihood of the AAO being >500 km², even with new localities being discovered, is rather remote. Throughout the region limestone habitats are threatened with mining, tourism and land use changes. The assessment is not altered by changes in the status of the dubious specimens below.


**Dubious specimens.** THAILAND: **Loei:** near Phu Kradung, Pha Nok Khao, 250–350 m, 6 Nov 1970, Charoenphol, C. et al. 4585 (AAU, E, L). Khon Kaen: Pha Nok Khao, 600–700 m, 9 Sep 1963, Smitinand, T. et al. 1129 (E, L).

**Notes.** *Microchirita aratriformis* is a poorly known species. The placement of any Thai specimens into it has to be considered tentative and based on the presence of axillary shoots, cristate inflorescence, pedicels with mixed indumentum types, ventral yellow line, and an approximate match of calyx and corolla size. The flowering material available for this study was extremely limited, therefore the only thorough description of the inner flower parts remains that of Wood (1972, 1974). The specimens cited as ‘dubious’ above are those placed in this species by Burtt (2001) which are not good collections and we cannot be entirely sure they belong here.

A revision of *Microchirita* in Thailand

Bull., Bot. 29: 87 (2001). – TYPE: Thailand, Maeklang Falls, c. 50 km Northwest of Chiang Mai, c. 430 m, 3 November 1967, *Burtt*, B.L. 5611 (holotype E [E00155280]). (Fig. 4)

Caulescent herb to 50 cm tall, internodes 2–10 cm. **Stems** succulent, green or brown, glabrous or glabrescent, unbranched. **Leaves** opposite, apart from the basal leaf; petioles 0.2–1.5 (–2.5) cm long, eglandular hairy; blades mid green above, pale green beneath, lanceolate or ovate, 3.2–16.6 (–30+) × 1.4–9.5 (–19) cm (measures in bracket refer to estimate measurements of incomplete basal leaves), 1.4–2.8 times as long as wide, base cordate, rounded or seemingly shortly attenuate, apex acuminate or acute, eglandular hairy above and beneath, not ciliate along the margin, margin entire, 8–15 pairs of secondary veins, venation slightly sunken above and raised beneath in fresh material, flat in dry specimens, tertiary venation laxly reticulate. **Inflorescences** cristate, peduncles reduced or emerging to 15 mm long and fused together; bracts absent; pedicels green to reddish brown, 5–20 mm long, eglandular hairy. **Calyx** pale to mid green, regular, succulent at base, tube 0.3–1 mm, lobes narrowly lanceolate to elliptic, 5–10 × 0.7–1.8 mm, apex acute, margin irregularly entire, occasionally toothed, hairy on midrib, margin and tip outside, glabrescent or glandular inside. **Corolla** c. 21 mm long, bright yellow with a reddish brown patch ventrally inside, sometimes split into two lateral patches, throat greenish yellow, narrow part of the tube curved, then widening, upper lobes spreading, base of tube glabrous, broader part sparsely eglandular hairy, lower lobes papillose, upper lobes and throat with scattered glandular hairs; tube 10.5–18 mm long dorsally, 12–19 mm ventrally, 10.5–15 mm laterally between lips; lobes elliptic, apices rounded, upper lobes 1–4 × 2.5–5.1 mm, lateral lobes 2.5–5 × 3.3–6 mm, ventral lobe 2.3–5.2 × 2.5–7.5 mm. **Stamens** arising 5–11 mm above the corolla base; filaments straight, pale green, glabrous, 2–2.6 mm long, c. 0.2–0.6 mm wide; anthers hairy dorsally, 1.1–2 × 0.6–1.1 mm, apically joined by a connective, thecae subparallel; lateral staminodes 0.6–1.5 mm long, arising 3–6.5 mm above the corolla base, central staminode 0.4–0.5 mm long, arising 7–8 mm above the corolla base. **Disk** annular or cleft dorsally, margin entire, 0.2–0.9 mm high. **Pistil** 11.5–15 mm long; ovary 2–6 mm long, papillose at the base, apically eglandular hairy; style 5–7.5 mm long, pubescent, eglandular in the bottom half, becoming predominantly glandular in the top half; stigma glabrous, 0.5–1.1 mm long. **Fruit** green, 1.5–5 cm long, 1.2–2 mm diameter, glabrous with sparse pubescence at the tip (where the persistent style starts), usually curved at maturity, occasionally straight. **Seeds** brown, narrowly elliptic, 0.3–0.4 × c. 0.1 mm.

**Distribution.** Northern and Northeastern Thailand. Laos, India. Likely also to be in Myanmar.

**Habitat.** On limestone in deciduous forest.

**Provisional IUCN conservation assessment.** Least Concern LC. This species is known over a wide area and from many localities within Thailand. Its distribution in Myanmar...
is currently unknown but is likely to occur there. As limestone habitats are threatened throughout the region the status of this species should be monitored.

Additional specimens examined. THAILAND: Buengkan: Bung Khla, Phu Wua Wildlife Sanctuary, Tham Foon Waterfall, 167 m, 21 Oct 2015, Suddee, S. et al. 4970 (BKF, SING). Chiang Mai: Cultivated at RBGE from Burtt 5611, C5927, (E); Chiang Dao, Doi Chiang Dao Wildlife Sanctuary, 28 Aug 1935, Garrett, H.B.G. 1280 (K); ibidem, 13 Oct 1926, Put, N. 306 (ABD, BM, K); ibidem, Bunchuai, K. 260 (BKF); ibidem, 24 Aug 1963, Tagawa, N. et al. T-9916 (BKF); ibidem, 28 Aug 1935, Garrett, H.B.G. 1002 (E, K [2 sheets], L, P); ibidem, 1100–1800 m, 13 Sep 1967, Tagawa, N. et al. T-9915 (BKF); ibidem, 9 Nov 1962, Smitinand, T. et al. 7734 (BK); Chiang Dao, Doi Chiang Dao Wildlife Sanctuary, Ban Chiang Dao, 25 Aug 1990, Maxwell, J.F. 90-902 (A, CMU, L); Doi Chiengdai, Ban Tham, 500 m, 14 Aug 1963, Smitinand, T. & Sleumer, H.O. 1003 (BKF); Wat Chiang Dao, c. 450 m, 24 Sep 1971, Murata, G. et al. T-14857 (BKF, L); Khao Chiang Dao, 30 Oct 1963, Bunchuai, K. 1294 (BKF); Chiang Dao, Doi Chiang Dao Wildlife Sanctuary, trail to Tam Chiang Dao, 500 m, 20 Sep 2008, Middleton, D.J. et al. 4520 (BKF, E, P, SING); Foot of Doi Chiang Dao, 500–600 m, 11 Sep 1967, Tagawa, N. et al. T-9785 (BKF); Doi Inthanon, Mae Pan Fall, c. 1400 m, Oct 1979, Santisuk, T. s.n. (BKF); Chom Tong, Doi Inthanon National Park, Wachirathan Waterfall, 710 m, 19 Sep 2008, Middleton, D.J. et al. 4514 (BKF, E); Doi Suthep, 10 Oct 1987, Maxwell, J.F. 87-1158 (CMU, L); ibidem, 8 Sep 1958, Sørensen, T. et al. 4829 (ABD); ibidem, 1500 ft, 25 Sep 1910, Kerr, A.F.G. 1422 (BM, K, L, P); ibidem, 1000 m, 5 Sep 1958, Sørensen, T. et al. 4751 (ABD, BKF); Summit of Doi Su Thep, 14 Oct 2003, Mattapha, S. 425 (BKF); Mueang Chiang Mai, Doi Suthep-Doi Pui National Park, Montatarhn waterfalls, 1 Nov 2005, Palee, P. 882 (A); Doi Suthep-Doi Pui National Park, above Huay Dteung Tau Lake, 825–875 m, 28 Aug 1990, Maxwell, J.F. 90-918 (L); East side of Doi Sutep, Kohntatahn Falls, 600 m, 4 Nov 1987, Maxwell, J.F. 87-1366 (BKF, CMU, L); Muang Chiang Mai, Doi Suthep-Doi Pui National Park, San Gou, 1030 m, 17 Sep 2008, Middleton, D.J. et al. 4479 (BKF, E, P); Hang Dong, Ban Pong, Tham Takkatan (Grasshopper Cave), above Nam Sum (Mong), 850–930 m, 3 Sep 2003, Maxwell, J.F. 03-270 (BKF, L); Mae Rim, Pong Yeang, Pong Taa Hoen, 1000 m, 8 Sep 1995, Nanakorn, W. 4160 (E, QBG); Mae Rim, Pong Yeang, c. 1100 m, 16 Aug 1994, Nanakorn, W. et al. 1348 (E, QBG); Mae Taeng, Doi Pah Dae, 9 Aug 1997, Maxwell, J.F. 97-1011 (A, BKF, L); Mae Taeng, Ban Keud, c. 520 m, 25 Aug 1994, Nanakorn, W. et al. 1458 (QBG); Mueang Chiang Mai, 12 Sep 1982, Fusai, P. 7 (CMUB); Inthanon, Mae Paam Falls, 1000 m, 5 Oct 1999, Sukhasan, P. 2336 (QBG); Mae Wang, Mae Win, Wang Pah Boon, 24 Aug 2004, Palee, P. 695 (A). Lampang: Chae Hom, Ja Sawo National Park, east side, 525 m, 25 Aug 1995, Maxwell, J.F. 95-556 (BKF, L); Chae Hom, Chae Son National Park, Tat Rung, 527 m, 2 Sep 2009, Norsaengsri, M., et al. 6042 (QBG); Jaie Son National Park, 300 m, 8 Nov 1999, Sukhasan, P. 1809 (E, QBG); Doi Pang La, Huay Tak, 400 m, 25 Sep 1967, Shimizu, T. et al. T-10790 (BKF); en route from Pang La to Huay Tak, 350 m, 24 Sep 1967, Shimizu, T. et al. T-10724 (BKF). Lamphun: Mae Tah, Doi Kuhn Dahn National Park, South side, Doi Hoa Chang, 1225 m, 4 Sep 1994, Maxwell, J.F. 94-981 (BKF, L). Mae Hong Son: Mae La Noi, road from Mae Sariang to Mae Hong Son, 560 m, 20 Oct 2014, Middleton, D.J. et al. 5800 (BKF, E). Phitsanulok: Thung Salaeng Luang National Park, Kaeng Sopa Waterfall, 375–410 m, Murata, G. et al. T-38537 (BKF); ibidem, 375–410 m, Murata, G. et al. T-38516 (BKF); ibidem, 17 Sep 1990, Chantharanothai, P. et al. 90/298 (K); Thung Salang Luang, Pinnin, S. et al. 113 (BKF, E); Thung Salang Luang, S.P. [Pinnin, S.?] et al. 84 (BKF); Tung Salaeng Luang
Notes. This species is broadly distributed across the North of Thailand. It is recognisable by the bright yellow corolla with lateral dark spots inside the throat, the often curved fruit, steep secondary veins, and the dull orange-silver hue of the abaxial side of the dry leaves.


Caulescent herb to 50 cm tall, internodes 3–10 cm long. **Stems** succulent, glabrous, branching from the petioles. **Leaves** opposite, apart from the basal leaf, but sometimes 2 single basal leaves are present; petioles 0.5–1.4 cm long, sparsely eglandular hairy; blades ovate, 1–10.5 × 2–6.3 cm (paired leaves, basal leaf not measured), 1.5–1.8 times as long as wide, base shortly attenuate to seemingly cordate, apex acute to shortly acuminate, with short eglandular hairs above and very sparse hairs beneath, minutely ciliate along the margin, margin entire, 4–21+ pairs of secondary veins. **Inflorescences** cristate, can be congested and many-flowered; peduncles 0.2–5 mm long, fused with each other, glabrous and curved; bracts absent; pedicels 8–12 mm long, glabrescent or sparsely hairy, curved. **Calyx** pale green, actinomorphic, tube 0.5–1 mm, lobes elliptic, 8–15 × 1.5–1.9 mm, apex narrowly acute, margin entire, sometimes with indistinct small teeth near the apex, eglandular hairy outside, especially on tip and margin, inside with sessile glands. **Corolla** 20–30 mm long, bright yellow, with lateral dark spots in throat, tube narrow, curved, then progressively widening, lobes spreading, eglandular hairy outside, lobes papillose, ventral lobe prominent; tube 17–21 mm long dorsally, 17–20 mm ventrally, 17–23 mm laterally between lips; lobes elliptic, apices obtuse to rounded, margin irregular, upper lobes 2–4.5 × 5–6 mm, lateral lobes 5–7 × 6–7.5 mm, ventral lobe 8–10 × 6.5–10 mm. **Stamens** arising 9.5–12 mm above the corolla base; filaments geniculate or twisted in the middle, pale in the lower half, darker above, glabrescent or sparsely hairy below the knee, glandular above, 4–5 mm long, 0.3–0.5 mm wide; anthers yellow, with long eglandular hairs dorsally, 2.5 × 1.7–2.5 mm, apically joined by a connective, thecae divergent; staminodes not seen. **Disk** partial, 0.4–0.5 mm high, or complete and 0.6–0.8 mm long. **Pistil** 18.5–20 mm long; ovary 5–8 mm long, 0.7–1.2 mm diameter, glabrous at the base, hairy apically; style...
7–10 mm long, hairy, becoming glabrescent towards apex; stigma glabrous, 0.5–0.6 mm long. **Fruit** straight or curved, 4–6.5 cm long, sparsely hairy. **Seeds** dark brown, elliptic, 0.4–0.5 × 0.2–0.3 mm.

**Distribution.** Northeastern to Southeastern Thailand. Cambodia.

**Habitat.** On limestone in evergreen forest.

**Provisional IUCN conservation assessment.** Endangered EN B2ab(iii). Although this species has a large EOO, it is known from rather few collections and has a currently known AOO well within the range for an Endangered status, coupled with a fragmented distribution and the many threats to limestone habitats throughout the region from mining, tourism and land use changes. Within the EOO there are rather limited opportunities for the AOO to increase beyond the threshold for Endangered due to the lack of suitable habitats.


**Notes.** Microchirita elphinstonia is a yellow-flowered species recognisable by the filament, which is somewhat divided in two halves (it can be geniculated or more commonly twisted), and appears darker in the upper part than in the lower in dry specimens. The leaves are ovate and the secondary veins can be numerous and very close to each other, although this is not a consistent character, e.g. in the type material.

**6. Microchirita glandulosa** C.Puglisi, sp. nov.

Similar to Microchirita involucrata (Craib) Yin Z.Wang and M. rupestris (Ridl.) A.Weber & Rafidah) in having bracteate inflorescences. Differs from both in the bracts being fused only at the base (i.e. not divided as in Microchirita involucrata and not fused into a cup as in M. rupestris), in the dimorphic indumentum of sparse, long eglandular hairs and dense short glandular hairs on the leaf (eglandular indumentum in M. involucrata and M. rupestris), and in the tripartite calyx. It differs further from
Microchirita involucrata in the serrate margin of the bracts and from M. rupestris in the much smaller size of the bracts. – TYPE: Thailand, Nan, Song Kwaw, Sakoen, Khao Tham Plakang, 750 m, 3 September 2006, Watthana, S. 2126 (holotype QBG; isotype CMU).

Herb to 50 cm tall. Stems fleshy, sparsely glandular hairy. Leaves opposite, with the exception of the single basal leaf; petioles 0.1–2 cm long, glandular hairy and with sparse long eglandular hairs; blades lanceolate, 2–8.5 × 1–6.5 cm, 1.3–2.2 times as long as wide, base cordate or obtuse, apex acute, with a dimorphic indumentum of dense and short glandular hairs and longer and thicker eglandular hairs, margin delicately serrate, 8–10 pairs of secondary veins in the opposite leaves, tertiary venation inconspicuous. Inflorescence 1–3-flowered, arising from the axil end of the petiole; peduncles 2–8 mm long, glandular hairy; bracts fused at the base and enclosing the pedicels, 0.6–1.1 × 0.3–0.5 mm, sessile or shortly petiolate, margin and indumentum matching those of the leaves; pedicels 0.8–1.2 cm long, covered in minute glandular hairs. Calyx zygomorphic, tube 1.5 mm dorsally, 1 mm laterally and 0.5 mm ventrally, lobes linear to oblanceolate, 4.5–7.5 × 0.8–2.2 mm, minutely toothed towards the apex, apex acute, densely glandular hairy outside and inside. Corolla 15–18 mm long, reportedly white, tube with a narrow basal portion, slightly curved downwards, then progressively broadening, externally with a minute glandular indumentum; tube c. 12.5 mm long dorsally, 15–16 mm ventrally, 13 mm laterally between lips; upper lobes elliptic, c. 1.5 × 2.5 mm, lateral and lower lobes seemingly small but not measured. Stamens arising c. 7 mm above the corolla base; filaments glabrous, c. 3.5 mm long, S-shaped; anthers with a dense indumentum at the insertion, c. 1.3 × 2.5 mm, apically joined by a connective, thecae subparallel; lateral staminodes c. 0.5 mm long, arising c. 6.5 mm above the corolla base, central staminode c. 0.7 mm long, arising c. 6.5 mm above corolla base. Disk annular, 0.4–0.5 mm high. Pistil 12–14 mm long; ovary 5–6 mm long, c. 1.5 mm diameter, with minute glandular hairs throughout its length, except for the lowermost half millimetre, which is glabrous; style c. 6 mm long, covered in the same indumentum as the ovary; stigma lobes c. 1.5 mm long, glabrous. Fruit and seeds not seen.

Distribution. Northern Thailand (Nan).

Habitat. On exposed limestone.

Provisional IUCN conservation assessment. Data Deficient DD. This species is only known from a single collection from a National Park. There is extensive but underexplored limestone in the region and more information is needed on the distribution of the species and on potential threats before a satisfactory conservation assessment can be given.

Notes. The epithet refers to the conspicuous presence of a glandular indumentum.

Caulescent herb to 25 cm tall; internodes 3–6 cm, although more often than not appearing as a unifoliate plant. **Stems** fleshy, with long eglandular hairs, pale green or sometimes tinged with purple-brown. **Leaves** opposite, except for the single basal cotyledon; petioles 0.1–0.5 cm long, densely hairy; blades green above, pale green beneath, ovate to lanceolate, 2–13.3 × 1.1–9.3 cm, 1.2–2.1 times as long as wide, base of macrocotyledon/basal leaf cordate, cauline leaves shortly attenuate, apex acute, densely eglandular tomentose above and beneath, margin entire or subentire, 6–12 pairs of secondary veins, venation slightly sunken above and raised beneath in fresh material, tertiary venation laxly reticulate. **Inflorescences** crista, few to many flowered; peduncles to 4 mm long, not fused with each other; bracts absent; pedicels pale green, 3–20 mm long, all axes with long eglandular hairs. **Calyx** green, regular, tube 0.1–0.3 mm, lobes narrowly lanceolate, 3–4.5 × 0.4–0.7 mm, eglandular hairy outside, glabrous inside except at the tip, apex acuminate, margin entire. **Corolla** 8.5–13 mm, white with a yellow stripe ventrally in tube, tube tubular, not curved downwards, lobes not spreading, outside eglandular hairy, glabrescent, becoming densely eglandular hairy towards the lobes, inside densely glandular, especially on lobes; tube 8–9 mm long, equal dorsally, laterally and ventrally; upper lobes 0.7 × 1 mm, lateral lobes 1.1 × 1.1 mm, lower lobe 1 × 0.7 mm. **Stamens** arising c. 3.9 mm above the corolla base; filaments white or pale yellow, straight, glabrous, c. 1.5 mm long, 0.1 mm wide; anthers white or pale yellow, glabrous, 0.6–1.1 × 1–2 mm, free, thecae divergent; staminodes not seen. **Disk** a single ventral lobe, 0.1 mm. **Pistil** c. 16 mm long; ovary c. 14 mm long, c. 0.7 mm diameter, glabrous or papillose in lower 1/3, densely pubescent in upper 2/3, many ovules; style c. 3 mm long, densely pubescent; stigma shallowly bilobed, c. 0.2 mm long. Style and stigma green to white. **Fruit** green, 1.2–2 cm long, 1–1.2 mm diameter, glabrous at the base, then becoming densely eglandular hairy, straight or slightly curved. **Seeds** dark brown, elliptic, 0.2–0.3 × 0.1–0.2 mm.

**Distribution.** Northern and Northeastern Thailand. India, China, Myanmar, Laos, Vietnam.

**Habitat.** On limestone rocks or sandy soil in dry dipterocarp forest.

**Provisional IUCN conservation assessment.** Least Concern LC. This species is common and widespread although could potentially be impacted by removal of limestone habitats for cement.

**Notes:** This species is recognisable by the small, white flower with a tubular corolla, and by the relatively short and densely hairy fruit. It is widespread across the north of Thailand and in the neighbouring countries. It frequently flowers when only a unifoliate plant.

*Microchirita hamosa* is conserved with a conserved type (proposed by Middleton & Puglisi, 2015; supported by Nomenclature Committee for Vascular Plants in Applequist, 2016).
Wood (1974) listed a number of synonyms for *Chirita hamosa*, all from India. As noted by Middleton & Triboun (2013), several different species were included in Wood’s concept of *Chirita hamosa* so we refrain from listing any of these synonyms pending a thorough revision of the genus in India.

8. *Microchirita hemratii* C.Puglisi, Kew Bull. 71(1)-2: 4 (2016). – TYPE: Thailand, Tak, Mae Sot distr., Wat Tham Inthanin, 660 m, 18 October 2014, Middleton, D.J., Hemrat, C., Karaket, P., Puglisi, C. & Suddee S. 5775 (holotype BKF; isotypes E [E00663027], SING). (Fig. 5A–B)

Herb to 50 cm tall. **Stems** fleshy, dark red or green at base, otherwise pale green, glabrous or sparsely hairy. **Leaves** opposite, with the exception of the single basal leaf, fleshy (very thin when dry); petioles 0.2–1.5 cm long, glabrous; blades pale green above, paler beneath, lanceolate, 3.75–14 × 2.6–8.5 cm, 1.3–1.7 times as long as wide, base obtuse to cordate, apex acute to acuminate, sparsely and minutely tomentose above and beneath, above with additional scattered eglandular hairs, margin entire to obscurely serrulate, 3–8 pairs of secondary veins in the opposite leaves, 7–13 in the basal leaf, venation raised beneath in fresh material, tertiary venation almost invisible. **Inflorescence** 1–8-flowered, cristate; peduncles reduced; bracts absent; pedicels green, 0.5–1.3 cm long, sparsely eglandular hairy. **Calyx** green, actinomorphic, tube 0.2–0.5 mm long, lobes lanceolate, 3–9 × 0.5–1 mm, inconsistently with some serration towards the apex, apex acute, outside sparsely eglandular hairy at base, hairier distally, inside with an indumentum of sparse sessile glands. **Corolla** 10–15 mm long, narrow basal portion greenish white, rest of tube white, with a yellow stripe ventrally inside, lobes pale lilac, tube with a narrow basal portion, then broadening into a funnel-shaped distal portion, this curved down, pubescent outside except at base, inside glabrous, the upper lobes densely covered in stalked glands, the lower central lobe sparsely so, the lower lateral lobes glabrous; tube 9–12 mm long dorsally, 10–11 mm ventrally, 8.5–9 mm laterally between lips, upper lobes broadly elliptic, 2.5–3 × 4–4.7 mm, lower lateral lobes elliptic, 2–4 × 4–5 mm, lower central lobe rounded, 3–4 × 4–5 mm. **Stamens** arising 4 – 6.5 mm above the corolla base, filaments glabrous, 3–3.5 mm long, straight; anthers with a dense indumentum of long hairs dorsally, c. 1 × 0.7–0.8 mm, apically joined by a connective, thecae divergent; lateral staminodes c. 2 mm long, arising 3–5 mm above the corolla base, central staminode c. 1 mm long, arising c. 4 mm above corolla base. **Disk** absent. **Pistil** 8–12 mm long; ovary 3–5 mm long, papillose, with pubescence restricted to the apex; style 5–6 mm long, apically curved, hairy; stigma with lobes c. 0.5 mm long, c. 0.8 mm wide, narrowly elliptic, glabrous. **Fruit** green, 2–6 cm long, 0.9–1.1 mm diam., glabrous at the base, sparsely hairy distally, straight or curved. **Seeds** light brown with reddish apices, elliptic, 0.5–0.6 × 0.2–0.3 mm.

**Distribution.** Northern Thailand (Tak).
Habitat. On limestone in deciduous forest.

Provisional IUCN conservation assessment. Endangered EN B1ab(iii,iv) + B2ab(iii,iv). The known EOO of this species would qualify it for Critically Endangered but the collecting localities are in a limestone range much of which has so far not been explored and where it is also likely to occur. Even if it were to occur throughout this range its EOO would still qualify it as Endangered. Parts of this range, including some of the known localities, are outside protected areas and subject to disturbance from visitors, particularly at the religious sites.

Additional specimens examined. THAILAND: Tak: Mae Sot, Tham Inthanin Temple, 640 m, 17 Oct 2013, Pooma, R. et al. 7851 (BKF, E); ibidem, 650 m, 5 Nov 2010, Pooma, R. et al. 7522 (BKF); ibidem, 500 m, 11 Sep 2009, Middleton, D.J. & Triboun, P. 4849 (BK, E); Maesot, Phra Wo, Phra Wo Spirit House, 700 m, 5 Nov 2010, Pooma, R. et al. 7507 (BKF); Mae Sot, Mae Kah Soh, Po Tip Tawng Cave, 300 m, 20 Aug 1994, Maxwell, J.F. 94-905 (A, BKF, L).

Notes. This species is recognisable by the pale lilac corolla with a yellow ventral line, the broad mouth, and the dense anther indumentum. It is currently known only from the Mae Sot district of Tak province.

9. Microchirita huppatazensis C. Puglisi, Kew Bull. 71(1)-2: 2 (2016). – TYPE: Thailand, Uthai Thani, Lan Sak, Huppata Non Hunting Area, 122 m, 14 October 2014, Middleton, D.J., Hemrat, C., Karaket, P, Puglisi, C., Suddee, S. 5689 (holotype BKF). (Fig. 5C–D)

Herb to 40 cm tall. Stems fleshy, red at base and around the basal nodes, otherwise pale green, pubescent. Leaves opposite, with the exception of the single basal leaf; petioles 0.5–1.2 cm long, pubescent; blades pale green above, paler beneath, lanceolate or elliptic, 5–12.8 × 1.6–6.1 cm (undamaged basal leaf not seen), 2–3 times as long as wide, base acute to obtuse, apex acuminate, minutely tomentose above and beneath, margin entire, 5–9 pairs of secondary veins in the opposite leaves, at least 13 in the basal leaf, venation raised beneath in fresh material, tertiary venation barely visible and loosely reticulate. Inflorescence cristate, 4–15-flowered; peduncles reduced, rarely emerging and fused together at the base; bracts absent; pedicels pale green, 0.2–2 cm long, pubescent. Calyx pale green, actinomorphic, tube 0.3–0.5 mm long, lobes narrowly lanceolate, 8–9 × 0.7–1.1 mm, apex acute, outside hairy throughout, with mixed glandular and eglandular hairs, inside with a sparse minute glandular indumentum. Corolla 15–20 mm long, base of tube greenish white, rest of tube white, ventral pouch of tube marked by a yellow, raised and papillose line running throughout the inner surface of the tube, with a purple-brown streak on either side of it, tube with a narrow basal portion, curved downwards, then abruptly broadening into a ventral pouch, upper lobes reflexed, lower lateral lobes spreading, the central lobe straight, limb externally sparsely hairy, with stalked glands at the base; tube 9–10 mm long
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Fig. 5. *Microchirita hemratii* C. Puglisi. A. Front view of flower. B. Side view of the flower. All from Middleton, D.J. et al. 5775. *Microchirita huppatatensis* C. Puglisi. C. Detail of the flower. D. Habit. All from Middleton, D.J. et al. 5689. (Photos: P. Karaket)

dorsally, 10–14 mm ventrally, c. 10 mm laterally between lips, upper lobes elliptic, 3–3.5 × 3.5–4 mm, lower lateral lobes elliptic, 5–6 × 4–5 mm, lower central lobe rounded, 6–8 × 5–8 mm. **Stamens** arising 4–6 mm above the corolla base, filaments yellow, minutely glandular, 1–1.5 mm long, with a thicker base and two geniculations; anthers yellow, connective white, with a small patch of short hairs dorsally, 1.5–2 × 1.2–1.5 mm, held at a right angle, apically joined by a connective, thecae parallel; all three staminodes much reduced, less than 0.5 mm long, arising 5–6 mm above the corolla base. **Disk** an annular ring, slightly lobed, 1–1.3 mm high, whitish at base and darker along the edge. **Pistil** c. 5 mm long; ovary 2.5–3.5 mm long, glabrous in the basal 2/3, apically eglandular hairy; style 0.5–0.7 mm, glabrous; stigma with lobes 0.5–0.7 mm long, 0.4–0.6 mm wide, elliptic. Immature **fruit** pale green, c. 1.5 cm long, 2–3 mm diam., pubescent throughout its length, straight. **Seeds** not seen.
**Distribution.** Northern Thailand (Tak).

**Habitat.** On limestone in secondary forest.

*Provisional IUCN conservation assessment.* Critically Endangered CR B1ab(iii,iv) + B2ab(iii,iv). This species is only known from the type collection growing in a mixed population with *Microchirita personata*. The limestone range there is only about 12 km$^2$ in total and is subject to disturbance from tourism. There are no collections from the nearby Khao Pha Ra, and the area is surrounded by cultivated land.

**Notes.** *Microchirita huppatatensis* is most similar to *M. woodii* D.J. Middleton & Triboun in the pattern of the corolla colour, but differs in the shorter corolla tube, acuminate leaves and the overall corolla shape. The description and measurements reported here match the original description (Puglisi et al., 2016), as no new specimens have been collected since.

**10. Microchirita hypocrateriformis** C. Puglisi, **sp. nov.**

Diffsers from all other species of *Microchirita* (C.B.Clarke) Yin Z.Wang in the combination of long, narrow corolla tube, abruptly opening into spreading limb, in the long lower corolla lobe, and in the presence of a fringe of glandular indumentum at the base of the upper lip. – **TYPE:** Thailand, Chaiyaphum, Khon Sarn, Wat Tham Huang Po, 400 m, 19 October 2015, Suddee, S., Keiwbang, W., Hemrat, C. 4967 (holotype BKF; isotype SING). (Fig. 6)

Herb to 50 cm tall with elongated stem runners. Habit caulescent, internodes 4–10 cm. **Stems** succulent, with sparse eglandular indumentum; branches sometimes arising from the petiole of the basal leaf. **Leaves** opposite, apart from the basal leaf; petioles 3–7 mm long, sparsely eglandular hairy; blades pale green above, paler beneath, lanceolate to elliptic, 3.5–22.5 x 2.4–17.5 cm, 1.1–2.4 times as long as wide, base shortly attenuate to cordate, apex acute to acuminate, sparsely eglandular tomentose above and beneath, ciliate along the margin, margin entire or sparsely and minutely denticulate, 5–17 pairs of secondary veins in the opposite leaves, venation slightly sunken above and raised beneath in fresh material, flat in dry specimens, tertiary venation inconspicuous. **Inflorescences** crista, peduncles reduced or to 6 mm long, not fused with each other, bracts absent; pedicels pale green, 0.5–2.5 cm long, pubescent. **Calyx** green, the two lips completely divided, ventral tube c. 1 mm long, dorsal tube c. 0.3 mm long, lobes ligulate to lanceolate, 12–15 x 1.7–3 mm, apex acute and slightly thickened, margin entire or with 1–2 few minute teeth, succulent at the base, eglandular hairy on both sides, outside with a dimorphic indumentum of fine and large eglandular hairs, inside hairy only towards the tip. **Corolla** 20–25 mm long, tube white outside, limb white or dark violet-blue with a bright yellow/orange stripe inside tube ventrally, which can almost circle the throat, tube narrow, more or less curved, abruptly opening up into spreading lobes, tube glabrous, lobes eglandular pubescent outside, inside with a
fringe of fine translucent glandular hairs and glands at the base of the upper lobes, and
glands and short hairs over the yellow ventral stripe; tube 15–17 mm long dorsally,
17–21 mm ventrally, 15–19 mm laterally between lips; upper lobes broadly elliptic,
4.2–5 × 6–7 mm, lateral lobes broadly ovate, 4–9 × 8–9 mm, ventral lobe ovate, 6–9
× 9–12 mm. Stamens arising 1–1.25 cm above the corolla base, filaments straight,
white, glabrous, 2–2.5 mm long, 0.4–0.7 mm wide; anthers white or pale yellow, with
an abundant indumentum of coloured hairs (blue in blue-flowered specimens, brown
in white-flowered specimens) above and dorsally, 2.3 × 1.3 mm, apically joined by a
connective, thecae more or less parallel; lateral staminodes 0.6–1.1 mm long, arising
c. 4.5–8.5 mm above the corolla base, central staminode 0.1–0.7 mm long, arising
5–8.5 mm above the corolla base. Disk annular, slightly lobed, 0.4–1 mm high. Pistil
c. 23 mm long; ovary 0.6–1.4 cm long, c. 1 mm diameter, glabrous in the basal 0.5–3
mm, then densely eglandular hairy; style c. 0.9 cm, sparsely eglandular hairy; stigma
with a weakly bilobed lower lip, densely hairy, 1–1.6 mm long. Fruit green, brown
when ripe, 2–3.7 cm long, c. 0.6 mm diameter, eglandular hairy, straight. Seeds brown,
narrowly elliptic, 0.3–0.4 × c. 0.1 mm.

Distribution. Eastern and Northeastern Thailand.

Habitat. On limestone in mixed deciduous forest.

Provisional IUCN conservation assessment. Endangered EN B1ab(iii) + B2ab(iii).
The known EOO is < 500 km² and the known AOO is only 12 km². Not all of the
known localities are in protected areas and those that are not are subject to disturbance
from visitors.

Additional specimens examined. THAILAND: Chaiyaphum: Khon Sarn, Wat Huang Po, 378
m, 7 Nov 2014, Tetsana, N. et al. 888 (BKF, SING); Khon Sarn, Wat Pa Thum Thip Nimit Doi
Kitchakoot, 484 m, 12 Sep 2014, Tetsana, N. et al. 834 (BKF, SING). Loei: Nong Hin, Suan Sa
Wan, Pha Ngam Forest Park, 662 m, 11 Sep 2014, Tetsana, N. et al. 824 (BKF, SING).

Notes. The epithet refers to the narrow corolla tube. Most of the specimens observed
have pure white corollas, a yellow ventral stripe, and brown anther indumentum. The
specimen Tetsana, N. et al. 834, instead, has a blue-purple corolla, with similarly
coloured anther indumentum and a yellow ventral stripe. The morphology of the white
and blue forms are otherwise identical, and no intermediate colour variants have been
observed.

The collection from Loei, Tetsana et al. 824, has a longer calyx than the material
from Loei. Further collections are needed to see whether the Loei material differs
taxonomically from Microchirita hypocrateriformis.

11. Microchirita involucrata ( Craib) Yin Z.Wang, J. Syst. Evol. 49: 60 (2011); Rafidah,
Edinburgh 33: 199 (1974); Burtt, Thai Forest Bull., Bot. 29: 88 (2001). – TYPE: Cult. Hort. Bot. Aberdeen from seeds collected by Kerr (Kerr 11172), Thailand, Kaw Tao [Surat Thani, Kao Tao], 30/12/1926 (lectotype ABD [specimen with appended protologue], designated by Puglisi in Rafidah (2017); isolecotypes ABD [2 sheets]). (Fig. 7)


Notes. This species is easily recognisable from the inflorescence, which has two bracts that are not fused across the axis (compare to Microchirita rupestris where the bracts are fused together). The flower is narrowly funnel shaped, variously coloured in shades of purple, and the fruit is narrow, long and more or less curved. In Thailand three varieties can be distinguished.

Key to the varieties of Microchirita involucrata

1a. Bracts 16–45 mm long; corolla 18–21 mm long ...................................................... 2
1b. Bracts to 10 mm long; corolla c. 35 mm long ......................................................

					11c. M. involucrata var. gigantiflora

11a. Microchirita involucrata var. involucrata
Lithophytic or terrestrial, succulent herb to 2 m tall. Stem fleshy, very sparsely hairy (mixed glandular and eglandular hairs), green or purple-reddish, especially around the nodes and the younger parts, branching, with internodes 1–7 cm. Leaves opposite, except for the single basal leaf; petioles 1.5–6 cm long, eglandular hairy; blades mid to dark green above, greenish white beneath, ovate or lanceolate, 4.1–11 × 2.6–6.8 cm, 1.2–1.9 times as long as wide, base shortly attenuate to rounded, often unequal, apex more or less broadly acute, eglandular tomentose above, much less so beneath, margin entire or obscurely denticulate, 5–8 pairs of secondary veins in the opposite leaves, venation slightly sunken above and raised beneath in fresh material, tertiary venation inconspicuous. Inflorescences arising from the petiole, close to the axil, consisting of a main pedunculate inflorescence, which can be more or less compound, and a bud at its base, axes light green; peduncles sparsely glandular and eglandular hairy, 2–35 mm long; bracts paired, free, sessile or shortly petiolate, petiole predominantly glandular hairy, lamina with mixed glandular and eglandular hairs above and beneath, entire to weakly serrate, ovate, 1.6–4.5 × 1.1–2.2 cm; pedicels sparsely hairy, mixed glandular and eglandular, predominantly glandular, 1–2.5 cm. Calyx light green to maroon,
tube 0.5–3 mm long, lobes lanceolate, overlapping, 4–7 × 0.7–1.4 mm, apex acute, predominantly glandular hairy on the outer side, inside glabrescent or with sparse, fine glandular hairs. **Corolla** 18–21 mm long, bluish-violet, dark purple at mouth and dorsally by the anthers, with two purple stripes laterally along the filaments, lobes violet or light blue, flower occasionally reported to be much paler to off white especially at mouth, tube narrow at base, straight to bent, gradually broadening, glandular pubescent outside, especially dorsally between the upper lobes and ventrally below the central lobe, internally with sparse eglandular hairs on the upper lip and centrally in the lower lip, tube glabrous inside, lobes not reflexed; tube 12.5–16.5 mm long dorsally, 15–19.5 mm ventrally, 12.5–17 mm laterally between lips; upper lobes broadly elliptic, 2.3–4.5 × 3.1–5 mm, lateral lobes elliptic, 2.2–4.5 × 2.6–7 mm, lower lobe elliptic, 2–5 × 2.9–9 mm. **Stamens** arising 8–10 mm above the corolla base; filaments white to purple, bent twice, or almost straight, sometimes swollen in the middle, glabrous, 3.3–4.6 mm.
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long, 0.4–0.7 mm wide, with a small projection at the anther’s insertion; anthers white, hairy dorsally and on the upper and lower surfaces, hairs sparse to abundant, 1.7–2.5 × 1.3–1.9 mm, apically weakly joined by a thin connective, free in old specimens, thecae slightly divergent, anthers whitish, apices slightly acuminate; lateral staminodes 0.7–3 mm long, to 0.1 mm wide, arising 8.5–10 mm above the corolla base, hairy at the tip, central staminode 0.3–0.7 mm long, arising 8–10 mm above the corolla base, often inconspicuous. Disk annular (some specimens appear to have a partial disk, probably due to breakage?), margin irregular to lobed, 0.2–0.6 mm high. Pistil 12–20 mm long; ovary 6.5–10 mm long, glabrous, many ovules; style green, 0.4–0.7 cm, glandular pubescent; stigma white, broadly bilobed, lobes 0.5–2.5 mm long, 0.4–0.7 mm wide, elliptic, often glandular hairy outside. Fruit light green, turning brown at maturity, to 10 cm long, glabrous or with persistent style hairs distally, straight or slightly curved. Seeds brown, broadly elliptic, c. 0.4 × 0.2 mm.


Habitat. Lithophyte on different types of rocks, in shaded areas in evergreen forest.

 Provisional IUCN conservation assessment. Least Concern LC. This variety is common and widespread.

Additional specimens examined. Unknown locality: Smith, E. 71 (BK); Cult. 11172 coll. 7/11/1929 (ABD [2 sheets]), Cultivated at RBGE from material grown at Botanische Anstalt University, Basel, acc. 801771, P12, C13666 (E); Cult Aberdeen “150”, no data (ABD), Cult Aberdeen “180” (ABD); Near Langkawi, 15 Jan 1916, Annandale, N. 1850 (SING); Kaw Koh Suwan near Langkawi, 14 Jan 1916, Annandale, N. 1833 (SING); Koh Si Kah, 17 Jan 1916, Annandale, N. 1589 (SING); Koh Si Kah, 17 Jan 1916, Annandale, N. 1590 (SING).

THAILAND: Ayutthaya: s.l., 8 Jan 2496 [1953], Piyakarnchown, T. 11 (BK). Chonburi: Si Racha, Chan Ta Then Falls, 300–400 m, 17 Nov 1974 Maxwell, J.F. 74-988 (BK); Sattahip, Si Chon Tiam, Nong Nooch BG, 6 Sep 2004, Palee, P. 715 (CMUB); Sriracha, 14 Nov 1926, Put, N. 444 (ABD, BK, BM, K); Sriracha, Nong Nam Kheo, 240 m, 15 Nov 1926, Collins, D.J. 1277 (K); Hoop Bon, Sriracha forest, c. 400 ft, 25 Oct 1927, Collins, D.J. 1694 (K); Si Racha, Kow Kieo, 200 m, 20 Oct 1975, Maxwell, J.F. 75-1064 (E). Chumphon: 24 Mar 1971, Bogner 434 (E); Cultivated RBGE from Bogner 434, C8252 (E); Sawi, Khao Thalu, 31 Dec 1999, Wongprasert, T. 9912-04 (BK); ibid., 5 Dec 1999, Wongprasert, T. 9912-14 (SING); Lamae, Tham Khao Phu, 25 m, 7 Feb 2005, Williams, K. et al. 1259 (A, BKF, E); Mueang Chumphon, Wat Tham Khao Khun Krating, 70 m, 12 Jun 2006, Williams, K. et al. 1666 (A, BKF, E); Thun Tako, Ban Khao Talu, 4 Dec 2002, Koonkhumthod, N. et al. 308 (BKF); Sawi, Khao Thalu, 5 Dec 1999, Wongprasert, T. 9912-20 (BKF); Pa Thieo, Thale Sap, Wat Tham Thale Sap, 50 m, 17 Dec 2006, Poona, R. et al. 6372 (BKF); Sawi, Khao Khai, Tham Thip Prada San Chang Len, 70 m, 26 Dec 2006, Poona, R. et al. 6680 (A, BKF); Bang Son, 10 Sep 1927, Put 1042 (K); Bang Son, 10 Sep 1927, Put, N. 1035 (BM, K); Sapli, 9 Sep 1927, Put, N. 1021 (BK, BM, K); cultivated in Edinburgh from seeds from Bogner 402, Nov 1971, C8251-71-0977 (E [2 sheets]); Luang Suan, 23 Mar 1971, Bogner 424 (E); Kao Muang, c. 20 m, 11 Jan 1927, Kerr, A.F.G. 11368 (BK, BM, K). Krabi: Cultivated in Penang BG, flowered in Aug 1897, Kasoom, Nov 1896, Curtis 3221 (SING [2 sheets]); Khao Phra Bang Wildlife Reserve, 50 m, 5 Oct 1996,


collected in Ratchaburi, 25 Oct 1924, Kerr, A.F.G. 9341 (BM). Satun: Tarutao National Park, Adang Island, Oct 1979, Congdon, G. 57 (E). Songkhla: s.l., 21 Dec 1978, Hamilton & Congdon, G. 101 (BKF); 0–10 m, 8 Apr 1928, Kerr, A.F.G. 15101 (BK, BM, K); Tam Ta Lord, 100 m, 25 Nov 1990, Larsen, K. et al. 41711 (BKF); ibidem, 100 m, 25 Nov 1990, Larsen, K. et al. 41714 (BKF, P); 10 km NE of Boriphat Falls, 28 Aug 1983, Eddie, W.M.M. s.n. (BKF); Rattapoom, Khao Rak Kiat, 50 m, 9 Dec 1986, Maxwell, J.F. 86-1035 (BKF, CMU); Boriphat Falls National Park, 20 Dec 1984, Maxwell, J.F. 84-538 (BKF); ibidem, 120–150 m, 18 Dec 1979, Shimizu, T. et al. T-27611 (BKF, L); ibidem, 120–150 m, 18 Dec 1979, Shimizu, T. et al. T-27591 (BKF, L); Boripath waterfall, 9 Nov 1990, Larsen, K. et al. 41239 (BKF); Rattaphum, 21 Dec 1965, Youngboonkird, U. 263 (BK); Sabahoy, Bahoi, Ban Ranuea, 200 m, 1 Nov 1998, Maknoi, C. 26 (QBG); Kao Changlan, c. 50 m, 24 Jul 1928, Kerr, A.F.G. 15894 (BM, K). Surat Thani: s.l., 5 Dec 1975, Phraphat, D. 103 (BKF); Tai Rom Yen National Park, 100 m, 18 Dec 2006, Poona, R. et al. 6409 (BKF, E); Tai Rom Yen National Park, Tham Khamin, 100 m, 18 Dec 2006, Poona, R. et al. 6419 (A, BKF); Viphavadee, Ta Kuk Tai, Viphavadee Waterfall, Ban Wan Phak Wan 16 Feb 2012, Sirimongkol, S. et al. 290 (BKF); Ko Samui, Namuang Falls, 50 m, 4 Feb 1987, Maxwell, J.F. 87-145 (BKF, CMU); Kaw Samui, c. 100 m, 10 Apr 1927, Kerr, A.F.G. 12591 (BM, K); Kaw Samui, c. 100 m, 8 Apr 1927, Kerr, A.F.G. s.n. (BM); Koh Samui, 50–100 m, 3 Dec 1974, Geesink, R., Hiepko, P. & Phengklai, C. 7738 (L); Khao Sok, 26 Dec 1976, Santisuk, T. 856 (BKF); Kaw Ngua Talam, 7 Apr 1927, Kerr, A.F.G. 12935 (K); Kaw Tao, c. 30 m, 30 Dec 1926, Kerr, A.F.G. 11172 (ABD, BM, K); Kaw Tao, c. 10 m, 14 Apr 1927, Kerr, A.F.G. 11172A (ABD, BM, K); Cult. from Kerr, A.F.G. 11172 coll. 7/11/1929 (ABD [2 sheets]); Cult. from Kerr, A.F.G. 11172 coll. 6/11/1928 (ABD [2 sheets]); Cult. from Kerr, A.F.G. 11172 no coll. date (ABD [2 sheets]); Ban Kawp Kep, c. 100 m, 5 Aug 1927, Kerr, A.F.G. 13179 (ABD, BK, BM, K); Ban Khan Thuli, 7 Sep 1931, Put, N. 4130 (BM, K); Kau Hoa Kwai, Tassateng, 3 Jan 1935, Seidenfaden 2134 (SING). Trang: Huay Yot, Wat Tham Iso, 130 m, 6 Mar 2006, Middleton, D.J. et al. 4099 (A, BKF, E); ibidem, 101 m, 9 Sep 2008, Middleton, D.J. et al. 4423 (BKF, E); Khao Pina, 16 Nov 1990, Larsen, K. et al. 41475 (BKF); Na Yong, Na Muen Si, Wat Hua Khao, Santikhunakorn ladder, 60 m, 24 Dec 2006, Poona, R. et al. 6598 (BKF, E); Khao Pina, 150 m, 23 Oct 1991, Larsen, K. et al. 42505 (BKF); Khao Chong, 5 Mar 1969, Sangkhachand, P. 1758 (BK). Yala: s.l., 31 Jan 1931, Put, N. 3685 (ABD [2 sheets], BM, K); Wat Tam, 50 m, 10 Dec 1972, Santisuk, T. & Nimanong, B. 367 (BKF (3), SING); Than To, Bang Lang National Park, 80 m, 8 Feb 2004, Middleton, D.J. et al. 2784 (A, BKF); Bannang Sata, Khuean Bang Lang, Ban Santi, 150 m, 28 Oct 2005, Poopath, M. 403 (BKF, E); Bannang Sata, Khuean Bang Lang, Ban Santi, 150 m, 1 Sep 2005, Poopath, M. 350 (BKF, E); Than To, Bang Lang National Park, 200 m, 8 Dec 2004, Palee, P. 681 (A, E).


Distribution. Central and Southwestern Thailand.

Habitat. On rocks and walls.
Provisional IUCN conservation assessment. Data Deficient DD. The known EOO and AOO for this variety would qualify it as Endangered if there were associated threats. However, most of the collections are old and distributions from the areas in Central Thailand cannot be verified.


Notes. This variety was first described by Craib (1930) as a species but was included in synonymy of Microchirita involucrata by Wood (1974). It is here reinstated at the rank of variety. The only distinguishing feature is the lack of an indumentum on the anthers. Given the otherwise identical morphology and the overlapping distribution, a varietal status is preferred for this taxon.

11c. Microchirita involucrata var. gigantiflora C.Puglisi, var. nov.
This variety differs from Microchirita involucrata var. involucrata in the longer flower (c. 35 mm vs. c. 20 mm) and the much smaller bracts (< 1 cm long in var. gigantiflora, ≥ 1.6 cm in var. involucrata). – TYPE: Thailand, Nakhon Si Thammarat, Kha Nom, Khuan Thong, Khao Wang Thong Cave, 50 m, 20 December 2006, Pooma, R., Phattarahirankanok, K. & Sirimongkol, S. 6472 (holotype BKF; isotype E [E00311111]).

Distribution. Peninsular Thailand (Nakhon Si Thammarat).

Habitat. On limestone in evergreen forest.

Provisional IUCN conservation assessment. Data Deficient DD. This variety is only known from the type collection and its distribution and potential threats to it are unknown.

Notes. The floral characters match Microchirita involucrata var. involucrata, including key features such as the glabrous ovary and the loosely coherent anthers, except that the corolla parts are proportionately larger.

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Karaket, P., Triboun, P., Kawatkul, U. & Meeboonya, R. 4526 (holotype BKF; isotypes E [E00629480], P [P00966764], QBG). (Fig. 8)

Herb to 60 cm tall with elongated stem runners. Habit caulescent, internodes c. 8 cm (only one seen). **Stems** succulent, green, sometimes tinged with reddish, glabrous or glabrescent; branches sometimes arising from the petioles. **Leaves** opposite, apart from the basal leaf; petioles 0.5–2 cm long, green, sparsely eglandular hispid; blades mid to dark green above, whitish green beneath, ovate, 5.1–25 × 3.5–19 cm, 1.6–2.6 times as long as wide, base cordate, apex acuminate, sparsely eglandular hairy above and beneath, ciliate along the margin, margin entire, 7–15 pairs of secondary veins, steeply ascending, venation sunken above and raised beneath in fresh material, flat in dry specimens, tertiary venation laxly reticulate. **Inflorescences** cristate, peduncles reduced or emerging to 10 mm long and sometimes fused together; bracts absent; pedicels pale green, 4.5–10 mm long, glabrescent or very sparsely hairy. **Calyx** green, bilabiate, lower lobes completely divided, upper lobes joined for 1–5 mm, lobes narrowly lanceolate, 1–6 × 0.8–1.6 mm, apex acuminate and slightly thickened, margin entire, sparsely hairy especially at the tip. **Corolla** 12–18 mm long, white with a yellow stripe ventrally inside and violet patches at its sides, lobes white, tube narrow, curved, progressively widening, upper lobes spreading, eglandular hairy outside, glabrous inside; tube 9–13 mm long dorsally, 9.3–14 mm ventrally, 7.8–14 mm laterally between lips; lobes broadly orbicular to elliptic, apices rounded, upper lobes 2.7–3.5 × 2.8–4.7 mm, lateral lobes 2.8–5 × 4–5.8 mm, ventral lobe 3–4.7 × 3.8–5.5 mm. **Stamens** arising 3.3–6.5 mm above the corolla base, filaments straight, glabrous, 2.8–3.5 mm long, c. 0.3 mm wide; anthers white or pale yellow, with a sparse long indumentum by the insertion, 1.4–2 × 0.8–1.2 mm, apically joined by a connective, thecae divergent; staminodes arising c. 3 mm above corolla base, c. 0.3 mm long. **Disk** absent or a ventral half ring 0.6–0.7 mm high. **Pistil** c. 15 mm long; ovary 3.5–5 mm long, c. 1 mm diameter, papillose or with sparse hairs in the top half; style 6–7 mm long, pubescent; stigma chiritoid, c. 1.2 mm long. Immature **fruit** green, to 5 cm long, c. 1.5 mm diameter, glabrous, straight or slightly curved. **Seeds** brown, narrowly elliptic, acuminate, 0.4–0.5 × c. 0.2 mm.

**Distribution.** Northern Thailand. Myanmar.

**Habitat.** On limestone in mixed deciduous forest.

**Provisional IUCN conservation assessment.** Vulnerable VU Blab(iii). The EOO is around 8,000 km², it is known only from fewer than 10 populations, and some of the known localities are not in protected areas and subject to disturbance. The assessment will have to be reviewed once the distribution in Myanmar is better known.

**Additional specimens examined.** THAILAND: Chiang Mai: Chiang Dao, road to Wiang Haeng, 610 m, 21 Sep 2008, Middleton, D.J. et al. 4536 (BKF, E); Chiang Dao, Daan Pha Woak, 740 m, 20 Aug 1999, Watthana, S. et al. 559 (QBG); Chiang Dao, Kio Phawok border

checkpoint, 750 m, 30 Sep 2009, Middleton, D.J. et al. 5017 (E). Mae Hong Son: Phang Mapha, Viewpoint, 867 m, 12 Sep 2013, Lakoet, C. 400 (QBG).

**Notes.** The description provided is a slightly updated version of the original description by Middleton & Triboun (2013). *Microchirita karaketii* is recognisable from its colour pattern (white corolla, with a ventral yellow line and lateral violet markings). Other species with a similar colour pattern are *Microchirita huppatatensis* and *M. tubulosa*, which, however, differ greatly in the shape of the corolla and the anther indumentum. *Microchirita karaketii* is otherwise remarkably similar to *M. bimaculata*, which is bright yellow with dark brownish markings. Although the two species are sympatric in northern Thailand, no intermediate colour forms have been observed. *Microchirita karaketii* has flowers smaller than *M. bimaculata*, and its dry leaves do not acquire the yellowish hue observed in *M. bimaculata*. 

Herb to 40 cm tall. **Stems** fleshy, red at base, otherwise green, with pale green hairs, which are lost in dried specimens. **Leaves** opposite, with the exception of the single one or two basal leaves, fleshy (very thin when dry); petioles 0.3–2.5 cm long, glabrous; blades pale to mid green above, paler beneath, ovate, 2.5–18 × 1.4–13 cm, 1.3–1.8 times as long as wide, base cordate, apex acuminate or rarely acute, densely tomentose above, sparsely so beneath, margin entire, 6–10 pairs of secondary veins in the opposite leaves, 10–15 in the basal leaf, venation raised beneath in fresh material, tertiary venation finely and irregularly reticulate, visible only beneath. **Inflorescence** epiphyllous, 2–15-flowered, cristate; peduncles reduced or shortly emerging and fused together; bracts absent; pedicels green, 0.2–1.5 cm long, glabrous or sparsely hairy. **Calyx** pale green, bilabiate, tube 0.5–1.5 mm long, lobes narrowly lanceolate, 6.5–7 × 0.8–1.2 mm, with the central upper lobe (alternate to the upper corolla lobes) c. 1 mm shorter than the other lobes, membranous along the margins, apex narrowly obtuse, outside with scattered eglandular hairs along the midrib, inside with a minute indumentum of sessile glands. **Corolla** 8–12 mm long, markedly variable even within populations, tube whitish pale lilac, with a yellow stripe ventrally, lobes very pale lilac, tube with a narrow basal portion 3–4 mm long, c. 2.5 mm diam., then abruptly broadening into a campanulate tube, pubescent with very fine eglandular hairs outside except at base, inside glabrous, the upper lobes with sparse stalked glands, especially abundant towards the centre of the upper lip, the lower minutely papillose; tube 11–13 mm long dorsally, 13–14 mm ventrally, 10.5–12.5 mm laterally between lips, upper lobes elliptic, 3–3.5 × c. 5 mm, lower lateral lobes elliptic, 3–3.5 × 5–6.5 mm, lower central lobe rounded, 4–4.5 × 4.5–5 mm. **Stamens** arising 4.5–5 mm above the corolla base, filaments glabrous, 3.5–4.5 mm long, slightly twisted; anthers cream-white with a dark spot beside the attachment of the filament, glabrous, 1.7–3 × 0.6–1.5 mm, apically joined by a connective, thecae divergent and apiculate; lateral staminodes 1.5–3 mm long, arising 3–3.7 mm above the corolla base, central staminode c. 1.7 mm long, arising c. 2.8 mm above corolla base. **Disk** a ventral lobe, 0.3–0.4 mm high, with irregular margin. **Pistil** 12–16 mm long; ovary 6–11 mm long, with scattered glands for 1/2–2/3 and then distally with fewer glands and a dense eglandular pubescence; style 5–6 mm long, curved downwards, hairy as the upper part of the ovary; stigma with pronounced lobes, lobes 1–1.4 mm long, 0.6 – 0.8 mm wide, narrowly elliptic, glabrous outside, papillose inside. **Fruit** green, 2–6 cm long, 0.8–1 mm diam., glabrous at the base, sometimes with indumentum terminally, straight or curved. **Seeds** brown, elliptic, 0.4–0.5 × c. 0.2 mm.

**Distribution.** Southwestern and Northern Thailand (Kanchanaburi, Tak).

**Habitat.** On limestone.

**Provisional IUCN conservation assessment.** Vulnerable VU Blab(iii). Puglisi et al. (2016) assessed this species as Endangered but since that publication several new localities have been discovered which have expanded the EOO to around <20,000 km². This new assessment recognises that the threats to the habitat of the species still exist but that its wider distribution reduces the overall threat.

*Additional specimens examined.* THAILAND: **Kanchanaburi:** Sangkhla Buri, Tham Sukho, 180 m, 17 Dec 2009, *Pooma, R. et al. 7433* (BKF); Sangkhla Buri, c. 120 m, 29 Aug 1999, *Chayamarit, K. et al. 1831* (BKF [2 sheets]). **Mae Hong Son:** Muang Mae Hong Son, Mae Surin National Park, 840 m, 21 Oct 2014, *Middleton, D.J. et al. 5820* (E, SING). **Tak:** Umphang, Pha Phueang, 990 m, 8 Oct 2014, *Suddee, S. et al. 4759* (BKF); Umphang, Doi Hua Mot, *Suddee, S. et al. 3312* (BKF); Umphang, Umphang-Maesot road, 500 m, 19 Oct 2013, *Pooma, R. et al. 7894* (BKF); Umphang Wildlife Sanctuary, Doi Hua Mot area, 900 m, 18 Oct 2013, *Pooma,
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**Note.** This species is recognisable by the pale lilac corolla and the glabrous anthers.

### 14. *Microchirita limbata* C.Puglisi, sp. nov.

Species characterised by the tubular corolla with white tube and blue lobes, and by the widespread glandular indumentum. It is most similar to *Microchirita albocyanea* C.Puglisi in the overall shape and colour of the corolla, but differs in the smaller flowers and in having a glandular indumentum. – **TYPE:** Thailand, Chaiyaphum, Khon San, Wat Tham Huang Po, 443 m, 19 October 2015, *Suddee, S., Keiwbang, W., Hemrat, C. 4968* (holotype BKF; isotype SING). (Fig. 10)

Herb to 80 cm tall. Habit caulescent, internodes 1–10 cm. **Stems** succulent, glandular hairy; branches sometimes arising from the petiole of the basal leaf. **Leaves** opposite, apart from the basal leaf; petioles 0.2–1.7 cm long, glandular hairy; blades mid green above, much paler beneath, lanceolate to elliptic, 3.1–13 × 0.6–5.2 cm, 1.6–5.2 times as long as wide, base shortly attenuate to acute, apex acute to acuminate, eglandular pubescent above and beneath, ciliate along the margin with glandular and eglandular hairs, margin entire or obscurely denticulate, 4–14 pairs of secondary veins, venation slightly sunken above and raised beneath in fresh material, flat in dry specimens, tertiary venation seldom visible in dry specimens. **Inflorescences** crisate, 1–7(–12)-flowered; peduncles reduced or 1–7 mm long, fused with each other, glandular pubescent; bracts absent; pedicels pale green to green, 0.2–1.2 cm long, glandular pubescent. **Calyx** pale green, succulent at the base, tube c. 0.3 mm long, lobes lanceolate, 4.5–8 × 0.7–1.5 mm, apex acuminate and thickened, margin entire, with mixed glandular and eglandular hairs on both sides, sparse inside, margin ciliate. **Corolla** 14–16 mm, tube white, throat white with a yellow patch at the base of the filaments, lobes purple-blue, tube narrow at the base, then becoming campanulate, only slightly curved, lobes almost equal, eglandular hairy outside except at base, densely glandular inside; tube 11–12.5 mm long dorsally, 11–12 mm ventrally, 11.5–13.5 mm laterally between lips; lobes obtuse (broadly elliptic becoming triangular with a broad apex) with irregular margin, upper lobes 2–3 × 3.7–4.8 mm, lateral lobes 2.5–4 × 3.5–6.5 mm, ventral lobe 3.5–4 × 2.7–7 mm. **Stamens** arising 4–5 mm above the corolla base, filaments geniculate near the base, green-yellow, glabrous, 2–3 mm long, 0.3–0.4 mm wide; anthers white, with white to brown hairs throughout except for the apices, 1.9–2.5 × 2.5–2.6 mm, apically coherent but not joined by a connective, or at most with a very weak and short ligature, thecae parallel or slightly divergent; lateral staminodes 0.3–0.9 mm long, arising 3–3.8 mm above the corolla base, central staminode 0.2–0.3 mm long, arising 3–3.6 mm above the corolla base. **Disk** annular, margin irregular,
0.1–0.2 mm high. **Pistil** c. 10.5 mm long; ovary 3.5–5 mm long, c. 1.1 mm diameter, glabrous at the base, then densely tomentose with glandular and eglandular hairs; style and stigma with the same indumentum observed on the ovary; style c. 4.5–5.5 mm; stigma bilobed, lobes elliptic, 0.5–1 mm. **Fruit** green, 1–4.5 cm long, 0.7–1.2 mm diameter,densely glandular hairy, straight or curved. **Seeds** brown, narrowly elliptic, mucronate, 0.3–0.4 × 0.1–0.2 mm.

**Distribution.** Northeastern and Eastern Thailand.

**Habitat.** On limestone in mixed deciduous forest.

**Provisional IUCN conservation assessment.** Endangered EN B1ab(iii) + B2ab(iii). The EOO and AOO are within the threshold for the Endangered status and not all of
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the localities are in protected areas with the associated threats to limestone habitats that entails.


Notes. The epithet refers to the contrast between the colour of the corolla tube and the lobes. The specimens from Khon Kaen have denser inflorescences (up to 12 flowers) and a denser indumentum, but are otherwise alike.

15. *Microchirita luteola* C.Puglisi, sp. nov.

Similar to *Microchirita tubulosa* (Craib) A.Weber & D.J.Middleton but differs in not having spots inside the lateral corolla lobes, having an entire disk (usually dorsally cleft in *M. tubulosa*), glandular indumentum on the stems (vs. eglandular), and acuminate calyx lobes (vs. usually acute, more rarely slightly acuminate). It is also similar to *Microchirita marcanii* in the shape of the corolla, but differs in the mixed eglandular and glandular indumentum on many plant parts (eglandular only in *M. marcanii* (Craib) A.Weber & D.J.Middleton) and the corolla colour pattern (light yellow corolla with a yellow stripe vs. orange corolla with lateral purple spots). Finally, it differs from *Microchirita elphinstonia* (Craib) A.Weber & D.J.Middleton in having a glandular indumentum and in the larger and much paler yellow corolla. – TYPE: Loei, Nong Hin, Suan Sa Wan, Pha Ngam Forest Park, 662 m, 11 September 2014, Tetsana, N. et al. 829 (holotype BKF; isotype SING). (Fig. 11A–C)

Caulescent herb to 50 cm tall, internodes 2.5–10 cm. Stems, petioles, pedicels and peduncles succulent, green and often tinged with reddish-brown, glandular and eglandular hispid; branches sometimes arising from the petioles of the basal leaf as well as the opposite leaves. Leaves opposite, apart from the basal leaf; petioles 0.1–1.5 cm long; blades pale to mid green above, whitish green beneath, ovate, elliptic or obovate, 3.8–8 × 1.5–5.8 cm, 1.2–3.1 times as long as wide, base shortly attenuate to cordate, apex acute to acuminate, eglandular strigose above, hispid beneath, ciliate along the margin with eglandular hairs, margin entire or obscurely denticate, 7–17+ (leaf incomplete) pairs of secondary veins, venation slightly sunken above and raised beneath in fresh material, flat in dry specimens, tertiary venation visible in dry specimens. Inflorescences cistrate, 1–4-flowered; peduncles 4–10 mm long, shortly fused with each other; bracts absent; pedicels pale green to reddish brown, 3–25 mm long. Calyx reddish brown at the base, green apically, succulent at the base, tube c. 1.6 mm long, lobes imbricate at base, lanceolate, 14–17 × 3–3.5 mm, apex acuminate, margin entire, outside with short, patent, mixed glandular and eglandular
hairs, inside glabrous except at the tip, margin ciliate at the tip. **Corolla** c. 35 mm long, tube white at the base, turning pale yellow distally, base of ventral lobe with a yellow stripe, lobes pale yellow at the base, paler towards the margin, tube narrow at the base, curved basally and gradually broadening, mouth broad and slightly gibbous laterally and ventrally, base of the tube, upper lobes and ventral lobe glabrous, the rest of the corolla externally covered in short mixed glandular and eglandular hairs, internally with sparse glandular hairs, forming a denser patch at the base of the upper lobes, lobes slightly papillose; tube c. 23 mm long dorsally, c. 27.5 mm ventrally, c. 24 mm laterally between lips; lobes broadly elliptic, upper lobes c. 5.5 × 10 mm, lateral lobes c. 6 × 8.5 mm, ventral lobe c. 8.5 × 10.5 mm. **Stamens** arising c. 17 mm above the corolla base, filaments strongly geniculate, with a basal, thinner segment c. 2 × 0.7 mm, and an apical, thicker segment c. 4.5 × 1.6 mm, pale yellow, glabrous; anthers white, with white hairs dorsally, c. 3.5 × 2.5 mm, apically joined by a connective, thecae parallel or slightly divergent; lateral staminodes c. 0.7 mm long, arising c. 9 mm above the corolla base, central staminode c. 0.5 mm long, arising c. 9 mm above the corolla base. **Disk** annular, margin entire, 1 mm high, c. 0.5 mm thick (exceptionally thick). **Pistil** c. 29 mm long; ovary c. 10 mm long, c. 1.6 mm diameter, lower 1/3 glabrous, then densely tomentose with eglandular and perhaps glandular hairs; style c. 18 mm long, with the same indumentum as ovary; stigma bilobed, lobes elliptic, 1 mm. **Fruit** green, 7–10.5 cm long, 0.5–2.5 mm diameter, densely hairy, straight or slightly curved. **Seeds** light brown, narrowly elliptic, with irregular surface, 0.3 × 0.1 mm.

**Distribution.** Northeastern Thailand.

**Habitat.** On limestone in evergreen forest.

**Provisional IUCN conservation assessment.** Endangered EN B2ab(iii). This species has an AOO of around 20 km² and is only known from a small number of collections, not all of which are in protected areas.


**Notes.** This species is named after its pale yellow corolla.

Caulescent herb to 60 cm tall, internodes 4–13 cm long, branches sometimes arising from the petiole of the basal cotyledon. **Stem** fleshy, pale green with purplish base, sparsely eglandular hairy. **Leaves** opposite, apart from the basal leaf; petioles pale green, 7–14 mm long; blades mid green above, paler beneath, ovate, 6.2–24 × 3.2–12.6 cm, 1.7–2 times as long as wide, base cordate, apex acute to obtuse, eglandular hairy above and beneath, margin ciliate, margin entire to obscurely toothed, 8–15 pairs of secondary veins, venation sunken above and raised beneath in fresh material, flat in dry specimens, tertiary venation laxly reticulate. **Inflorescences** cristate, 10–16-flowered, all floral axes sparsely to densely eglandular hairy; peduncles 2–13 mm long, shortly fused with each other; bracts absent, except for first inflorescence arising from the petiole of each leaf, observed only in cultivated material; pedicels pale green to reddish brown, 3–26 mm long. **Calyx** actinomorphic, green, lobes succulent along the midrib, tube 1.3–3 mm, lobes imbricate, narrowly ovate, 7–18 × 2.9–3.6 mm, apex acute, margin entire, outside with eglandular hairs along the midrib, tip and margin, inside with sessile glands. **Corolla** 32–45 mm long, tube pale green at the base, then becoming dark orange, throat dark red with lateral purple spots, tube narrow at base, curved, then becoming broad, upper and lateral lobes spreading, tube glabrous at the base, then with mixed glandular (especially ventrally) and eglandular (especially dorsally) hairs, lobes papilllose inside, the rest of the inside of the corolla glabrescent or sparsely glandular; tube 26–30 mm long dorsally, 29–32 mm ventrally, 22–27 mm between the lips; lobes with broadly obtuse apex and a minutely crenate margin, upper lobes 6–6.5 × 10 mm, lateral lobes 8 × 12–13 mm, ventral lobe 10–11 × 12 mm. **Stamens** arising 1.6–1.9 cm above the corolla base (the point where the corolla broadens), filaments slightly to strongly geniculate, 4.5–7 × 1 mm, pale yellow, glabrous, anthers white, hairy dorsally, 3–3.5 × 1.5–2.7 mm, apically joined by a connective, thecae divergent; lateral staminodes 0.5–2 mm long, arising 0.8–1.25 cm above the corolla base, central staminode 0.3–1 mm long, arising 0.9–1.35 cm above the corolla base. **Disk** annular, margin slightly lobed, 0.8–1 mm high. **Pistil** 27 mm long; ovary c. 1 cm long, 1.7 mm diameter, glabrous in the bottom 1/3–1/2, densely hairy above; style slender, 1–2 cm long, hairy; stigma bilobed, lobes c. 0.9–1 mm, papilllose/plumose. **Fruit** green, 4.5–6.2 cm long, 3.5–4 mm diameter, glabrous at the base, eglandular hairy apically, slightly curved. **Seeds** very dark brown, oval, 0.7–0.8 × 0.2–0.4 mm.

**Distribution.** Central and Eastern Thailand.

**Habitat.** On limestone.

**Provisional IUCN conservation assessment.** Vulnerable VU B1ab(iii) + B2ab(iii). This species has an EOO and an AOO within the threshold to be considered endangered but is known from 5–10 localities, thereby making the Vulnerable status more appropriate.

A revision of *Microchirita* in Thailand


**Notes.** This species is easily recognised by the large, orange corolla. It is most similar to *Microchirita tubulosa*, which however has a white flower with purple lateral markings and a ventral yellow line.

In the protologue, Craib (1926) cited the wild collection *Marcan 1872* and a cultivated plant grown in Aberdeen from seeds of this plant and noted that the description was largely based on the cultivated plant. This would make the cultivated plant a better choice for lectotypification but we have been unable to find any material unequivocally vouchered from this living collection in Aberdeen before publication of the protologue.


Caulescent herb to 30 cm tall, internodes 4–7 cm long. **Stems** succulent, glabrescent or sparsely eglandular hairy, branching from the petiole of the basal leaf. **Leaves** opposite apart from the basal leaf; petioles to 3 cm long, glabrescent; blades lanceolate to elliptic, 7–25 × 4.1–12 cm, 1.7–2.5 times as long as wide, base shortly attenuate to subcordate, apex acute to broadly acuminate, with eglandular hairs above and sparse hairs beneath, margin entire or minutely serrulate, 8–18+ pairs of secondary veins. **Inflorescences** cristate, 4–10-flowered (20 according to the protologue), floral axes sparsely eglandular hairy to glabrescent; pedicels short and fused with each other; bracts absent; pedicels straight or curved, 7–16 mm long. **Calyx** actinomorphic, lobes divided to base, lanceolate, 7.5–13 × 1.2–1.7 mm apex acute, margin entire, with minute glands on both sides, and a sparse eglandular indumentum outside on margin and midrib. **Corolla** 20–26 mm long, yellow with an orange patch ventrally, narrow at base then gradually broadening, with eglandular hairs along the upper part of the tube and glandular hairs inside by the mouth; tube c. 16.5 mm long dorsally, c. 17.5 mm
laterally, c. 20 mm ventrally; lobes elliptic with rounded apex, upper lobes 3.5–4.5 × 6 mm, lateral lobes 5–6 × 6 mm, lower lobe 5–6 × 5.5 mm. **Stamens** arising c. 11 mm above the corolla base, filaments straight, sparsely eglandular hairy, c. 3 mm long, c. 0.3 mm diameter; anthers pale, with a dimorphic indumentum of long purple hairs pointing upwards and short straight white hairs pointing down, arising from the base of the anther, anthers c. 1.5 × 1.5 mm, apically joined by a connective, thecae slightly divergent; staminodes 2, 0.4 mm long, arising 7.5 mm above the corolla base. **Disk** annular, slightly lobed, 0.4–0.6 mm tall. **Pistil** c. 15 mm long; ovary c. 6 mm long, glabrous or finely glandular at base, eglandular hairy in the upper 1/3; style curved, c. 6 mm long, hairy; stigma lower lip elongate, 1.2–1.5 mm long, 1 mm wide. **Fruit** straight or occasionally slightly curved, c. 5–6 cm long, narrow, with sparse glands along most its length and eglandular hairs terminally. **Seeds** not seen.

**Distribution.** Central and eastern Thailand. Possibly also occurring in Nakhon Ratchasima (photos from Sukonthip Sirimongkol seen).

**Habitat.** “On sandy soil in deciduous forest”. Habitat data are missing from most collections of this species but it is noteworthy that the collection localities appear to be from areas that do not have karst limestone or a limestone bedrock. This makes it unusual in the genus.

**Provisional IUCN conservation assessment.** Data Deficient DD. There are rather few collections of this species and many of these are more than 40 years old. Further collections are needed in the Khao Yai and Sisaket areas to set a conservation assessment.

**Additional specimens seen.** **Unknown province:** Cultivated at Cornell University, Ithaca, originally from Montreal Botanical Garden, 23 Oct 1958, Moore, J.R. 7685 (E); Cult. RBGE, received from Smitinand, C3797 (E); Cult. RBGE, received from Frankfurt BG in 1964, Sep 1964, C4327 (E). **THAILAND:** **Nakhon Nayok:** Suvatabundha, K., s.n. (BK); Muang, Nahng Rawng falls [Nang Rong Waterfall], 16 Sep 1972, Maxwell, J.F. 72-355 (AAU, BK); ibidem, c. 100 m, 22 Oct 1960, Smitinand, T. 6984 (A, E, K). **Sisaket:** Kantalak, Panomdongrak Wildlife Sanctuary, Samrong Kiat Waterfall, 300 m, 21 Oct 2003, Palee, P. 647 (CMU).

**Notes.** Microchirita micromusa is similar to *M. elphinstonia*, from which it differs in the orange patch in the corolla and in the clearly dimorphic anther indumentum. Burtt named it “micromusa” because M. Raymond described the fruits as “a miniature hand of bananas” (Burtt, 1960). However, short, curved fruits are rather more characteristic of another yellow-flowered species, *Microchirita bimaculata*, than of *M. micromusa*. There has been some confusion between the two species, resulting in many specimens of *M. bimaculata* from Northern Thailand being misidentified as *M. micromusa*. *Microchirita micromusa* is distributed in Central and Eastern Thailand and is not known to overlap with the distribution of *M. bimaculata*. 

**Notes.** *Microchirita mollissima* is easily recognised by its elongated and sessile or subsessile leaves with a dense white indumentum, and by the nearly axillary inflorescences. Three varieties can be distinguished in Thailand.

**Key to the varieties of Microchirita mollissima**

1a. Anthers hairy, with a small projection at the filament insertion .................. 2
1b. Anthers glabrous, without a projection at the filament insertion .................. 18b. *M. mollissima* var. glabra

2a. Leaves, calyx and corolla with eglandular indumentum only ....................
2b. Leaves, calyx and corolla with glandular indumentum .............................. 18a. *M. mollissima* var. *mollissima*

18a. **Microchirita mollissima** var. *mollissima*

Caulescent perennial herb to 50 cm tall with elongated stem runners, internodes to c. 2 cm. **Stems** not fleshy, densely hairy. **Leaves** opposite, condensed at the stem apex; petioles inconspicuous or to 2.5 cm long, densely eglandular hairy; blades pale to dark green above with silvery white soft hairs, grey-green, flushed purple beneath, lanceolate, 3.5–28 × 0.7–9 cm, 2.2–7.2 times as long as wide, base acute to attenuate, often unequal, apex acute to acuminate, densely eglandular tomentose above and beneath, margin entire to irregularly denticulate, 6–14 pairs of secondary veins in the opposite leaves, venation slightly sunken above and raised beneath in fresh material, tertiary venation inconspicuous. **Inflorescences** cristate, peduncles 10–60 mm, not fused to each other, densely eglandular hairy, the first inflorescence is rarely compound and bracteate. **Calyx** green, tube c. 0.3 mm long, lobes lanceolate, 5–14 × 1.5–4 mm, apex acute, eglandular hairy on both sides, with additional sparse, minute glands inside. **Corolla** 18–33 mm long, blue, pale blue, purple, pink or white, tube creamy white or greenish white, lobes very pale lilac, dorsal fringe of yellow/orange glandular, papillose hairs inside, narrow at base (7–11 mm, c. 2.2 mm diameter), then slightly curved downwards and gradually broadening, lobes not reflexed, eglandular pubescent outside except at base, especially dorsally between the upper lobes and ventrally below the central lobe; tube 14–26 mm long dorsally, 20–36 mm ventrally,
14–28 mm laterally between lips; upper lobes broadly elliptic, 4–7 × 7–11 mm, lower lateral lobes elliptic, 3–12.5 × 4–13 mm, lower central lobe round-elliptic, 4.5–10.5 × 6.5–17 mm. **Stamens** arising 7.5–16 mm above the corolla base; filaments white or pale yellow, glabrous, 7.5–9 mm long, 0.8–1.3 mm wide; anthers white or pale yellow, hairy dorsally, 3.5–4.5 × 2–2.5 mm, apically coherent but not joined by a connective, thecae divergent; lateral staminodes 3.5–4.5 mm long, 0.2 mm wide, arising c. 7.5–16 mm above the corolla base, central staminode 0.6 mm long, arising c. 8 mm above the corolla base. **Disk** annular, margin irregular, dark, 0.4–0.5 mm high. **Pistil** 13 (immature)–28 mm long, eglandular hirsute throughout; ovary 0.7–1.3 cm long, c. 1 mm diameter; style c. 1.2 cm; stigma broadly bilobed, lobes 1.1–2 mm long, 0.9–1.3 mm wide, elliptic. **Fruit** brown when ripe, 3–7 cm long, 1–1.5 mm diameter, densely eglandular hairy, straight. **Seeds** not seen.

**Distribution.** Peninsular Thailand.

**Habitat.** On limestone, in shade.

**Provisional IUCN conservation assessment.** Near Threatened NT. This variety has an EOO and an AOO within the limits to be considered endangered; it is, however, known from many localities.

**Additional specimens examined.** **Unknown locality:** 1930, Kerr, A.F.G. 240 (L). **Thailand:** **Krabi:** Nai Chong, Khap Thong Thai, 30 m, 19 Jan 1966, Hansen, B. & Smitinand, T. 11997 (BKF, E, K, SING); Aoluk, Ban Naiyuan Khaek, c. 20 m, 5 Sep 1982, Shimizu, T. et al. T-29113 (BKF); Mueang Krabi, Thambon Krabi Noi, Wat Tham Seua, 85 m, 11 Sep 2008, Middleton, D.J. et al. 4443 (BKF, E); Cult. RBGE from Middleton, D.J. et al. 4443, Middleton, D.J. 5208 (E); Khao Phanom Bencha National Park, c. 100 m, 13 Sep 1983, Smitinand, T. s.n (BKF); between Krabi and Panom Bencha, 0 m, 24 Oct 1991, Larsen, K. et al. 42534 (AAU, BKF); Muang, near Panom Bencha National Park, Tham Khao Pheung, 60 m, 17 Jun 2006, Williams, K. et al. 1826 (BKF); Khao Kophi, c. 50 m, 14 Aug 1965, Smitinand, T. 8929 (BKF); Ao Luk, 8 Oct 1970, Charoenphol, C. et al. 3444 (AAU, E); Plai Praya, Wat Ban Hian, 24 Sep 2010, Triboun, P. & Sonsupab, B. 4583 (E). **Phang Nga:** Pungah, 6 Dec 1918, Haniff & Nur 3880 (SING); Muang, Tham Khao Gnom, 20–50 m, 7 Sep 1982, Shimizu, T. et al. T-29191 (BKF); Mueng, Suan Somdej, 11 Dec 1986, Phengklai, C. & Smitinand, T. 6015 (BKF); Tupput, Tham Saeng Tham Nimit Dharma office, 60 m, 23 Feb 2001, Chayamarit, K. et al. 2655 (BKF); Mueng, Tha Manopkhiep, c. 50 m, 1 Jan 2000, Wongsrassert, T. 001-11 (BKF); Muang, Sra Nang Manora Forest Park, 224 m, 17 Nov 2014, Suddee, S. et al. 4800 (BKF); Khao Phang Nga, 200 m, 27 Feb 1929, Kerr, A.F.G. 17265 (K); Muang Phangnga, Sra Nang Manora Forest Park, 16 Sep 2010, Middleton, D.J. et al. 5449 (E); Kan Bow Koranee cascade, 9 May 1973, Geesink, R. & Santisuk, T. 5292 (L). **Surat Thani:** Phanom, Kholong Phanom National Park, 200 m, 7 Sep 2008, Middleton, D.J. et al. 4361 (BKF, E).

**18b. Microchirita mollissima** var. *glaabra* C.Puglisi, var. nov.

Differs from the type variety in the lack of an indumentum dorsally on the anthers and the small projection of the filament at the insertion. – **TYPE:** Thailand, Krabi,
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Tum Pra Sat Na Ra Ki Ling, c. 50 m, 29 October 2006, Triboun, P. 3671 (holotype E [E00428772]).

**Distribution.** Thailand (Krabi).

**Habitat.** On limestone.

**Provisional IUCN conservation assessment.** Data Deficient DD. This variety is only known from the type collection and its distribution is too poorly known.

**Note.** The corolla of the type specimen is reported to be pale pink.

**18c. Microchirita mollissima** var. glandulophylla C.Puglisi, var. nov.

Differs from the type variety by the glandular indumentum on the calyx and corolla, and the mixed glandular and eglandular indumentum on the leaves. – TYPE: Thailand, Phang Nga, Ban Tham Thong Lang, c. 50 m, 25 January 1969, Smitinand, T. & Scheller, R. 10642 (holotype BKF).

**Distribution.** Thailand (Phang Nga).

**Habitat.** On limestone rocks.

**Provisional IUCN conservation assessment.** Endangered EN B1ab(iii) + B2ab(iii). This species has an EOO and AOO of < 20 km² and is only known from a small number of collections from fewer than 5 locations, not all of which are in protected areas.

**Additional specimens examined.** THAILAND: Phang Nga: Thap Put, Khao Sam’kob, c. 80 m, 24 Aug 1967, Shimizu, T. et al. T-7903 (BKF); Tham Thong Lang, 50 m, Jun 1971, Cultivated RBGE, accession number 691872, vouchered as C8246 (E); Muang Phangnga, 29 Sep 2006, Triboun, P. 3665 (E).


Caulescent herb to 40 cm tall, internodes 1–11 cm. **Stems** succulent, green, eglandular tomentose; branches sometimes arising from the petioles of the basal leaf. **Leaves** opposite, apart from the basal leaf; petioles 0.2–1.7 cm long, green, sparsely eglandular...
hairy; blades green above, paler beneath, ovate or lanceolate, 4–16 × 1.7–10 cm, 1.4–2.4 times as long as wide, base obtuse to subcordate, apex acute to acuminate, dimorphic eglandular indumentum above, more sparsely so beneath, ciliate along the margin, margin entire to obscurely toothed, 5–14 pairs of secondary veins, steeply ascending, venation slightly sunken above and raised beneath in fresh material, flat in dry specimens, tertiary venation lax. Inflorescences cistate, all axes with a dense indumentum of white eglandular hairs; peduncles reduced or to 2 mm long, not fused with each other; bracts absent; pedicels pale green, 1–6 mm long. Calyx whitish green, actinomorphic, tube 0.5 mm, lobes triangular, 11.5–13 × 1.4–1.6 mm wide, apex acuminate, margin entire, densely eglandular hairy outside, inside hairy only towards the tip. Corolla 16–20 mm long, bright yellow, with a dark reddish brown ring at the throat, tube narrow, straight or curved, abruptly widening, lobes spreading, the ventral prominent, eglandular hairy outside, papillose inside, especially on the lobes, and with larger glands at the base of the upper lobes; tube 14–17 mm long dorsally, 15–18 mm ventrally, 14–16 mm laterally between lips; lobes broadly orbicular and imbricate, apices obtuse to rounded, margin obscurely crenulate, upper lobes 2.5–4.5 × 4.5–6.5 mm, lateral lobes 4–5 × 5–9 mm, ventral lobe 4–8 × 6–11 mm. Stamens arising 9–10.5 mm above the corolla base; filaments straight, glabrescent or sparsely hairy, 1.5–2 mm long, 0.2 mm wide; anthers white, with an indumentum of thick, probably glandular, dark hairs dorsally, 1.3–2 × 1–1.1 mm, apically joined by a connective, thecae divergent, the apices pointing towards the base of the corolla; staminodes all inconspicuous, or only the lateral staminodes present, lateral staminodes 1–9 mm long, arising 2.1–7 mm above the corolla base. Disk a small ventral lobe up to a ½–3/4 ring, 0.4–0.5 mm high. Pistil c. 12 mm long; ovary c. 5 mm long, 0.7–0.8 mm diameter, glabrous at the base, densely covered in white hairs apically; style c. 5.5 mm long, hairy, becoming glabrescent towards the top; stigma glabrous or papillose-plumose, 1 mm long. Fruit 3–4 cm long, slightly curved. Seeds not seen.

Distribution. Eastern Thailand (Sa Kaeo).

Habitat. On limestone.

Provisional IUCN conservation assessment. Endangered EN B1ab(iii). This species has a very small EOO and AOO, being only known from the Khao Chakan District of Sa Kaeo Province. None of the known localities are in protected areas and are subject to high human disturbance.

Additional specimens examined. THAILAND: Sa Kaeo: Khao Chakan, Wat Ratanakiri, 100 m, 21 Aug 2012, Middleton, D.J. et al. 5581 (BKF, E, P); Khao Chakan Temple, 88 m, 17 Oct 2010, Staples, G. et al. 1408 (BKF, E, SING); Krabin, Kao Sakan, c. 50 m, 24 Dec 1924, Kerr, A.F.G. 9750 (ABD, BK, BM, K [2 sheets]).

Notes. This plant is easily recognised by its corolla colour pattern: yellow, with a dark reddish brown ring at the throat. All other species of Microchirita which have a yellow or orange corolla have smaller lateral spots at each side of the ventral corolla lobe.
Another characteristic feature of *Microchirita oculata* is the dense white indumentum on the pedicels and calices. Floral dissection of the material available suggest this species to be strongly protandrous.


Herb to 35 cm tall. **Stems** fleshy, pale green, glabrous or sparsely hairy. **Leaves** opposite, with the exception of the single basal leaf, fleshy (very thin when dry); petioles 0.1–0.5 cm long, sparsely hairy; blades pale green above, pale grey-green beneath, lanceolate, 3.4–40 × 1.7–29 cm, 1.3–2.2 times as long as wide, base usually rounded obtuse, sometimes slightly cordate or slightly decurrent, apex acuminate to acute, minutely tomentose above and beneath, margin entire, 6–11 pairs of secondary veins in the opposite leaves, 8–14 pairs in the basal leaf, venation raised beneath in fresh material, tertiary venation barely visible and loosely reticulate. **Inflorescence** epiphyllous, many-flowered (10 to more than 20 flowers), cristate; peduncles reduced; bracts absent; pedicels pale green, 5–13 mm long, pubescent. **Calyx** green, slightly bilabiate, tube 0.4–0.7 mm long, lobes lanceolate, 4–7 × 0.4–0.6 mm, membranous along the margins, apex more or less narrowly obtuse, outside eglandular hairy throughout, inside only towards the apex. **Corolla** 7–10 mm long, tube greenish white, upper lip pale green, lower lip white, with a densely papillose yellow marking at base, tube narrowly tubular, mouth personate due to the raised ventral lip, upper lip strongly reflexed upwards, tube glabrous at the base, limb densely pubescent outside, densely papillose inside; tube 4–8 mm long dorsally, 6–9 mm ventrally, 4–7 mm laterally between lips; upper lobes small and elliptic, 0.7–0.8 × 1–1.3 mm, lower lateral lobes elliptic, 1.5–1.8 × 2.2–2.3 mm, lower central lobe elliptic, 1.2–1.3 × 1.8–3 mm. **Stamens** arising 2.7–3.7 mm above the corolla base, filaments pale green, glabrous, 0.5–1.2 mm long; anthers white, glabrous, 1.1–1.7 × 0.3–0.5 mm, apically joined by a connective, thecae slightly divergent; lateral staminodes absent or to 0.2 mm long, arising c. 1.7 mm above the corolla base, central staminode extremely reduced or absent. **Disk** a ventral lobe, 0.6–1 mm high. Pistil 2.2–2.3 mm long; ovary urceolate, c. 1.5 mm, glabrous or sparsely glandular at base, apically eglandular hairy; style c. 0.6 mm, hairy; stigma broadly bilobed, lobes 0.1–0.2 mm long, rounded. **Fruit** green, 1–3 cm long, 1–2 mm diam., hairy almost exclusively in the terminal half, straight or curved. **Seeds** pale brown, elliptic, 0.4–0.5 × 0.2–0.3 mm.

**Distribution.** Northern Thailand (Uthai Thani).

**Habitat.** On limestone in secondary forest.

**Provisional IUCN conservation assessment.** Critically Endangered CR B1ab(iii,iv) +
B2ab(iii,iv). This species is only known from the type collection in the Huppatat Non Hunting Area, where only one, small population was observed. The limestone range there is only about 12 km² in total and is subject to disturbance from tourism. There are no collections from the nearby Khao Pha Ra, and the area is surrounded by cultivated land.


Notes. This species can be recognised by the small, personate corolla and the glabrous anthers. The measurements reported are largely based on the original publication in Puglisi et al. (2016), integrated with the newly acquired material.


‘*Chirita* sp. nov.? ’ in Barnett, Fl. Siam. 3: 228 (1962).

Caulescent herb 25–100 cm tall with elongated stem runners, internodes 2–10 cm. *Stems* succulent, green with reddish parts, with a sparse hispid eglandular indumentum; branches sometimes arising from the petioles. *Leaves* opposite, with the exception of the basal leaf; petioles 2–9.5 cm long, reddish, sparsely eglandular hairy; blades pale green above and beneath, ovate or obovate, 4.3–20 × 2.7–9.5 cm, 1.3–1.8 times as long as wide, base cordate, apex acuminate, sparsely hairy above and beneath with a dimorphic indumentum of longer and shorter eglandular hairs ciliate along the margin, margin entire, 9–23 pairs of secondary veins, steeply ascending, venation slightly sunken above and raised beneath in fresh material, flat in dry specimens, tertiary venation inconspicuous. *Inflorescences* crista, peduncles reduced or emerging and fused together; peduncle absent or to 5 mm long; bracts absent; pedicels pale green or tinged with reddish purple, 5–30 mm long, densely pubescent. *Calyx* green, actinomorphic, completely divided to base, lobes narrowly ovate, 7–9.5 × 1.5–1.9 mm, apex acuminate, pubescent. *Corolla* 24–30 mm long, purple, slightly paler on tube and lobes, darker in the throat, tube narrow at base, curved, then widening abruptly into a campanulate upper tube, lobes not spreading, purple, eglandular hairy outside, glabrous inside, except for a patch of glandular hairs dorsally in the tube by the anthers; tube c. 19–19.5 mm ventrally; lobes broadly orbicular, apices rounded, upper lobes 4 × 6 mm, lateral lobes 6 × 9.5 mm, ventral lobe c. 5–8.5 × 13–15 mm. *Stamens* arising from the point where the tube widens, c. 9 mm above the corolla base, filaments upright, glabrous, c. 1.5 mm long, c. 0.2 mm wide; anthers white or pale yellow, attached at a right angle from the filament, with hairs by the filament insertion,
c. 2.5 x 1.5 mm, apically joined by a connective, thecae parallel; lateral staminodes c. 1 mm long, arising near the corolla base, central staminode c. 0.7 mm long, arising near the corolla base. Disk annular, lobed, 1 mm high. Pistil c. 12 mm long; ovary 5 mm long, c. 0.5 mm diameter, glabrous; style 7 mm long, glabrous; stigma chiritoid, sparsely glandular, c. 1.2 mm long. Fruit green when immature, c. 4 cm long, c. 2 mm diameter, glabrous, curved. Seeds not seen.

**Distribution.** Southeastern Thailand. Vietnam.

**Habitat.** On limestone.

**Provisional IUCN conservation assessment.** Endangered EN B2ab(iii). This species is common at the type locality and can be observed occurring high up on rather inaccessible cliffs. At the site where it was collected there is only about 1 km² of suitable habitat and the base of the outcrop and the surroundings are degraded by human activity. The only other locality where it has been collected is just over 400 km to the SE from the type locality in southern Vietnam. Available limestone sites inbetween are rather few.


**Notes.** This species can be recognised by the dark purple colour of the corolla, the abruptly campanulate corolla, and the small upper two lobes and the broad lower three lobes of the corolla. The description is largely based on the original publication (Middleton & Triboun, 2013), with some additional data.


**Chirita glasgovii** Ridl., J. Straits Branch Roy. Asiat. Soc. 44: 60 (1905). – TYPE: Malaysia, Perak, Waterloo Estate, December 1897, Robertson-Glasgow s.n. (holotype SING [SING0042988]).

ChiritageoffrayiPellegr.inLecomte,Fl.Indo-Chine4:529(1930).—TYPE:Cambodia,
Kampot,Kabal-Roméas,18October1903,Geoffray123(lectotypeP[P00602516],
designatedbyWood(1974:199)).


Terrestrialorlithophyticcaulescentherbt050cm tall,notbranching.Stemsfleshy,
eglandularhairy,greenorpurple-brown,withwhiteandpatenthairs,internodesto
c.13cm. Leaves opposite,except for the single basal cotyledon; petioles 2–10 cm
long,eglandularhairy;bladespale to dark green above with hispid eglandular hairs,
pale green beneath,with the same type of indumentum, elliptic, ovate or lanceolate,
4.2–14.5 ×1.8–7.5cm,1.5–2.7timesas long as wide,baseacuteto obtuse or almost
cordate,often unequal, apex acute to acuminate, margin entire to serrate, 7–16 pairs of
secondary veins, venation slightly sunken above and raised beneath in fresh material,
tertiary venation often inconspicuous. Leaves and bracts mid green above, whitish
green beneath.Inflorescences arising from the petiole, at the axil or in close proximity,
consisting of one to three main pedunculate inflorescences, each very compressed and
thus appearing subumbellate and bearing 1–10 flowers; peduncle 2–140 mm long,
eglandular hairy;bracts sessile, partly or completely fused in a cup, 5–50 mm long,
withpatentwhiteeglandularhairs on both sides, palmate venation, margin serrate
and when partly fused, with acute apex; pedicels green, 0.1–15 mm long, eglandular
pubescent. Calyx yellow-green, bilabiate with the lower lobes shorter than the upper,
tube 0.3–0.5 mm long, lobes narrowly lanceolate to triangular, 7–8 ×1.1–1.2 mm, apex
narrowly acute, eglandular hairy on the outer side, sometimes only at the tip and along
the margin, inside glabrous. Corolla 16.5–22 mm long, with tube white and lobes
white to violet, with thin dark stripes and a yellow marking ventrally in the throat,
tube narrow at base (5.5–6 mm), then abruptly opening into spreading lobes, tube
glabrous, limb densely eglandular hairy outside, internally with dense glandular hairs
in the throat, especially on the upper lip and on the ventral lobe, further in with shorter
glandular hairs; tube c. 13–13.5 mm long dorsally, 12–16.5 mm ventrally, 11.5–13.5
cm laterally between lips; upper lobes broadly elliptic, 4.5–5.5 × 4.5–6 mm, lateral
lobes elliptic, 4–5.5 × 5–6 mm, lower lobe elliptic, 4.5–6.5 × 5.5–7 mm. Stamens
arising 6–9 mm above the corolla base, slightly bent, glabrous, 3.5–4 mm long, 0.4–
0.5 mm wide; anthers pale yellow, hairy dorsally and partially beneath, 2–2.1 ×1–1.3
mm, free, thecae divergent; lateral staminodes 0.7–2.5 mm long, arising 5.5–7.5 mm
above the corolla base, glabrous, central staminode 0.2–0.7 mm long, arising 6–8
mm above the corolla base. Disk a partial ring interrupted dorsally, lobed, 0.3–0.5
mm. Pistil 13.5–16.5 mm long; ovary 7.5–11 mm long, glabrous for 2–3 mm at base,
otherwise densely eglandular hairy; style white, 4.5 mm, more sparsely hairy than the
ovary; stigma white, elongated and flexed downwards, eglandular hairy, lobes 1.5–1.8
×0.4–0.5 mm, elliptic. Fruit green, 1.1–4 cm long, c. 1.5 mm diameter, glabrous at the
base, otherwise sparsely eglandular hairy, straight or slightly curved. Seeds not seen.
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Habitat. On rocks in shady areas.

Provisional IUCN conservation assessment. Least Concern LC. This species is common and widespread.

Additional specimens examined. THAILAND: Ayutthaya: s.l., c. 30 m, 21 Nov 1970, Smitinand, T. et al. 11377 (BKF, E). Chiang Mai: 400 m, 23 Nov 1920, Kerr, A.F.G. s.n. (BM); Sangamphang, Muang Awn Cave, 525 m, 12 Oct 1989, Maxwell, J.F. 89-1221 (CMU, E); Mae On, 500 m, 7 Sep 2011, Pooma, R. et al. 7797 (BKF, E); Mae On, Doi Lohn, 13 Apr 2005, Palee, P. 799 (CMUB); Mae Ping Rapids 150 m, 17 Dec 1913, Kerr, A.F.G. 3044 (BM,
Kanchanaburi: Ban Wangpho, 15 Oct 1967, Chermsirivathana, C. 791 (BK); Thong Pha Phum Pha Tad National Park, 130 m, 6 Sep 2007, Suddee, S. et al. 3268 (BKF); Thong Pha Phum, 22 Aug 2006, Triboun, P. 3635 (E); ibidem, 130 m, 15 Sep 2006, Suddee, S. et al. 2854 (BKF); ibidem, 240 m, 29 Nov 1982, Koyama, H. et al. T-30467 (BKF); Thong Pha Phum, Wat Tham Mong Kala, 5 Oct 2015, Puglisi, C. et al. CP409 (SING); Thong Pha Phum, Wat Tha Khanun, 170 m, 28 Oct 2009, Middleton, D.J. & Triboun, P. 5204 (BKF, E); Thong Pha Phum, Cha Lae, Ban Kroeng Krawia, 20 Sep 2011, Sirimongkol, S. 226 (BKF, SING), S. 227 (BKF); Erawan Waterfall, c. 150 m, 10 Oct 1971, Murata, G. et al. T-16141 (BKF, L); Mahidol University Campus, 4 Oct 2015, Puglisi, C. et al. CP402 (BKF); Sai Yok, Mahidol University Campus, 275 m, 13 Sep 2005, Maxwell, J.F. 05-489 (BKF, CMUB); Srisawat, Erawan National Park, 100–300 m, 3 Nov 1979, Shimizu, T. et al. T-21532 (BKF); Erawan National Park, 400 m, 18 Nov 1971, van Beusekom, C.F. et al. 3843 (L); Sai Yok, Khao Yen, 7 Oct 2015, Puglisi, C. et al. CP430 (BKF, E, MUCA, SING).


Notes. Thai specimens from south of the Isthmus of Kra have leaves with longer petioles, more strongly serrate margin and more acuminate apex, and inflorescences less hairy on pedicels and bracts. Wood (1974) attributed some Thai specimens to Microchirita caerulea (R.Br.) Yin Z.Wang, an Indonesian species with a bracteate inflorescence. Microchirita caerulea has glandular hairs intermixed with eglandular hairs in the stem. The bracts are fused on one side only and have glandular and eglandular hairs along the margin. The peduncles have a mixed indumentum, too, and the pedicels are glandular. Microchirita rupestris does not have any glandular hairs. Furthermore, the leaf base is cordate in Microchirita caerulea and only very rarely so in M. rupestris.

23. Microchirita suddeei D.J.Middleton & Triboun, Thai Forest Bull., Bot. 41: 18 (2013). – TYPE: Thailand, Phrae, Rong Kwang District, Tham Pha Nang Khoi, 210 m alt., 17 August 2012, Middleton, D.J., Karaket, P., Suddee, S. & Triboun, P. 5618 (holotype BKF; isotypes E [E00629451], P [P00966761], QBG, SING [SING0229832]). (Fig. 15A–C)
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Caulescent herb to 40 cm tall, internodes 4–13 cm. **Stems** succulent, pale green or red at base, sometimes branching from basal petiole, with sparse sessile glands. **Leaves** opposite, apart from the basal leaf; petioles 0.3–2.2 cm long, very sparsely eglandular hairy; blades mid green above, paler beneath, ovate, 4.2–35 × 1.3–18.8 cm, 1.3–3.3 times as long as wide, base rounded to cordate, apex acuminate, sparsely eglandular hairy above and beneath, sparsely ciliate along the margin, margin entire, 6–22 pairs of secondary veins, venation slightly sunken above and raised beneath in fresh material, flat in dry specimens, tertiary venation laxly reticulate. **Inflorescences** cristate; peduncles fused, 2.5–5 mm long, fused together, glabrous; bracts absent; pedicels green, 4.4–11 mm long, sparsely hairy. **Calyx** green, bilabiate, the two lips completely divided, ventral tube c. 0.1 mm long, dorsal tube to c. 3.5–5 mm long, lobes ligulate, dorsal lobes 7.4–8 mm long, lower lobes 3–5 mm long, apex acute, margin entire, irregular towards the tip, sparsely hairy outside, hairier at the tip, sparsely glandular inside. **Corolla** 10–12 mm long, tube white, lobes pale lilac, tube narrow, straight or just slightly curved, lobes not always spreading, eglandular hairy outside, glabrous inside; tube c. 8 mm long dorsally, c. 10 mm long ventrally; lobes broadly orbicular, apices rounded or obtuse, upper lobes c. 2.6 × 3.7 mm, lateral lobes c. 2.4 × 4 mm, ventral lobe c. 1.8–3 × 4 mm. **Stamens** arising 3.2–4 mm above the corolla base, filaments slightly curved, glabrous, 2.2–2.5 mm long, c. 0.3–0.4 mm wide; anthers with an abundant indumentum at the sides and dorsally, 2.2–2.5 × 1.1–1.2 mm, apically joined by a weak connective. **Disk** a small ventral lobe, 0.1–0.6 mm high. **Pistil** c. 10 mm long; ovary 5.5–6.5 mm long, papillose in the bottom half, densely pubescent above; style white, 3.3–4 mm long, densely pubescent; stigma white, c. 1 mm long. Immature **fruit** 2–3 cm long, c. 1 mm diameter, glabrous, straight. **Seeds** not seen.

**Distribution.** Northern Thailand.

**Habitat.** On limestone in evergreen or mixed deciduous and bamboo forest.

**Provisional IUCN conservation assessment.** Vulnerable VU Blab(iii) + B2ab(iii). The EOO is almost 10,000 km², well within the boundary for Vulnerable. However, the AOO is within the boundary for Endangered, not all of the localities are within protected areas, and limestone sites are degraded throughout the region. Since there are five known localities and there are likely to be more, an assessment of Vulnerable is more appropriate than Endangered.


**Notes.** The floral characters reported are taken from the original description of Microchirita suddeei (Middleton & Triboun, 2013), as no new material has been
identified during this study. This species can be recognised by the hairy anthers, the pale lilac corolla and the absence of a ventral line and lateral spots in the corolla. It is most similar to *Microchirita lilacina*, which has a broader mouth and glabrous anthers, and to *M. albiflora*, which is completely white and lacks sessile glands on the stem.

24. *Microchirita tadphoensis* C.Puglisi, sp. nov.
Most similar to *Microchirita hamosa* (R.Br.) Yin Z.Wang in the delicate habit and to *M. bimaculata* (D.Wood) A.Weber & D.J.Middleton in the shape of the corolla. Differs in having a shortly campanulate pale yellow corolla (white in *Microchirita hamosa*) with a ventral darker yellow marking but no lateral spots (spots always present in *M. bimaculata*). – TYPE: Thailand, Nakhon Phanom, Ban Phaeng, Phu Langka National Park, Tad Pho Waterfall, 224 m, 23 October 2015, Suddee, S., Keiwbang, W. & Hemrat, C. 4980 (holotype BKF; isotype SING). (Fig. 15D–F)

Herb to 20 cm tall, stem sparsely aglandular hairy, not branched, internodes c. 3 cm long. Leaves opposite, apart from the basal leaf; petioles 1–4 mm long, sparsely eglandular hairy; blade ovate to elliptic, 1.7–4.2 × 1.2–3.2 (a partial much larger basal leaf was seen that would be beyond these measurements if complete), 1.3–1.5 times as long as wide, base subcordate, apex acute to broadly acute, eglandular hairy on both surfaces, margin entire and ciliate, 7–9+ pairs of secondary veins, flat and scarcely visible on both sides. Inflorescence cristate, 1–5-flowered, floral axes eglandular hairy; bracts absent; pedicels 0.5–1.5 cm, straight or curved. Calyx pale green, slightly zygomorphic, lobes almost free, lanceolate-elliptic, 3–3.3 × 0.5–0.9 mm, lower lobes slightly larger than the upper, apex acute, margin entire, eglandular hairy outside, glabrous inside. Corolla c. 12 mm long, white outside, inside pale yellow with a yellow patch ventrally, base of tube narrow and curved, then gradually broadening, sparsely eglandular hairy outside, inside glabrous basally and with sessile glands apically and on the lobes; tube c. 9.3 mm dorsally, c. 9.7 mm ventrally and c. 8 mm between the lips; upper lobes c. 2 × 2.5 mm, lateral lobes c. 1.3 × 3 mm, ventral lobe c. 2 × 3 mm. Stamens arising c. 4.6 mm above the corolla base; filaments c. 2 mm long, 0.2 mm diamenter, straight, glabrous at the base, with sessile glands in the top half; anthers c. 1.2 × 0.5 mm, probably ligate, with a small patch of straight hairs by the attachment, thecae strongly divergent; staminodes not seen. Disk absent. Pistil c. 10 mm long; ovary c. 5 mm long, c. 0.7 mm diameter, glabrous in the basal 1/3 to ½, then eglandular hairy; style c. 3.5 mm, delicate, eglandular hairy; stigma with lobes c. 0.7 × 0.5 mm, somewhat plumose inside. Fruit eglandular hairy, more or less curved, 1.7–3.4 cm long, 0.7–1.2 cm diameter. Seeds dark brown to black, broadly elliptic and furrowed, c. 0.5 × 0.2 mm.


Habitat. On sandstone in dry evergreen forest.
Provisional IUCN conservation assessment. Data Deficient DD. This species is only known from the type collection, which is within a protected area.

Notes. The epithet refers to the type locality.

25. Microchirita tetsanae C.Puglisi, sp. nov.
Species characterised by the presence of a dimorphic indumentum on the anthers and sparse hairs on the filaments, and by a little projection at the anther insertion. It is most similar to Microchirita thailandica C.Puglisi, but differs in the upper lobes not being imbricate with the lower, and in the filament projection. – TYPE: Thailand, Phetchabun, Mueang Phetchabun, Wat Tham Nam Bang, 130 m, 13 September 2014, Tetsana, N. et al. 855 (holotype BKF; isotype SING). (Fig. 16A–B)

Caulescent herb to 50 cm tall with elongated stem runners, internodes to 3.5–12.5 cm. Stems succulent, with some eglandular indumentum; branches to 30 cm long, sometimes arising from the petioles. Leaves opposite, apart from the basal leaf; petioles 0.1–2.5 cm long, eglandular hairy; blades mid green above, paler beneath, lanceolate to elliptic, 3–16 × 2.2–10 cm, 1.3–2.1 times as long as wide, base subcordate to cordate, apex acute to acuminate, finely pubescent above and beneath, ciliate along the margin, margin entire or sparsely and minutely denticulate, 6–17 pairs of secondary veins, venation slightly sunken above and raised beneath in fresh material, flat in dry specimens, tertiary venation inconspicuous. Inflorescences cistrate, 1–5-flowered; peduncles reduced or 3–8 mm long, fused with each another, pubescent; bracts absent; pedicels pale green, 0.1–2.5 cm long, pubescent. Calyx pale green, succulent at the base, tube 0.3–0.5 mm long, lobes imbricate, narrowly lanceolate, 4.5–8 × 1–1.2 mm, apex acuminate and thickened, margin entire, outer indumentum of long eglandular hairs along the midrib, margin eglandular ciliate, inner indumentum of eglandular hairs at the tip and sparse sessile glands. Corolla 17–26 mm, tube white to pale blue, lobes white or purple-blue, the base of the upper lobes white or dark blue, lower lip pale blue or white at the base, with a bright yellow stripe ventrally, tube narrow, strongly curved, lower lip expanded, upper lip slightly reflexed, glabrous at the base, then finely eglandular hairy, the base of the upper lobes and of the ventral lobe with a dense glandular indumentum, the lobes sparsely glandular hairy; tube 10–13 mm long dorsally, 13–20 mm ventrally, 10–14.5 mm laterally between lips; upper lobes elliptic, 2–6 × 2–7 mm, lateral lobes obtuse, 4–6 × 5–8.5 mm, ventral lobe elliptic, 4.5–7.5 × 6–12 mm. Stamens arising 6–10.5 mm above the corolla base; filaments straight, with a little projection dorsally at the base of the anther, pale yellow, sparsely and minutely hairy, 2.5–3 mm long, 0.4–0.6 mm wide; anthers white, with an indumentum of long coloured hairs growing on the outer end and short white hairs growing on the inner end, 1.7–2.5 × 1.5 mm, apically joined by a connective, thecae parallel; lateral staminodes 0.7–1 mm long, arising c. 1.5–7 mm above the corolla base, central staminode 0.2–0.5 mm long, arising 3–7.5 mm above the corolla base. Disk annular, margin subentire, 0.3–0.7 mm high. Pistil c. 15–20 mm long; ovary 6–6.5 mm long, c. 1 mm diameter,
sparsely eglandular hairy or glabrescent in the bottom half, hairier towards the apex; style arising at almost a right angle to the ovary, 8.5–9.5 mm, eglandular hairy; stigma c. 0.7 mm long, glabrescent, bilobed, lobes rounded, 0.3–0.5 mm. Fruit and seeds not seen.

Distribution. Northern and Northeastern Thailand.

Habitat. On limestone in dry evergreen forest.

Provisional IUCN conservation assessment. Vulnerable B1ab(iii). This species is only known from a few collections and has an EOO of < 6,000 km². Not all of the localities are within protected areas. Its AOO might suggest a status of Endangered but much of the potential distribution has not been adequately explored to be confident that its AOO is within the limit.


Notes. This species is named after Dr Naiyana Tetsana from the Forest Herbarium Bangkok, who collected and shared a number of specimens and photos of the new species described in this article. Microchirita tetsanae has individuals with purple-blue and cream-white flowers, sympatric in Phitsanulok. No morphological characters support a possible recognition of these as different taxa and they are treated here only as color forms of the same species. It is also reported from Uttaradit (photos from Pranee Nangnam seen).

26. Microchirita thailandica C.Puglisi, sp. nov.
Species most similar to Microchirita tetsanae C.Puglisi in the colour pattern of the corolla, differing in having a narrower tube which widens abruptly (gradually widening in M. tetsanae), all corolla lobes imbricate (vs. lateral lobes not imbricate with the upper in M. tetsanae), a shorter ventral tube, and in not having a projection at the anther insertion. – TYPE: Thailand, Chaiyaphum, Phak Dee Chumphon, Wat Thum Wua Daeng, 460 m, 8 November 2014, Tetsana, N. et al. 904 (holotype BKF; isotype SING). (Fig. 16C–E)

Caulescent herb 10–50 cm tall, internodes 3–6 cm. Stems succulent, with sparse eglandular indumentum, branching from the basal petiole. Leaves opposite, apart from the basal leaf; petioles 0.3–0.8 cm long, sparsely eglandular hairy; blades mid
green above, ovate to lanceolate, 2.8–11 × 1.5–6.8 cm (basal leaf likely to have been larger but not seen), 1.6–1.9 times as long as wide, base truncate to shortly attenuate, apex acute to acuminate, eglandular hairy above and beneath, margin ciliate, margin entire, 7–8 pairs of secondary veins (basal leaf not seen), venation slightly sunken on the adaxial side. **Inflorescence** cristate, many-flowered, floral axes hispid with mixed eglandular and glandular hairs; peduncles extremely reduced and fused with each other; bracts absent; pedicels 2–15 mm long. **Calyx** pale green, c. 9.5 mm long, tube 5–7 mm long, lobes narrowly lanceolate, c. 8.5 × 1.5 mm, apex narrowly acute to acuminate, lobes not imbricate, with sparse eglandular hairs outside and an even sparser indumentum inside, mixed with sessile glands. **Corolla** c. 23 mm long, tube purple, lobes purple-blue, mouth pale blue, with a yellow ventral marking and a dark purple patch at the base of the upper lobes, tube narrow, bent downwards, abruptly widening, outer side hairy throughout, inside densely covered in eglandular hairs in the mouth and dense sessile glands over the ventral yellow spot; tube c. 13.5 mm dorsally, c. 14 mm ventrally and laterally; upper lobes c. 5.5 × 8.5 mm, lateral lobes c. 5.5 × 8 mm, ventral lobe c. 7 × 8 mm. **Stamens** arising c. 9 mm above the corolla base, filaments straight, c. 2 mm long, c. 0.5 mm diameter, without any projection; anthers ligate, with an indumentum of long brown hairs growing on the outer end and short white hairs growing on the inner end, c. 1.1 × 1.3 mm; lateral staminodes c. 1 mm long, arising c. 8 mm above the corolla base, central staminode c. 0.8 mm long, arising c. 9 mm above the corolla base. **Disk** annular, c. 0.9 mm. **Pistil** c. 13 mm long; ovary c. 8 mm long, c. 1 mm diameter, glabrous in the basal 1/3, eglandular tomentose above; style enantiostylos, c. 5 mm, eglandular hairy; stigma 0.8 mm long, densely glandular hairy, shallowly bilobed, lobes rounded, c. 0.4 mm. **Fruit** straight, sparsely eglandular hairy, 3–5 cm. **Seeds** c. 0.4 × 0.2 mm, brown, elliptic.

**Distribution.** Eastern Thailand.

**Habitat.** On limestone.

**Provisional IUCN conservation assessment.** Data Deficient (DD). This species is only known from the type locality and too little is known of its distribution or possible threats (except that the single collection was not made in a protected area).

**Notes.** This species has been named after the country to which it is endemic.


Caulescent herb to 50 cm tall, internodes 1.5–9 cm long, sometimes branches arising from the petioles. Stem fleshy, green or flushed red-brown, eglandular hairy. Leaves opposite, apart from the basal leaf; petioles green or purple-brown, 2–20 mm long; blades pale to dull green above, paler beneath, lanceolate, elliptic or ovate, 3.5–36 × 1.4–20 cm, 1.7–3.9 times as long as wide, base obtuse to subcordate to rarely somewhat attenuate, apex acute to acuminate, eglandular hispid above and beneath, margin ciliate, margin entire to obscurely toothed, midrib green or red-brown, 5–14 pairs of secondary veins, venation more or less sunken above and raised beneath in fresh material, flat in dry specimens, tertiary venation lax and inconspicuous. Inflorescences cristate, 1–8-flowered; peduncles 2–10 mm long, sometimes fused with each other; bracts absent; pedicels green, 0.5–2 cm long, eglandular hairy. All floral axes with sparse to dense eglandular hairs. Calyx bilabiate, green, lobes succulent along the midrib, lower tube 0.6–0.8 mm, lateral tube 0.1–0.6 mm, upper tube c. 1.2 mm, lobes imbricate, lanceolate, 11–17 × 2–3 mm (the dorsal wider than the lateral, which in turn are wider than the ventral), apex acute to slightly acuminate, margin entire, eglandular hairy outside on margin and midrib, glabrous inside except tip. Corolla 17–25 mm long, white outside on tube and lobes, creamy yellow in throat, with a yellow ventral stripe and lateral purple-brown stripes or spots, tube narrow, usually curved, becoming pouches, with upper and lateral lobes spreading, ventral lobe prominent and forming a sinus at the base where it connects with the lateral lobe, tube glabrous at the base, outside densely and minutely eglandular and glandular hairy, glabrous inside, with sessile or stalked glands all over the throat but especially dense under the upper lobes; tube 12–20 mm long dorsally, 16–22 mm ventrally, 15–20 mm between the lips; lobes with obtuse apex, upper lobes 2–4.5 × 5–5.5 mm, lateral lobes 4.5–6 × 6.5–10 mm, ventral lobe 5.5–7.5 × c. 7 mm. Stamens arising 1.1–1.2 cm above the corolla base, filaments bent at base, 4–7 × 0.7–1.2 mm, yellow, glabrous; anthers white with white hairs at the top and dorsally, 3–3.3 × 2–2.5 mm, apically joined by a connective, thecae divergent, apiculate; staminodes absent or 2, 0.3–0.4 mm long, arising 6–7.5 mm above the corolla base. Disk annular or more often dorsally cleft, margin slightly lobed, 0.5–1 mm high. Pistil 13–20 mm long; ovary 0.9–1.2 cm long, c. 1.1 mm diameter, glabrous to minutely glandular in the bottom 1/3–1/2, densely eglandular hairy above and with some glandular hairs between ovary and style; style 0.2–0.5 mm diameter, eglandular hairy except at the very top, 0.8–1.4 cm long; stigma broadly bilobed, lobes 1–1.3 mm, hairy. Fruit green, 2.5–4 cm long, 1.7–2.6 mm diameter, sparsely eglandular hairy, straight or slightly curved. Seeds dark brown, elliptic, acuminate, c. 0.4 × 0.2 mm.

Distribution. Widespread in Central, Eastern and Southeastern Thailand.

Habitat. On limestone in deciduous forest.

Provisional IUCN conservation assessment. Near Threatened NT. The EOO is > 45,000 km², well beyond the threshold for a Vulnerable status. The AOO, however, is
<75 km², which would be within the threshold for an Endangered status except that the number of locations is too high for Endangered or Vulnerable. Nevertheless, many of the collection localities for this species are not in protected areas and the regions in which this species occurs are also where mining of limestone is particularly active.

**Additional specimens examined.** **Unknown locality:** “145” coll. 9 Nov 1927 (ABD [2 sheets]); Cultivated at RBG Kew, 5 Nov 1923, 418-23 (K); various specimens with no data or barcode (ABD). THAILAND: **Ayutthaya:** Kanam Pasak, Keng Koi, 50 m, 9 Dec 1923, Kerr, A.F.G. 7961 (ABD, BK, K). **Chonburi:** Sriracha, Koh Seechang Isl., 7 Nov 1969, van Beusekom, C.F. & Smitinand, T. 2039 (AAU, BKF, E, L, P); Sriracha, Si Chang Island, 25 m, 10 Sep 1993,
Notes. Several specimens in ABD have no label data and could be original material. *Microchirita tubulosa* is characterised by a white corolla with a ventral yellow stripe and lateral purple markings (blotches or stripes; if stripes, sometimes multiple on each side). It is most similar to *Microchirita marcanii* and *M. luteola* (see discussion under each), but differs in the corolla colour pattern and the smaller flower.

Cauliscent perennial herb to 40 cm tall, internodes 1–10 cm, occasionally branching from the basal portion of the basal petiole. **Stems** purple or green, strigose, more densely so at the nodes. **Leaves** opposite; petioles 2–10 mm long, c. 1.5 mm diameter, strigose; blades elliptic to lanceolate, green above, pale green beneath, 2.1–15 × 1.6–8.4 cm, 1.1–2.3 times as long as wide, base shortly attenuate to rounded to subcordate, apex acute, eglandular tomentose above, hispid beneath, ciliate along the margin, margin entire (can be serrate in some Malaysian specimens), 6–11 pairs of secondary veins in the opposite leaves, venation slightly sunken above and raised beneath in fresh material, tertiary venation lax and seldom visible. **Inflorescence** cristate, 1–6-flowered; peduncles reduced; bracts absent; pedicels 7–20 mm long, eglandular hairy. **Calyx** green, succulent at the base, lobes almost free to base, narrowly lanceolate, c. 6–10 × c. 1 mm, apex narrowly acute, outside eglandular hairy, inside with sparse hairs becoming denser at the tip. **Corolla** 17–21 mm long, tube yellowish white inside, lobes blue-purple with with dark blue lines, tube narrow at base, bent downwards, then gradually expanding, with sessile glands inside, elongated glands at the base of the upper lobes and very minute glandular hairs on the lower lip; tube 13 mm long dorsally, 16 mm ventrally, 12 mm laterally between lips; upper lobes c. 2.5 × 4 mm, lateral lobes, c. 3.5 × 4.3 mm, lower lobe c. 5 × 4.5 mm. **Stamens** arising c. 8.5 mm above the corolla base; filaments straight, glabrous, c. 3 mm long, c. 0.3 mm wide; anthers sparsely hairy dorsally, c. 2 × 1 mm, apically coherent but not joined by a connective, thecae divergent; lateral staminodes c. 1.2 mm long, central staminode not seen. **Disk** annular, margin slightly lobate, c. 0.3 mm high. **Pistil** c. 14 mm long, densely eglandular hairy throughout except at the base of the ovary; ovary c. 5.5 mm long, c. 0.6 mm diameter; style c. 6.5 mm; stigma deeply bilobed, lobes c. 0.9 × 0.4 mm, shortly plumose inside. **Fruit** 1–4.5 cm long, 0.9–1 mm diameter, densely eglandular hairy, straight or slightly curved. **Seeds** brown, broadly elliptic, 0.4–0.5 × 0.2–0.3 mm.

**Distribution.** Peninsular Thailand. Malaysia.

Habitat. On limestone in evergreen forest.

**Provisional IUCN conservation assessment.** Vulnerable VU Blab(iii). This species occurs on Langkawi in Malaysia and has also previously been collected on the mainland in Kedah. Rafidah (2017) reports that no recent collections have been made from the Kedah mainland and suggests a conservation assessment of Near Threatened as the species is reported to be common and protected on Langkawi. In Thailand, however, most of the known localities are not in protected areas and are subject to high disturbance. The EOO and number of collection localities, coupled with these threats, suggest an assessment of Vulnerable.

**Additional specimens examined.** THAILAND: **Krabi:** Ao Luek, c. 50 m, 17 Nov 1959, Smitinand, T. & Abbe, E.C. 6151 (BKF, K (2)); Muang, Krabi Noi, Wat Tham Suea, 25 m, 17 Sep 2010, Middleton, D.J. et al. 5467 (E); Kasoom, Nov 1896, Curtis 3221 (K). **Phangnga:** s.l., 28 Feb 1929, Kerr 17563 (K); Mueang Phangnga, Sri Nakharin Park, 1 m, 18 Nov 2014,
Notes. *Microchirita viola* is represented by rather few specimens in Thailand. A more comprehensive description of this species is provided by Rafidah (2017).

29. *Microchirita woodii* D.J.Middleton & Triboun, Thai Forest Bull., Bot. 41: 15 (2013). – TYPE: Thailand, Nan, Muang Nan, Tham Pha Tup Forest Park, trail to Phra Cave, 300 m alt., 16 August 2012, *Middleton, D.J.*, Karaket, P., *Suddee, S.* & Triboun, P. 5612 (holotype BKF; isotypes BK, E [00629450], P [P00966763]). (Fig. 18C–F)

Caulescent herb to 50 cm tall with elongated stem runners, internodes 2–15 cm. **Stems** succulent, green, glabrescent or with a sparse eglandular indumentum. **Leaves** opposite, apart from the basal leaf; petioles 0.3–1 cm long, green, sparsely eglandular hairy; blades pale green above and beneath, ovate to elliptic, 2.7–30 × 1.8–21.5 cm, 1.2–2.2 times as long as wide, base cordate, apex acute, sparsely eglandular hairy above and beneath, ciliate along the margin, margin entire with sparse obscure teeth, 8–15 pairs of secondary veins, venation sunken above and raised beneath in fresh material, flat in dry specimens, tertiary venation laxly reticulate. **Inflorescences** cristate, peduncles reduced or emerging to 5 mm long but not fused together, bracts absent; pedicels pale green, 7–20 mm long, pubescent. **Calyx** green, actinomorphic, lobes completely divided, narrowly ovate, 5.7–10.5 × 0.9–1 mm, apex acuminate and slightly thickened, margin entire, glabrescent or sparsely hairy, hairier at tip, glabrous inside. **Corolla** 18–22 mm long, tube very pale green, lobes yellow-white, throat yellow with a darker yellow ventral patch and dark brown spots to its sides, tube narrow, curved, then widening gradually, lobes somewhat spreading, eglandular hairy outside, inside with glandular hairs at the base of the upper lobes and dorsally in the tube; tube 12.5–15.5 mm long dorsally, 15.9–19.5 mm ventrally, c. 15 mm laterally between lips; lobes broadly orbicular to ovate, apices rounded, upper lobes 3–4.2 × 4–6.6 mm, lateral lobes 4.5–5.7 × 5.5–7 mm, ventral lobe 5–7.5 × 6.2–8 mm. **Stamens** arising 9–11.2 mm above the corolla base, filaments straight, glabrous, 2–2.5 mm long, 0.4 mm wide; anthers white, with a dimorphic indumentum of long brown hairs above dorsally and short white hairs below, 1.9–2.2 × 1.3–1.8 mm, apically joined by a connective, thecae more or less parallel; staminodes reduced, c. 0.2 mm long. **Disk** annular, 0.4–0.8 mm high. **Pistil** c. 12 mm long; ovary 5.5–7.5 mm long, c. 1.2 mm diameter, papillose at the base, pubescent above; style 6–7.5 mm long, pubescent; stigma c. 0.8 mm long. **Fruit** green, to 7 cm long, 0.8–1.2 mm diameter, eglandular hairy or glabrescent, straight or slightly curved. **Seeds** maroon, narrowly elliptic, acuminate 0.3–0.5 × 0.1–0.2 mm.

**Distribution.** Northern Thailand (Nan).

**Habitat.** On limestone in evergreen forest.

*Provisional IUCN conservation assessment. Data Deficient (DD). Microchirita woodii*
is only known from Tham Pha Tup Forest Park which is less than 1 km² in size and subject to disturbance from tourism. However, there have been far fewer collections made in other forested areas to the north and until it can be assessed whether this species also occurs there, its conservation status is uncertain.

Additional specimens examined. THAILAND: Nan: Tham Pha Toop Forest Park, 230 m, 2 Sep 1999, Middleton, D.J. 148 (BKF); Tham Pa Tok, 350 m, 13 Sep 1995, Larsen, K. et al. (AAU, BKF, SING); Mueang Nan, Tham Pha Toop, 400 m, 18 Sep 1999, Srisanga, P. & Puff, C. 1110 (BKF, E, QBG); Muang, Taam Paa Toop, c. 300 m, 13 Sep 1995, Nanakorn, W. et al. 4236 (E, QBG).

Notes. This species is recognisable by the colour pattern of the corolla which is pale yellow-white with dark reddish-brown spots, and the dimorphic anther indumentum. The other pale-coloured species with markings are *M. huppatatensis*, from which *M. woodii* differs in the slightly compressed corolla mouth and the dimorphic anther indumentum, and *M. karaketii*, which has violet markings and differs in the shape of the corolla (more slender). In central and eastern Thailand, *M. tubulosa* has a similar colour pattern, but its corolla is much larger and a very different shape.

Incertae sedis

The following specimens could not be determined to species for a variety of reasons, either because the material was sterile or otherwise too poor to identify, or because the specimen may be of an undescribed taxon but the material inadequate to describe.


A revision of Microchirita in Thailand

Garden Edinburgh, Singapore Botanic Gardens and the Forest Herbarium Bangkok for other help. This study was funded by the Sibbald Trust of the Royal Botanic Garden Edinburgh (UK), the Garden City Fund (Singapore), the Carlsberg Foundation (Denmark) and the National Parks Board (Singapore).

References


Ceropegia laotica (Apocynaceae, Asclepiadoideae): the first new species of Ceropegia described from Laos

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ABSTRACT. A new species, Ceropegia laotica Rodda & Meve, from the Bolaven Plateau in southern Laos, is described and illustrated. It shows a twining habit, linear-lanceolate leaves and possesses small root tubers. The new species is compared with Ceropegia cochleata Kidyoo from Thailand.

Keywords. Ceropegia cochleata, Ceropegia digitiformis, Ceropegieae, Indochinese Peninsula, Southeast Asia

Introduction

In the traditional, morphology-based circumscription of Ceropegia L. the genus includes only taxa possessing pitfall flowers that trap small visiting flies for 24 hours in funnel-shaped, basally inflated corollas. Molecular-based studies have shown, however, that the phylogeny of the terminal branch of the tribe Ceropegieae, the Stapeliinae, to which Ceropegia belongs, is complex. The other genera of Stapeliinae (Brachystelma R.Br. and the stapeliads) are all nested and scattered through the Ceropegia tree, making Ceropegia multiply paraphyletic (Meve & Liede-Schumann, 2007; Surveswaran et al., 2009; Bruyns et al., 2015). These studies have documented that complex pitfall flowers – always thought to represent the peak of evolution in the Ceropegieae – have been independently lost several times during evolution to be replaced by open, radiate flowers. However, in order to prevent severe taxonomic instability in an extremely species-rich group (Stapeliinae comprises around 700 species), Meve & Liede-Schumann (2007) suggested that paraphyly in Ceropegia / Stapeliinae be accepted and that the “Ceropegia pitfall flower” be retained as a diagnostic character for Ceropegia. However, recently, Bruyns et al. (2017) proposed about 400 new names and combinations in Ceropegia in order to make it monophyletic. As long as the driving forces of the complex evolution in this group are not at least minimally understood, we prefer to retain the traditional classification, keeping Brachystelma and the stapeliad genera separate. There are around 210 “true” Ceropegia species of small erect or twining herbs which occur widely in the Old World tropics and subtropics of...
Southeast Asia, India, Arabia, Africa, Madagascar, reaching east to New Guinea and Northern Australia and west to the Canary Islands (with two species). The diversity within *Ceropegia*, its wide distribution, and the attractive flowers were and are fascinating. Many floristic, often geographically focused works, have been produced for places such as India (Hooker, 1883; Ansari, 1984), China (Li et al., 1995), Arabia (Bruyns, 1988), Madagascar (Meve & Liede, 1994), Southern Africa (Dyer, 1980), and Tropical East Africa (Masinde, 2012). Only one complete revision of the genus has been undertaken (Huber, 1957), although a wide-ranging treatment (lacking the non-succulent taxa) was published more recently by Meve (2002). China (Li et al., 1995) and India (Ansari, 1984) are by far the diversity hotspots in Asia. Without doubt Asia is the centre of origin of *Ceropegia* (Bruyns et al., 2015; Meve et al., 2017). In Southeast Asia, however, the number of taxa is considerably lower. Myanmar has nine species, according to the last compilation by Kress et al. (2003) and the inclusion of *Ceropegia farrokhii* McCann in *C. kachinensis* Prain by Singh et al. (2015), and in Vietnam just three species are recorded (Costantin, 1912; Vietnam Plant Data Center: http://www.botanyvn.com). However, recent research on *Ceropegia* in Thailand has led to the discovery of numerous new species bringing the count for the country to ten (Kerr, 1951; Boonjaras & Thaithong, 2003; Meve, 2009; Kidyoo, 2014a, 2014b, 2015a, 2015b; Kidyoo & Paliyavuth, 2017). Finally, in Laos, only one unidentified *Ceropegia* species has so far been recorded (Newman et al., 2007). Recent fieldwork in southern Laos by the first author has now led to the discovery of an unknown species of *Ceropegia* that is here described and illustrated as a new taxon.

**Taxonomy**

*Ceropegia laotica* Rodda & Meve, sp. nov.

Similar to *Ceropegia cochleata* Kidyoo in trailing to twining annual growth habit, presence of small tubers, leaves more or less lanceolate and small, and in habitat preferences: sandstone rocks with sparse soil. *Ceropegia laotica* can be separated from *C. cochleata* because the former has corolla lobes broadly ovate and folded while the latter has corolla lobes long-tailed and twisted. – TYPE: Laos, Champasak Province, Pakse, Dong Ha Sao NBCA, Bolaven Plateau, Ban Hnongluang Wat, 15°07'57"N 10°20'57"E, 1258 m, 23 October 2015, Rodda, M., Tan, L., Guglielmone, L., Peereman, J.M.E., Souvannaphou, S. & Soulimoungichoun, O. MR1418 (holotype SING; isotypes FOF, Herbarium of Pha Tad Ke Botanic Garden, TO). (Fig. 1, 2)

Perennial climbing herb with 1 or 2 stems from the base, twining, with clear sap in all parts. **Rootstock** tuberous; tubers subglobose, slightly apically compressed, smooth, medium brown, 2–3 cm in diameter, with many additional, straight, fleshy **roots**. **Stems** rarely branched, terete, glabrous, to 2 m long, 1.5–2.5 mm in diameter, greenish red to maroon red; internodes (3–)5–10(–15) cm long. **Leaves** spreading, petiolate, **petiole** terete, slightly channelled above, 5–7 × 1–1.5 mm in diameter, pubescent only above, trichomes curved, 100–200 μm long; **lamina** linear(-lanceolate), (4–)5–
New Ceropegia from Laos

Fig. 1. Ceropegia laotica Rodda & Meve. A. Single flower. B. Corolla, longitudinal section with corona removed. C. Corona, side view. D. Corona, top view. E. Corona, from underneath. F. Pollinarium. A–C & F based on M. Rodda et al. MR1418, D, E based on M. Rodda et al. MR1802. (Photos: M. Rodda)
Fig. 2. *Ceropegia laotica* Rodda & Meve. A. Fruiting branch. B. Plant *in situ*, climbing over bamboo. C. The exposed tuber and roots after removing a thin layer of leaf litter. (Photos: M. Rodda)
New Ceropegia from Laos

10(−12) × 0.5–1.2 cm, slightly fleshy but flexible, base attenuate, apex acute, pale green above, paler underneath, sparsely pubescent above, underneath pubescent along main vein only, trichomes curved, 100–200 μm long, older leaves glabrous; venation pinnate, lateral veins obscure; **colleters** 1 or 2 at base of lamina, globose, 200–300 μm in diameter. **Inflorescences** 1–2 flowered, with only one flower open at a time, **peduncles** extra-axillary, one per node, 0.5–2 × 1.5–2 mm in diameter, reddish green, glabrous; pedicels erect, 8–15(−25 when fruiting) × c. 1.5 mm in diameter, reddish green to whitish, glabrous or very sparsely pubescent; bracts 1 or 2 at base of pedicel, lanceolate, 1–2 mm long, reddish, apex acute. **Calyx** lobes narrowly lanceolate, 4–5 × 0.7–1 mm, glabrous, apex acuminate, reddish, glabrous; with one colletter at each sinus, conical, 400–500 × 150–200 μm, acute. **Corolla** 35–45 mm in total length, **tube** upright, straight or slightly curved, glabrous, with a bulbous base, a cylindrical mid portion and funnel shaped apex; tube (20–)23–27 mm long, base 5–7 mm in diameter, cylindrical part 2.5–3.5 mm in diameter; base white and densely spotted red outside, inside white and striped red; cylindrical part red with paler dots outside, dark red and striped maroon inside; apex red and spotted green outside, cream and striped green inside; **corolla lobes** broadly ovate, folded, (12–)15–17 × 7–8.5 mm, basal part cream-yellow, ciliate, apex acute, connate at tips, green and pubescent and ciliate inside, maroon red and glabrous outside. **Gynostegium** stipitate, stipe 0.4–1.6 × 0.9–1.1 mm in diameter, white, glabrous. **Gynostegial corona** of staminal and interstaminal parts, interstaminal lobes joined to form a shallow cup, 4.5–5 mm in diameter, purple with a white base; free lobes deeply bifid with the tips of adjacent lobules touching each other, ascending-erect, small triangular, c. 1.5 × 1 mm, maroon red, inside pilose with spreading translucent-white trichomes c. 0.5 mm long, staminal corona lobes connivent-erect, linear, terete, 1–1.2 × 0.25–0.35 mm, pinkish white. **Pollinaria**: pollinium broadly ovoid, yellow, 350–400 × 350–400 μm, caudicles c. 200 μm long, corpusculum clavate, reddish brown, 250–300 × 90–110 μm. **Ovary** narrowly conical, 2.1–2.3 × 0.5–0.7 mm wide at the base, apex truncate, glabrous. **Mericarps** held erect, linear, slightly curved, c. 11.5 × 3 mm (immature), reddish green. **Seeds** not seen.

**Distribution.** Laos, Champasak Province, in the vicinity of Ban Hnongluang Wat.

**Habitat and ecology.** *Ceropegia laotica* is a perennial tuberous herb found in a single population where all individuals were rooted in very thin soils (3–6 cm thick) over large sandstone boulders partially exposed. The plants were growing among grasses and climbing over gingers, bamboo and *Ficus* spp. at the edge between open grassland vegetation and short stunted forest (Fig. 3).

**Provisional IUCN conservation assessment.** Endangered EN B1ab(iii) + B2ab(iii) using the guildelines from the IUCN Standards and Petitions Subcommittee (2017). *Ceropegia laotica* is known only from the type locality. A thorough survey of the Bolaven Plateau is lacking and we have little information on similar habitats in neighbouring Thailand and Vietnam for a conclusive conservation assessment. If, however, we estimate the EOO as the entire Bolaven Plateau (< 5000 km²) and...
consider that only a small part of it has suitable rocky habitat for the species (AOO < 500 km²) and also take into account that the area is heavily affected by habitat loss due to land conversion to agriculture, mining and dams (Delang et al., 2013), a provisional conservation status can be assessed as endangered pending more information which might increase the threat status further.


Notes. The type of Ceropegia thorelii Constantin was collected from the border region of Cambodia and Laos. It was treated by Huber (1957) as Ceropegia macrantha Wight var. thorelii (Constantin) H.Huber and is a lowland species only reported from Steung Treng (Cambodia, Mekong River). The type specimen in P (Thorel 2148) is a fairly sturdy plant with elliptical leaves, pedunculate inflorescences and a corolla which is coarsely brownish spotted. Hence, Huber (1957) placed it in Ceropegia macrantha despite its hairy peduncles and pedicels, as did Meve (2002) who included C. thorelii as a full synonym of C. macrantha. Interestingly, a later collection made at Steung Treng (cf. Maxwell, 2009: fig. 14) has a corolla superficially comparable to the type of C. thorelii, but the stems and leaves are densely pilose, the leaves seem to be rather
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small and, most importantly, the basal inflation of the corolla tube (ostiolum) is basally constricted. This latter character is significant and of high taxonomic value in, for example, African Ceropegia. Therefore, Maxwell’s (2009) determination as C. thorelii cannot be confirmed here. Instead, although the corolla of Ceropegia cochleata Kidyoo, with its long-tailed, twisted lobes, does not show much similarity with the relatively short and obtuse corolla lobes of the new species, Ceropegia cochleata and C. laotica are vegetatively, ecologically and geographically much closer. They share the trailing to twining (when support is available) habit and growth form; they have wiry stems and spreading, fairly small, more or less lanceolate leaves; they have similar habitat preferences as they both occur on sandstone rocks with sparse soil and vegetation cover dominated by grasses and mosses (Kidyoo, 2015b); both species develop small tubers; and the above-ground parts do not survive the dry season.

There are also a number of similarities in habit, ecology and flower morphology between Ceropegia laotica and C. digitiformis Kidyoo. The latter species is found in Thailand in the Phu Wua Wildlife Sanctuary and Phu Langka National Park, c. 400 km northwest of the type locality of C. laotica. However, although Ceropegia digitiformis is also deciduous, the aerial stems survive the dry season because they are fleshy (Kidyoo & Paliyavuth, 2017), and not wiry as in C. laotica. Also the leaves are laminar, elliptic, ovate to rounded in Ceropegia digitiformis (and not rather linear and fleshy as in C. laotica) – displaying a close relationship to the Indian C. thwaitesii Hook. Kidyoo & Paliyavuth (2017) distinguish Ceropegia digitiformis from C. thwaitesii only on small deviations in corona morphology. In addition, Ceropegia digitiformis is unlikely to be a sister species of C. laotica because of the pollinarium morphology. The shape of the pollinium in Ceropegia digitiformis is ovoid with the germination crest subapical (cf. Kidyoo & Paliyavuth, 2107: figs. 1F and 2E), whereas the pollinia in C. laotica (and C. cochleata) are broadly ovate to (sub)rectangular with the pellucid margin along the inner side of the pollinium (Fig. 2f). On the other hand, Ceropegia digitiformis and C. laotica share the character of a stipitate corona although the interstaminal lobules in C. laotica are not linear-lanceolate as in C. digitiformis, but rather triangular and much more similar to those of C. cochleata, including in indumentum.

To conclude, Ceropegia laotica, C. cochleata and C. digitiformis all inhabit rocky, montane habitats on sandstone with sparse vegetation in the central Indochinese Peninsula. They share a number of morphological similarities but can each be distinguished by unique morphological characters. In the important habit, leaf and corona/gynostegial characters, we regard Ceropegia cochleata as presumably most closely related to our new species.

ACKNOWLEDGEMENTS. This study is part of an on-going research project on the systematics of Asian Apocynaceae. Financial support was received from the National Parks Board (Singapore) which sponsored numerous field trips to Laos and herbarium study trips to Asian and European institutions. The curators of the E, P and SING herbaria are thanked for allowing access and/or for allowing loans or high quality images of herbarium specimens. We thank two anonymous reviewers and Dr David Middleton, Editor of Gardens’ Bulletin Singapore, for suggesting improvements to this manuscript.
References


New Ceropegia from Laos


Two new species of *Oreocharis* (Gesneriaceae) from Northwest Vietnam

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ABSTRACT. Two new species of *Oreocharis* (Gesneriaceae), *O. argyrophylla* W.H.Chen, H.Q.Nguyen & Y.M.Shui and *O. blepharophylla* W.H.Chen, H.Q.Nguyen & Y.M.Shui, from the Xuan Nha nature reserve, Van Ho district, Son La province, in northwestern Vietnam are described. They are compared to their most similar species and diagnostic characteristics are provided.

Keywords. China, corolla colour, Indo-China Peninsula, Thailand

Introduction

The genus *Oreocharis* Benth. in the Gesneriaceae has recently been greatly enlarged by the inclusion of a number of other genera (Möller et al., 2011). Most of the approximately 113 species are found in China, with a few species also in north-eastern India, northern Myanmar, northern Thailand and northern Indo-China (Möller et al., 2011, 2015, 2016; W.H. Chen et al., 2014, 2016; Cai et al., 2015; Yang et al., 2015, 2017; Wei et al., 2016; R.Z. Chen et al., 2017; Do et al., 2017; Li et al., 2017). A recent botanical exploration in north-western Vietnam near the border to Laos resulted in collections of two unknown *Oreocharis* species. After consultation of the literature (Pellegrin, 1930; Wang et al., 1990, 1998; Ho, 2000; Li & Wang, 2004) and examination of type specimens, as well as comparison to other species in the genus,
we propose two new species: *Oreocharis argrophylla* W.H. Chen, H.Q. Nguyen & Y.M. Shui (Fig. 1, 2) and *O. blepharophylla* W.H. Chen, H.Q. Nguyen & Y.M. Shui (Fig. 3, 4). The former species is most similar to *Oreocharis argyreia* Chun ex K.Y. Pan and *O. hirsuta* Barnett, and the latter to *O. magnidens* Chun ex K.Y. Pan and *O. curvituba* J.J. Wei & W.B. Xu, but differ from these species in the characters listed in Tables 1 and 2. The two new species occur in close proximity to each other in the Van Ho district in Son La province in north-western Vietnam.

Below, CPC refers to the Herbarium of the Center for Plant Conservation, Vietnam Union of Science and Technology Associations, Hanoi.


The new species is most similar in leaf characteristics to *Oreocharis argyreia* Chun ex K.Y. Pan but differs from it in having yellow flowers (vs purple), corolla narrowly infundibuliform (vs tubiform) and 2.5–3.1 cm long (vs 2–2.3 cm), and coherent anthers (vs free). In flower characteristics it is also similar to *Oreocharis hirsuta* Barnett in its yellow and tubular corolla but differs from it in its deeply bilabiate corolla limb (vs shallowly bilabiate) and coherent anthers (vs free). – TYPE: Vietnam, Son La province, Van Ho district, Tan Xuan municipality, Cot Moc village, territory of Xuan Nha nature reserve, eastern slopes of Pha Luong Mountain, at an elevation of 1000–1400 m, 20°40’33.3”N 104°39’00.3”E, 15 November 2013, in flower, Averyanov, L., Hiep, N.T., Khang, N.S., Thang, N.D. & Qui, L.D. CPC 7175 (holotype KUN; isotypes CPC, LE). (Fig. 1, 2)

Perennial herb with very short stem. **Leaves** numerous, rosulate, petiolate; petiole 4–9 cm, densely appressed pubescent; blade narrowly obovate to broadly lanceolate, 12–18 × 4.5–6.5 cm, both surfaces densely pubescent with appressed silvery hairs especially adaxially, base narrowly cuneate, apex acute to short acuminate, margin serrulate above middle of leaf blade, lateral veins 6–8 on each side of midrib, distinct. **Inflorescences** axillary, 3–4-branched, cymes 3–many-flowered; peduncle 8–12 cm long, pubescent with appressed hairs; bracts 2, linear-lanceolate, 10–13 × 1–2 mm, apex tapering, margin entire, pubescent and villous abaxially, glabrous adaxially; pedicels 0.7–1.8 cm long, white pubescent. **Calyx** of 5 lobes free to base; lobes equal, linear, 6–8 × c. 1 mm, margin entire, pubescent with appressed hairs abaxially, glabrous adaxially. **Corolla** yellow, tubular, apically infundibuliform, 2.5–3.1 cm long, outside glandular pubescent, glabrous inside; tube gradually slightly ampliate from the middle, 1.6–2.2 cm long, 2.8–3 mm in diam. at base, 6–6.2 mm in diam. and not constricted at the throat; limb 2-lipped; adaxial lip 2-lobed, dissected from near base of the adaxial lip, lobes ovate, apices rounded or obtuse, 5.8–6 × 4.1–4.3 mm; abaxial lip 3-lobed, lobes ovate, apices rounded or obtuse, subequal, median lobe slightly larger, 7.4–7.5 × 6.1–6.2 mm, lateral lobes 7–7.1 × 4.4–4.7 mm. ** Stamens** 4, anthers coherent in pairs, included, adaxial stamens 8–9 mm long, adnate to corolla tube 1.5–1.6 cm from base, abaxial stamens 1.4–1.5 cm long, adnate to corolla tube 5–5.5 mm from base; filaments glabrous; anthers basifixed, subglobular, 2-locular, dehiscing
Two new species of *Oreocharis* in Vietnam

Fig. 1. *Oreocharis argyrophylla* W.H.Chen, H.Q.Nguyen & Y.M.Shui. 
A. Habitat. B. Habit (scale bar 4 cm). C. Inflorescences (scale bar 3 cm). D. Flowers (scale bar 2 cm). (Photos: S.K. Nguyen)

longitudinally; staminode 1.4–1.5 mm long, adnate to corolla tube 4–5 mm from base. **Disc** ring-like, c. 1.2 mm long, shallowly 5-lobed. **Pistil** 1.5–1.6 cm long, glabrous; ovary fusiform, 1.1–1.4 cm long, glabrous, unilocular; style glabrous, 4–5 mm long; stigma 1, peltate. **Capsule** straight, fusiform, loculicidally dehiscent, 3.3–4 cm long, with persistent style 5–6 mm long. **Seeds** fusiform, 5–6 × c. 2 mm.

**Etymology.** The specific epithet refers to the silvery leaf indumentum.

**Ecology, distribution and phenology.** The species grows as a lithophytic herb on large moss covered boulders in remnants of primary and secondary broad-leaved evergreen
Fig. 2. *Oreocharis argyrophylla* W.H.Chen, H.Q.Nguyen & Y.M.Shui. **A.** Flowering plant. **B.** Dissected corolla showing two pairs of stamens cohering at the anther tips. **C.** Pedicel, calyx, disc and pistil (mature). Drawn by Ling Wang from the holotype Averyanov, L. *et al.* CPC 7175.
Two new species of *Oreocharis* in Vietnam

Table 1. Characteristics distinguishing *Oreocharis argyrophylla*, *O. argyreia* and *O. hirsuta*.

<table>
<thead>
<tr>
<th>Characters</th>
<th><em>O. argyrophylla</em></th>
<th><em>O. argyreia</em></th>
<th><em>O. hirsuta</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Leaf hairs</td>
<td>Densely appressed silvery pubescent</td>
<td>Densely appressed silvery pubescent</td>
<td>Sparsely spreading hirsute</td>
</tr>
<tr>
<td>Corolla</td>
<td>Yellow, narrowly infundibuliform, 2.5–3.1 cm</td>
<td>Blue-purple to purplish white, nearly cylindrical, 2–2.3 cm</td>
<td>Yellow, nearly cylindrical, 2–2.9 cm</td>
</tr>
<tr>
<td>Corolla tube</td>
<td>1.7–2.2 cm long, 2.8–3 mm in diam. at base, 6–2.8 mm in diam. at throat</td>
<td>1.5–2 cm long, almost 0.5–0.6 cm in diam. from base to top</td>
<td>1.6–1.9 cm long, 4–5 mm in diam. from base to top</td>
</tr>
<tr>
<td>Corolla limb</td>
<td>Distinctly 2-lipped, lips unequal;</td>
<td>Slightly 2-lipped, lips subequal;</td>
<td>Weakly 2-lipped, lips unequal;</td>
</tr>
<tr>
<td>Adaxial lip</td>
<td>Lobes oblong, 5.8–6 × 4.1–4.3 mm</td>
<td>Lobes suborbicular, 2–3 mm in diam.</td>
<td>Lobes ovate, 7.6–8 × c. 5 mm</td>
</tr>
<tr>
<td>Abaxial lip</td>
<td>Lobes oblong, subequal, middle 7.4–7.5 × 6.1–6.2 mm, lateral lobes 7–7.1 × 4.4–4.7 mm</td>
<td>Lobes suborbicular, equal, 2–3 mm in diam</td>
<td>Lobes ovate, subequal, middle 7.6–8 × 6.7–7 mm, lateral lobes 7.2–7.7 × 6–6.1 mm</td>
</tr>
<tr>
<td>Anthers</td>
<td>Coherent in 2 pairs</td>
<td>Not coherent</td>
<td>Not coherent</td>
</tr>
</tbody>
</table>

Humid forests on very steep mountain slopes composed of shale and sandstone at elevations of 1000–1850 m. This species is only known from the Xuan Nha nature reserve, Son La province of north-western Vietnam, where it is common. Flowering in September–December and fruiting in October–December.

**Provisional IUCN conservation status.** Endangered EN B1ab(ii,iii,v) + B2ab(ii,iii,v), following IUCN (2012, 2016) guidelines. This is based on an EOO of < 5000 km² and an AOO of < 500 km², being known from fewer than five populations, and with evidence of a reduction in the area of occupancy, a decline in habitat quality, and a decline in the number of individuals due to deforestation, largely for agriculture and due to fire.

**Additional specimens examined.** VIETNAM. **Son La:** Van Ho district, Chieng Xuan municipality, Co Hong village, territory of Xuan Nha nature reserve, Pha Luong Mountain, 13 Nov 2013, in fruit, Averyanov, L. et al. CPC 7020 (CPC, KUN, LE); Moc Chau Distr., Chieng Son comm., Pha Luong vill., Pha Luong Mountains, 1400–1500 m a.s.l., 20°41′33.2″N 104°37′37.0″E, 22 Sep 2016, Averyanov, L. et al. CPC 7939 (CPC, LE); Moc Chau Distr., Chieng Son comm., Pha Luong vill., Pha Luong Mountain, 20°40′23.0″N 104°37′52.0″E, 1750–1850 m a.s.l., 23 Sep 2016, Averyanov, L. et al. CPC 7993 (CPC, LE); Moc Chau Distr., Chieng Son comm., Pha Luong vill., Pha Luong Mountain system, 20°41′30.9″N 104°38′08.9″E, 1425 m a.s.l., 25 Sep 2016, Averyanov, L. et al. CPC 8026 (CPC, E); Van Ho Distr., Tan Xuan comm., A Lay village, around point 20°40′46.2″N 104°39′49.6″E, approx. 1500 m a.s.l., 1 Oct 2016, Averyanov, L. et al. CPC 8173 (CPC, PE).
Notes. The new species is similar to *Oreocharis argyreia* in its leaf characteristics (silvery indumentum with densely appressed hairs), but can be distinguished easily by its yellow corolla which is also of a different size and shape. The differences between the two species are detailed in Table 1. In Indo-China, *Oreocharis argyrophylla* is also quite similar to *O. hirsuta* from northern Thailand in the yellow and tubular corolla, but differs in the densely appressed pubescence on the leaves and the cuneate leaf base (hirsute hairs and obtuse to rounded base in *O. hirsuta*), more unequal upper and lower corolla lips (subequal lips in *O. hirsuta*), and anthers coherent in pairs (free in *O. hirsuta*).

*Oreocharis blepharophylla* W.H.Chen, H.Q.Nguyen & Y.M.Shui, **sp. nov.**

This species is similar to *Oreocharis magnidens* Chun ex K.Y.Pan in leaf characteristics, but differs from it in the linear bracts and calyx lobes (vs ovate in *O. magnidens*), a slightly 2-lipped corolla (vs strongly 2-lipped), a cylindrical corolla tube without inflated base (vs a corolla tube with inflated base) and coherent anthers (vs free anthers). In habit characteristics it is also similar to *Oreocharis curvituba* J.J.Wei & W.B.Xu but differs from it mainly in having narrowly obovate corolla lobes with purple stripes at base (vs narrowly oblong without purple stripes in *O. curvituba*). – **TYPE:** Vietnam, Son La province, Van Ho district, Chieng Xuan municipality, Co Hong village, territory of Xuan Nha nature reserve, Pha Luong Mountain, at an elevation of 1200–1400 m, 20°41’40.5”N 104°39’24.7”E, 13 November 2013, in flower, Averyanov, L., Hiep, N.T., Khang, N.S., Thang, N.D. & Qui, L.D. CPC 7019 (holotype KUN; isotypes CPC, LE). (Fig. 3, 4)

Perennial herb with very short stem. **Leaves** rosulate, petiolate; petiole 1.1–2.9 cm long, densely spreading villous; blade narrowly obovate to elliptic, 3.5–6 × 2–3.8 cm, adaxially with tuberculate setae, abaxially with sparsely strigose hairs along veins, base cuneate, margin crenulate and ciliate, apex short acuminate to obtuse, lateral veins 5–6 on each side of midrib, indistinct adaxially and distinct abaxially. **Inflorescences** axillary, with few flowers; peduncles 5–6 cm long, spreading villous; bracts 2, linear, 2.4–3 × 0.4–0.5 mm, adaxially glabrous and abaxially villous, margin entire; pedicels 8–9 mm, white villous. **Calyx** of 5 lobes free to base, lobes equal, linear, 6–7 × 1–1.2 mm, glabrous adaxially, villous abaxially, margin entire. **Corolla** purple with white limb, 2–2.4 cm long, outside pubescent, inside glabrous; tube cylindrical, purple, 1.1–1.2 cm long, 2.1–2.2 mm in diam., not constricted at throat; limb 2-lipped, white with purple stripes at the base; adaxial lip 2-lobed, dissected from near base, lobes broadly obovate, 6–8 × 4–5 mm, apices rounded or slightly retuse; abaxial lip 3-lobed, lobes subequal, obovate, 9–12 × 5–7 mm, broadening from the base, apices rounded or slightly retuse. **Stamens** 4, anthers coherent in 2 pairs; adaxial stamen 1.5–6 mm long, adnate to corolla tube 2.5–3 cm from base, abaxial stamen 2.6–3.1 mm long, adnate to corolla tube 5–6 mm from base; filaments glabrous, slender; anthers basifix, subglobular, 2-locular, dehiscing longitudinally; staminode c. 1.2 mm long, adnate to corolla tube from the base. **Disc** ring-like, 1.2–1.4 mm in diam., shallowly
Two new species of *Oreocharis* in Vietnam

Fig. 3. *Oreocharis blepharophylla* W.H.Chen, H.Q.Nguyen & Y.M.Shui A. Habit (scale bar 1 cm). B. Flower (scale bar 6 mm). C. Villous leaves (scale bar 2 cm). D. Habitat (scale bar 6 cm). (Photos: S.K. Nguyen)

5-lobed. **Pistil** 4–5 cm long, glabrous; ovary narrowly fusiform, glabrous, 1.5–1.6 mm long, unilocular; style glabrous, 2.6–2.8 cm long; stigma 1, peltate. **Capsule** straight, fusiform, loculicidally dehiscent, 0.8–1 cm long, with persistent style 2.4–2.9 mm long. **Seeds** fusiform, 0.5–0.6 × c. 0.2 mm.

**Etymology.** The specific epithet refers to the long-ciliate leaf margin.

**Ecology, distribution and phenology.** The new species grows as a lithophytic herb in primary coniferous and mixed forests with *Pinus cernua* Aver. et al. on very steep slopes along a ridge composed of brown sandstone (Averyanov et al., 2014) at elevations of 1200–1850 m. It is endemic to the Xuan Nha nature reserve in Son La province of north-western Vietnam. Flowering is October–November and fruiting is December–January.
Two new species of *Oreocharis* in Vietnam

Table 2. Characteristics distinguishing *Oreocharis blepharophylla*, *O. magnidens* and *O. curvituba*.

<table>
<thead>
<tr>
<th>Characters</th>
<th><em>O. blepharophylla</em></th>
<th><em>O. magnidens</em></th>
<th><em>O. curvituba</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Petiole</td>
<td>Densely spreading villous</td>
<td>Densely appressed silvery pubescent</td>
<td>Sparsely spreading hirsute</td>
</tr>
<tr>
<td>Leaf lateral veins</td>
<td>Adaxially with tuberculate setae, lateral veins 5–6 on each side</td>
<td>Adaxially with tuberculate setae, lateral veins 8–9 on each side</td>
<td>Adaxially with strongly bullate setae, lateral veins 4–7 on each side</td>
</tr>
<tr>
<td>Peduncle</td>
<td>5–3 cm, spreading villous</td>
<td>7–20 cm, densely glandular pubescent</td>
<td>3–15 cm, brown pubescent, glandular puberulent apically</td>
</tr>
<tr>
<td>Bracts</td>
<td>Linear, 2.4–3 × 0.4–0.5 mm, and abaxially villous</td>
<td>Ovalate, 5–6 × 1.5–3.5 mm, abaxially brown sericeous lanate</td>
<td>Lanceolate-linear, c. 3 mm long, glandular puberulent villous</td>
</tr>
<tr>
<td>Calyx</td>
<td>Lobes linear, 6–7 × 1–1.2 mm</td>
<td>Lobes ovate, 2.5–3 × 1–1.5 mm</td>
<td>Lobes ovate-triangular, 2–2.2 × 0.7–1 mm</td>
</tr>
<tr>
<td>Corolla</td>
<td>2–2.4 cm long</td>
<td>0.75–1.2 cm long</td>
<td>1.1–1.3 cm long</td>
</tr>
<tr>
<td>Corolla tube</td>
<td>Not constricted at throat, straight, purple</td>
<td>Narrowed at throat, inflated at base, straight, white</td>
<td>Not constricted at throat, slightly curved, purple</td>
</tr>
<tr>
<td>Corolla limb</td>
<td>Limb slightly 2-lipped, lobes white with purple stripes</td>
<td>Limb distinctly 2-lipped, lobes white with purple tips</td>
<td>Limb distinctly 2-lipped, lobes white or purplish without tips</td>
</tr>
<tr>
<td>Adaxial lip</td>
<td>Lobes obovate or oblong, 6–8 × 4–5 mm</td>
<td>Lobes narrowly oblong to lanceolate, 5–6 × 1.5–2 mm</td>
<td>Upper lips narrowly oblong, ca. 3.8–4 × 1.2–1.4 mm</td>
</tr>
<tr>
<td>Abaxial lip</td>
<td>Lobes obovate or oblong, 9–12 × 5–7 mm, apex rounded or obtuse</td>
<td>Lobes narrowly oblong to lanceolate, 5–9 × 1–1.5 mm, apex acuminate</td>
<td>Lower lips narrowly oblong, 4.2–4.8 × 1.3–1.5 mm, apex slightly retuse</td>
</tr>
<tr>
<td>Anthers</td>
<td>Coherent in 2 pairs</td>
<td>Not coherent</td>
<td>Not coherent</td>
</tr>
</tbody>
</table>

Provisional IUCN conservation status. Endangered EN B1ab(ii,iii,v) + B2ab(ii,iii,v), following IUCN (2012, 2016) guidelines. This is based on an EOO of < 5000 km² and an AOO of < 500 km², being known from fewer than five populations, and with evidence of a reduction in the area of occupancy, a decline in habitat quality, and a decline in the number of individuals due to deforestation, largely for agriculture and due to fire.

Additional specimens examined. VIETNAM. Son La: Moc Chau Distr., Chiem Son comm., Pha Luong village, Pha Luong Mountain summit, 1750–1850 m a.s.l. 20°40’23.0"N 104°37’52.0"E, 23 Sep 2016, Averyanov, L. et al. CPC 8000 (CPC, LE); Van Ho Distr., Tan Xuan comm., A Lay village, 20°40’46.2"N 104°39’49.6"E, 1500 m a.s.l., 1 Oct 2016, Averyanov, L. et al. CPC 8171 (CPC, LE).
Notes. This new species can be distinguished from *Oreocharis magnidens* by the purple base of the white corolla lobes (vs white base of purple corolla lobes), corolla tube throat not constricted (vs constricted throat), and coherent anthers (vs free anthers). It is also similar to *Oreocharis curvituba* but differs mainly in the colour pattern and shape of the corolla (Wei et al., 2016). Table 2 details the differences between these species.

ACKNOWLEDGMENTS. This work was supported by projects of The National Natural Science Foundation of China (grant no. 31470306, 31000258); Key Laboratory of Plant Diversity and Biogeography of East Asia, Kunming Institute of Botany, the Chinese Academy of Sciences (grant no. 2014CB954100); a US National Geographic Society project entitled “Exploration of primary woods along constructed highway Hanoi–Ho Chi Minh for their sustainable conservation in limits of Ha Tinh and Nghe An provinces of central Vietnam” (grant no. #9129-12); the Mohamed bin Zayed Species Conservation Fund “Conservation assessment of endangered Lao-Vietnamese stenoendemic–*Pinus cernua*, Pinaceae” (grant 152511753); and the National Parks Board Singapore. RBGE is funded by the Rural and Environment Science and Analytical Services division (RESAS) in the Scottish Government.

References


Two new species of *Oreocharis* in Vietnam


Primulina wuae (Gesneriaceae), a new species from southern China

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²Gesneriad Conservation Center of China (GCCC), CN-541006, Guilin, Guangxi, China
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ABSTRACT. A new species, Primulina wuae F.Wen & L.F.Fu (Gesneriaceae), is described from the southern part of China. This new species is most similar to Primulina pseudoroseoalba Jian Li et al., P. roseoalba (W.T.Wang) Mich.Möller & A.Weber, P. subrhomboidea (W.T.Wang) Yin Z.Wang and P. beiliuensis B.Pan & S.X.Huang var. fimbribracteata F.Wen & B.D.Lai, but differs from these in characters such as the size and indumentum of the bracts, the indumentum of the pedicels and anthers, the length of the pistils etc. A provisional conservation assessment is also provided.

Keywords. Critically endangered, IUCN conservation assessment, limestone flora, new taxon, Primulina pseudoroseoalba

Introduction

Until recently Primulina Hance was a monotypic genus in the family Gesneriaceae. Based on molecular phylogenetic and morphological studies, all species of Chiritopsis W.T.Wang, two species of Wentsaiboea D.Fang & D.H.Qin, and almost all species of Chirita sect. Gibbosaccus C.B.Clarke have since been incorporated into a dramatically expanded Primulina (Wang et al., 2011; Weber et al., 2011). Now the genus comprises more than 176 species, including many recently described species (Möller et al., 2016; IPNI, 2017).

While conducting field investigations of the limestone flora of northern Guangxi (China), we found an unknown species of Primulina that required further study. As well as herbarium specimens, live plants and seeds were collected and grown at the nursery of Guilin Botanical Garden and the Gesneriad Conservation Center of China. After comparison to other Primulina species in local Floras and monographs (e.g. Wang et al., 1990, 1998; Li & Wang, 2004; Wei et al. 2010), comparison to the many new larger-flowered species described in recent years, especially those from Guangxi (e.g. Zhu et al., 2014; Huang et al., 2015; Ning et al., 2015; Liu et al., 2016; Luo et al.,...
2016; Wen et al., 2016), and comparison to specimens of *Primulina* in herbaria (e.g. IBK, IBSC, KUN, PE), we have confirmed that it is indeed a new species of *Primulina* that is here described and illustrated. A provisional IUCN conservation assessment following the guidelines in IUCN Standards and Petitions Subcommittee (2016) is also provided.

**Taxonomy**

*Primulina wuae* F.Wen & L.F.Fu sp. nov.

This new taxon is morphologically similar to *Primulina pseudoroseoalba* Jian Li et al., *P. roseoalba* (W.T.Wang) Mich.Möller & A.Weber, *P. subrhomboidea* (W.T.Wang) Yin Z.Wang and *P. beiliuensis* B.Pan & S.X.Huang var. *fimbribracteata* F.Wen & B.D.Lai, but differs from these in the following characters (taxa listed in same order in each comparison to avoid repetition): bract size (2.1–2.5 x 0.85–1.1 cm in *P. wuae* vs 1.5–2 x 0.8–1.2 cm in *P. pseudoroseoalba*, vs 1.1–1.3 x 0.25–0.3 cm in *P. roseoalba*, vs 0.4–0.6 x 0.2–0.3 cm in *P. subrhomboidea*, and vs 2.8–4 x 2.5–3 cm in *P. beiliuensis* var. *fimbribracteata*); bract indumentum (outside sparsely erect pubescent and densely puberulent, inside puberulent vs outside densely puberulent, inside glabrous, vs outside strigose, inside glabrous, vs outside puberulent and pilose, inside glabrous, and vs outside sparsely purple-pubescent, inside glabrous); pedicel indumentum (pubescent vs puberulent and glandular puberulent, vs puberulent and glandular puberulent, vs densely pubescent and pilose, and vs densely glandular-pubescent); anther indumentum (glabrous vs bearded, vs sparsely puberulent, vs villous, and vs densely white lanate), and pistil length (3–3.5 cm long vs 2.2–2.5 cm long, vs c. 2.8 cm long, vs c. 3.3 cm long, and vs 8–4 cm long). – TYPE: China, Guangxi Zhuangzu Autonomous Region, Quanzhou County, Shitang town, alt. 900 m, 18 July 2014, flowering, Wu Xiang-Hong & Wen Fang WF140718-01 (holotype IBK; isotype IBK). (Fig. 1)

Perennial herb. **Stem** axis extremely short with indistinct internodes. **Leaves** 4–8, all basal, opposite, petioles 1.5–2.5 x 0.35–0.5 cm; leaf blade ovate to ovate-oblong, left-right slightly asymmetric, but not falcate, 6.5–9.5 x 4.8–8 cm, chartaceous when dried, adaxially and abaxially appressed eglandular-puberulent, base cuneate to broadly cuneate, margin entire, repand to undulate, apex acute, obtuse to nearly rounded; lateral veins 3–4 on each side of midrib, adaxially impressed, abaxially conspicuously prominent. **Inflorescence** axillary, a dichasium, 1 or 2 inflorescences on each plant, (1–)2–4-flowered or more; **peduncle** 5.5–7 cm long, eglandular-puberulent and eglandular-pubescent; **bracts** 2, free and opposite, narrowly cordate to rhombic, 2.1–2.5 x 0.85–1.1 cm, outside sparsely erect pubescent and densely puberulent, inside puberulent, margin entire and usually revolute, apex acute; pedicels 1.1–1.6 cm long, pubescent. **Calyx** 5-sect from base; segments equal, narrowly lanceolate to lanceolate, 9–10 x c. 3.5 mm, outside puberulent and glandular puberulent, inside nearly glabrous, margin entire, apex acute. **Corolla** 35–40 mm long, dark pink to purple, the throat pale purple, the upper part of the interior of the corolla tube with
two dark brown flaps, the surface of the flaps glandular-puberulent, outside glandular-pubescent, inside glandular-puberulent; tube tubular, 24–26 mm long, orifice c. 18 mm in diameter; limb distinctly 2-lipped, adaxial lip 2-partite for more than half of length, lobes slightly oblique to obviously oblique, triangular to ovate, adaxial lobes 7–8 × 8–8.5 mm; abaxial lip 3-partite to half or slightly more than half of length, lateral lobes obliquely ovate to oblong, 12–14 × 6–8 mm, the central one oblong, c. 12 × 6 mm, all five lobes with 4–5 dark purple stripes which sometimes connect and become somewhat reticulate. **Stamens** 2, adnate to corolla tube c. 12 mm above the base; filaments white to pale purple, geniculate near the base, c. 11 mm long, glabrous; anthers fused by their entire adaxial surfaces, oblong, c. 3 × 1 mm, glabrous dorsally; **staminodes** 2, translucent to white, linear, apex capitate, glabrous, c. 7 mm long, adnate to corolla 10–12 mm above base. **Disc** purplish brown, annular, glabrous, 1.3–1.5 mm high. **Pistil** 30–35 mm long; ovary cylindrical, 16–18 mm long, 1.8–2 mm in diameter, densely puberulent and glandular puberulent; **style** 15–17 mm long, c. 1 mm in diameter, densely glandular puberulent. **Stigma** translucent to white and pale purple, cuneate, chiritoid, 2-lobed, 2.2–2.5 mm long. **Capsule** linear, slightly upward-curved, 5–6 cm long, surface densely puberulent when young.

**Distribution.** Only known from the type locality, near Shijiaopen Village, Shitang Town, Quanzhou County, Guangxi Zhuangzu Autonomous Region, China.

**Habitat.** Primary forest on shaded slopes and vertical cliffs in limestone valleys and hills, rare, at low altitude, c. 177 m. It occurs in crevices in limestone rocks under evergreen forest and is rather prone to human disturbance.

**Etymology.** The new species is named after Ms Xiang-Hong Wu, who first discovered and collected this rare species and who accompanied us on a number of subsequent field expeditions in Quanzhou, Guangxi.

**Provisional IUCN Conservation Assessment.** Critically Endangered CR B2ab(iii,v) according to the IUCN red list criteria (IUCN Standards and Petitions Subcommittee 2016). We have visited the type locality of this new species many times and have found not more than 400 individuals which are scattered in a fairly narrow area at the top of a cliff. They grow in a popular scenic spot near the village of Shitang town, but most of the plants are protected from tourists by their elevated location.

**Vernacular name.** 吴氏报春苣苔. The Chinese pronunciation of *Primulina wuae* is ‘Wú Shi Bào Chūn Jǜ Tái’.

<table>
<thead>
<tr>
<th>Characters</th>
<th>Primulina wuae</th>
<th>Pseudorosea</th>
<th>Rosea</th>
<th>Subhomoidea</th>
<th>Beilinensis var. fimbriracteata</th>
</tr>
</thead>
<tbody>
<tr>
<td>Petiole</td>
<td>1.5–2.5 × 0.35–0.5 cm</td>
<td>2.5–4.5 × 0.7–1 cm</td>
<td>2.5–5 × 0.7–1.5 cm</td>
<td>0.4–2.5 × c. 0.5 cm</td>
<td>3–6 × 0.7–1.0 cm</td>
</tr>
<tr>
<td>Leaf blade</td>
<td>Slightly oblique, ovate to ovate-oblong, adaxially and abaxially appressed glandular-puberulent</td>
<td>Broadly ovate to elliptic, slightly oblique but not falcate, adaxially glandular-puberulent and abaxially glabrous</td>
<td>Slightly oblique, ovate, adaxially and abaxially sparsely strigose, glandular-puberulent</td>
<td>Rhomboid-ovate to elliptic, broadly ovate, or spatulate, adaxially sparsely strigose, glandular, abaxially sparsely pubescent</td>
<td>Broadly ovate, adaxially and abaxially appressed pubescent</td>
</tr>
<tr>
<td>Peduncle</td>
<td>5.5–7 cm long, glandular-puberulent and glandular-pubescent</td>
<td>3.3–4.2 cm long, glandular-puberulent</td>
<td>9–13 cm long, glandular-puberulent</td>
<td>5.5–8 cm long, densely purple puberulent and pilose</td>
<td>15–20 cm long, pubescent</td>
</tr>
<tr>
<td>Bracts</td>
<td>Narrowly cordate to rhombic, 2.1–2.5 × 0.85–1.1 cm, outside sparsely erect pubescent and densely puberulent, inside puberulent</td>
<td>Ovate to orbicular-ovate, 1.5–2 × 0.8–1.2 cm, outside densely puberulent, inside glabrous</td>
<td>Linear-lanceolate, 1.1–1.3 × 0.25–0.3 cm, outside strigose, inside glabrous</td>
<td>Narrowly ovate to triangular, 0.4–0.6 × 0.2–0.3 cm, outside puberulent and pilose, inside glabrous</td>
<td>Ovate-cordate or cordate, 2.8–4 × 2.5–3 cm, outside sparsely purple-pubescent, inside glabrous</td>
</tr>
<tr>
<td>Pedicel</td>
<td>1.1–1.6 cm long, pubescent</td>
<td>c. 3.8 cm long, puberulent and glandular-puberulent</td>
<td>1–2.5 cm long, puberulent and glandular-puberulent</td>
<td>0.8–1.4 cm long, densely puberulent and pilose</td>
<td>1.5–2 cm long, densely glandular-pubescent</td>
</tr>
<tr>
<td>Calyx lobes</td>
<td>9–10 × c. 3.5 mm, outside puberulent and glandular puberulent, inside nearly glabrous</td>
<td>10–13 × 1–1.5 mm, outside puberulent and glandular puberulent, inside sparsely puberulent</td>
<td>4–6 × 0.8–1 mm, outside puberulent and glandular puberulent, inside glabrous</td>
<td>6–7 × 1–1.2 mm, outside puberulent and pilose, inside nearly glabrous</td>
<td>7.5–8.5 × 2–2.5 mm, outside purple-pubescent, inside pubescent</td>
</tr>
<tr>
<td>Corolla indumentum</td>
<td>Outside glandular-pubescent, inside glandular-puberulent</td>
<td>Outside sparsely puberulent, inside puberulent on adaxial lip</td>
<td>Outside sparsely puberulent, inside puberulent on adaxial lip</td>
<td>Outside puberulent, inside puberulent below adaxial lip</td>
<td>Outside puberulent, inside pubescent</td>
</tr>
<tr>
<td>Filament indumentum</td>
<td>Glabrous</td>
<td>Glabrous</td>
<td>Glabrous</td>
<td>Base sparsely pubescent, apex sparsely glandular puberulent</td>
<td>Apically sparsely puberulent</td>
</tr>
<tr>
<td>Anther indumentum</td>
<td>Glabrous on the back</td>
<td>Bearded on the back</td>
<td>Sparsely puberulent</td>
<td>Villous</td>
<td>Back densely white lanate</td>
</tr>
<tr>
<td>Stamina indumentum</td>
<td>Glabrous</td>
<td>Densely glandular puberulent</td>
<td>Glabrous</td>
<td>Glabrous</td>
<td>Glabrous</td>
</tr>
<tr>
<td>Pistil length</td>
<td>3–3.5 cm long</td>
<td>2.2–2.5 cm long</td>
<td>c. 2.8 cm long</td>
<td>c. 3.3 cm long</td>
<td>3.8–4 cm long</td>
</tr>
</tbody>
</table>
Mich. Möller & A. Weber (Wang, 1981; Weber et al., 2011), *P. maguanensis* (Z. Yu Li et al.) Mich. Möller & A. Weber (Xu et al., 2008; Weber et al., 2011), and others. Although *Primulina wuae* shares this very striking large bract character with these species, overall it more closely resembles *P. beiliuensis* var. *fimbribracteata* F. Wen & B. D. Lai (Lai & Wen, 2015). The corolla of many *Primulina* species is generally rather featureless except for a few distinct features such as yellow ridges ventrally in the corolla tube (also present in other Gesneriaceae genera) and coloured ‘flaps’ dorsally in the tube that hold the style in place (Weber, 2004), as in *P. wuae*. The new species also looks rather similar to *Primulina pseudoroseoalba* (Li et al., 2014) which has the same leaf shape but differs in corolla characters. *Primulina wuae* lacks corolla ridges but has ‘flaps’, whereas both ridges and flaps are lacking in *P. pseudoroseoalba*. However, flaps and a similar corolla colouration are present in other species such as *Primulina subrhomboidea* and *P. roseoalba*. *Primulina wuae* is compared to the morphologically similar taxa *P. pseudoroseoalba*, *P. roseoalba*, *P. subrhomboidea* and *P. beiliuensis* var. *fimbribracteata* in Table 1.

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