



## *Ceropegia phuchongensis* (Apocynaceae, Asclepiadoideae), a new species from eastern Thailand

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**ABSTRACT:** A new species from Phu Chong-Na Yoi National Park, Ubon Ratchathani Province, eastern Thailand, *Ceropegia phuchongensis* Kidyoo & K. Suwann. (Apocynaceae, Asclepiadoideae), is described, illustrated and compared with the related *C. tenuicaulis* Kidyoo. The new species differs in corolla tube shape, color and trichomes inside the corolla tube, as well as pollinium and corpusculum shape. In addition, the gynostegium surfaces of the two species also support the distinctiveness of the new species.

**KEY WORDS:** Apocynaceae, Asclepiadoideae, Ceropegieae, dry deciduous forest, grass-like habit, Thailand, *Tiloris*.

### INTRODUCTION

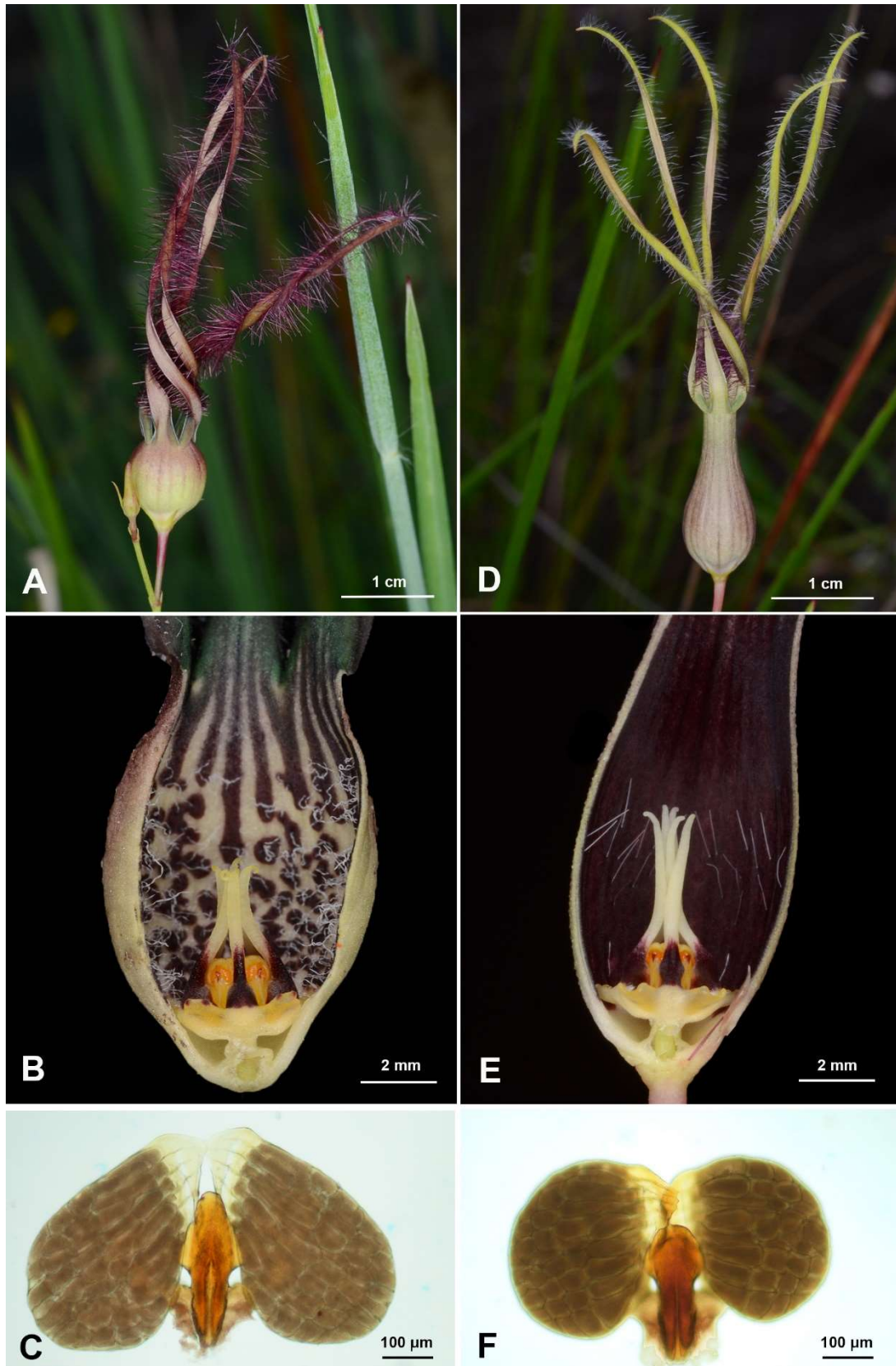
*Ceropegia* L., according to the phylogenetically-based concept, is currently the most species-rich genus of the subfamily Asclepiadoideae (Apocynaceae), encompassing more than 700 species with the inclusion of the former *Brachystelma* species and the stapeliads (Bruyns *et al.*, 2017). The circumscription of the genus is thus broadened substantially, resulting in lower morphological conformity in the group. In the morphology-based concept, *Ceropegia* sensu stricto (Linnaeus, 1753) is, despite huge variation, traditionally characterized by flowers with a corolla united to form a tubular to urceolate structure with a basal portion that is more or less inflated, and usually connate at tip to form a cage-like structure (Huber, 1957; Li *et al.*, 1995; Meve, 2002).

*Ceropegia* sensu stricto includes over 200 species and has a distribution from Southeast Asia, China, India, Madagascar, tropical Arabia, the Canary Islands, Africa, Papua New Guinea and Northern Australia (Huber, 1957; Li *et al.*, 1995; Meve, 2002; Thaithong *et al.*, 2018). In Thailand, there are 18 described species (Kidyoo, 2018; Thaithong *et al.* 2018), with new species being regularly discovered and further unknown plants actually being under investigation. A new species to be described here has been discovered in northeastern Thailand, the region locally known as 'Isan' (including the northeastern and eastern floristic regions) which is the area with the greatest diversity of *Ceropegia* in Thailand (Meve, 2009; Kidyoo, 2018; Thaithong *et al.*, 2018). This unknown *Ceropegia* species was first found more than fifteen years ago in Phu Chong-Na Yoi National Park, Ubon Ratchathani province by Hasachai Boonnuang, who drew my attention to the plant. It was found growing in sandy soil, in the open areas of dry deciduous dipterocarp forest. Subsequently, in September 2014,

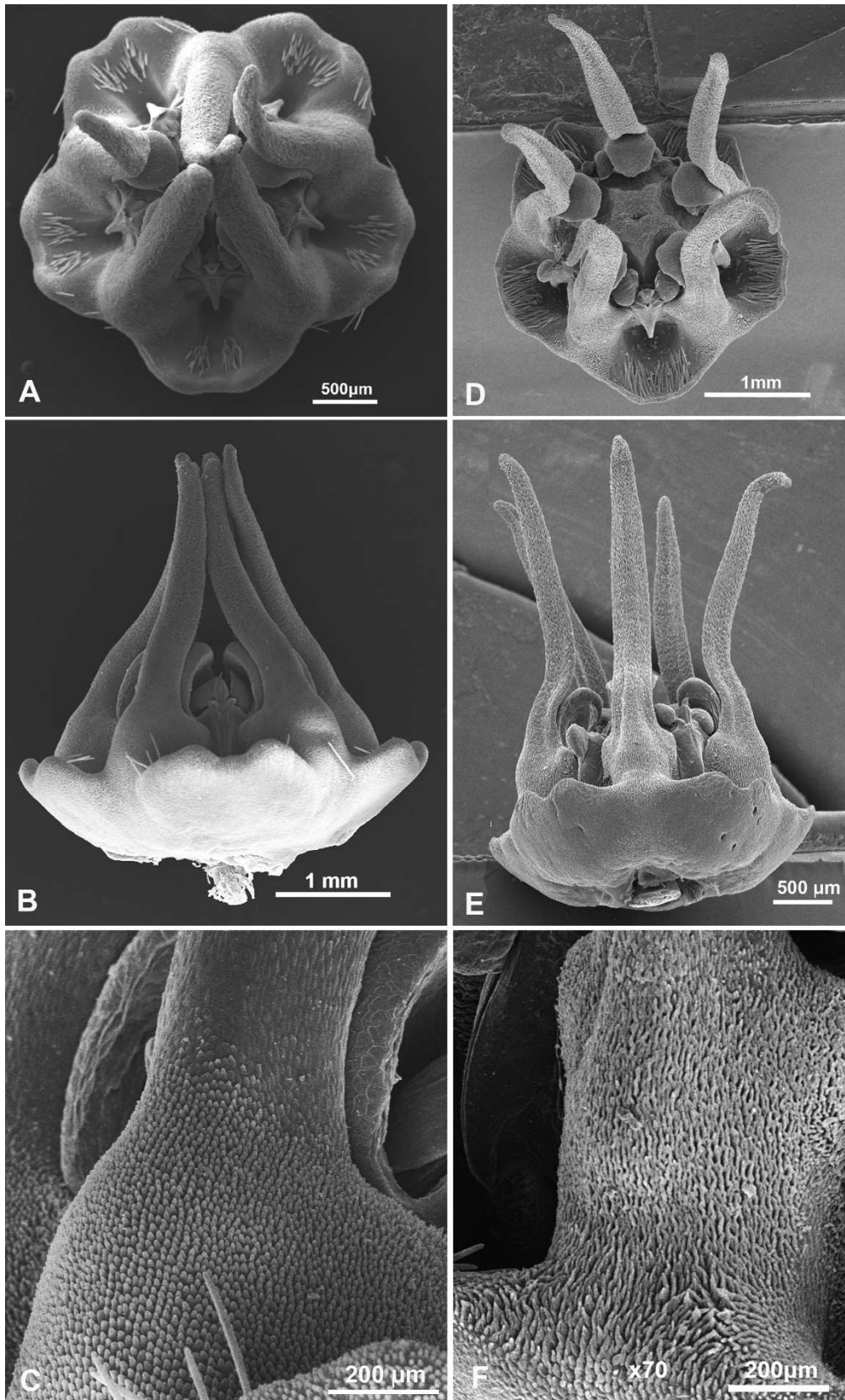
this plant was also spotted by a nature photographer about 500 kilometers away, at Khao Yai National Park, Nakhon Ratchasima Province, growing in similar environmental conditions. The photographer, Chaiwat Tunkpradit, distributed his photographs to a facebook group named 'Wild flowers of Thailand'. Examination and comparison of vegetative and reproductive structures indicated that this plant did not belong to any known *Ceropegia* species. Thereby, it is here described as a new species and named *C. phuchongensis*. Detailed comparison of morphological characteristics between the new species and its putatively most close relative is provided.

### MATERIALS AND METHODS

Plant materials were collected in their natural habitats between 2012 and 2017. Voucher specimens were prepared and deposited at BKF and BCU. Morphological characters of the freshly collected specimens and the preserved specimens in the herbaria: BK, BKF, K, L, BM, P, QBG and BCU were examined and compared. The morphological characters of vegetative and reproductive parts were mostly observed under light microscope (LM). In addition, observations of floral structures were made under scanning electron microscope (SEM). The gynostegia were cut and separated from the flowers and preserved in 70% ethanol for at least 24 hours before being dehydrated in alcohol series and subsequently critical-point dried with liquid CO<sub>2</sub>. The dried specimens were then mounted on the stubs and coated with gold. Lastly, the surface of gynostegia were observed under a JSM-6610 LV microscope at 15 KV and compared with those of the similar *C. tenuicaulis*, revealed in previously published studies.



**Fig 1.** Reproductive structures of *Ceropegia phuchongensis* sp. nov. (A-C) and *C. tenuicaulis* (D-F): A, D. Flowers; B, E. Longitudinal sections of corolla tubes; C, F. Pollinaria. Photographs by M. Kidyoo.



**Fig 2.** SEM photographs of gynostegium and corona of *Ceropegia phuchongensis* sp. nov. (A-C) and *C. tenuicaulis* (D-F). A, D. Top view of gynostegia; B, E. Side view of gynostegia (stipes were removed); C, F. Basal parts of staminal corona lobes.

Table 1. Morphological comparison of *Ceropegia phuchongensis* and the similar species.

Characters	<i>C. phuchongensis</i>	<i>C. tenuicaulis</i>
<b>Stem</b>	35–50 cm tall, unbranched, glabrous	30–50 cm tall, unbranched, glabrous
<b>Leaves</b>	linear to linear-lanceolate, 4.5–8.7 × 0.14–0.4 cm, glabrous	linear to linear-lanceolate, 5–10.5 × 0.15–0.25 cm, glabrous
<b>Peduncle</b>	0.8–2 cm length, glabrous	1–2.7 cm length, glabrous
<b>Pedicel</b>	4–7 mm length, 0.5–0.8 mm in diam., glabrous	4–8 mm length, 0.8–1 mm in diam., glabrous
<b>Calyx lobes</b>	linear-lanceolate, 2.7–3.5 × 0.3–0.5 mm, glabrous	lanceolate, 1.4–1.7 × 0.4–0.5 mm, glabrous
<b>Corolla tube</b>	globose, 0.7–1.0 cm length, inflated at midlength, 0.6–0.9 cm in diam.; inside the inflated portion yellowish white with irregular purplish brown dots (basally) and broad stripes (apically), with whitish, wrinkled and 0.9–1.5 mm long trichomes	tubular-urceolate, 1.7–2.2 cm length, slightly inflated at base, 0.5–0.6 cm in diam.; inside the inflated portion purplish brown, concentric with scattered, stiff, 0.8–1.5 mm long trichomes
<b>Corolla lobes</b>	narrowly linear, 3.9–6 × 0.15–0.2 cm, covered with purple hairs, leaving hair free orifices basally	narrowly linear, 2.6–3.5 × 0.08–0.17 cm, covered with purplish white to purple hairs, leaving hair-free orifices basally
<b>Gynostegium</b>	interstaminal corona lobes with a few trichomes on the inner side and margins; epidermis of the lower parts of staminal corona lobes covered with conical papillae	interstaminal corona lobes with a beard of trichomes inside; epidermis of staminal corona lobes covered with pointed (trichome-like) papillae
<b>Pollinaria</b>	pollinia teardrop-shaped, 0.49–0.52 × 0.31–0.34 mm; corpusculum spatulate with rounded apex, 0.32–0.35 × 0.14–0.16 mm	pollina ovoid, 0.53–0.57 × 0.41–0.42 mm; corpusculum spatulate with rounded apex, 0.40–0.41 × 0.19–0.21 mm

## RESULTS

Examination of the morphological characteristics of the new species in comparison to the similar *C. tenuicaulis* showed that both species are characterized by grass-like habit, with slender, erect and usually unbranched stems that arise from a tuber, and bear linear leaves and 1-flowered cymes with a slender peduncle. Their corolla lobes are linear, covered with purple trichomes on the adaxial surface and margins. In full bloom, the distal portions of these lobes are not twisted, the basalmost parts are glabrous to leave (5) orifices. Despite their similar corolla lobes, there is a clear distinction between the two species in features of the calyx, corolla tube, gynostegium and pollinarium (Figs 1 & 2, Table 1). Detailed comparison will be provided in Discussion.

Scanning electron microscopic studies of gynostegium with corona, again, show a high level of concordance between the two elements. However, ultrastructural characters significantly support the separation in two different taxa. *Ceropegia tenuicaulis* bears interstaminal corona lobes that are densely pubescent on the inner side with stiff trichomes of 0.13–0.26 mm length, and staminal corona lobes of which the lower portion is covered by pointed (trichome-like) papillae. In *C. phuchongensis*, two clusters of a few stiff trichomes of 0.08–0.15 mm length covering the inner surface and scattered trichomes along the margins characterize its interstaminal corona lobes. The surface of the lower part of its staminal corona lobes is covered with conical papillae (Fig. 2).

## TAXONOMIC TREATMENT

*Ceropegia phuchongensis* Kidyoo & K. Suwann., *sp. nov.*

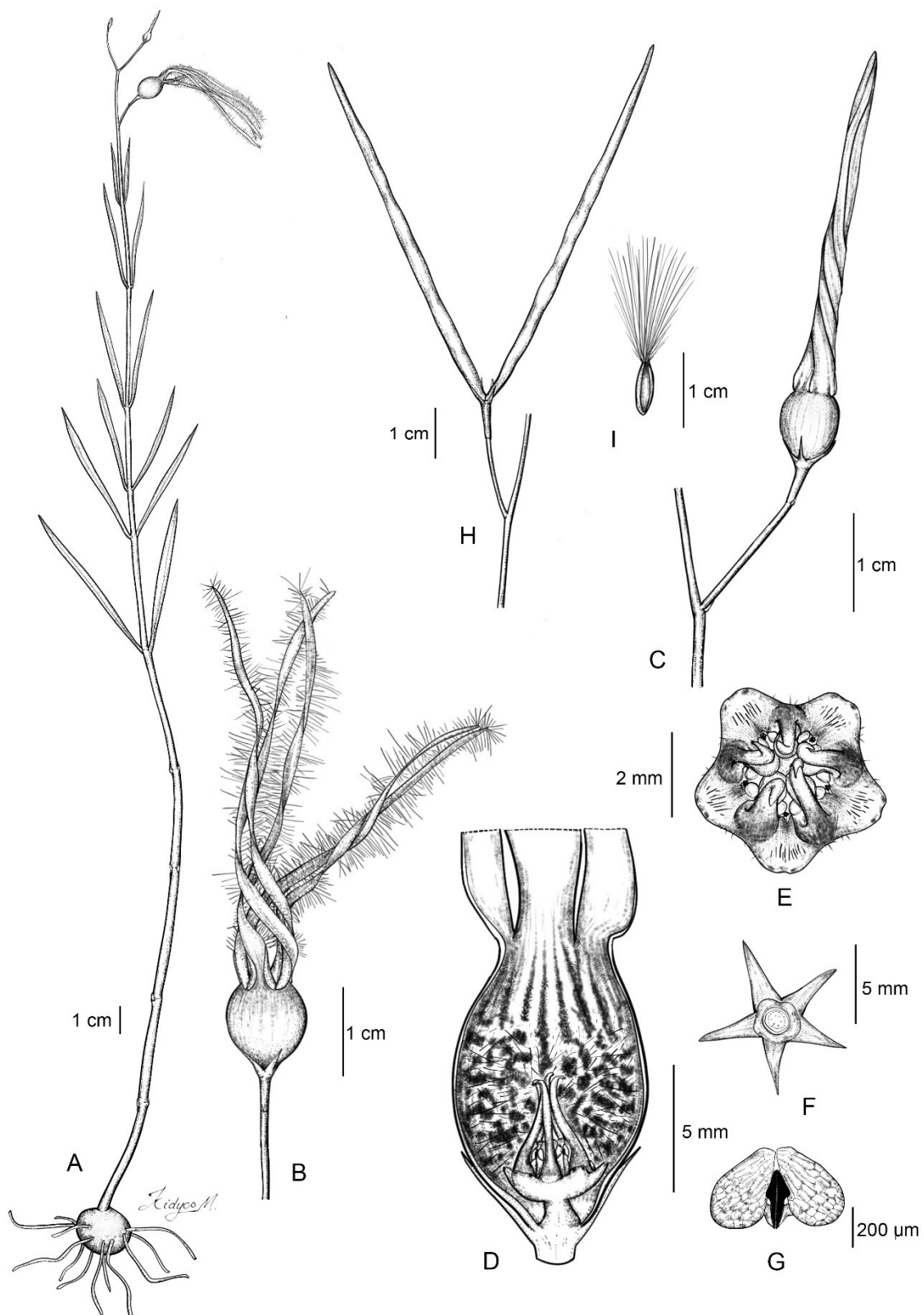
**Figs. 3–4**

**Diagnosis:** *Ceropegia phuchongensis* differs from *C. tenuicaulis* in having an ovoid to globose corolla tube of

0.7–1.0 cm length and 0.6–0.9 diam. which is inflated at its mid-length. The interior of this inflated part is yellowish white with irregular purplish brown dots and stripes, and densely covered with wrinkled, whitish trichomes of 0.9–1.5 mm length. In contrast, *C. tenuicaulis* has an ovoid-tubular corolla tube of 1.7–2.2 cm length and 0.5–0.6 cm diam. The tube has a slightly inflated basal portion and a long narrow upper part. The interior of its inflated part is plain purplish brown and covered with scattered white trichomes of 0.7–1.4 mm length.

**Type:** THAILAND. Ubon Ratchathani: Phu Chong-Na Yoi National Park, 450 m, 13 September 2012, *M. Kidyoo 1570* (holotype, BKF!, isotype, BCU!).

**Description:** Herbs, perennial, erect, not twining, with clear exudate in all vegetative parts. Rootstock tuberous; tubers subglobose to globose, smooth, light brown, 1.6–2.2 cm in diam. Stem terete, solitary, glabrous, unbranched, 35–50 cm tall, 1.1–2 mm in diam., green when young and turning brown with age; internodes 2–8 cm long. Leaves opposite, sessile; blade linear to linear-lanceolate, 4.5–8.7 × 0.14–0.4 cm, coriaceous, base attenuate, margins entire, slightly revolute, apex acute to acuminate; abaxial surface pale green, glabrous, adaxial surface green, glabrous; midrib greenish white, slightly convex on abaxial surface; lateral veins obscure on both surface. Inflorescence a 1-flowered cyme, extra-axillary; peduncle ascending to erect, straight, green to reddish brown, glabrous, 0.8–2 cm long, 0.5–0.7 mm in diam.; pedicel pinkish white to reddish brown, 4–7 mm long, 0.5–0.8 mm in diam., glabrous; bract solitary, attached at base of pedicel, triangular-lanceolate, ca. 0.7 × 0.2 mm, green or pinkish white to reddish brown, apex acute. Calyx deeply 5-parted, lobes yellowish green or green, narrowly lanceolate, 2.7–3.5 × 0.3–0.5 mm, glabrous, apex sharply acute, yellowish green with pink to reddish brown tint at apex. Corolla urceolate, upright; corolla tube ovoid to globose, straight, basal part greenish white



**Fig 3.** Illustrations of *Ceropegia phuchongensis* sp. nov. **A.** Flowering branch; **B.** Flower; **C.** Flower bud; **D.** Longitudinal section of flower showing corona and gynostegium; **E.** Top view of gynostegium; **F.** Calyx; **G.** Pollinarium; **H.** Fruit; **I.** Seed. Drawn by Manit Kidyoo from *M. Kidyoo 1570*(A-F) and *M. Kidyoo 1652*(G-I).



**Fig 4.** *Ceropegia phuchongensis* sp. nov. **A.** Habitat; **B.** Habit; **C.** Flowers. All photographs by M. Kidyoo.



to yellowish green and upper part reddish brown, outside glabrous, 0.7–1.0 cm long, inflated at midlength, 0.6–0.9 cm in diam.; interior of inflated part yellowish white with irregular purplish brown dots and stripes, densely covered with white trichomes of 0.9–1.5 mm long; lobes linear, 3.9–6 × 0.15–0.2 cm, long caudate, outside brown or purplish brown, inside reddish brown to dark brown; the basal portion 2.9–4 × 2.5–3 mm, loosely twisted, margins reflexed, auriculate, auricles green to greenish brown, glabrous, the upper portion opened, margins and adaxial surface densely covered with purple or purplish brown trichomes. Gynostegium stipitate, stipe 1–1.7 mm long, 0.8–1.2 mm in diam. Gynostegial corona double; interstaminal corona joined to form a shallow cup, 4.1–4.5 mm in diam., with stiff trichomes inside, apex of lobes truncate or shallowly bifid, yellowish white; staminal corona lobes terete, 3.7–4.1 mm long, 0.25–0.3 mm in diam., basal part dark brown, incumbent on dorsal surface of anthers, apical part usually long connivent-erect, yellowish white, apex acute and slightly recurved. Pollinaria: pollinium teardrop-shaped, yellow, 0.49–0.52 × 0.31–0.34 mm, translators stout, hyaline, ca. 0.09 × 0.1 mm, corpusculum spatulate, reddish brown, 0.32–0.35 × 0.14–0.16 mm. Ovaries 2, ovoid, ca. 2 mm long, 0.5 mm in diam., glabrous. Follicles usually 2 per flower, linear-lanceolate in outline, reddish brown with age, 6.6–8.2 cm long, 2.5–3 mm in diam. Seeds ovate-oblong, 6–8 × 1.5–1.8 mm, a silky white coma of 1.1–1.3 cm long.

**Etymology:** *Ceropegia phuchongensis* is named after the Phu Chong-Na Yoi National Park, the type locality.

**Distribution and habitat:** *Ceropegia phuchongensis* is currently known from only two localities in eastern Thailand. This plant is a perennial herb growing in sandy soil among tall grasses in the open area of dry deciduous dipterocarp forest, at 300–450 m a.s.l. Flowering July–October.

**Conservation status:** *Ceropegia phuchongensis* is endemic to Thailand, apparently rare and only known from two localities, i.e. Phu Chong-Na Yoi National Park, Ubon Ratchathani Province, where it was first discovered and Khao Yai National Park, Prachinburi Province. In Phu Chong-Na Yoi National Park, two populations were found at a distance of about 5 km from each other. In each population, there were 30–40 individuals occurring in a grass field of about 500 m<sup>2</sup>. Plants usually grow in shallow soils over rock slabs. These habitats are highly affected by soil erosion and human activities and drastically degraded. Over a 7-year period, the number of plants has been rapidly reduced to about 5 and 20 individuals in each of the two populations. Following the IUCN Red List Categories and Criteria (2017), *C. phuchongensis* should be considered as critically endangered species (CR).

**Additional specimen examined** (paratype): THAILAND. Ubon Ratchathani: Phu Chong-Na Yoi National Park, 300 m, 13 September 2012, *M. Kidyoo 1571* (BCU!); 450 m, 4 November 2017, *M. Kidyoo 1652* (BCU!).

***C. tenuicaulis* Kidyoo:** THAILAND. Ubon Ratchathani: Pha Taem National Park, 230 m, 13 September 2010, *M. Kidyoo 1508* (holotype, BCU!, isotype, BKF!).

## DISCUSSION

*Ceropegia phuchongensis* shows sufficient congruence with the morphological features with those of the section *Tiloris* series *Attenuatae*: habit primarily a grass-like, stems erect, arising from globose tubers, leaves (sub-) sessile, lanceolate to linear, inflorescences one- to few-flowered (Kambale and Yadav, 2019). The majority of the members of the series *Attenuatae* occur in India (Huber, 1957; Manudev *et al.*, 2016; Kambale and Yadav, 2019). In Thailand, prior to the discovery of *C. phuchongensis*, eight species of this series have previously been reported, including *C. arnottiana* Wight, *C. sootepensis* Craib, *C. thailandica* Meve, *C. suddeei* Kidyoo, *C. acicularis* Kidyoo, *C. tenuicaulis* Kidyoo, *C. tribounii* Kidyoo and *C. chuakulii* Kidyoo (Meve, 2009; Bruyns, 2017; Kidyoo, 2014a,b; Kambale and Yadav, 2019; Kidyoo and Kidyoo, 2019).

Thorough comparison of morphological characters showed that certain species of the series are particularly characterized by a long, slender, erect peduncle and linear corolla lobes being tightly twisted in bud, that make them clearly different from the other members. These species are *Ceropegia thailandica*, *C. suddeei*, *C. tenuicaulis* and *C. phuchongensis*. Among these four species, *C. thailandica* and *C. suddeei* are distinguished from the latter two species in having stems up to 30 cm tall, peduncles of 5–11 cm length, and corolla lobes with glandular trichomes that are tightly twisted in full bloom (Meve, 2009; Kidyoo, 2014a). *Ceropegia phuchongensis* and *C. tenuicaulis*, on the other hand, develop slender stems of more than 30 cm length, shorter peduncles of less than 3 cm length, and corolla lobes covered with non-glandular trichomes and being opened and loosely twisted only at their basal part in full bloom.

Furthermore, *C. phuchongensis* is clearly differentiated by its linear-lanceolate calyx lobes that are twice as long as those of *C. tenuicaulis*. In addition, the corolla tube of the former is swollen near its midlength and twice shorter than that of the latter which is slightly inflated at base with a long narrow upper portion. In *C. phuchongensis*, the inner surface of the inflated portion is yellowish white with irregular purplish brown dots and densely covered with wrinkled white trichomes, whereas in *C. tenuicaulis*, it is purplish brown and with scattered straight trichomes arranged in 2–3 rings (Fig 1). The interstaminal corona lobes of the new species are covered with a few trichomes on the inner side and margins, those of *C. tenuicaulis*, in turn, are densely bearded inside. The staminal corona lobes are ornamented either with conical papillae in *C. phuchongensis*, or pointed (trichome-like-) papillae in *C.*



*tenuicaulis*. Furthermore, the two species clearly differ from each other in shapes of pollinium. That of the new species has a teardrop-shape, while that of *C. tenuicaulis* is ovoid (Figs 1–2, Table 1).

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