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Two new species of *Curcuma* L. (Zingiberaceae) from Thailand

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Abstract. *Maknoi C, Saensouk S, Saensouk P, Rakarcha S, Thammarong W. 2021. Two new species of* Curcuma *L. (*Zingiberaceae*) from Thailand. Biodiversitas 22: 3910-3921. Curcuma aruna* and *C. pitukii*, two new species from northern Thailand, are described, illustrated, and photographed. They are endemic to Sukhothai and Lampang Provinces, northern Thailand, and the morphological characteristics of two new species are compared with their closest species, *C. flaviflora*, *C. eburnea*, and *C. pierreana*. Two new species, *C. aruna* and *C. pitukii* are assignable to *Curcuma* subgenus *Ecomata. C. aruna* is recognized by leaves ovate with thin chartaceous, fertile bracts 6–12, it's glabrous on nearly all parts of the plant, flowers yellow and labellum yellow with 2 darker yellow bands in the center. *C. pitukii* is recognized by bracts 20–40 with purplish white to purple, corolla lobes purplish white to pale purple, staminodes white, and labellum white with an embossed yellow path along the midrib from base to apex. A detailed description, distribution, ecology, etymology, preliminary conservation status, and photographs of two new species are provided. A key to 20 species of *Curcuma* subgenus *Ecomata* in Thailand is presented.

Keywords: *Curcuma flaviflora*, *C. eburnea*, *C. pierreana*, Lampang, subgenus *Ecomata*, Sukhothai, taxonomy, Zingiberales

INTRODUCTION

Zingiberaceae (Zingiberales), or Ginger family, is one of the largest flowering families in monocotyledons, aromatic herbs, creeping horizontal or tuberous rhizomes with about 57 genera of about 1,600 species worldwide (KewScience 2021). It is widely distributed in the tropical zone throughout tropical Africa, Asia, and the Americas. Southeast Asia is located at the center of the diversity of the family Zingiberaceae (Saensouk and Saensouk 2021; Saensouk et al. 2021a, b). Zingiberaceae in Thailand is represented by more than 26 genera and over 300 species, and the numbers will most certainly rise (Larsen and Larsen 2006). It is important used for food, spices, medicine, dyes, cosmetics, perfume, and ornamental plants such as *Alpinia mutica*, *Boesenbergia rotunda*, *Curcuma longa*, *C. parviflora*, *C. singularis*, *C. alismatifolia*, *C. thorelii*, *Kaempferia galanga*, *K. parviflora*, *K. rotunda*, *Zingiber officinale*, *Z. isanensis*, etc. (Saensouk and Saensouk 2021). The genus *Curcuma* L. is one of the largest genera in the family Zingiberaceae with approximately 120 species (Leong-Škorničková et al. 2020). This genus is mainly distributed from India to south China, Southeast Asia, Papua New Guinea, and northern Australia (Sirirugsa et al. 2007; Saensouk and Saensouk 2021; Saensouk et al. 2021a, b). This genus is also importantly used for food, spices, medicine, dyes, cosmetics, and ornamental plants such as *Curcuma aeruginosa*, *C. longa* (popular one for food and medicinal plant), *C. alismatifolia* (or Siam tulip, the popular one for ornamental plant) (Saensouk et al. 2016; Saensouk and Saensouk 2021).

The genus is most diverse in Thailand, where more than 50 species of three subgenera (*Ecomata* Škorničk. & Šída f., *Curcuma* L. and *Hitcheniopsis* (Baker) K.Schum.) are reported. Recently, many new species of *Curcuma* were described from Thailand (e.g. Boonma and Saensouk 2019; Maknoiet al. 2019; Leong-Škorničková et al. 2020, 2021; Soonthornkalump et al. 2020, 2021; Saensouk et al. 2021a, b, c).

During the author's study of plant diversity in northern Thailand, two unknown species of *Curcuma* were collected and photographed. Later, the authors rechecked the unidentified specimen of *Curcuma* and after carefully consulting the relevant literature comparison of its morphological characters with the protologues and type material, we found that it clearly represents an undescribed species which we describe and illustrate below as *Curcuma aruna* and *C. pitukii*. Therefore, this study aimed to describe and illustrate below, *Curcuma aruna* and *C. pitukii* from the northern part of Thailand.

MATERIALS AND METHODS

Plant materials and photographs of *Curcuma aruna* Maknoi & Saensouk were collected from 2020 to 2021 in Sukhothai Province, northern Thailand and additional

second new species, *Curcuma pitukii* Maknoi, Saensouk, Rakarcha & Thammar., was collected from Lampang Province, northern Thailand. The morphology is described under a stereomicroscope. Measurements were recorded from living, dry specimens and spirit specimens. Type specimens from both new species of morphologically similar species were compared, and verified, including using digital images available online, and all the published literature of *Curcuma* especially in subgenus *Ecomata* (Maknoi 2006; Maknoi et al. 2006; Sirirugsaet al. 2007; Chen et al. 2015; Maknoi et al. 2019; Leong-Škorničková et al. 2020; Saensouk et al. 2021a)with the living dry specimens and spirit specimens under a stereoscopic microscope. A preliminary conservation assessment was prepared based on the IUCN Red List categories. Photographs were taken from living specimens in the field.

RESULTS AND DISCUSSION

During the fieldwork aimed to study the species diversity of the plants in the northern part of Thailand, we found two species undescribed science in the genus *Curcuma*, the family Zingiberaceae. They have been collected from Sukhothai and Lampang Provinces. The taxonomic treatment, description, flowering period, etymology, distribution, preliminary conservation status, ecology, vernacular names, uses, notes, illustrations, and photographs of *Curcuma aruna* and *C. pitukii* (Figures 1–6 and Tables 1–2) were observed. Both species belong to subgenus *Ecomata* and an identification key for 20 species of subgenus *Ecomata* in Thailand is provided.

Taxonomic treatment

Curcuma aruna Maknoi & Saensouk, **sp. nov.** – Figures 1–3, Table 1–subgenus *Ecomata*

This species is similar to *C. flaviflora* in early flowering habits, short peduncle, no coma and yellow flowers. The leaves of *C. aruna* are ovate and glabrous on both surfaces, instead of leaves elliptic to oblanceolate and pubescent on both surfaces in *C. flaviflora*. The length of the corolla tube of *C. aruna* is shorter than in *C. flaviflora* (2.3–2.8 cm long in *C. aruna* vs 3.8–4.2 cm in *C. flaviflora*). The staminodes of *C. aruna* are obovate, whilst those of *C. flaviflora* are ovate to elliptic. The staminodes of *C. aruna* are larger than those of *C. flaviflora* (2.2–2.6 × 1.4–1.6 cm in *C. aruna* vs 2.0 × 1.2 cm in *C. flaviflora*).

Type: THAILAND, Sukhothai Province, Thung Saliam District, 13 May 2020, *Maknoi & Intamma 1936*(holotype QBG!; isotypes BKF!, KKU!).

Rhizomatous herb. *Leafy shoots* 25–50 cm tall. *Bladeless sheath* 3–4, 5–18 cm long, green, glabrous. *Leaf-sheaths* green, 10–20 cm long, glabrous; *ligule* shallowly bilobed, 2–4 mm long, lobes apices rounded, margin finely eroded, glabrous; *petiole* distinct, 2–3 cm long, glabrous; *lamina* ovate, 20–35 × 9–12 cm, apex acute, base rounded, glabrous on both surfaces, thin chartaceous. *Inflorescence* from rhizome before the leafy shoot; *peduncle* 5–8 cm long, greenish-white, glabrous, with 3–4 sheathing bracts, 3–6 cm long, glabrous; *spike* 5–8 cm long, 1.5–3 cm diam.; cincinus 1–3 flowers. *Comma bract* absent. *Fertile bracts* 6–12, narrowly ovate to elliptic, 2.5–4.5 × 1.2–2.5 cm, apex acuminate, green, glabrous. *Bracteoles* triangular, ca 2 mm long, glabrous. *Flowers* ca 5.8 cm long, exerted from bracts. *Calyx* tubular, 1.3–1.6 cm long, apex 3-lobed with a unilateral incision 4–7 mm long from the apex, translucent white, glabrous. *Corolla tube* slender, 2.3–2.8 cm long, outside white and glabrous at the basal part, yellowish and puberulent at the apical part, inside puberulent at the apical part; *dorsal corolla lobe* lanceolate, 18–20 × 6–8 mm, apex acute-mucronate, mucro ca 1 mm long, yellow, glabrous; *lateral corolla lobes* lanceolate, 16–19 × 5–7 mm, apex acute, yellow, glabrous. *Lateral staminodes* obovate, 2.2–2.6 × 1.4–1.6 cm, apex rounded, yellow. *Labellum* obovate, 2.4–2.8 × 1.5–1.7 cm, sinus 0.5–0.7 cm depth, yellow with 2 darker yellow bands in the center. *Stamen* ca 1.4 cm long, yellow; *filament* flat, 4–5 × 2–3 mm, puberulent; *anther* 8–9× 1.5 mm; *anther spurs* 3–4 mm long, point forwards, apex slightly curved outwards; anther crest not obvious; *anther thecae* 6–7 mm long. *Ovary* subspherical, ca 2 × 2 mm, glabrous; epigynous gland 2, cylindrical, ca 5 mm long; *style* slender, white, glabrous; *stigma* yellow, ca 1 mm long. *Fruit and Seed* not seen.

Distribution: Endemic to Thailand, currently found only in the type locality.

Ecology: Scrub forest foothill of limestone, 100-150 m a.s.l.

Phenology: Flowering in May, early rainy season.

Vernacular name: Krachiao Arun (Krachiao in Thai means *Curcuma* and arun means dawn in Thai).

Etymology: The specific epithet of the new species is "aruna", which means "dawn" in Thai, refer to flower color resemble the color of the dawn and name of God of the Dawn in Thai mythology. The name of the type locality province "Sukhothai" means the dawn of happiness also.

Preliminary conservation status: *Curcuma aruna* is endemic to Thailand and currently known only from the type location. Based on the known information, we propose to preliminary treat this plant as *Endangered* species [*EN: B2ab(ii), C2a(i)*], according to IUCN Standards and Petitions Committee (2019). Further fieldwork is needed as suitable habitats still seem to exist, to assess changes in population, distribution, and abundance in the future.

Uses: Auspicious ornamental plant.

Note: This species belongs to the subgenus *Ecomata* Škorničk. & Šída f. (Záveská et al. 2012) because of lacking coma bracts, presence of epigynous gland and anther spurs, and fertile bracts connate only at the base. *C. aruna* is recognized by lamina ovate with thin chartaceous, fertile bracts 6–12, it's glabrous on nearly all parts of the plant, flowers yellow and labellum yellow with 2 darker yellow bands in the center. *Curcuma aruna* is the most similar to *C. flaviflora* having a similar color of the flower and numbers of bracts but *C. aruna* was found in scrub forest foothill of limestone, alt. 100–150 m (vs *C. flaviflora* was found in the pine forest, alt. 1,200 m or higher). In

addition, *C. aruna* can be clearly distinguished from *C. flaviflora* in the diagnosis and a comparison showing in Table 1 and Fig. 3.

Curcuma pitukii Maknoi, Saensouk, Rakarcha & Thammar., **sp. nov.** –Figures 4–6, Table 2–subgenus *Ecomata*

Curcuma pitukii is most similar to *Curcuma eburnea* Škorničk., Suksathan & Soonthornk. by its terminal inflorescence, the number of bracts, without coma bracts, and small filiform anther spurs. The leaves of *C. pitukii* are densely puberulent on the adaxial surface, but the leaves of *C. eburnea* are glabrous on the adaxial surface. *C. pitukii* has purplish white to purple bracts, whilst *C. eburnea* has cream-white or pale greenish bracts. The length of the calyx of *C. pitukii* is longer than in *C. eburnea* (14–18 mm long in *C. pitukii* vs 8–10 mm long in *C. eburnea*). The length of the corolla tube of *C. pitukii* is shorter than in *C. eburnea* (2.2–3 cm long in *C. pitukii* vs 3.5 cm long in *C. eburnea*). The corolla lobes of *C. pitukii* are purplish white to pale purple and sparsely puberulent at the apex, but in *C. eburnea* they are pure white and glabrous. The length of the filament of *C. pitukii* is longer than in *C. eburnea* (5–8 mm long in *C. pitukii* vs 2 mm long in *C. eburnea*). The length of the anther of *C. pitukii* is shorter than in *C. eburnea* (2.5–4 mm long in *C. pitukii* vs 8–9 mm long in *C. eburnea*).

Type: THAILAND, Lampang Province, Sop Prap District, 20 August 2020, *S. Rakarcha, W. Thammarong, S. Wongwan & M. Tabut 940* (holotype QBG!; isotypes BKF!, KKU!).

Perennial herb. *Rhizome* ovoid to elliptic, 2.2–4 × 1.8–2 cm, outside light brown, inside pale yellow. *Root* fibrous and bearing ovate to elliptic tubers, 2.5–4.5 × 1.3–2 cm, inside translucent white. *Leafy shoots* 35–50 cm tall. *Bladeless sheaths* 2–3, 5–18 cm long, margin ciliate, reddish, adaxially glabrescent, abaxially puberulent. *Leaves* 2–5; *leaf sheaths* 12–20 cm long, margin ciliate, reddish, adaxially glabrescent, abaxially puberulent; *ligule* bilobed, ca 2 mm long, densely puberulent; *petiole* canaliculate, 9–15 cm long, green to reddish, puberulent; *lamina* elliptic, 22–32 × 9–12 cm, apex acute, base cuneate to rounded, adaxially green, densely puberulent, abaxially pale green, glabrescent with sometimes densely puberulent running near margin, ca 0.5 mm wide. *Inflorescence* terminal; *peduncle* 3–7 cm long, greenish-white, puberulent; *spike* 6–9 cm long, 4–5 cm diam.; cincinnus 2–4 flowers. *Comma bract* absent. *Fertile bracts* 20–40, broadly ovate, 1.8–3.5 × 2.5–4.5 cm, connate 4–5 mm at the base, apex acute, margin entire, purplish-white to purple, adaxially glabrescent, abaxially puberulent at the base, sparsely puberulent towards apical part. *Bracteoles* small, narrowly triangular, ca 4 × 2 mm, sometimes fully reduced (absent). *Flowers* 4–5 cm long, exerted from bracts. *Calyx* tubular, 14–18 mm long, apex 3-lobed with a unilateral incision 3–6 mm long from apex, pale purple, puberulent, 2 lobes apices mucronate with sparsely puberulent. *Corolla tube* 2.2–3 cm long, narrowly cylindrical at the base, funnel-shaped at apex, outside purplish-white or pale purple, puberulent, inside white, glabrous at basal part, with a ring of densely hairs at ca 2 cm from the base, puberulent at funnel-shaped; *dorsal corolla lobe* triangular-lanceolate, 16–22 × 5–8 mm, apex mucronate, mucro ca 1 mm, purplish-white to pale purple at basal part with increasing purple tinge towards the apical part, glabrous at basal part with sparsely puberulent at apex and mucro; *lateral corolla lobe* triangular-lanceolate, 12–19 × 4–7 mm, apex broadly acute, purplish-white to pale purple at basal part with increasing purple tinge towards the apical part, glabrous at basal part with sparsely puberulent at the apex. *Lateral staminodes* irregularly elliptic, 12–17 × 7–12 mm, white, adaxially puberulent, abaxially sparsely puberulent to glabrous. *Labellum* irregularly obovate-rhomboid, 14–20 × 8–14 mm, sinus 2–3 mm depth, white with an embossed yellow path along the center from base to apex (divided into two patches at the base like a Y-shape), minutely puberulent on either side of mid-band. *Stamen* 8–11 mm long, white; *filament* flat, 5–8 × 2–3 mm, puberulent; *anther* 2.5–4 mm long, white, connective tissue puberulent; *anther spurs* small, ca 0.8 mm long, filiform; *anther crest* 1–3 mm long, apex slightly emarginate. *Ovary* oblong, 3–6 × 1.5–2 mm, trilocular, white, densely puberulent or rarely sparsely puberulent; epigynous gland 2, cylindrical, 3–6 mm long, pale yellow; *style* white, glabrous; *stigma* capitate, 1–1.5 mm wide, ostiole ciliate, white. *Fruit* obovate, 8–12 × 6–8 mm, pure white with red dots towards the apical part, glabrous; *seed* elliptic, 3–5 × 2–3 mm, light brown with white aril.

Distribution: Endemic to Thailand.

Ecology: It grows on clay loamy soil in the shade in deciduous forest, altitude 700 m a.s.l.

Phenology: Flowering and fruiting in August.

Vernacular: Cho MuangPituk(Cho in Thai name means inflorescence, Muang means purple, and Pituk is the first name of Mr.Pituk Punyajun).

Etymology: The specific epithet "*pitukii*" is named in honor of "Mr.Pituk Punyajun", a supporter and backup plant taxonomists in Thailand for over 25 years and who first found the plant.

Preliminary conservation status: *Curcuma pitukii* is endemic to Thailand and currently known only from the type location. The total number of individuals is less than 250 and the distribution area is less than 500 km^2. Therefore, the conservation status is provisionally evaluated as Endangered [*EN: B2ab(ii), C2a(i)*], according to IUCN Standards and Petitions Committee (2019).

Uses: The mature rhizomes (fresh) of this plant by local villagers are used in Thai traditional medicine to treat gastritis and relieve flatulence. In addition, they ate young fresh rhizomes as vegetables

Note: The species belongs to subgenus *Ecomata* Škorničk. & Šída f. (Záveská et al. 2012). Considering the two closest species namely *Curcuma eburnea* and *C. pierreana* have terminal inflorescence without comma bract, presence of epigynous gland, and small filiform anther spurs. These three species can be easily distinguished by the indumentum of leaves, number and color of bracts, the length and color of calyx, proportions, and color of various flower parts, and indumentum of flowers. Morphologically, *C. pitukii* is most similar to *C.*

eburnea by the number of bracts, white staminodes, and white with a yellow medium band running through the center of the labellum, but sometimes the color of staminode of *C. eburnea* is white with a yellowish patch in the center and the apex. In addition, *C. pitukii* can be clearly distinguished from *C. eburnea* in the diagnosis and a comparison showing in Table 2. It is also similar to *C. pierreana* by its small filiform anther spurs and ovary hairy but differs in 20–40 bracts (vs10–20 bracts in *C. pierreana*), purplish-white to purple bract (vs cream-white bracts in *C. pierreana*), and white staminode (vs white with dark purple tips of staminode in *C. pierreana*). The other morphological differences between *C. pitukii* and similar species are provided in Table 2.

Key to 20 species of *Curcuma* subgenus *Ecomata* in Thailand

1. Corolla tube longer than bracts, narrow; flowers yellow; petiole very distinct from leaf blade ***C. supraneeana***
1. Corolla tube short, wide, flowers of various colors, leaf-blade tapering into the petiole
2. Anther spurs filamentose, 0.5–2 mm long
3. Staminodes white with dark purple tips ***C. pierreana***
3. Staminodes white or white with yellowish patch in center and apex
4. Fertile bracts less than 20
5. Leaves puberulous on both surfaces, staminodes white with a yellow patch in the center ***C. chantaranothaii***
5. Leaves upper surface glabrous; staminodes pure white ***C. cochinchinensis***
4. Fertile bract more than 20
6. Leaves glabrous on both surfaces, bracts cream-white or pale greenish ***C. eburnea***
6. Leaves densely puberulent on the upper surface, bracts purplish white to purple ***C. pitukii***
2. Anther spurs conical or cylindrical, forward-pointed, longer than 2 mm long
7. Inflorescence terminal
8. Leaves upper glabrous
9. Staminodes yellow or light orange; leaves lower glabrous
10. Labellum approx. reniform, oblique, yellow with inside half orange, apex acute turning outward; staminodes rhomboid, light orange with dotted dark red at base, apex rounded; leaves glabrous on both ***C. rhomba***
10. Labellum ovate, yellow with dark yellow band in the middle and light pale yellow at base, apex obtuse; staminodes asymmetrical trullate to ovate, yellow with pale yellow at base, apex obtuse; glabrous on both surfaces except a few shortly hairy at tip ***C. rangsimae***
9. Staminodes white; leaves lower pubescent
11. Labellum diamond-shaped, white with yellow patch in center and red spots at base; white with dark purple spots at base ***C. peramoena***
11. Labellum suborbicular, white with two deep orange bands at the center with deep purple lines at the base ***C. woodii***
8. Leaves upper pubescent
12. Corolla lobes whitish-green to pale green; leaves base cuneate to attenuate ***C. putii***
12. Corolla lobes pink, red or purple; leaves base oblique, rounded or cordate
13. Leaves lower glabrous; staminodes lanceolate, subacute, yellow ***C. stenochila***
13. Leaves lower pubescent
14. Staminodes elliptic, lower half dark red, upper half orange-yellow, base with pyramidal lump, apex rounded, ventral side pilose, margins with globular dots ***C. bicolor***
14. Staminodes oblique obovate, pale yellow, glabrous on both sides ***C. cinnabarina***
7. Inflorescence lateral
15. Staminodes purple ***C. ecomata***
15. Staminodes white or yellow or white with yellow
16. Labellum yellow
17. Leaves elliptic to oblanceolate and pubescent on both surfaces, staminodes ovate to elliptic ***C. flaviflora***
17. Leaves ovate and glabrous on both surfaces, staminodes obovate ***C. aruna***
16. Labellum white with a yellow median band
18. Leaves upper green with red patch along the midrib ***C. candida***
18. Leaves upper green without red patch along the midrib
19. Staminodes lower half white, upper half golden yellow, central purple patch covered with dense ***C. glans***
19. Staminodes white ***C. singularis***

Table 1. Morphological comparison between *Curcuma aruna* and *C. flaviflora*

Characters	***C. aruna***	***C. flaviflora***
Leaf	ovate, 20–35 × 9–12 cm	elliptic to oblanceolate, 18–30 × 6–8.5
Leaf indumentum	glabrous on both surfaces	pubescent on lower leaf surface
Bract	narrowly ovate to elliptic, 2.5–4.5 × 1.2–2.5 cm, green, glabrous	ovate to lanceolate, 3–4.5 × 1.3–2.6 cm, pale purplish red, densely pubescent on both surfaces
Calyx	1.3–1.6 cm long, glabrous	21 mm long, hairy along ridges
Corolla tube	2.3–2.8 cm long, puberulent	3.8–4.2 cm long, pubescent
Staminodes	obovate, 2.2–2.6× 1.4–1.6 cm	ovate to elliptic, ca 2 × 1.2 cm
Labellum	obovate, 2.4–2.8× 1.5–1.7 cm	obovate, ca 2 × 1.5 cm
Ecology	scrub forest foothill of limestone, 100–150 m above sea level	open areas in pine forests, 1,200 m above sea level or higher

Table 2. Morphological comparison between *Curcuma eburnea*, *C. pierreana*, and *C. pitukii*

Characters	***C. eburnea***	***C. pierreana***	***C. pitukii***
Internally rhizome	light yellow	pale brown	pale yellow
Adaxial surface of lamina	bright green, glabrous	green with reddish-brown patch along midrib, glabrous	green, densely puberulent
Abaxial surface of lamina	lighter green, puberulent, midrib green, glabrous	green, densely short-hairy	pale green, glabrescent with sometimes densely puberulent running near margin, ca 0.5 mm wide
Leaf base	oblique, rounded to subcordate	cuneate to attenuate	cuneate to rounded
Number of fertile bracts	30–40	10–20	20–40
Bract	broadly ovate to trullate, cream-white or pale greenish, glabrous on both sides	broadly ovate, whitish or greenish, hairy	broadly ovate, purplish-white to purple, adaxially glabrescent, abaxially puberulent at base, sparsely puberulent towards apical part
Calyx	8–10 mm long, semitranslucent white, glabrous	ca 16 mm long, scattered fine hairy	14–18 mm long, pale purple, puberulent
Corolla tube	ca 3.5 cm long	ca 3.2 cm long	2.2–3 cm long
Corolla lobe	14–18 × 10–12 mm, triangular-ovate or triangular with rounded, pure white, glabrous	12 × 7–9 mm, white, glabrous	12–22 × 4–8 mm, triangular-lanceolate purplish to pale purple at base with increasing purple tinge towards the apical part, glabrous at basal part with sparsely puberulent at apex and mucronate
Staminode	ca 15 × 12 mm, white or with yellowish patch in the center and the apex	ca 15 × 12 mm, white with maroon tips	12–17 × 7–12 mm, white
Labellum	18–20 × 17–18 mm, obscurely trilobed, white with a bright yellow medium band running through the center	ca 15 × 12 mm, broadly obovate, white with yellow band at the center with maroon tips	14–20 × 8–14 mm, irregularly obovate-rhomboid, white with embossed yellow path along the midrib from base to apex
Filament	2 mm long	ca 2 mm long	5–8 mm long
Anther	8–9 mm long; spurs 1–1.5 mm long; crest 1.5–2 mm long, apex rounded	ca 6 mm long; spur ca 1 mm long; crest quadrangular ca 1 mm long, apex truncate	2.5–4 mm long; spurs ca 0.8 mm long; crest 1–3 mm long, apex slightly emarginate

Figure 1. *Curcuma aruna* Maknoi & Saensouk: A. and B. habit; C.inflorescence; D. flower in front view; E. flower in side view; F. flower dissection (from left: abaxial of bract, adaxial of bract, calyx, floral tube with stamen, ovary with epigynous gland, lateral staminode, labellum, dorsal and lateral corolla lobes). Photographed by C. Maknoi (A, C from type location); S. Rakarcha (B, D–F from cultivation)

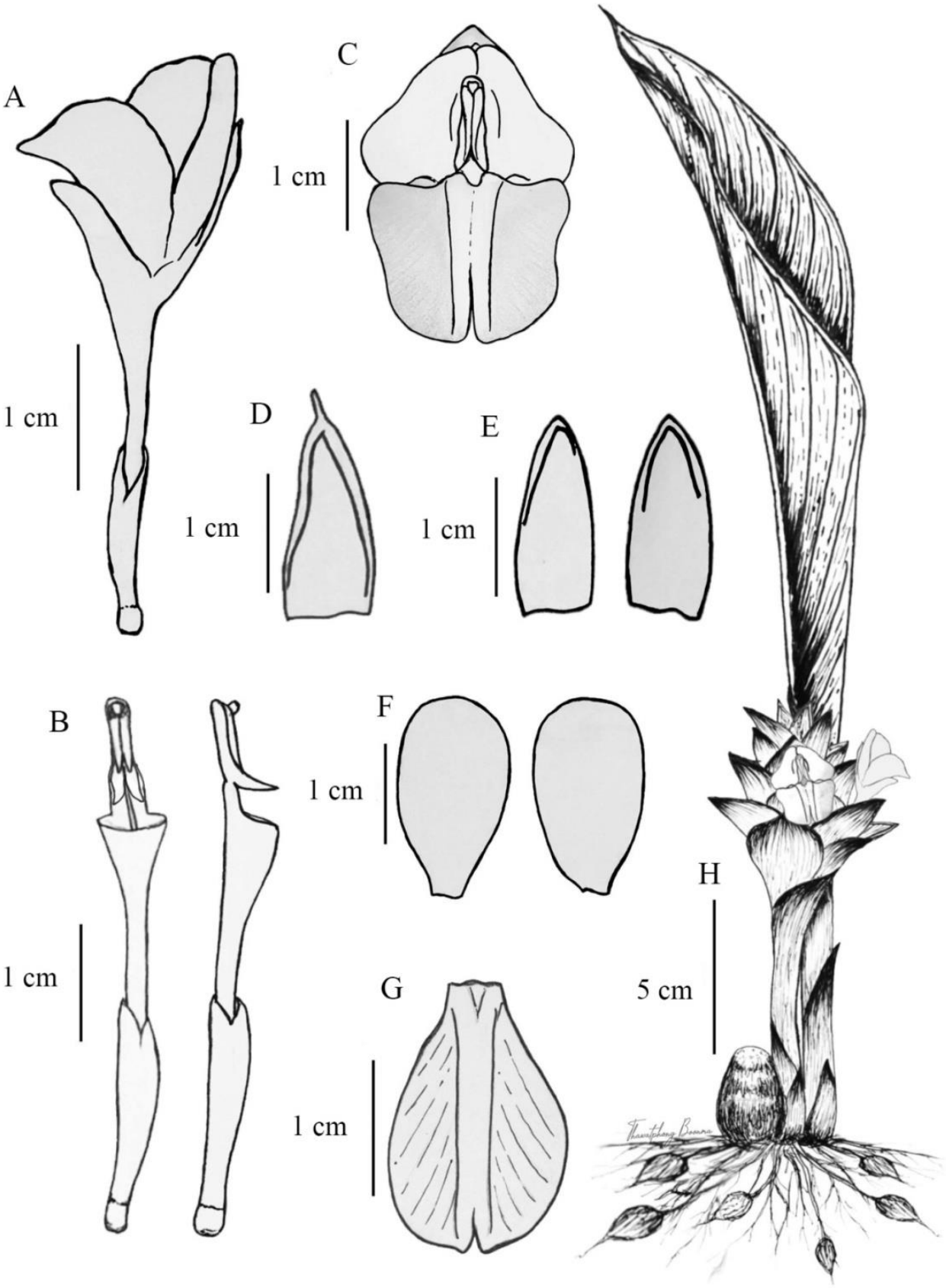

Figure 2. *Curcuma aruna* Maknoi & Saensouk: A. flower; B. stamen with corolla tube, calyx and ovary; C. top view of flower; D. dorsal corolla lobe; E. lateral corolla lobes; F. lateral staminodes; G. labellum; H. habitat with inflorescence and the underground parts. Drawn by T.Boonma

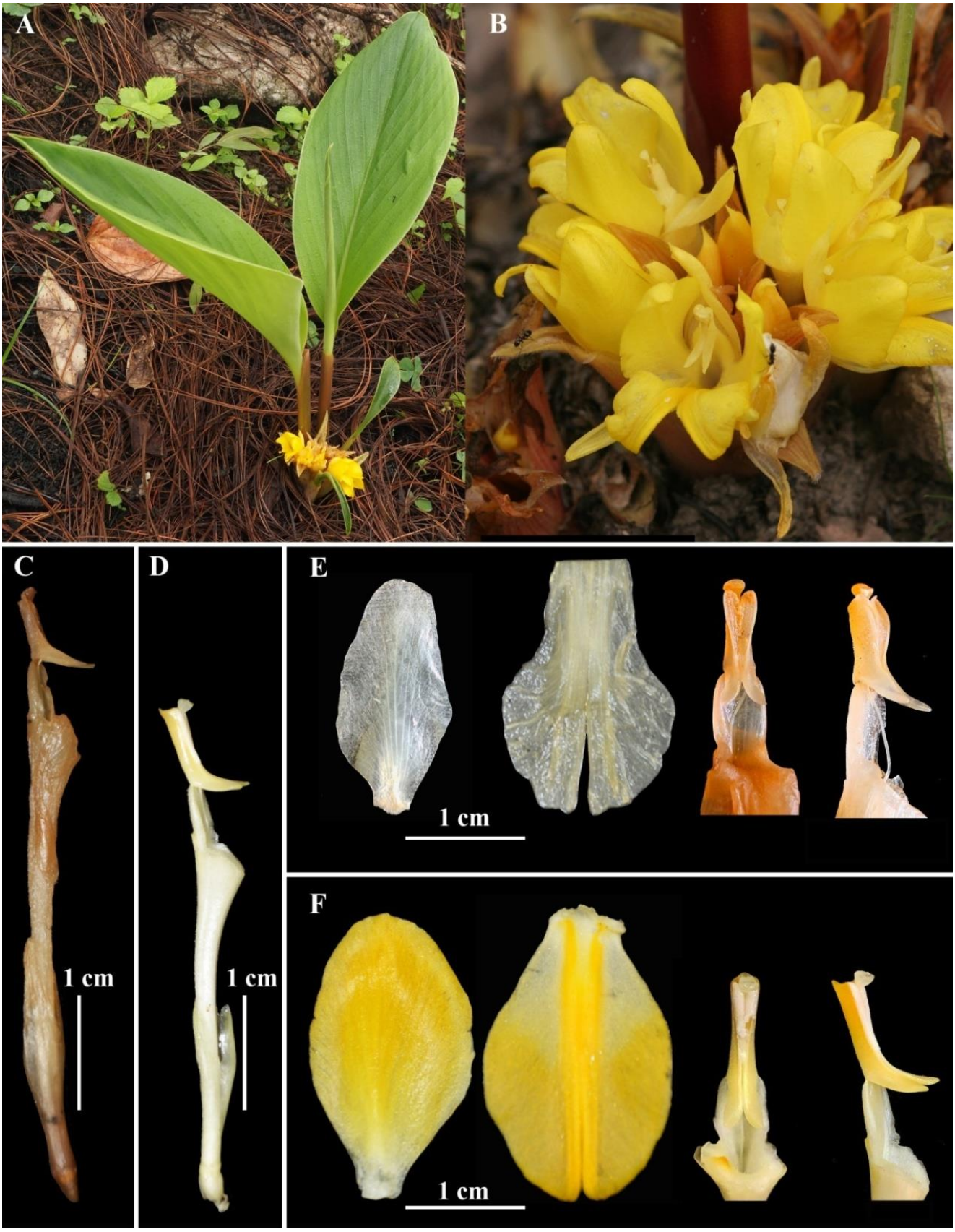

Figure 3. Comparison of *Curcuma aruna* and *C. flaviflora*. *C. flaviflora*: A. habit; B. inflorescence; C. corolla tube with ovary, calyx, and stamen; E. flower dissection (from left: lateral staminode, labellum, stamen in front view, and stamen in side view). *C. aruna*: D. corolla tube with ovary, calyx and stamen; F. flower dissection (from left: lateral staminode, labellum, stamen in front view and stamen in side view). Photographed by W. Pongamornkul (A, B from Doi Ang Khang, Chiang Mai, N. Thailand); S. Rakarcha (C, E from *Maknoi 356* (**QBG**); D, F from cultivation)

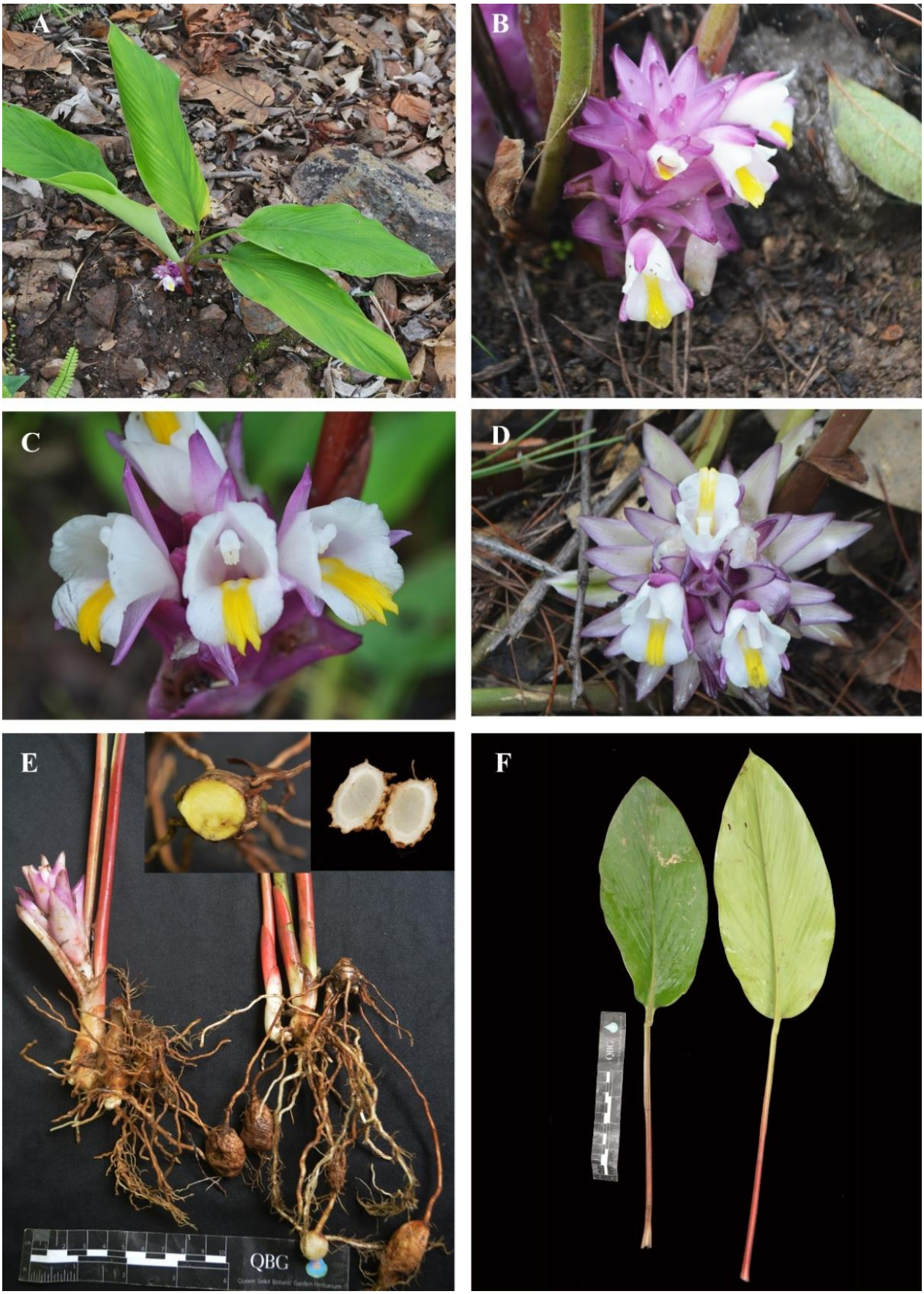

Figure 4. *Curcuma pitukii* Maknoi, Saensouk, Rakarcha & Thammar.: A. habit; B. inflorescence; C. close up flowers; D. inflorescence (top view); E. rhizome and roots (inset: detail of rhizome and root tubers); F. leaf. Photographed by S. Rakarcha

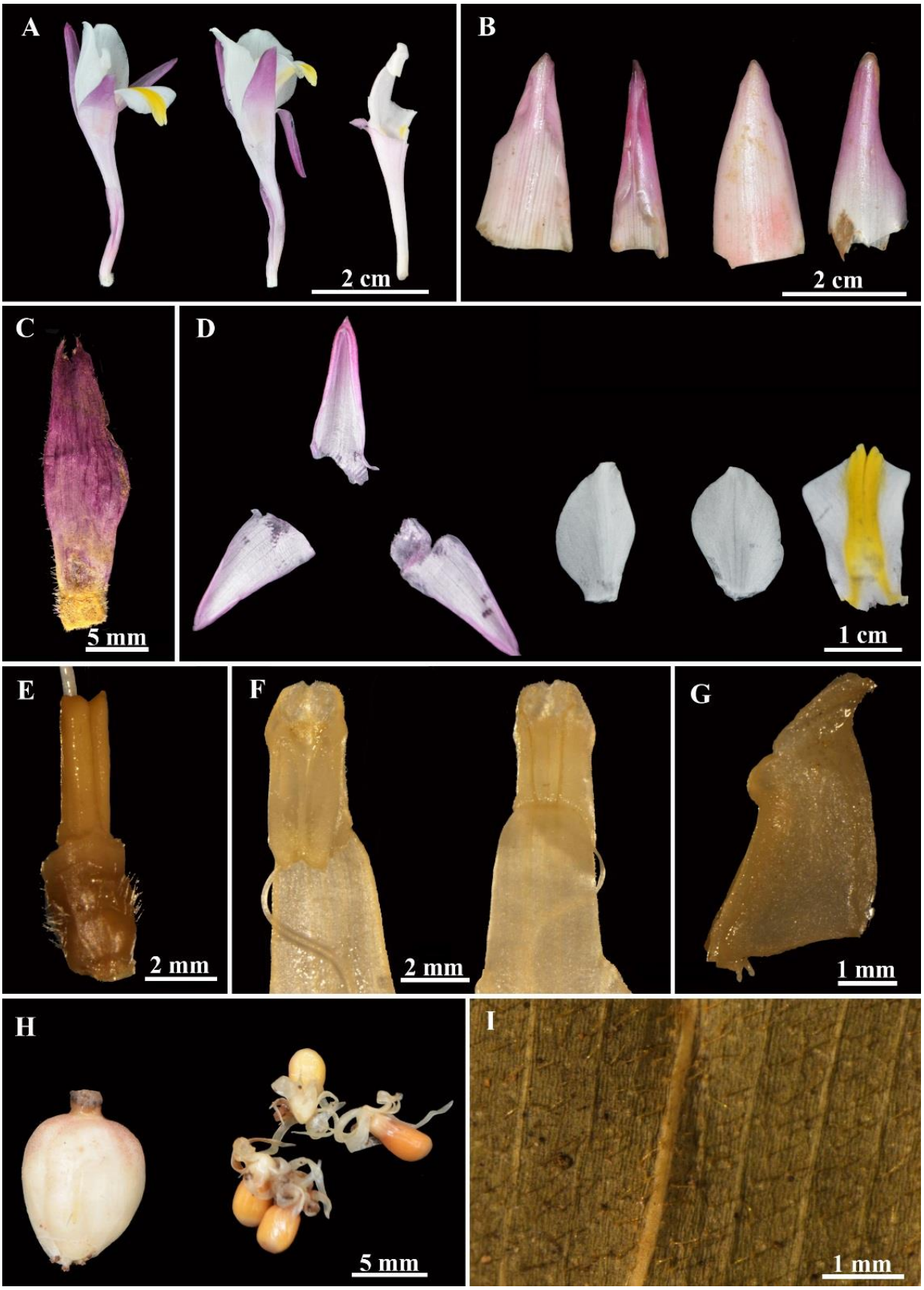

Figure 5. *Curcuma pitukii* Maknoi, Saensouk, Rakarcha & Thammar.: A. flower in side view and corolla tube with stamen; B. bracts; C. ovary with calyx; D. corolla lobes, lateral staminode and labellum, from left to right; E. ovary with epigynous gland; F. front and back view of anther; G. side view of anther; H. fruit and seeds; I. adaxial surface of lamina**.** Figure 2E–G photographed from a specimen preserved in alcohol, while figure 2C and 2I photographed from dry specimens. Photographed by S. Rakarcha.

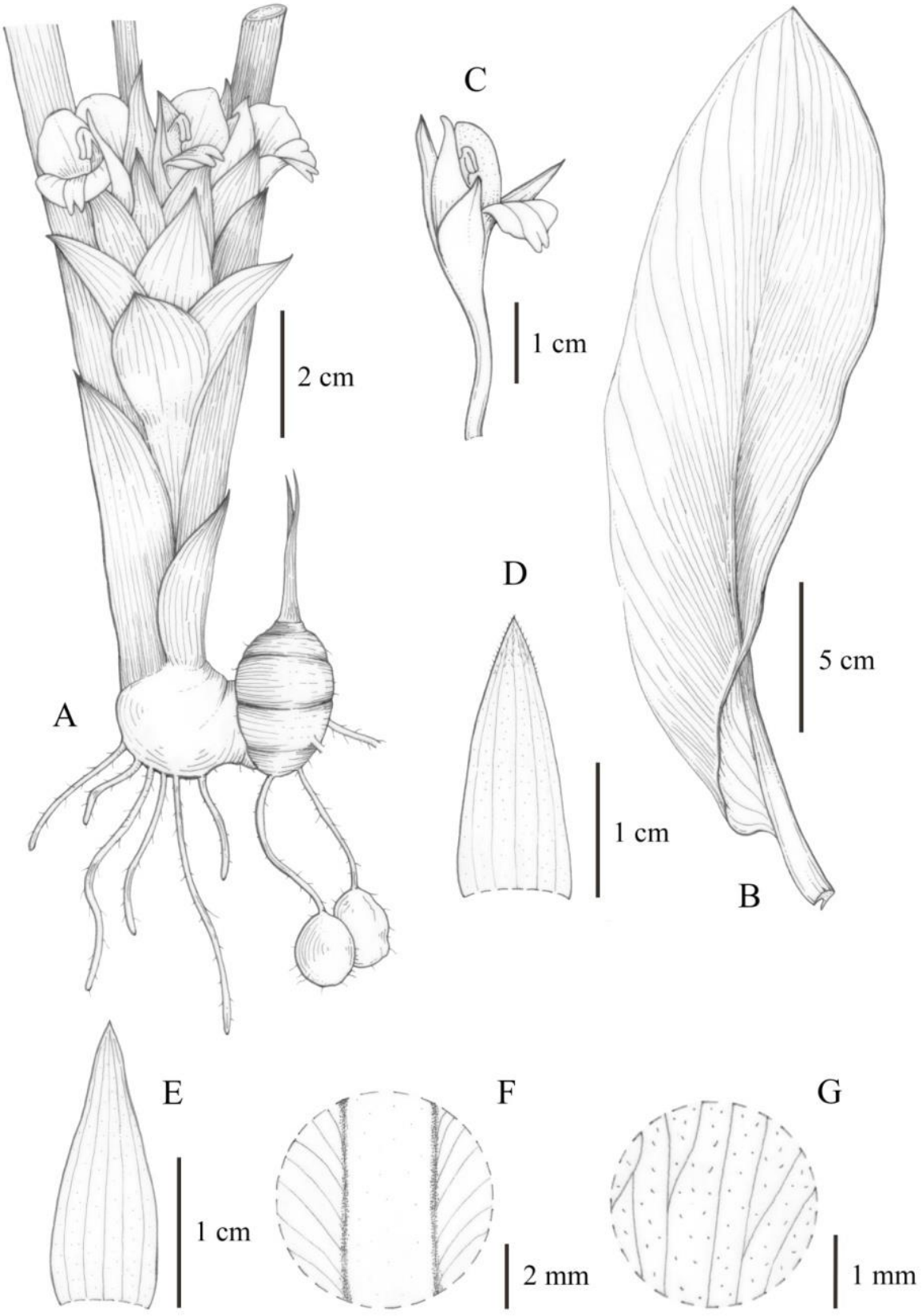

Figure 6. *Curcuma pitukii* Maknoi, Saensouk, Rakarcha & Thammar.: A. habit; B. leaf.; C. flower without calyx and ovary; D. abaxial surface of dorsal corolla lobe; E. abaxial surface of lateral corolla lobe; F. adaxial surface of labellum; G. adaxial surface of lateral staminode. Drawn by W. Thammarong

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