

Six new species and a new record of *Curcuma* L. (Zingiberaceae) from Thailand

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Abstract. Saensouk S, Boonma T, Saensouk P. 2021. Six new species and a new record of *Curcuma* L. (Zingiberaceae) from Thailand. *Biodiversitas* 22: 1658-1685. All six new species and a new record of *Curcuma* were described with detailed illustrations, photographs, summaries for their distribution, ecology, IUCN conservation status, and followed by a new record and key to 63 species of *Curcuma* revised and present in Thailand. The study surveyed six new species and a new record of *Curcuma* to collect, describe, measure, and illustrate the living and spirit specimens under a stereoscopic microscope. Plant materials and photographs were collected in the field from 2018 to 2019. The results of the study described six new species, including *Curcuma chantaranothaii* Boonma & Saensouk sp. nov., *C. charanii* Boonma & Saensouk sp. nov., *C. rangsimae* Boonma & Saensouk sp. nov., *C. phrayawan* Boonma & Saensouk sp. nov., *C. puangpeniae* Boonma & Saensouk sp. nov., *C. purpurata* Boonma & Saensouk sp. nov., and a first new record of *C. peramoena*. All six new species were recognized to be endemic to Thailand.

Keywords: *Curcuma*, new species, new record, Thailand, Zingiberaceae

INTRODUCTION

The genus *Curcuma* L. established by Carolus Linnaeus in 1753 classified in the family of Zingiberaceae. The genus is one of the largest genera in Zingiberaceae, distributed from India to South China, Southeast Asia, Papua New-Guinea and Northern Australia. Thailand is one of the richest areas of *Curcuma* with all three subgenera and more than 50 species reported (Siriruga et al. 2007; Larsen and Larsen 2006; Škorničková et al. 2017; Boonma and Saensouk 2019; Maknoi et al. 2019, Leong-Škorničková et al. 2020; Soonthornkalump et al. 2021). Škorničková et al. (2021) proposed a new classification of subgenus and combined some genus and species to be part of the *Curcuma* genus, causing the number of species of genus *Curcuma* in Thailand significantly increased.

MATERIALS AND METHODS

Plant materials and photographs were collected from 2018 to 2019. Measurements were recorded from living and preserved specimens. Type specimens of morphologically similar species were compared, and verified, including using digital images available online, and all the published literatures of *Curcuma* with the living and spirit specimens under stereoscopic microscope. A preliminary conservation assessment was prepared based on the IUCN Red List categories.

RESULTS AND DISCUSSION

During the fieldwork to study the species diversity of the Zingiberaceae family in Thailand and preparing a revision of the Zingiberaceae for the Flora of Thailand, six new species and a new record of *Curcuma* have been found. Three new species, i.e. *Curcuma charanii* sp. nov., *C. puangpeniae* sp. nov., *C. purpurata* sp. nov., belong to *Curcuma* subgenus *Hitcheniopsis*. Two new species, i.e. *C. chantaranothaii* sp. nov. and *C. rangsimae* sp. nov., and a new record *C. peramoena* Souvann. & Maknoi belong to *Curcuma* subgenus *Ecomatae*, and *C. phrayawan* sp. nov. belongs to *Curcuma* subgenus *Curcuma*. All six new species and a new record of *Curcuma* are described here with the taxonomic treatment, description, detailed illustrations, photographs, summaries for their distribution, ecology, IUCN conservation status, and followed by a new record and key to 63 species of revised and present *Curcuma* in Thailand (Figures 1-14 and Tables 1-6).

Taxonomic treatment

***Curcuma chantaranothaii* Boonma & Saensouk sp. nov.** – Figures 1–3, Table 1–subgenus *Ecomatae*

Curcuma chantaranothaii is the most similar to *C. newmanii* having a similar color of the flower and some characters but differ in produced terminal inflorescence enclosed by leaf-sheaths; leaves narrowly, 4–6 cm wide, upper surface puberulous; staminodes rhomboid; labellum with unique two paler yellow curves like a crescent moon from the apex parallel along with each side of the embossed yellow patch to half of the labellum; epigynous glands apex blunt, 4 mm long (whereas *C. newmanii*

produces lateral inflorescence before the new leaves; leaves broader than 6 cm wide, upper surface glabrous; staminodes obovate; labellum with a bright yellow median band without paler yellow curves; epigynous gland apex sharp and longer than *C. chantaranothaii*) (Table 1).

Type: THAILAND. Nakhon Nayok Province, 29 May 2019, *Boonma 15* (Holotype: KKU!; isotypes: QBG!, BKF!, BK!)

Perennial herb. *Rhizome* cylindrical and creeping, pale yellowish-white internally, fragrant, 8–12 cm long, 0.5–1.0 cm in diameter. *Root* fibrous and bearing globose to ovoid tubers, 1 × 1–1.3 cm, white internally, cool aromatic like camphor. *Leafy-shoot* 18–25 cm tall. *Bladeless sheaths* 2–3 sheaths, 3–12 cm long, apex mucronate, green, puberulous. *Leaves* 2–3; *sheaths* 4–5 cm long, pale green, puberulous; *ligule* bilobed, 7–8 mm, pale green, lobe triangular, apex acute, puberulous; *petiole* 6–8 cm long, green, puberulous; *lamina* elliptic to narrowly elliptic, 12–15 × 4.0–6.5 cm, apex acuminate, base attenuate, margin entire, slightly undulate, hyaline, upper surface dark green, lower surface pale green, puberulous on both surfaces. *Inflorescence* terminal; *spike* 4–6 × 5 cm; *peduncle* 4–6 cm long, 4–5 mm in diameter, greenish-white to white, puberulous. *Coma bract* absent. *Fertile bracts* 5–8, lanceolate to narrowly ovate, 4–6 × 2–3 cm, connate 0.4–0.6 cm at base, pale green, apex acuminate-mucronate, margin entire, hyaline, puberulous on both surfaces. *Bracteole* absent. *Flowers* white, 5.3–5.5 cm long. *Calyx* tubular, 1.6–1.8 cm long, translucent white, apex 3-lobed, with unilateral incision up to 7 mm, sparsely puberulous, 2 lobes apices mucronate and one obtuse with minutely hairy at tips. *Corolla tube* funnel-shaped, 2.4–2.6 cm long, white, hairy at base inside, puberulous outside; *dorsal corolla lobe* ovate, hooded, 2.1–2.3 cm long and 1.5–1.7 cm wide, white, apex mucronate, margin entire, hairy at apex; *lateral corolla lobes* ovate, 1.9–2.2 cm long and 1.4–1.6 cm wide, white, apex obtuse-hooded, margin entire, sparsely puberulous at base. *Lateral staminodes* rhomboid, 2.5–2.7 cm long and 1.6–1.7 cm wide, white with yellow patch at center, apex acute, minutely pubescent in center. *Labellum* obovate, 2.2–2.4 cm long and 2.1–2.2 cm wide, apex emarginate incision up to 2 mm, white with embossed yellow patch along the midrib from tip to base (divided into two patches at the base like a Y-shape), minutely puberulous on each side of the yellow patch and two paler yellow crescent patches from the apex on each side to the half of length. *Stamen* 1.0–1.1 cm long; *filament* flat, c. 5 mm long, 5–6 mm wide at base, 2–3 mm wide at apex, puberulous, pale yellowish-white; *anther* dorsifixed, white c. 8 mm long and c. 2.7 mm wide; *spurs* very short, c. 0.5 mm long, puberulous; *anther crest* rounded, c. 0.8 mm long. *Ovary* prolate ellipsoid, pale greenish-yellow, c. 3 × 5 mm, pubescent. *Epigynous glands* 2, pale yellow, c. 4 mm long, apex blunt. *Stigma* white, flat-cone 2.6–2.7 × 2.7 mm and about 1 mm thick, ciliate, puberulous; *style* white, very slender, 3.3–3.5 cm long. *Fruit and Seed* not seen.

Common name. “*Khamin-Noi*” in Thai language, “*Khamin*” refers to “*Curcuma*” and “*Noi*” name after a nickname of Prof. Dr. Pranom Chantaranothai.

Phenology. Flowers in late May to August.

Distribution. Cultivated plant throughout Thailand.

Etymology. The specific epithet “*chantaranothaii*” in honors Professor Dr. Pranom Chantaranothai who is a special Thai Plant Taxonomist, and an outstanding botanist of the Thai Flora.

Conservation status. *Curcuma chantaranothaii* became a cultivated plant, popular in the collectors of sacred plants throughout the country. Due to its popularity and market demand, such that it is prone to the effects of human activities within a very short time in an uncertain future, so we propose to treat this species provisionally as *Vulnerable* (VU D2), which capable of becoming a critically endangered species or even extinct species in a very short period. However, we expect that the species is still found in adjacent native areas as suitable habitat seems still exist. Further fieldwork and observations are needed to assess changes in population distribution and abundance in the future.

Uses. Auspicious ornamental plants.

***Curcuma rangsimae* Boonma & Saensouk sp. nov.** – Figures 4–5, Table 2–subgenus *Ecomatae*

Curcuma rangsimae is very similar to *C. vetellina* but differs in having leaf narrowly elliptic to oblanceolate, 12–20 cm wide, 40–70 cm long, base attenuate-slightly oblique; spike 12–20 cm long, 7.8–9.5 cm in diam. at the middle; calyx glabrous; lateral staminodes asymmetrical trullate to ovate; anther spurs conical, 2.8–3.4 mm long; ovary 3.5–4.0 × 2.5–3.0 mm, prolate spheroids, glabrous (whereas *C. vetellina* has leaf elliptic to elliptic-ovate 8–15 cm wide, 20–45 cm long, base rounded; spike 8–15 cm long, 4–5 cm diam. at the middle; calyx sparsely hairy on the three main veins leading from the tooth to the base; lateral staminodes obovate; anther spurs filamentous, c. 0.5 mm long; ovary c. 3 × 2 mm, trilobular, hairy, hairs c. 0.2 mm long) (Table 2).

Type: THAILAND. Nakhon Nayok province, Ban Na District, 8 August 2018, *Boonma 8* (Holotype: KKU!; isotypes: QBG!, BKF!, BK!)

Perennial herb, *primary rhizome* ovoid, pale yellow inside, fragrant, 25.8–30.5 mm in diameter and 36.0–40.0 mm tall, *branches rhizome* pale yellow inside stretched down to the ground and bent the tip upwards to germinate into new stems 8.5–12.5 mm in diameter and 5–8 cm long. *Root* fibrous with tuberous root, elliptic, 2–4 cm long. *Leafy shoot* 60–100 cm tall. *Leafless-sheaths* 1–2, green or green with red at base and underground part white, wilt while growing, apex acute, glabrous, 5–15 cm long. *Leaf-sheaths* alternate, green or green with reddish at base, glabrous; *ligule* bilobed, 4–6 mm long, translucent pale green, apex rounded, hairy; *petiole* green, glabrous, 8–15 cm long. *Leaf-blades* 5–7, narrowly elliptic to oblanceolate, apex acuminate, base attenuate-slightly oblique, margin entire with translucent white c. 0.5 mm wide, green with lighter green along the midrib, embossed veins, glabrous on both surfaces except a few shortly hairy at tip, 12–20 cm wide, and 40–70 cm long. *Inflorescence* terminal, emerges from the side of the pseudostem at base, cylindrical, mature 7.8–9.5 cm in diameter and 12–20 cm long; *peduncle* green

with white at base, pilose, 0.8–1.2 cm in diameter and 8–15 cm long. *Coma bract* absent. *Fertile bracts* 29–48 per inflorescence, creamy white or pale green with white at base, sometimes pale pink, lower bract ovate, upper bract obovate, apex lower obtuse to rounded, apex upper acute, 2.6–3.2 cm wide, and 3.4–3.9 cm long, margin entire with translucent white or light pale green c. 0.5 mm wide, pilose. *Flowers* yellow, 4–6 cm long, exerted from bracts. *Calyx* translucent white (pale brown if soaked in rainwater that remains in the bract), 1.2–2.0 cm long, apex 3 lobed with one deep incision up to 8 mm, glabrous. *Corolla tube* white turning pale yellowish towards the apex, tubular with funnel-shaped at apex, 2.5–3.5 cm long, apex 8–10 mm in diameter, scattered fine hairs; *dorsal corolla lobe* one and hooded, light pale yellow, apex acuminate, margin entire, glabrous, 10–12 mm wide and 16–17 mm long; *lateral corolla lobes* 2, light pale yellow, hooded one side at apex, apex obtuse, margin entire, 9–11 mm wide and 15–17 mm long, glabrous. *Lateral staminodes* 2, asymmetrical trullate to ovate, yellow with pale yellow at base, apex obtuse, 10–12 mm wide and 14–16 mm long, with fine hairs. *Labellum* ovate, 16–17 mm wide and 15–16 mm long, deeply emarginate, incision up to 6 mm, yellow with dark yellow band in the middle and light pale yellow at base, apex obtuse, fine hairy along sides of mid-band. *Stamen* light pale yellow 2–3 mm wide and 10–12 mm long; *filament* flat, light pale yellow, 6–7 mm long, 5–6 mm wide at base and 2–3 mm wide at the attachment, dorsifixed anther attachment, finely hairy; *anther* light pale yellow, finely hairy, c. 3.5 mm long with 2 pale yellow spurs at base, conical, 2.8–3.4 mm long; *anther crest* 2–3 mm wide and c. 1 mm long, apex rounded; *Stigma* white c. 1 x 1 mm, ciliate; *style* very slender, 0.2–0.3 mm in diameter, 53–57 mm long. *Epigynous glands* 2, pale yellow 0.9–1.1 mm in diameter and 4–5 mm long. *Ovary* prolate spheroids, light pale yellow 2.5–3.0 mm in diameter and 3.5–4.0 mm tall, 3 carpels, glabrous. *Ovule* axile placentation. *Fruit* prolate spheroids to subglobose, very pale yellow to white, 0.8–1.2 x 0.7–1.2 cm, glabrous. *Seed* yellowish-brown, ovoid or asymmetrically ovoid, some seed slightly curved, with white arils, 3.5–4.2 x 2.0–2.5 mm, glabrous.

Common name. “*Bussarakham*”, in Thai language means “*Yellow Sapphire*” refers to its yellow flowers or the vernacular name of the species is “*Krachiao Rangsim*” in Thai language which “*Krachiao*” refers to the local name of *Curcuma* genus in Northeastern Thailand and “*Rangsim*” refers to the first name of “*Rungsima Tantalakha*”.

Phenology. Flowering period in the rainy season (June to September), fruiting in late August to October.

Distribution. Thailand; Central: Nakhon Nayok province and Saraburi province, Southeast: Prachin Buri province and Chachoengsao province, Eastern: Nakhon Ratchasima province.

Ecology. In a deciduous forest, semi-open area, 80–250 meters above sea level.

Etymology. The specific epithet “*rangsimae*” is named in honor of “*Rungsima Tantalakha*” who is a supporter and backup plant taxonomists in Thailand.

Conservation status. The species has a distribution area found in five provinces which consist of Nakhon Nayok, Saraburi, Prachin Buri, Nakhon Ratchasima, and Chachoengsao. The total area of the species distribution, including extent of occurrence, is estimated less than 15,000 km² and the area of occupancy less than 2,000 km² with less than 10 locations. The species is also popular among the collectors of sacred plants. The flowers and inflorescence or whole plants are preserved in sandalwood oil with the belief that it will bring attractiveness, charisma, popularity, and reputation. Due to its distribution, popularity, and market demand causing the species is continuously smuggled out of the forest, such that it is prone to the effects of human activities more than natural drought within a very short time in an uncertain future, so we propose to treat this species provisionally as *Vulnerable*, which capable of becoming a critically endangered or even extinct in a very short period. However, we expect that the species is still found in adjacent native areas as suitable habitat seems still exist. Further fieldwork and observations are needed to assess changes in population distribution and abundance in the future.

Specimens examined. Thailand: central; Saraburi province; *Maxwell* 73-480, Sahn Lahn forest, Muang district, Saraburi, 13 October 1973 (AAU!, BK!), *Maxwell* 74-629, Sahn Lahn forest, Muang district, Saraburi, 29 June 1974 (AAU!, BK!), *Maxwell* 74-649, Sahn Lahn forest, Muang district, Saraburi, 30 June 1974 (AAU!, BK!, L!), *Maxwell* 74-699, Sahn Lahn forest, Muang district, Saraburi, 13 July 1974 (AAU!, BK!, L!), *Maxwell* 75-692, Sahn Lahn forest, Muang district, Saraburi, 15 July 1975 (AAU!, BK!, L!). Additionally, another specimen collected from the provinces of Saraburi, Nakhon Nayok, Prachin Buri, Chachoengsao, and Nakhon Ratchasima were preserved in alcohol and living specimens are also kept and planted at Brio Garden.

Uses. Auspicious ornamental plants.

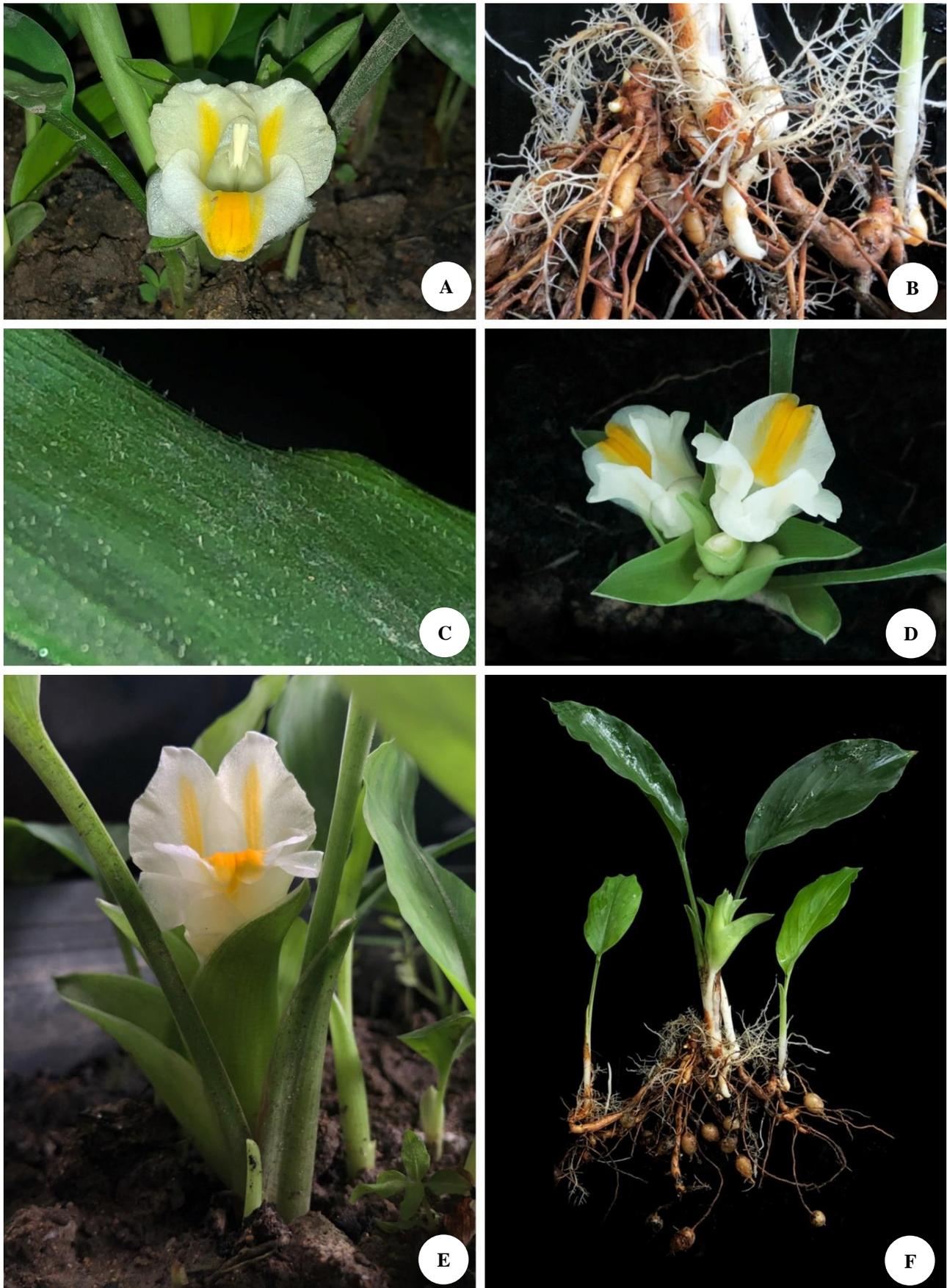


Figure 1. *Curcuma chantaranothaii* Boonma & Saensouk sp. nov.: A, front view of flower; B, rhizomes and roots; C, close up the upper surface of leaf; D, top view of inflorescence with flowers; E, side view of inflorescence with flower and leafless sheath; F, habit. Photographed by Thawatphong Boonma

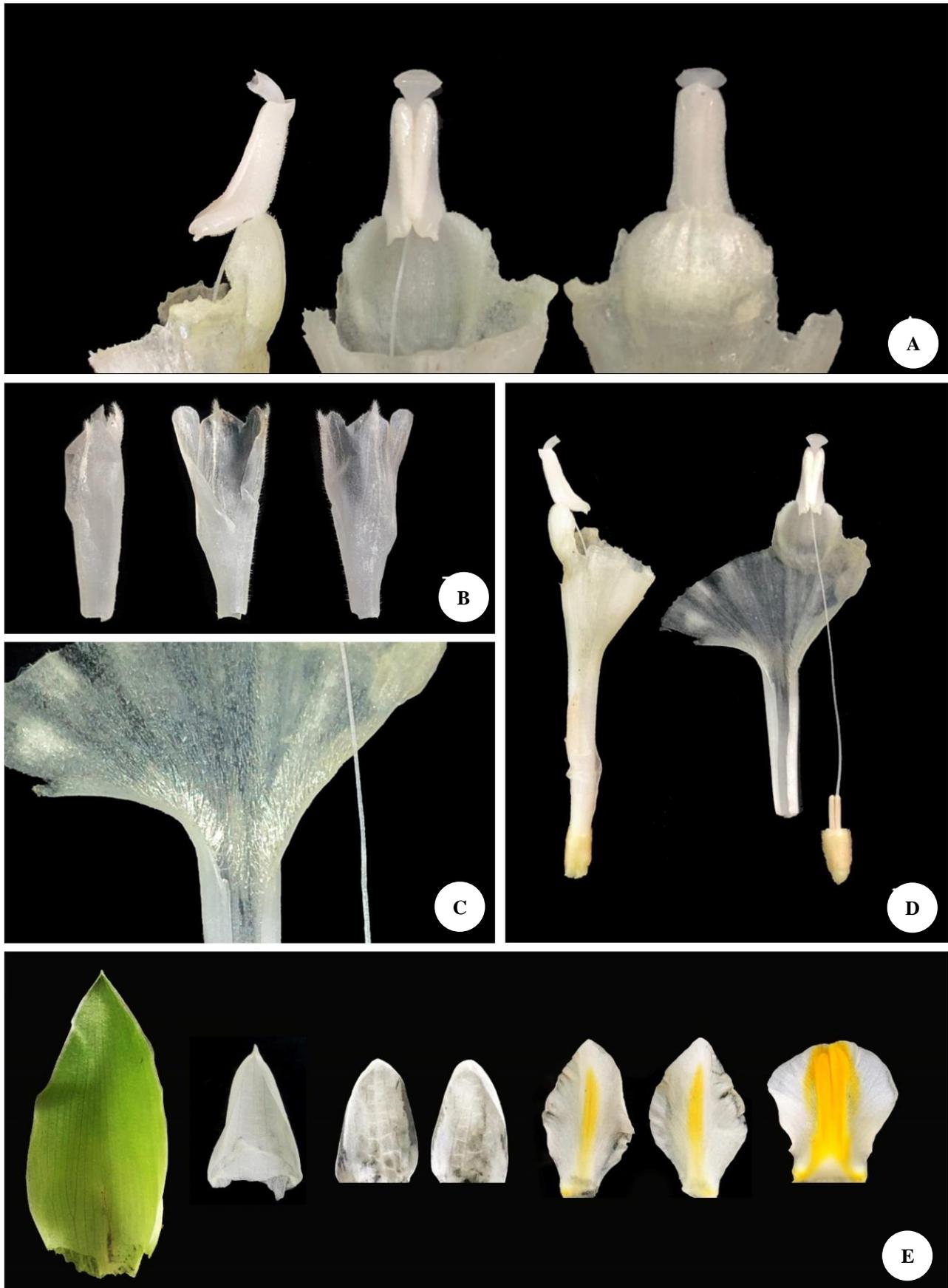


Figure 2. *Curcuma chantaranothaii* Boonma & Saensouk sp. nov.: A, side, front, and back view of anther; B, side, front, and back view of calyx; C, close up the dissection of an inner floral tube; D, dissection of the floral tube with ovary and epigynous glands; E, bracts, dorsal corolla lobe, lateral corolla lobes, lateral staminodes, and labellum. Photographed by Thawatphong Boonma

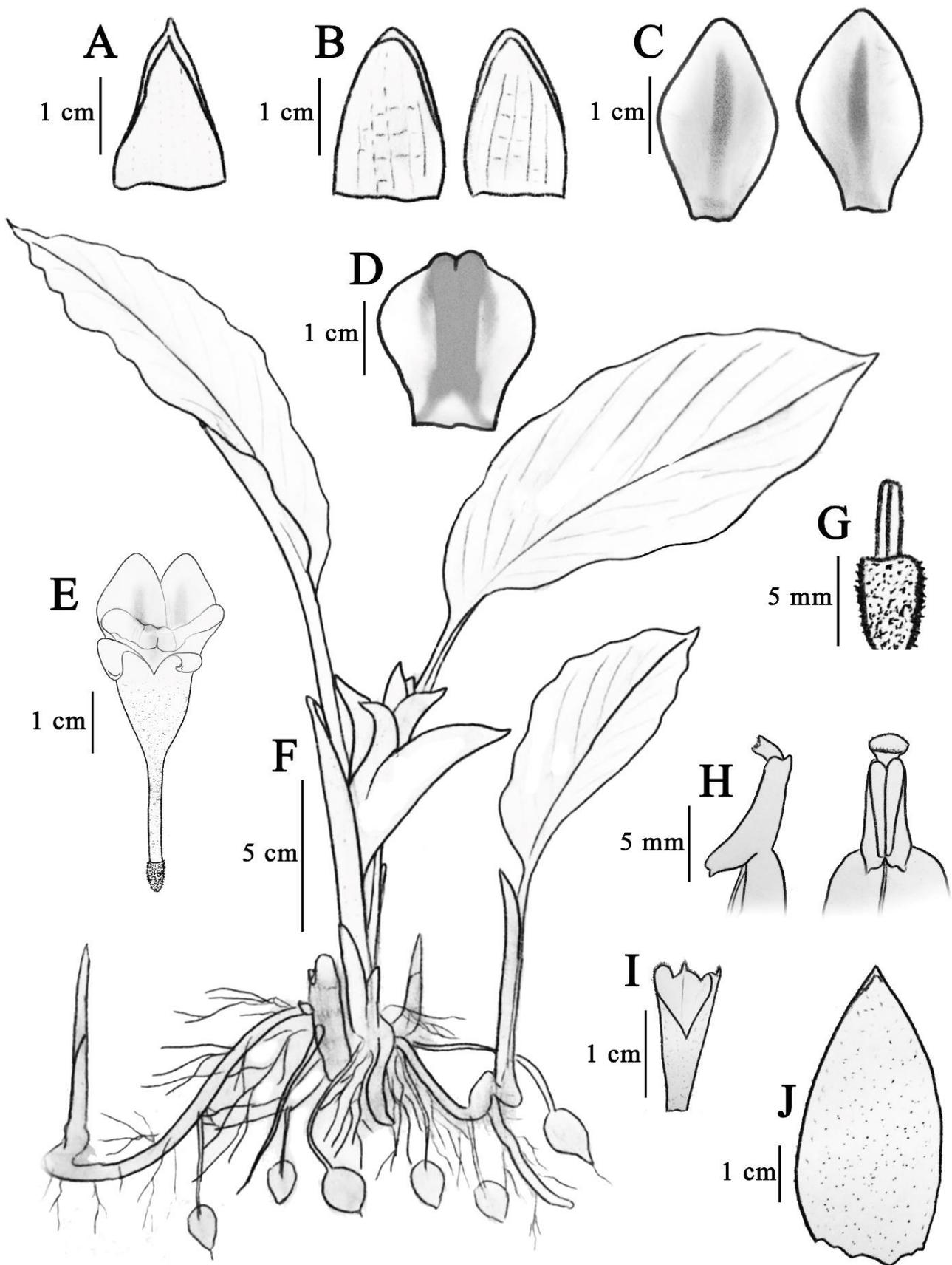


Figure 3. *Curcuma chantaranothai* Boonma & Saensouk sp. nov.: A, dorsal corolla lobe; B, lateral corolla lobes; C, lateral staminodes; D, labellum; E, side view of flower; F, habit; G, ovary with epigynous glands; H, side and front view of anther; I, calyx; J, bract. Drawn by Thawatphong Boonma

Table 1. Characters comparison between *Curcuma chantaranothaii* and *C. newmanii*

Characters	<i>C. chantaranothaii</i>	<i>C. newmanii</i> (based on Škorničková and Trần 2013)
Rhizome	Creeping, cylinder, pale yellowish-white inside	Ovoid, cream white internally
Leafless-sheaths	Green, puberulous	Tinged with dark red-purple
Leaf-sheaths	Pale green, puberulous	Green with red-purple, puberulent
Ligule	Bilobed, apex acute, puberulous	Bilobed, externally puberulent
Petiole	6–8 cm long, puberulous	Up to 11 cm long, puberulent
Leaves-number	Usually 2 leaves (sometimes 3 leaves)	3–6 leaves
Leaves-shape	Elliptic to narrowly elliptic	Slightly unequal, narrowly lanceolate
Leaves-size	12–15 x 4–6 cm	Up to 32 x 8 cm (larger later in the season)
Leaf-upper surface	Dark green, puberulous	Glabrous, dark green with a dark red band running along the midrib across the entire lamina length
Leaf-apex	Acuminate	Caudate
Leaf-base	Attenuate	Obtuse, slightly oblique
Inflorescence	Terminal	Lateral, appear before the leaves
Peduncle	4–6 cm long	C. 3 cm long
Bracts	Pale green, apex acuminate-mucronate, margin entire, hyaline	Green with various degree of deep red tinge towards the apex
Bracts-surfaces	puberulous on both surfaces	Puberulent on both sides
Calyx	1.7 cm long	2.3 cm long
Flowers	not exert from bracts	Much exerted from the bracts
Floral tube	c. 2.5 cm long	4.5–3.5 Cm long
Staminodes	Rhomboid, white with yellow patch along the midrib, minutely pubescent at the midrib White with embossed yellow patch along the midrib from tip to base (divided to two patch at base like a Y-shape), minutely puberulous along both sides of yellow patch, and two paler yellow curved like a crescent moon from the apex along both sides to the mid lobe	Irregularly obovate, white with short glandular hairs on the adaxial side White except a bright yellow Median band, puberulent with glandular hairs
Labellum		
Anther spurs	With very short spurs at base c. 0.5 mm long	c. 1 mm long with two blunt knobs at apex
Anther crest	Apex rounded	Not obvious
Epigynous glands	4 mm long, pale yellow, apex blunt	5-7 mm long, cream-white, apex sharp

Table 2. Comparison of different characteristics of *Curcuma rangsimae* and *C. vitellina*

Characters	<i>C. rangsimae</i>	<i>C. vitellina</i> (based on Škorničková et al. 2010)
Leave shape	Narrowly elliptic to oblanceolate	Elliptic to elliptic-ovate
Leaf size	12–20 cm wide, 40–70 cm long	8–15 cm wide, 20–45 cm long
Leaves base	Attenuate-slightly oblique	Rounded
Spike	12–20 cm long, 7.8–9.5 cm in diam. At the middle	8–15 cm long, C. 4–5 cm diam. At the middle
Calyx	Glabrous	Sparsely hairy on the three main veins leading from the tooth to the base
Lateral staminodes	Asymmetrical trullate to ovate	Obovate
Anther spurs	Conical, 2.8–3.4 mm long	Filamentous, c. 0.5 mm long
Ovary	3.5–4.0 x 2.5–3.0 mm, Prolate spheroids, Glabrous	3 x 2 mm, Trilocular, Hairy, hairs c. 0.2 mm long

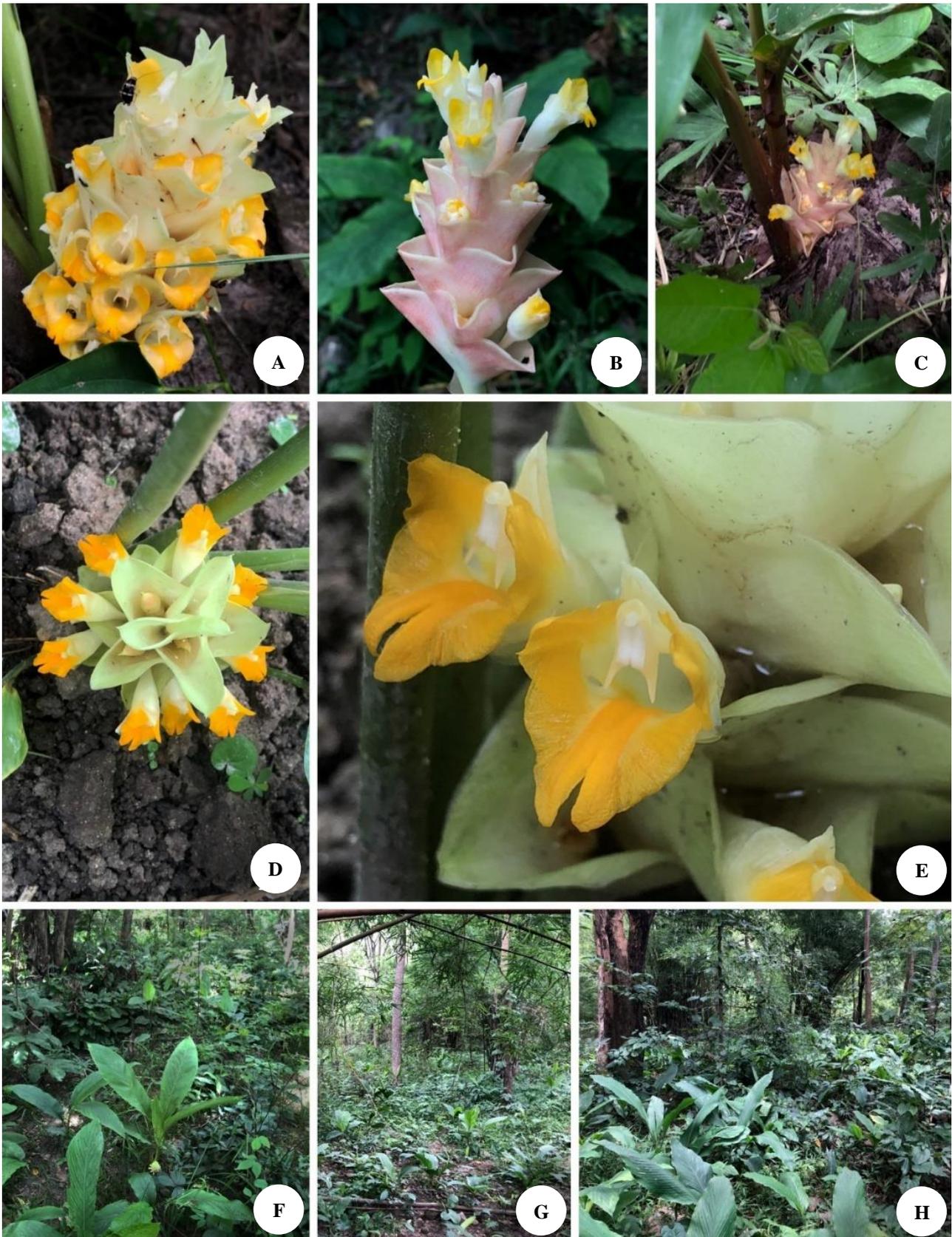


Figure 4. *Curcuma rangsimae* Boonma & Saensouk sp. nov. A-C, Inflorescences in various colors of bracts; D, Top view of inflorescence; E, Close up flowers; F-H, Habitats. Photographs by Thawatphong Boonma

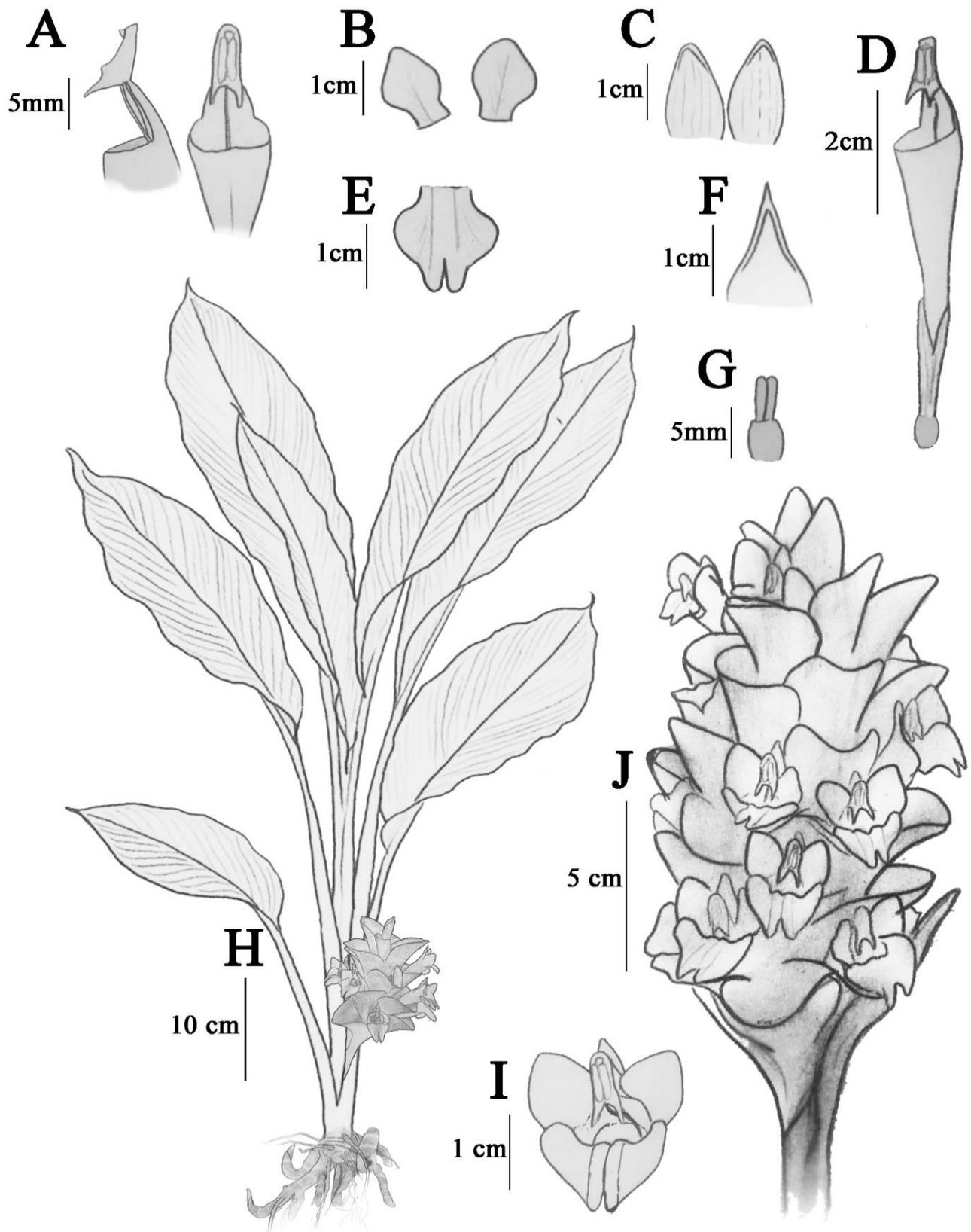


Figure 5. *Curcuma rangsimae* Boonma & Saensouk sp. nov. A, Front and side view of stamen; B, Lateral staminodes; C, lateral corolla lobes; D, Floral tube with ovary, calyx and stamen; E, Labellum; F, Dorsal corolla lobe; G, Ovary with epigynous glands; H, Habit; I, Front view of flower; J, Inflorescence. Drawn by Thawatphong Boonma

Curcuma charanii Boonma & Saensouk **sp. nov.** – Figures 6–7, Table 3–subgenus *Hitcheniopsis*

Curcuma charanii is similar to *C. Prasina* (based on Škorničková et al. 2017) in many characters but differ in having rhizome ovoid with white internally; bladeless sheaths glabrous except for a few hairs at tip; ligule triangular, bilobed, apex acute; leaves-apex acute to acuminate; bracteole slarger; flowers exserted from bracts; calyx pale purple; dorsal corolla lobe ovate, white with pale yellow at the tip, apex acute, hooded; lateral staminodes narrowly obovate to oblanceolate, pale pinkish-purple to pale purple with white at base; labellum apex bilobed, deep incision up to 5 mm, each lobe apex rounded or retuse, pale pinkish purple to purple, with a small white line (sometimes very pale yellowish-white) in the middle from sinus almost to the base, flanked by very small purple dots on both sides, very pale pinkish purple to purplish-white lines like a herringbone pattern interspersed with purple, two dark yellow spots at base, finely glandular hairs in the middle; anther white, very fine pubescent at back; anther crest very pale purple; filament light pale purple; ovary pale yellow (Table 3).

Type: THAILAND. Lop Buri Province, Sa Bot district, 28 August 2019, *Boonma 4* (Holotype: KKU!; isotypes: QBG!, BKF!, BK!)

Perennial herb. *Rhizome* ovoid, 10–15 mm in diameter, 15–18 mm long, white inside. *Root* fibrous roots with narrowly ovate tuberous, 7–9 mm in diameter, 16–25 mm long, white inside. *Leafy shoot* 18–30(50) cm tall; *Bladeless sheaths* 1–2 sheaths, 8–14 cm long, dark red or green with brownish-red, glabrous except for a few hairs at tip. *Leaf-sheaths* green with brownish-red or dark red, 12–20 cm long, glabrous; *ligule* triangular, membranous, translucent light pale green, bilobed, apex acute, c. 1.5 mm long, glabrous; *petiole* green, 5–15 cm long, glabrous. *Leaves* 3–4, narrowly elliptic to elliptic, 10.5–20.0 cm long, 4.2–6.5 cm wide, apex acute to acuminate, base attenuate, margin entire, hyaline, c. 0.2 mm wide, green, glabrous on both surfaces. *Inflorescence* terminal; *spike* cylindrical, 3.3–7.0 cm long, 2.4–3.9 cm in diameter; *peduncle* green, 4.5–12.7 cm long, glabrous. *Coma bract* absent. *Bracts* 5–11, containing 5–9 flowers in each bract (mostly found 6 flowers), 1.8–2.9 cm long, 2.4–2.9 cm wide (gradually reduce the size to the top of the inflorescence), broadly ovate, apex obtuse to acute, green, margin entire with translucent white 0.2–0.3 mm wide, glabrous. *Bracteoles* translucent white, narrowly ovate, 9.2–10.0 mm long and 4.6–6.8 mm wide at base, apex acute, glabrous. *Flowers* 3.5–3.8 cm long, various in colors from pale pinkish-purple to purple, exserted from bracts. *Calyx* pale purple, tubular, 5.5–5.7 mm long, apex 3-lobed split one side up to 2 mm, glabrous. *Corolla tube* white, 2.0–2.3 cm long, glabrous; *dorsal corolla lobe* ovate, 6.2–6.9 mm long, 4.5–4.8 mm wide, white with light pale yellow at tip, apex acute, hooded, glabrous; *lateral corolla lobes* ovate, 5.7–6.0 mm long, 4.8–5.4 mm wide, white, apex obtuse, hooded, glabrous. *Lateral staminodes*

narrowly obovate to oblanceolate, pale pinkish-purple to pale purple with white at base, 7.3–8.7 mm long, 3.7–4.4 mm wide, apex rounded, glabrous. *Labellum* obovate, 9.8–11.2 mm long, 8.6–9.5 mm at the widest part and c. 4 mm wide at the base, bilobed, deep incision up to 5 mm, each lobe apex rounded or retuse, upper side pale pinkish purple to purple (darker from sinus and gradually faded to the edge), with a small white line (sometimes very pale yellowish-white) in the middle from sinus almost to the base, flanked by very small purple dots on both sides, very pale pinkish purple to purplish-white lines like a herringbone pattern interspersed with purple (next to the very small purple dots) and two dark yellow spots at base; lower side very pale pinkish purple, finely glandular hairs in the middle. *Stamen* 4.0–4.2 mm; *anther* spurless, white, c. 3 mm long and c. 1.6 mm wide, very fine pubescent at back; *anther crest* very pale purple, 1.0–1.3 mm long and 1.5 mm wide; *filament* flat, light pale purple c. 2 mm, dorsifixed anther attachment, glabrous. *Epigynous glands* absent. *Ovary* globose, pale yellow, 1.2–1.5 × 1.2–1.5 mm, 3 carpels, glabrous. *Style* very slender, 2.0–2.4 cm long. *Stigma* white 0.7 × 1.0 mm, glabrous. *Ovule* axile placentation. *Fruit* and *Seed* not seen.

Common name: The vernacular name of the species is “*Krachiao Charan*” in the Thai language which “*Krachiao*” refers to the local name of *Curcuma* genus in Northeastern Thailand and “*Charan*” refers to the first name of “*Charan Maknoi*”.

Phenology: Flowering period in the rainy season (June to September).

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

Ecology: Mixed deciduous forest 85–100 m above sea level.

Etymology. The specific epithet “*charanii*” name in honors Dr. Charan Maknoi who is an outstanding botanist of the genus *Curcuma* in Thailand.

Conservation status. The species is currently found in the type locality in Lopburi Province and further exploring nearby found the total number of mature individuals was less than 1,000. The plant has not been known yet among horticultural collectors. If the plant is known more, it could increase its market demand, and thus in the future, it would be easily taken out of its habitat as it was not in a national park. The restricted area of occupancy or number of locations with a plausible future threat could drive the taxon to CR or EX in a very short time in an uncertain future, so we propose to treat this species provisionally as *Vulnerable*, which capable of becoming a critically endangered species or even extinct species in a very short period. However, we expect that the species is still found in adjacent native areas as suitable habitat seems still exist. Further fieldwork and observations are needed to assess changes in population, distribution, and abundance in the future.

Uses. Auspicious ornamental plants.

Table 3. Comparison of morphological characters of *Curcuma charanii* and *C. prasina*

Characters	<i>C. charanii</i>	<i>C. prasina</i> (based on Škorničková et al. 2017)
Rhizome-shape, internally	Ovoid, white	Globose to ovoid, pale yellow
Bladeless sheaths-surfaces	Glabrous except for a few hairs at the tip	Glabrous
Ligule	Triangular, bilobed, apex acute	Obscurely bilobed
Leaves-apex	Acute to acuminate	Attenuate
Bracteoles	9.2–10.0 x 4.6–6.8 mm	3–5 x 1.5–2.5 mm
Flowers	C. 3.8 cm long, exerted from bracts	C. 2.5 cm long, slightly exerted from bracts
Calyx	5.5–5.7 mm long, apex 3-lobed split one side up to 2 mm	C. 5 mm long (including 3 short teeth at apex), with no obvious unilateral incision
Calyx-color	Pale purple	White
Corolla tube	2.0–2.3 cm long	C. 1.5 cm long
Dorsal lobe-shape	Ovate	Elliptic
Dorsal lobe-color	White with pale yellow at tip	White
Dorsal lobe-apex	Acute, hooded	Slightly concave
Lateral staminodes	Narrowly obovate to oblanceolate	Unequally obovate
Lateral staminodes-color	Pale pinkish purple to pale purple with white at base	Pale purple
Labellum-apex	Bilobed, deep incision up to 5 mm, each lobe apex rounded or retuse	Bilobed, split c. 3 mm,
Labellum-color	Pale pinkish purple to purple, with a small white line (sometimes very pale yellowish-white) in the middle from sinus almost to the base, flanked by very small purple dots on both sides, very pale pinkish purple to purplish-white lines like a herringbone pattern interspersed with purple, two dark yellow spots at the base, finely glandular hairs in the middle	Pale to dark purple, with a bright yellow and swollen median band composed of two central lines extending from the base to about two-thirds the length of the labellum towards the apex, sides of the labellum with paler lines radiating towards the margin
Anther	White, very fine pubescent at back	Connective tissue pale pink, with glandular hairs on sides and back
Anther crest	Very pale purple	Pale pink
Filament	Light pale purple	Very pale pink
Ovary-color	Pale yellow	Cream-white

Curcuma phrayawan Boonma & Saensouk **sp. nov.** – Figures 8–9, Table 4–subgenus *Curcuma*

Curcuma phrayawan is similar to *C. ferruginea* having red tones of leaf-sheaths and some morphology characters but differ in producing inflorescence terminal, appears between the leaf-sheaths; peduncled, minutely pubescent and having rhizome deep yellow internally, branches rhizome with 2 layers, outer layer yellow, innermost darker yellow; leaf-sheaths brownish red; leaves oblanceolate, upper surface green with red along the midrib almost to the apex, lower surface pale green with red along the midrib almost to the apex; coma bracts white with pink at the apex; bracts pale green with pale pink in the middle and at the apex, minutely pubescent on both surfaces; corolla lobes dorsal white with pale pink at tip, lateral light pale pink with light pale yellow at base; staminodes pale yellow, apex rounded, outer glabrous, inner hairy at the mid lobes; labellum pale yellow with yellow patch in the middle, apex emarginate, each lobe obtuse, outer glabrous, inner hairy on mid-band, whereas *C. ferruginea* producing inflorescence lateral, apart from the earlier formed leaves and has rhizome pale yellow internally, branches rhizome pale yellow internally; leaf-sheaths ferruginous-red; leaf

broadly lanceolate; bright green with a faint reddish tinge down the middle of the upper surface of the leaves; peduncle with rusty-reddish sheaths; coma bracts bright crimson red; bracts ferruginous or tinge with rusty-red; corolla lobes reddish; staminodes and labellum deep yellow (Table 4).

Type: THAILAND. Nakhon Nayok Province, Ban Na District, 1 September 2019, Boonma 5 (Holotype: KCU!; isotypes: QBG!, BKF!, BK!)

Perennial herb. *Primary rhizome* ovoid, deep yellow internally, fragrant, 4–6 cm in diameter and 6–9 cm tall; *branches rhizomes* have 2 layers inside, outer layer yellow, innermost layer darker yellow, 22–24 mm in diameter. *Root* fibrous without tuberous root. *Leafy-shoot* up to 2 m tall. *Leafless sheaths* 1–4, brownish-red with white at base and greenish-red at tip, apex mucronate, minutely pubescent, 5–10 cm long (wilt while growing). *Leaf-sheaths* alternate, brownish red, minutely pubescent, 45–50 cm long; *ligule* bilobed triangular, 2–3 mm, triangular, 2.5–3.8 mm, translucent white, apex acute, pubescent; *petiole* red, glabrous, 8.5–12 mm in diameter, 20–34 cm long. *Leaves* 7–9, oblanceolate, apex caudate, base attenuate, margin entire with translucent white c. 0.3 mm wide,

parallel venation, upper surface green with red along the midrib almost to the apex, lower surface pale green with red along the midrib almost to the apex, glabrous on both surfaces, 14–18 cm wide and 65–80 cm long. *Inflorescence* terminal appears between the leaf-sheaths, cylindrical, mature 7–10 cm in diameter and 15–24 cm long; *peduncle* red, minutely pubescent, 10–12 mm in diameter, and 42–50 cm long, with or without sterile bract. *Fertile bracts* 25–30 per inflorescence, broadly elliptic, pale green with pale pink in the middle and at the apex, apex rounded, margin entire, 2.8–3.6 mm wide and 5–6.7 mm long, minutely pubescent on both surfaces; *coma bracts* 3–5, white with pink at the apex, narrow than the fertile bract, apex obtuse, margin entire, 1.7–2.0 cm wide and 6.0–7.1 cm long, minutely pubescent on both surfaces. *Bracteole* obovate, light pale yellow, apex obtuse with little hooded, margin entire, pubescent, 16.2–17.9 mm wide and 21.3–24.8 mm long. *Flowers* pale yellow, c. 5.2 cm long. *Calyx* translucent white, c. 12.5 mm long, apex 3-lobed with the deep incision up to 6 mm, pubescent. *Corolla tube* pale yellow, glabrous; *dorsal corolla lobe* one and hooded, white with pale pink at tip, apex mucronate, margin entire, pubescent, c. 12.9 mm wide and 14.7 mm long; *lateral corolla lobes* 2, light pale pink with light pale yellow at base, c. 12.5 mm wide and 14.6 mm long, apex obtuse, margin entire, glabrous. *Labellum* obovate, pale yellow with yellow patch in the middle, apex emarginate, incision up to 2 mm, each lobe obtuse, outer glabrous, inner hairy on mid-band, glabrous, 17.5 mm wide and 16.0 mm long. *Lateral staminodes* 2, obovate, pale yellow, apex rounded, c. 7.7 mm wide and c. 10.86 mm long, glabrous. *Stamen* 1, pale yellow c. 4.5 mm long, glabrous; *anther* white c. 2.5 mm wide and c. 2.8 mm long with 2 pale yellow *spurs* at base c. 3.5 mm long, pointing down, the tip of the spur points out in the opposite direction. glabrous; *filament* flat, pale yellow, c. 4.35 mm at base, 2 mm at the attachment, and 2.65 mm long, glabrous, dorsifixed anther attachment. *Stigma* white c. 0.75 x 1.30 mm, glabrous; *style* very slender, c. 50 mm long. *Epigynous glands* 2, pale yellow c. 0.65 mm in diameter and c. 4.0 mm long. *Ovary* subglobose, pale yellow c. 3.0 x 3.4 mm, 3 carpels, pubescent. *Ovule* axile placentation.

Common name. The vernacular name of the species is "Phraya Wan" in Thai language means "The Prince of Herbs"; "Phraya" means "Prince" and "Wan" means "Herbs".

Phenology. Flowering period in the rainy season (June to September).

Distribution. Cultivated plant throughout Thailand.

Conservation status. The species has been brought from the forest to be cultivated and used as a traditional medicine for more than four decades as recorded in a short morphological description and uses in Thai Herb books. In the present, the species becomes a cultivated plant throughout the country especially popular among the collectors of sacred plants and herbs. The villagers in Tak province who have cultivated the species informed that the species has been brought out of the forest and has been planted for many generations. In our survey and according to all information about this species, we preliminary

suggest the species as Vulnerable. However, we expect that the species is still found in adjacent native areas as suitable habitat seems still exist. Further fieldwork and observations are needed to assess changes in population, distribution, and abundance in the future.

Etymology. The specific epithet "*phrayawan*" is derived from its vernacular name in the Thai language.

Uses. Traditional medicinal and auspicious ornamental plants.

Curcuma puangpeniae Boonma & Saensouk, sp. nov. – Figures 10–11, Table 5 – subgenus *Hitcheniopsis*

Curcuma puangpeniae is similar to *C. prasinain* some characters but differ in having rhizome ovoid with creeping branches; root tubers placed far from the rhizome; bladeless sheaths reddish-brown with green tip and white at base, glabrous, except the tip has a few hairs; leaves asymmetrical lanceolate to narrowly elliptic, base attenuate-oblique, margin slightly undulate; fertile bracts broadly obovate, apex acute, curved outward, green with dark green veins and pale green at base; bracteoles ovate, half-folded, translucent white with pale green at tip, apex acute, glabrous on both surfaces except for the tip at the ridge-folds has a few hairs; flowers exerted from the bract; calyx 3.8–4.2 cm long, apex trilobed with unilateral deepest incision up to 2.5 mm; floral tube longer; dorsal corolla lobe ovate, apex obtuse with slightly mucronate, hooded, glabrous except for a few hairy at tip; lateral corolla lobes ovate, 6.5–6.8 mm long and 3.5–3.7 mm wide, apex obtuse, slightly hooded; lateral staminodes white; labellum lilac with lilac veins gradually fade to white at base, white in the mid lobe without yellow, two short lilac dashes along both margin from the base 2.5–3 mm long and two short yellow dashes along each side about half of the incision margin; filament white; anther crest white (Table 5).

Type: THAILAND. Ratchaburi Province, 5 June 2018, Boonma 3 (Holotype: KKU; isotypes: QBG, BKF, BK)

Perennial herb. *Primary rhizome* ovoid, 1.5–1.9 cm tall, 1.0–1.5 cm in diameter, 2 layers of pale-yellow inside, fragrant, with 2–3 branches, creeping, ca. 6–10 mm in diameter, covered with dark brown sheathed scales 1.0–2.5 cm long, 2.5–3.2 cm wide at base. *Root* tuberous with fibrous root, tuber ovoid, 1.2–1.7 x 2.0–2.5 cm. *Leafy shoot* 25–45(60) cm tall. *Bladeless sheaths* 2–4 (only 1 bladeless sheath appear over the ground), reddish-brown with green at tip and with white at base, decaying while the pseudostem grows up, 6–15 cm long, apex slightly mucronate, margin entire, glabrous on both surfaces except the tip has a few hairs. *Leaf-sheaths*, distichous, green with reddish-brown tinge at base, 6–19 cm long, margin entire and hyaline, glabrous. *Ligule* bilobed, 2–3 mm long and 3.5–4.5 mm wide, each lobe apex obtuse, membranous, glabrous. *Petiole* green, (8)12–22(30) cm long, glabrous. *Lamina* asymmetrical lanceolate to narrowly elliptic, (7)12–23(30) x (3.3)4.5–6.5(8.5) cm, adaxially surface green, abaxially surface green, apex acuminate, base attenuate-oblique, margin hyaline, slightly undulate, both surfaces glabrous. *Inflorescence* terminal; *spike* 2.5–3.0(4.0) cm in diameter, 3.8–6.0(7.2) cm long; *peduncle*

green, (7)10–18(25) cm long, 2.3–3.4 mm in diameter, glabrous. *Coma bract* absent. *Fertile bract* 3–5(7), broadly obovate, 1.7–2.5 cm long, 2.9–3.6 cm wide, green with dark green veins and pale green at base, apex acute, tip curved outward, margin semi-hyaline, the top bract rolls like a tube, lower bract connate to lower half or base of upper bract, glabrous on both surfaces. *Bracteoles* ovate, 8.5–11 x 4.9–5.7 mm, half-folded, translucent white with pale green at tip, apex acute, glabrous on both surfaces except for the tip at the ridge-folds has a few hairs. *Flower* numerous, 3.0–3.2 cm long, cincinnus, bloom one per bract and 1–4 flowers per inflorescence at considerable intervals, flower exerted from the bract; *calyx* tubular, 3.8–4.2 mm long, translucent white, apex trilobed with unilateral deepest incision up to 2.5 mm, glabrous; *corolla tube* white, 2.0–2.2 cm long, glabrous; *dorsal corolla lobe* ovate, 6.5–6.8 mm long and 3.9–4.4 mm wide, white, apex obtuse with slightly mucronate, hooded, glabrous on both surfaces except a few hairy at tip; *lateral corolla lobes* 2, ovate, 6.5–6.8 mm long and 3.5–3.9 mm wide, white, apex obtuse, slightly hooded, glabrous on both surfaces; *lateral staminodes* oblanceolate, 8.2–8.8 mm long and 2.8–4.0 mm wide, white, apex rounded to obtuse with erose margin, sometimes apex retuse, glabrous on both surfaces; *labellum* obovate, 0.8–1.0 cm long and 0.8–1.0 cm wide, bilobed, deeply divided to half of length up to 5 mm long, broadly sinus, margin erose, lilac with lilac veins gradually fade to white at base, white in the mid lobe without yellow, two short lilac dashes along both margin from the base 2.5–3 mm long and two short yellow dashes along each side about half of the incision margin, 1.5–2.0 mm long and 1.0–1.2 mm wide, white in the mid-lobe sometimes with light pale yellow, glabrous on both surfaces. *Stamen* c. 4.3 mm long; *filament* flat, c. 1.2 mm long and c. 1.25 mm wide, white, glabrous; *anthers* spurless with bloated base, white 2.6–2.7 mm long and 1.4–1.6 mm wide, finely hairs at back and sides; *anther crest* white, c. 1 x 1.3 mm, apex rounded and curved backward, glabrous; *style* very slender, white. *Stigma* white, c. 0.78 x 1 mm, flatten-inverted cone, glabrous. *Epigynous glands* absent. *Ovary* subglobose, 1.2–1.4 x 1.4–1.7 mm, pale yellow, glabrous. *Fruit* not seen.

Common name. “*Khamin-Puangpen*” in Thai language, named in honors Professor Puangpen Sirirugsa.

Phenology: The flowering period from June to October.

Distribution. Cultivated plant throughout Thailand. So far known from Ratchaburi Province.

Conservation status. The species has been brought from the forest to be planted as an auspicious ornamental plant. In the present, this species becomes a cultivated plant throughout the country especially popular among the collectors of sacred plants and herbs. Due to its distribution, popularity, and market demand causing the species is continuously smuggled out of the forest, it is prone to the effects of human activities within a very short time in an uncertain future, so we preliminary suggest treating this species as *Vulnerable*, which capable of becoming a critically endangered or even extinct in a very short period. However, we expect that the species is still found in adjacent native areas as suitable habitat seems still exist. Further fieldwork and observations are needed to

assess changes in population distribution and abundance in the future.

Etymology: The specific epithet “*puangpeniae*” is named in honors Professor Puangpen Sirirugsa, an outstanding botanist of the Thai Flora and she is also the first Thai to study the family Zingiberaceae in Thailand.

Uses. Auspicious ornamental plants.

Curcuma purpurata Boonma & Saensouk, **sp. nov.** – Figures 12–13, Table 6–subgenus *Hitcheniopsis*

Curcuma purpurata is similar to *C. prasinain* some characters but differ in having leaf-sheaths sparsely pubescent; petiole minutely pubescent; leaves narrowly ovate, minutely pubescent on both sides, apex acuminate, base oblique-acute, margin undulate; bracts green, pubescent; coma bracts green, 2–3, lanceolate, apex narrowly obtuse, minutely pubescent; bracteoles white with pale green at tip; corolla tube 3 cm long, longer than bracts, distinctive protruding from the inflorescence; staminodes oblanceolate, white, apex obtuse to acute; labellum broadly obovate, bilobed, deeply divided almost half of length up to 5 mm long, purple at base gradually fades to pale purple at the tip of both lobes, with the yellow bands in the middle continuously reaching 2/3 length of the incision of the labellum, flanked on both sides of the middle yellow bands by white stripes about 2/3 of the length of the yellow bands and white hairy on the middle of the labellum (Table 6).

Type: THAILAND. Si Sa Ket Province, 22 August 2019, Boonma 7 (Holotype: KKU!; isotypes: QBG!, BKF!, BK!)

Perennial herb. *Rhizome* ovoid, pale yellow inside, mild fragrant, 1.6–1.8 cm in diameter, and 2.5–2.8 cm tall. *Root* tuberous with fibrous roots, tuber c. 1.5 cm in diameter and c. 2 cm long, white inside. *Leafy shoot* 30–50 cm tall. *Leafless sheaths* 1–2, dark red with white at base, apex acute, sparsely pubescent, 4–10 cm long. *Leaf-sheaths* alternate, green with reddish at base and translucent red at edges, sparsely pubescent; *ligule* bilobed, c. 2–3 x 4–5 mm, translucent red, apex truncate to rounded, each lobe 1.5–2.5 x 4–6 mm, glabrous; *petiole* green, minutely pubescent, 8–14 cm long. *Leaves* 4–6, narrowly ovate, asymmetrical (the right side is bigger than the left side), apex acuminate, base oblique, margin undulate with translucent white c. 0.25 mm wide, adaxially surface dark green, abaxially surface green, both surfaces minutely pubescent, 9–12 cm wide, and 24–28 cm long. *Inflorescence* terminal, cylindrical, mature c. 3.5–4.2 cm in diameter and 6.5–7.9 cm long; *peduncle* green, minutely pubescent, 2.5–3.0 mm in diameter, and 18–22 cm long. *Fertile bracts* 8–9 per inflorescence, green, asymmetrical obovate with the dark green tip stick out, apex obtuse, 22.9–24.6 mm wide and 27.6–29.3 cm long, margin entire with translucent white c. 0.3 mm wide, inner surfaces glabrous, outer surface minutely pubescent; *coma bracts* 2–3, lanceolate, apex narrowly obtuse, 7.9–10.8 mm wide and 29.3–32.7 cm long, margin entire with translucent white c. 0.28 mm wide, inner surfaces glabrous, outer surface minutely pubescent. *Bracteoles* ovate, white with pale green at tip, apex acute, 6.2–6.9 mm wide and 10.25–14.5 mm long. *Flowers* purple and white, 4.2 cm long. *Calyx* translucent white, c. 8.4 mm long, apex 3-lobed with

the deep incision c. 2 mm, glabrous. *Corolla tube* white, c. 3 cm long, longer than bract, exerted from inflorescence, glabrous; *dorsal corolla lobe* one and hooded, white, ovate, apex acute, margin entire, glabrous, 3.3–3.5 mm wide and 7–8 mm long; *lateral corolla lobes* 2, white, ovate, 3.2–3.5 mm wide and 7–8 mm long, apex obtuse, margin entire, glabrous. *Lateral staminodes* 2, oblanceolate, white, apex obtuse to acute, c. 2.7 mm wide and c. 8.5 mm long, glabrous. *Labellum* broadly obovate, 8.9–9.4 mm wide and 9.5–9.8 mm long, bilobed, deeply divided almost half of length up to 5 mm long, broadly sinus, purple at base gradually fades to pale purple at the tip of both lobes, with yellow bands in the middle continuously reaching 2/3 length of the incision of the labellum, flanked on both sides of the middle yellow bands by white stripes about 2/3 of the length of the yellow bands and white hairy on the middle of the labellum, lobes c. 3 mm wide, narrowly ovate, apex obtuse with irregularly eroded, margin erose and undulate. *Stamen* 1, white c. 5.8 mm long; *anther* white c. 1.5 mm wide and c. 3.5 mm long, spurless, pubescent; *anther crest* white, c. 0.35 x 1.5 mm; filament flat, glabrous, white, c. 1.6 mm at base, c. 0.75 mm at the attachment and 3.2 mm long, dorsifixed anther attachment. *Stigma* white c. 0.6 x 1.0 mm, glabrous; *style* very slender c. 0.03 mm in diameter, c. 3.8 mm long. *Ovary* subglobose, pale yellow c. 1.6 mm, 3 carpels, glabrous. *Ovule* axile placentation. *Fruit* and *seed* not seen.

Common name. "Amethyst" refers to its color of flowers.

Phenology. Flowering at the beginning of the rainy season (June–September).

Distribution. *Curcuma purpurata* is currently found in the type of locality in Si Sa Ket Province, Thailand.

Ecology. In a deciduous forest, 200–400 meters above sea level.

Conservation status. Due to the limited distribution survey close to the border between Thailand and Cambodia, the species may be distributed in areas of neighboring (Cambodia). According to its very small population with the number of mature individuals of less than 100 found in the habitat area and the closer area. Its small number also makes the species have high market demand. It is prone to the effects of human activities more than natural drought within a very short time in uncertain future. Therefore, the preliminary status of conservation was assessed from the data as we surveyed and suggest conserving this rare species as *Endangered* which capable of becoming critically endangered or even extinct in a very short period. However, we expect that the species is still found in adjacent native areas as suitable habitat seems still exist. Further fieldwork and observations are needed to assess changes in population, distribution, and abundance in the future.

Etymology. The specific epithet "*purpurata*" is derived from the Latin words "*Purpuratus*" which means "*purple*" to refers to its purple labellum.

Uses. Auspicious ornamental plants.

Table 4. Characters comparison between *Curcuma phrayawan* and *C. ferruginea*

Characters	<i>C. phrayawan</i>	<i>C. ferruginea</i> (based on Roxburgh 1810 and Khanna and Mudgal 1994)
Rhizome internally	Deep yellow	Pale yellow
Branches rhizome	Outer layer yellow, innermost darker yellow	Pale yellow
Leaf-sheaths	Brownish red	Ferruginous-red
Leaves shape	Oblanceolate	Broadly-lanceolate
Leaves color	Upper surface green with red along the midrib almost to the apex, lower surface pale green with red along the midrib almost to the apex	Bright green with a faint reddish tinge down the middle of the upper surface of the leaves
Leaves size	14–18 cm wide and 65–80 cm long	1–1.5 m long, 4–12 cm wide
Inflorescence	Terminal, appears between the leaf-sheaths	Lateral, apart from the earlier formed leaves
Peduncle	Red, minutely pubescent	With rusty-reddish sheaths
Coma bracts	White with pink at the apex	Bright crimson red
Bracts	Pale green with pale pink in the middle and at the apex, minutely pubescent on both surfaces	Ferruginous, tinge with rusty-red
Corolla lobes	Dorsal white with pale pink at the tip, lateral light pale pink with light pale yellow at base	Reddish
Staminodes	Pale yellow, apex rounded, outer glabrous, inner hairy at the mid lobes	Deep yellow
Labellum	Pale yellow with yellow patch in the middle, apex emarginate, each lobe obtuse, outer glabrous, inner hairy on mid-band	Deep yellow
Phenology	Flowering in June to September	Flowering in April to May

Table 5. Comparison of morphological characters between *Curcuma puangpeniae* and *C. prasina*

Characters	<i>C. puangpeniae</i>	<i>C. prasina</i> (based on Škorničková et al. 2017)
Rhizome	Ovoid with creeping branches	Globose to ovoid without creeping branches
Root tubers	Placed far from the rhizome	Placed close to the rhizome
Leafy shoot	25–45(60) cm tall	15–40 cm tall
Bladeless sheaths-color	Reddish-brown with green tip and with white at base	Plain green or green with a red tinge
Bladeless sheaths-surface	Glabrous with a few hairs at the tip	Glabrous
Leaves-shape	Asymmetrical lanceolate to narrowly elliptic	Narrowly elliptic
Leaves-base	Attenuate-oblique	Narrowly attenuate
Leaves-margin	Slightly undulate	Entire
Fertile bracts-number	3–5(7)	6–18
Fertile bracts-characters	Broadly obovate, apex acute, curved outward, green with dark green veins and pale green at base	Almost orbicular, slightly wider than long with acute, strongly reflexed apex, bright green
Bracteoles	Ovate, 8.5–11 x 4.9–5.7 mm, half-folded, translucent white with pale green at tip, apex acute, glabrous on both surfaces except for the tip at the ridge-folds has a few hairs	Triangular, 3–5 x 1.5–2.5 mm at base, hyaline, translucent-white, glabrous
Flowers	3.0–3.2 cm long, exerted from the bract	C. 2.5 cm long, slightly exerted from bracts
Calyx	3.8–4.2 cm long, apex trilobed with unilateral deepest incision up to 2.5 mm	C. 5 mm long (including 3 short teeth at apex), with no obvious unilateral incision
Corolla tube	2.0–2.2 cm long	C. 1.5 cm long
Dorsal corolla lobe	Ovate, 6.5–6.8 mm long and 3.9–4.4 mm wide, apex obtuse with slightly mucronate, hooded, glabrous except for a few hairy at tip	Elliptic, c. 6 x 3.5 mm, apex slightly concave, glabrous
Lateral corolla lobes	Ovate, 6.5–6.8 mm long and 3.5–3.7 mm wide, apex obtuse, slightly hooded	C. 5.5 x 2.5 mm, triangular-ovate, apex rounded, slightly concave
Lateral staminodes	White	Pale purple
Labellum	Lilac with lilac veins gradually fade to white at base, white in the mid lobe without yellow, two short lilac dashes along both margin from the base 2.5–3 mm long, and two short yellow dashes along each side about half of the incision margin	Pale to dark purple, with a bright yellow and swollen median band composed of two central lines extending from the base to about two-thirds the length of the labellum towards the apex, sides of the labellum with paler lines radiating towards the margin
Filament	White	Pale pink
Anther crest	White	Pale pink

Table 6. Characters comparison between *Curcuma purpurata* and *C. prasina*

Characters	<i>C. purpurata</i>	<i>C. prasina</i> (based on Škorničková et al. 2017)
Leaf-sheaths	Sparsely pubescent	Glabrous
Petiole	Minutely pubescent	Glabrous
Leaf	Narrowly ovate	Narrowly elliptic
Leaf-surfaces	Minutely pubescent on both sides	Glabrous on both sides
Leaf-apex	Acuminate	Attenuate
Leaf-base	Oblique - acute	Narrowly attenuate
Leaf-margin	Undulate	Entire
Bracts	Green, pubescent	Bright green, glabrous
Coma bracts	Green, 2–3, lanceolate, minutely pubescent	Absent
Bracteoles	White with pale green at tip	Translucent–white
Corolla tube	3 cm long, longer than bracts, distinctive protruding from the inflorescence	1.5 cm long, slightly exerted from bracts
Staminodes	Oblanceolate, white, apex obtuse to acute Broadly obovate, bilobed, deeply divided almost half of length up to 5 mm long, purple at base gradually fades to pale purple at the tip of both lobes, with the yellow bands in the middle continuously reaching 2/3 length of the incision of the labellum, flanked on both sides of the middle yellow bands by white stripes about 2/3 of the length of the yellow bands and white hairy on the middle of the labellum	Unequally obovate, pale purple Obovate, bilobed, split c. 3 mm, pale to dark purple, with a bright yellow and swollen median band composed of two central lines extending from the base to about 2/3 the length of the labellum towards the apex, sides of the labellum with paler lines radiating towards the margin
Labellum		

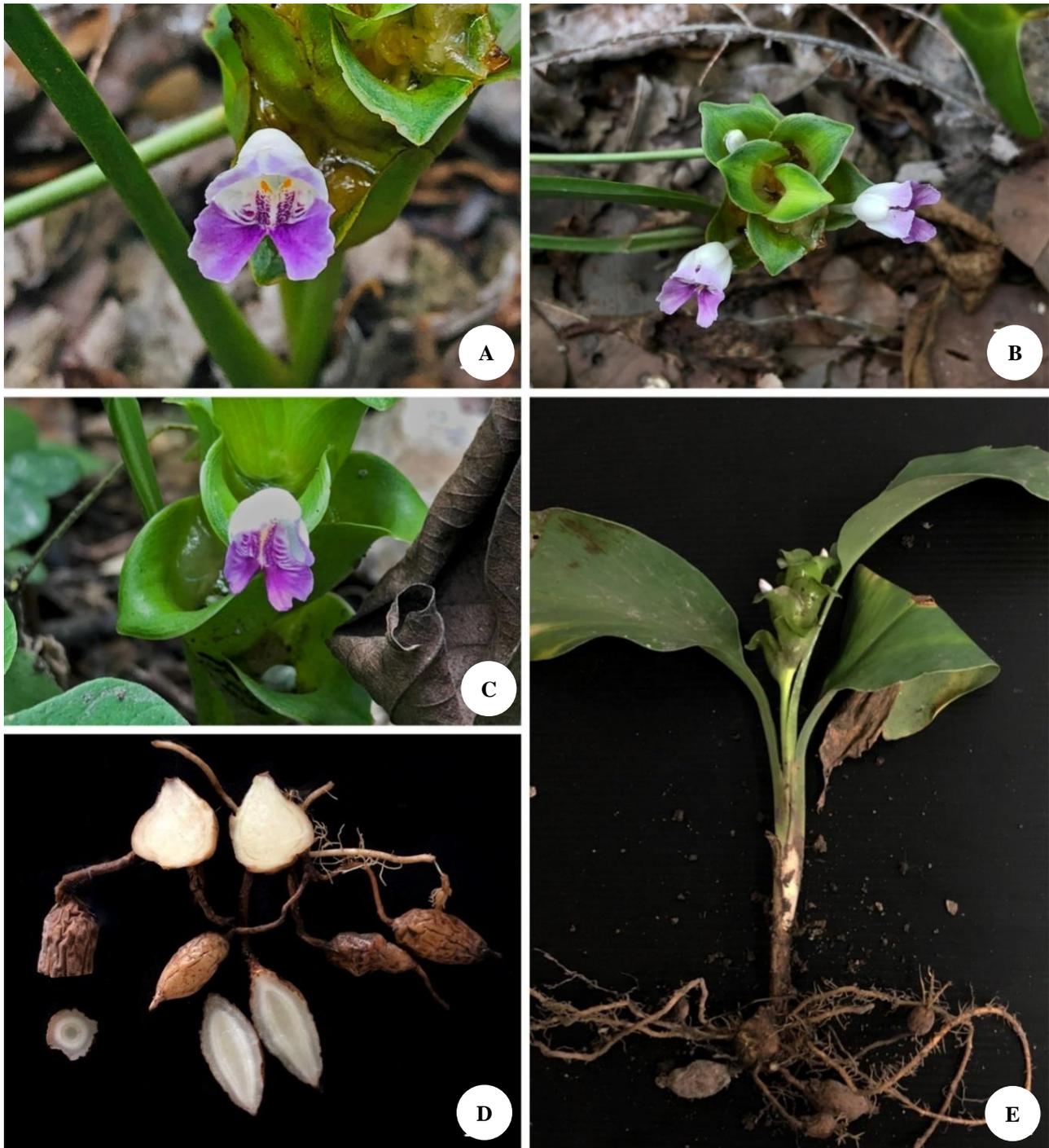


Figure 6. *Curcuma charanii* Boonma & Saensouk; A. front view of flower-labellum lobe rounded; B. top view of inflorescence; C. semi front view of flower-labellum lobe retuse; D. rhizome and roots with tubers; E. habit. Photographed by Thawatphong Boonma

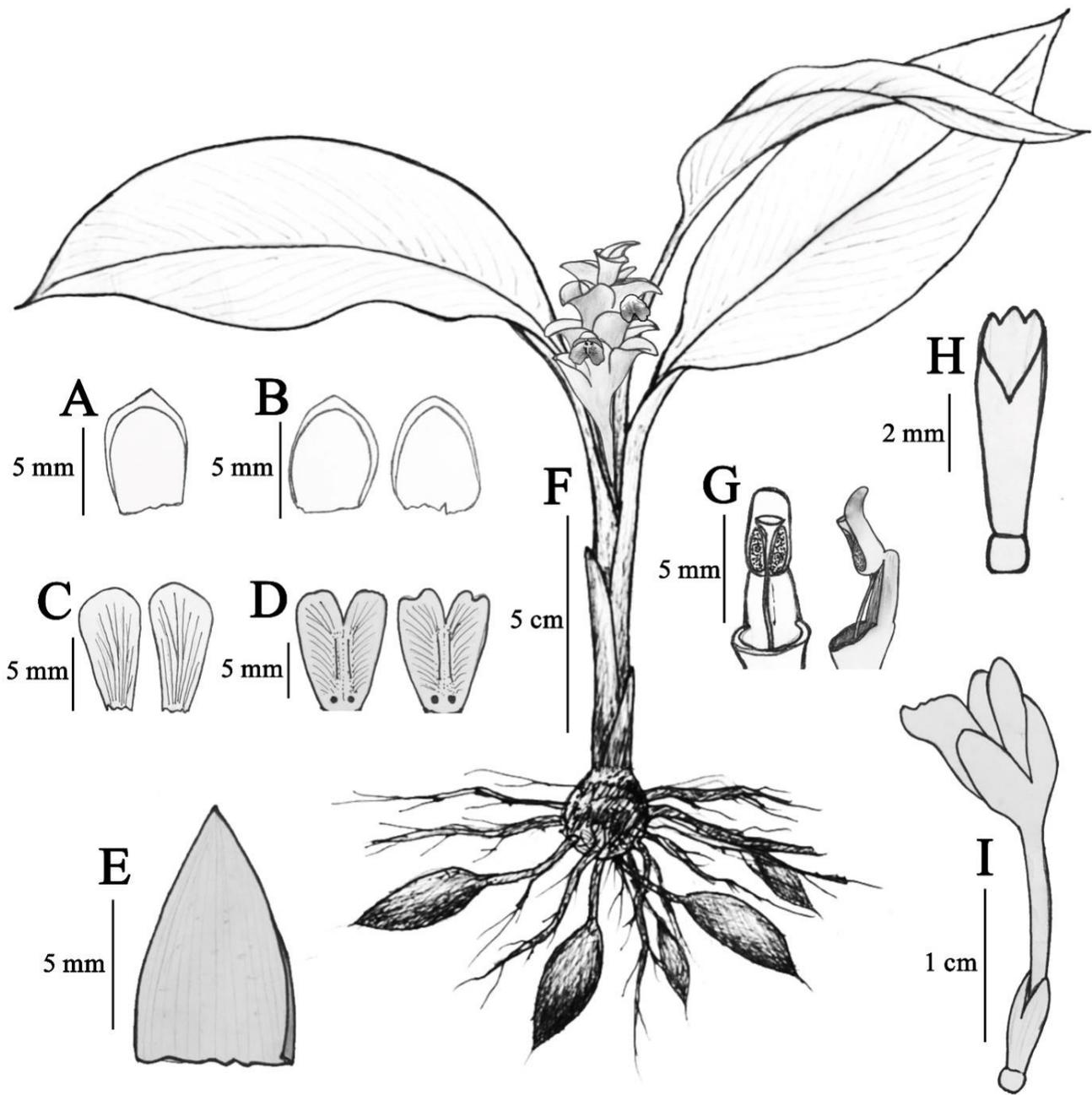


Figure 7. *Curcuma charanii* Boonma & Saensouk; A, dorsal corolla lobe; B, lateral corolla lobes; C, staminodes; D, labellum with different tip; E, bracteole; F, habit; G, Stamen—front and side view; H, calyx with ovary; I, flower. Drawn by Thawatphong Boonma

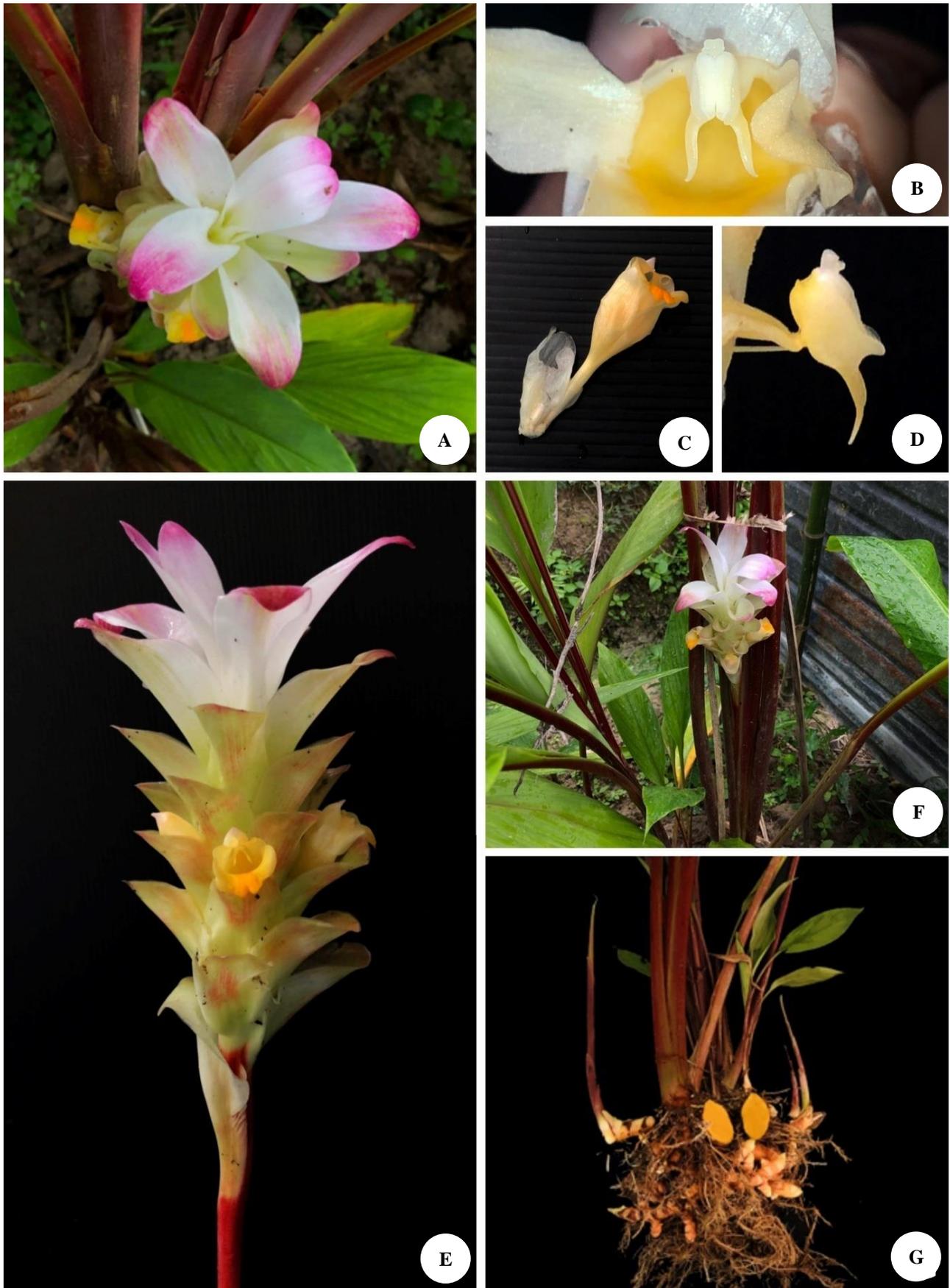


Figure 8. *Curcuma phrayawan* Boonma & Saensouk sp. nov.: A, top view of inflorescence; B, front view of stamen with anther and spurs; C, flower with calyx, ovary and bracteole; D, side view of stamen with anther and spurs; E, inflorescence with flowers; F, rhizomes with fibrous roots. Photographed by Thawatphong Boonma

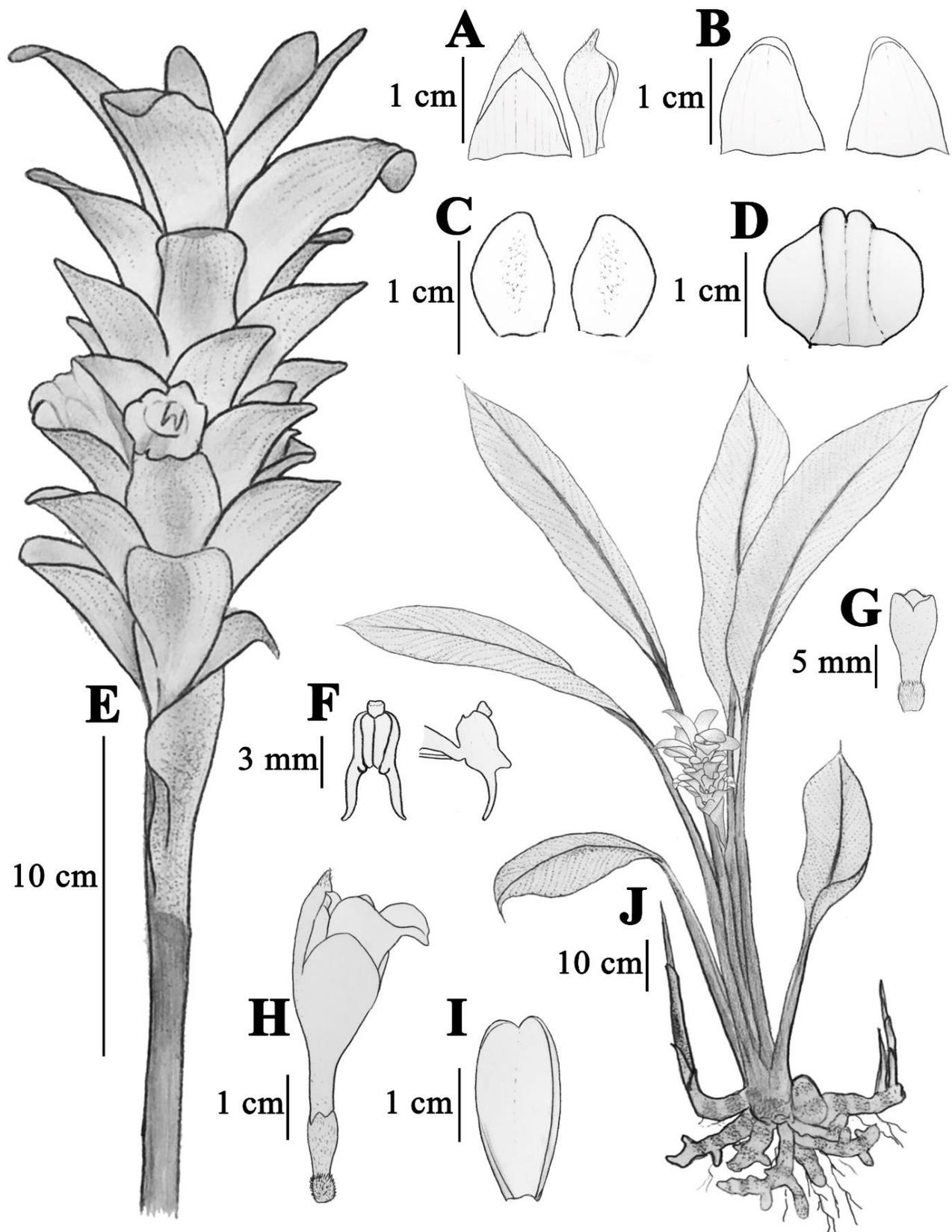


Figure 9. *Curcuma phrayawan* Boonma & Saensouk sp. nov.; A, dorsal corolla lobe; B, lateral corolla lobes; C, staminodes; D, labellum; E, inflorescence; F, front and side view of anther; G, ovary and calyx; H, flower; I, bracteole; J, habit. Drawn by Thawatphong Boonma



Figure 10. *Curcuma puangpeniae* Boonma & Saensouk; A, inflorescence with flowers; B, habit-top view; C, rhizomes with roots and tuber; D, flower-front view; E, bladeless sheaths; F, side view of pseudostem. Photographed by Thawatphong Boonma

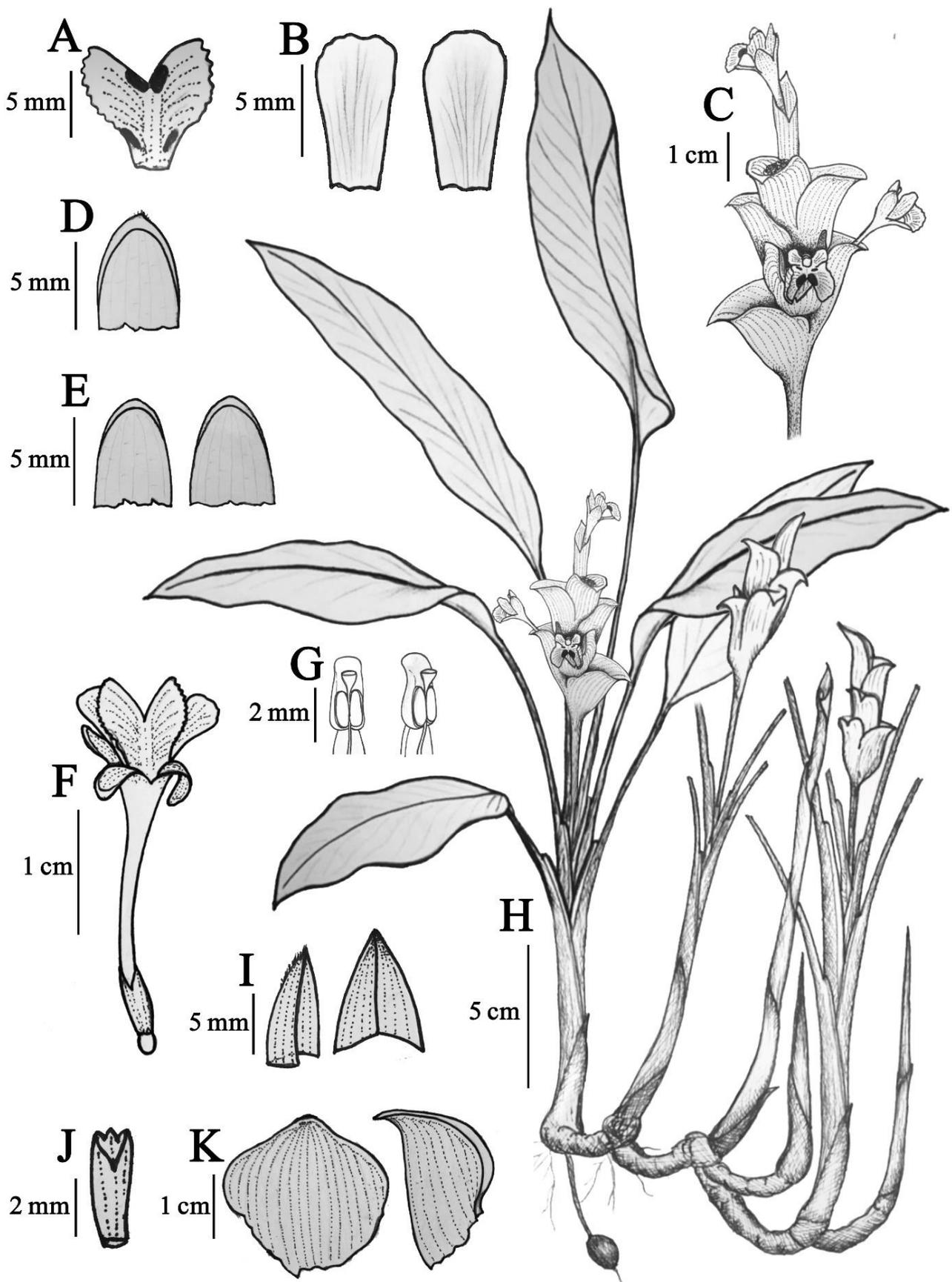


Figure 11. *Curcuma puangpeniae* Boonma & Saensouk; A, labellum; B, staminodes; C, inflorescence with flowers; D, dorsal corolla lobe; E, lateral corolla lobes; F, flower – side view; G, anther–front and semi-side view; H, habit; I, bracteoles –semi side and front view; J, calyx; K, bracts–front and side view. Drawn by Thawatphong Boonma

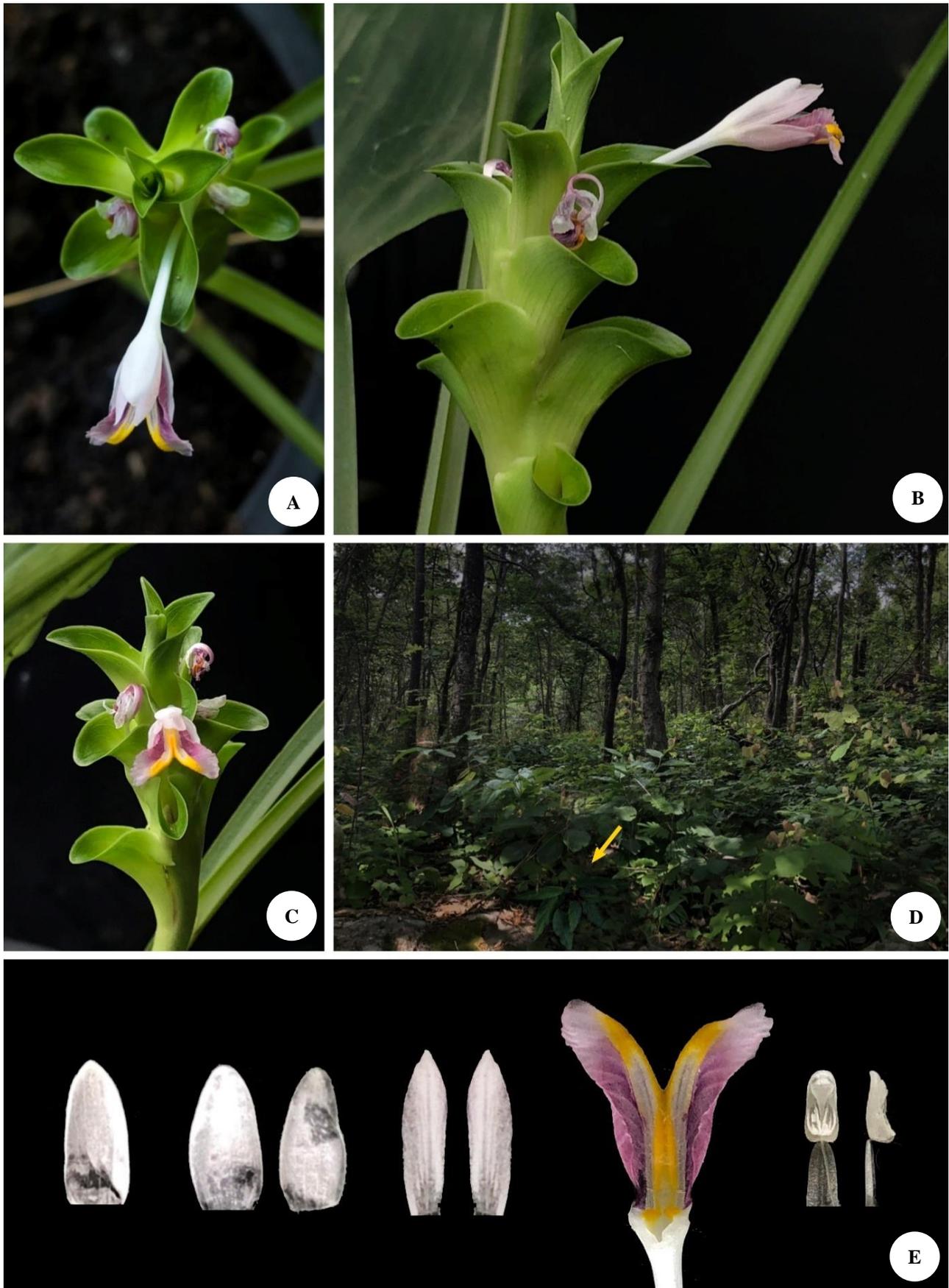


Figure 12. *Curcuma purpurata* Boonma & Saensouk sp. nov.: A, top view of inflorescence and flower; B, side view of inflorescence and flower; C, front view of flower, roll withered flowers with inflorescence; D, habit; E, dorsal corolla lobe, lateral corolla lobes, lateral staminodes, labellum, front and side view of stamen with filament and anther. Photographed by Thawatphong Boonma

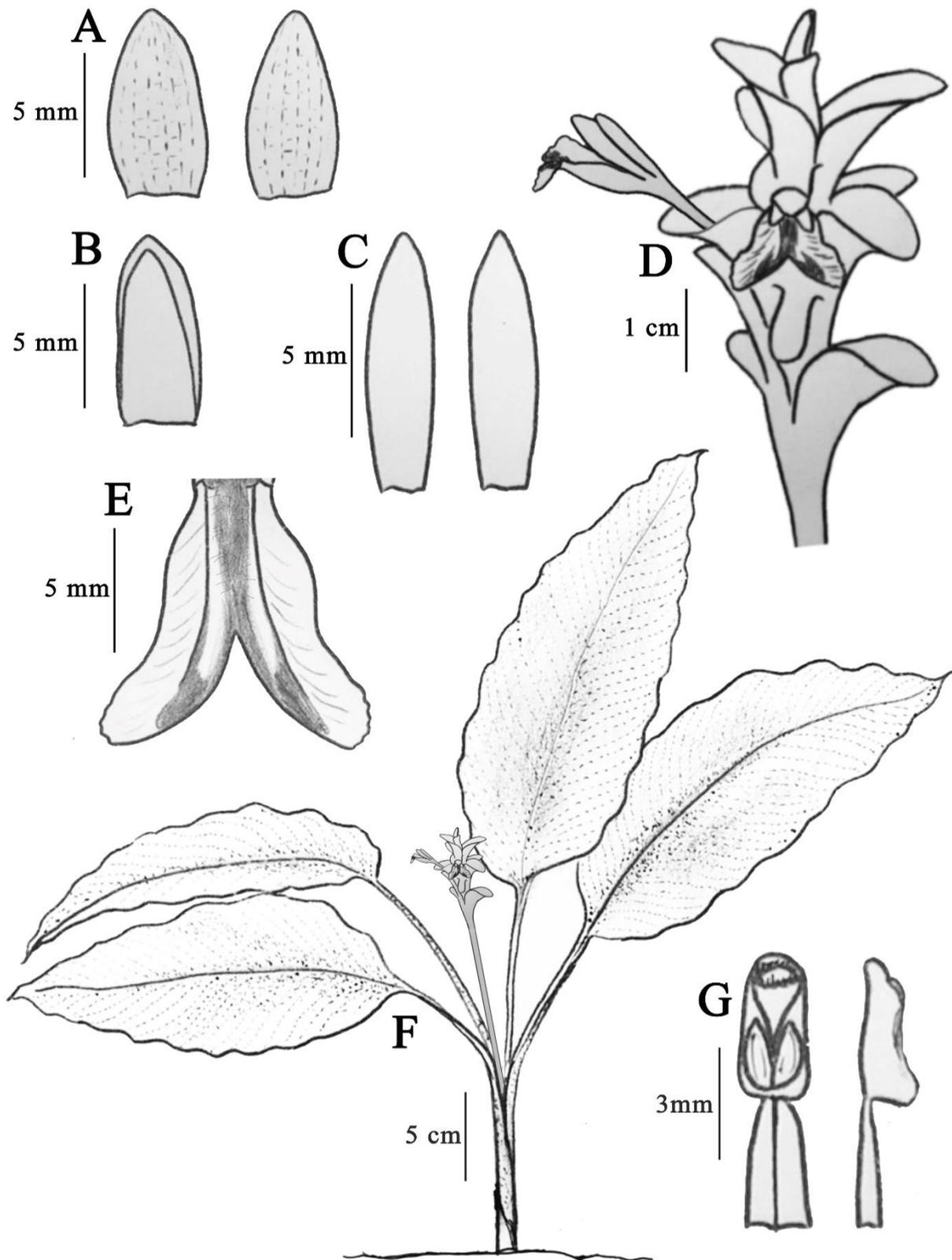


Figure 13. *Curcuma purpurata* Boonma & Saensouk sp. nov.: A, lateral corolla lobes; B, dorsal corolla lobe; C, staminodes; D, side view of inflorescence with flowers; E, labellum; F, habit; G, front and side of anther. Drawn by Thawatphong Boonma

A new record in Thailand

Curcuma peramoena Souvann. & Maknoi. Thai. J. Bot. 6(2): 125–130. 2014. - Fig. 14—subgenus *Ecomatae*

Type: THAILAND. Uttaradit Province, 9 May 2019, Boonma16

Perennial herb, *primary rhizome* spherical to ovoid, creamy white internally, fragrant, 1.8–2.5 x 2.0–2.5 cm. *Branches rhizome* creamy white internally, fragrant, diameter 0.8–1.2 cm. *Root* tuberous with fibrous roots, the tuberous roots ovate, creamy white internally. Leafy-shoot 28–45 cm tall. *Leafless sheaths* 2–3, brownish-red or brownish red with green, apex mucronate, pubescent, 3–12 cm long. *Leaf-sheaths* alternate, green or green with red at base. *Ligule* 2–4 mm long. *Petiole* green, glabrous, 9–15 cm long. *Lamina* 2–4, narrowly elliptic, apex acute, base oblique or attenuate, margin entire, green on both surfaces, adaxially surface glabrous, abaxially surface pubescent, 22–27 x 7–11 cm. *Inflorescence* terminal, 1–5 flowers open at the same time, spike 5–7 cm long; *peduncle* 4–6 cm long. *Bracts* 10–16, ovate, apex acute, reddish-brown with red at base or reddish-brown with green, both side glabrous, 3.4–4 x 2–3 cm. *Flowers* 4–5 cm long. *Calyx* very light pale pink to white, 13–15 mm long, apex 3-lobed (one lobe deep incision c. 7 mm), glabrous. *Corolla tube* white, pubescent; *dorsal corolla lobe* one-hooded, pink with white at base, lanceolate, apex mucronate, c. 16 x 9 mm, glabrous; *lateral corolla lobes* 2, lanceolate to ovate, apex obtuse partly hooded, pink with white at base, 14–15 x 5–7 mm. *Lateral staminodes* 2, ovate to rhomboid, white with dark purple spots at base, apex acute to obtuse, 15–17 x 11–14 mm. *Labellum* obovate, apex bilobed, deep incision 3.5–6 mm long, white with 2 yellow patches in the middle and reddish-orange spots at base, 17–18 x 12–15 mm. *Stamen* white, 12–14 mm long, with two spurs at base 2–3 mm long; *anther* c. 8 mm long; *filament* flat, white

with pale pink at base, 4–7 mm long. *Stigma* white 1–2 x 1–2 mm, glabrous; style very slender, 0.25–0.3 mm in diameter, 35–39 mm long. *Epigynous glands* 2, 1–2.5 mm long; *Ovary* subspherical, 2–3 mm, 3 carpels, pubescent. *Ovule* axile placentation. *Fruit* and *seed* not seen. *Flowering period* in the rainy season (May–September).

Thailand. Northern; Uttaradit province; Ban Khok District.

Ecology. In deciduous forest 280–300 meters above sea level.

Conservation status. In our survey and according to all information about the species, we preliminary suggest treating this species as *Near Threatened*, it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or *Vulnerable* now, but it is close to qualifying for or is likely to qualify for a threatened category in the near future. However, we expect that the species is still found in adjacent native areas as suitable habitat seems still exist. Further fieldwork and observations are needed to assess changes in population, distribution, and abundance in the future.

Distribution. Laos: Nam Phouy National Protected Area, Xaignabouri; Thailand: Uttaradit Province: Ban Khok District.

Specimens examined. Laos, Xaignabouri Province, Phieng District, along the road from Nakhanyang to Vangkhamane Village, Nam Phouy National Protected Area, alt. ca. 323 m above sea level, 26 May 2014: P. srisanga, M. Norsaengsri, W. La-onsri, S. Suk-ieam, K. Phouthavong & K. Souvannakhommmane L2-294 (holotype QBG!; isotypes HNL!, Pha Tad Ke Botanical Garden Herbarium!). Additionally, another specimen (Boonma T. no.31; deposited at KGU) from Uttaradit Province was preserved in alcohol and a living specimen is also kept and planted at Brio Garden.



Figure 14. Top view of the inflorescence of *Curcuma peramoena* Souvann. & Maknoi. Photographed by Thawatphong Boonma

Key to species of *Curcuma* in Thailand

1. Absent of epigynous glands
- Subgenus *Hitcheniopsis***
2. Bracts not laterally connate, campanulate involucre with two slits
3. Bract purplish-brown *C. macrochlamys*
3. Bract green or red
4. Leaves upper surface glabrous, lower surface pubescent; bract green with densely stripes from the base to apex or red *C. pedicellata*
4. Leaves glabrous on both surfaces; bract green
5. Leaves 2-3, lanceolate; 15-20 flowers *C. campanulata*
5. Leaves 4-5, oblanceolate-oblong; 6-8 flowers *C. involucrata*
2. Bracts laterally connate to each other for about half their length and forming basal pouches
6. Inflorescence without coma
7. Bracts pink with green or purple at tip, or reddish-brown with green margin
8. Labellum light purple to purple, basally with two bright to dark red thick bands (one on each side), distally pale to bright purple, median band only slightly darker than remainder of labellum *C. lithophila*
8. Labellum not purple as above
9. Bracts pink with green or purple at tip; labellum pale to dark red with bright yellow patches on the bright red swollen band at the base half of the labellum, yellow towards the apex *C. sparganiifolia*
9. Bracts reddish-brown with green margin, apex rounded; labellum white with pink apex and yellowish band in center *C. bella*
7. Bracts pale green to dark green
10. Bracts puberulent on both sides *C. papilionacea*
10. Bracts glabrous on both sides
11. Labellum with prominently fimbriate margin, fimbriae c. 1.5 mm long, curly *C. fimbriata*
11. Labellum not fimbriate as above
12. Bracts lanceolate, with upper half, suddenly narrowed to acute apex *C. harmandii*
12. Bracts almost orbicular or broadly ovate or broadly obovate
13. Flowers slightly exerted from bracts; bracts almost orbicular *C. prasina*
13. Flowers exerted from bracts; bracts broadly ovate or broadly obovate
14. Labellum with two dark yellow spots at base and a small very pale-yellow line at mid lobe from sinus almost to base; bracts broadly ovate; staminodes pale pinkish purple to pale purple with white at base *C. charanii*
14. Labellum without two dark yellow spots at base, with two short yellow dashes along each side of incision margin about half-length; bracts broadly obovate; staminodes white *C. puangpeniae*
6. Inflorescence with well-developed coma
15. Labellum with red
16. Staminodes pale purple or violet with red
17. Anther spurless *C. rhabdota*
17. Anther spurred, L-shape, connective white to cream, sometimes very pale purple dorsally, covered with short glandular hairs *C. rufostriata*
16. Staminodes yellow or white with red
18. Labellum yellow with red lines; staminodes pale yellow to yellow with red tinge *C. gracillima*
18. Labellum white with red; staminodes white with red
19. Fertile bracts light green with two white circle patches and light pale green or white longitudinal line; coma bracts outer light green with green longitudinal line alternating with light green or white lines, inner white with green edges *C. saraburiensis*
19. Fertile bracts pale green to cream with white; coma bracts white *C. spathulata*
15. Labellum without red
20. Coma bract pink *C. alismatifolia*
20. Coma bract green or white
21. Fertile bracts green with rich reddish-brown tinge *C. micrantha*
21. Fertile bracts green without reddish-brown tinge
22. Corolla tube longer than bract, flower distinctive protruding from the inflorescence; staminodes white; coma bracts green on both surfaces *C. purpurata*
22. Corolla tube short; staminodes purple or violet; coma bracts white or with green
23. Labellum deeply bilobed; coma bracts pure white *C. thorelii*
23. Labellum fringed edge; coma bracts white with green at apex *C. parviflora*
1. Present of epigynous glands
24. Inflorescences lacking a conspicuous coma of sterile bracts, fertile bracts connate only at the base; anther spurs filamentose or conical, forward-pointed **Subgenus *Ecomatae***
25. Corolla tube longer than bracts, narrow; flowers yellow; petiole very distinct from leaf blade *C. supraneana*
25. Corolla tube short, wide, flowers of various colors, leaf-blade tapering into the petiole
26. Anther spurs filamentose, 0.5–2 mm long
27. Staminodes white with dark purple tips *C. pierreana*
27. Staminodes white or white with yellowish patch in center and apex

28. Leaf puberulous on both surfaces *C. chantaranothaii*
28. Leaf upper surface glabrous
29. Rhizome crawling; leaves base attenuate; staminodes pure white *C. cochinchinensis*
29. Rhizome ovoid; leaves base oblique, rounded to subcordate; staminodes white or with yellowish patch in the center and the apex *C. eburnea*
26. Anther spurs conical or cylindrical, forward-pointed, longer than 2 mm long
30. Inflorescence terminal
31. Leaves upper glabrous
32. Staminodes yellow or light orange; leaves lower glabrous
33. Labellum approx. reniform, oblique, yellow with inside half orange, apex acuteturning outward; staminodes rhomboid, light orange with dotted dark red at base, apex rounded; leaves glabrous on both *C. rhomba*
33. 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*
32. Staminodes white; leaves lower pubescent
34. Labellum diamond-shaped, white with yellow patch in center and red spots at base; white with dark purple spots at base *C. peramoena*
34. Labellum suborbicular, white with two deep orange bands at the center with deep purple lines at the base *C. woodii*
31. Leaves upper pubescent
35. Corolla lobes whitish-green to pale green; leaves base cuneate to attenuate *C. putii*
35. Corolla lobes pink, red or purple; leaves base oblique, rounded or cordate
36. Leaves lower glabrous; staminodes lanceolate, subacute, yellow *C. stenochila*
36. Leaves lower pubescent
37. 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*
37. Staminodes oblique obovate, pale yellow, glabrous on both sides *C. cinnabarina*
30. Inflorescence lateral
38. Staminodes purple *C. ecomata*
38. Staminodes white or yellow or white with yellow
39. Labellum yellow, rarely with red streaks at sinus *C. flaviflora*
39. Labellum white with yellow median band *C. candida*
40. Leaves upper green with red patch along the midrib
40. Leaves upper green without red patch along the midrib
41. Staminodes lower half white, upper half golden yellow, central purple patch covered with dense *C. glans*
41. Staminodes white *C. singularis*
24. Inflorescences usually with a coma bract; flowers closed form, bullet-type; anther spurs flat, acute, downward-pointed or absent **Subgenus *Curcuma***
42. Inflorescence without or with inconspicuous coma
43. Anther ecalcarate; bracts orange; inflorescence terminal *C. roscoeana*
43. Anther calcarate; bracts bright red with yellowish or yellowish-green towards the base; inflorescence terminal but protruding through the base of the pseudostem through lateral slits above ground *C. rubrobracteata*
42. Inflorescence with well-developed coma
44. Inflorescence terminal
45. Anther ecalcarate *C. aurantiaca*
45. Anther calcarate
46. Bracts glabrous
47. Ovary glabrous *C. antinaia*
47. Ovary pubescent *C. sattayasaiorum*
46. Bracts pubescent
48. Rhizome deep orange *C. longa*
48. Rhizome yellow or pale yellow
49. Coma bracts greenish-white *C. viridiflora*
49. Coma bracts pink or white with pink at tip
50. Rhizome yellow; leaf-sheaths brownish red; peduncle red *C. phrayawan*
50. Rhizome pale yellow; leaf-sheaths green; peduncle green
51. Ovary glabrous *C. petiolata*
51. Ovary pubescent *C. amada*
44. Inflorescence usually lateral
52. Branched rhizome not produced *C. angustifolia*
52. Branched rhizome present
53. Leaves lower surface pubescent
54. Leaves upper green *C. aromatica*
54. Leaves upper green with red or reddish-purple patch along midrib

55. Bracts glabrous *C. zedoaroides*
 55. Bracts pubescent
 56. Labellum ovate, slightly lobed, reflected, yellow, with a few brown lines down the center; bracts green, short-hairy on both surfaces *C. latifolia*
 56. Labellum broadly ovate to irregularly orbicular, obscurely trilobed, cream-white to pale yellow with bright yellow median band extending from base of labellum to margin; bract bright green to brownish green with pale green venation, adaxially puberulent, abaxially glabrous *C. globulifera*
 53. Leaves lower surface glabrous
 57. Petioles and leaf-sheaths reddish-brown *C. rubescens*
 57. Petioles and leaf-sheaths green
 58. Leaves upper green with red or reddish-purple patch along the midrib
 59. Rhizome aeruginous green *C. aeruginosa*
 59. Rhizome yellow or orange
 60. Corolla lobes nearly white or with very slight pinkish shade; rhizome pale straw to yellowish-white *C. picta*
 60. Corolla lobes conspicuously pink to reddish; rhizome deep bright orange to yellow-orange *C. zanthorrhiza*
 58. Leaves upper green without red patch along midrib
 61. Fertile bracts pale pink; rhizome pale ochraceous *C. comosa*
 61. Fertile bracts green; rhizome white to pale yellow
 62. Bracts glabrous *C. leucorrhiza*
 62. Bracts minutely puberulous on both sides *C. mangga*

The study showed that six new species and one new record of the genus *Curcuma* have been found in several parts of Thailand. While, the diversity of genus *Curcuma* with all three subgenera and more than 50 species in Thailand was previously reported by several botanists, namely Siriruga et al. (2007), Larsen and Larsen (2006), Škorničková et al. (2017), Boonma and Saensouk (2019), Maknoi et al. (2019), Leong-Škorničková et al. (2020 and 2021), Soonthornkalump et al. (2021), and Saensouk et al. (2016). Moreover, Škorničková et al. (2015) proposed a new classification of subgenus and combined some genus and species to be part of the genus *Curcuma*, causing the number of species of genus *Curcuma* in Thailand significantly increased. Therefore, the number of species of the genus *Curcuma*, including from this study, presented 63 species. Thus, Thailand will be one of the richest areas of the genus *Curcuma*. The key to species of Thai *Curcuma* is constructed from dominant characteristics - rhizome (color, shape), petiole, leaves, the position of inflorescences, fertile bracts, coma bracts, corolla lobes, labellum, anther with anther spur and ovary.

In conclusion, this study discovered six new species in the genus *Curcuma* from many areas in Thailand, namely *Curcuma chantaranothaii* Boonma & Saensouk sp. nov., *C. charanii* Boonma & Saensouk sp. nov., *C. rangsimae* Boonma & Saensouk sp. nov., *C. phrayawan* Boonma & Saensouk sp. nov., *C. puangpeniae* Boonma & Saensouk sp. nov., and *C. purpurata* Boonma & Saensouk sp. nov. In addition to new species, a first new record of *C. peramoena* in Thailand was also found. The most use-category of all species was for ornamental plant, except *C. phrayawan* Boonma & Saensouk sp. nov. is used for traditional medicinal and ornamental plant. The conservation status of all species is preliminary suggested, as follows: *Curcuma peramoena* Souvann. & Maknoi. (Near Threatened), *C. purpurata* (Endangered), *C. puangpeniae* (Vulnerable), *C. phrayawan* (Vulnerable), *C. rangsimae* (Vulnerable), *C.*

charanii (Vulnerable), and *C. chantaranothaii* (Vulnerable).

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