

# *Curcuma nakhonphanomensis* (Zingiberaceae), a new species from the lower Mekong River basin, northeastern Thailand

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**Abstract.** Saensouk P, Boonma T, Saensouk S. 2022. *Curcuma nakhonphanomensis* (Zingiberaceae), a new species from the lower Mekong River basin, northeastern Thailand. *Biodiversitas* 23: 6040-6048. *Curcuma nakhonphanomensis* Boonma, Saensouk & P. Saensouk sp. nov. (Zingiberaceae: Zingiberaceae) was distributed in Nakhon Phanom Province, northeastern Thailand. The morphological characteristic of this species makes it fall into *Curcuma* subgenus *Ecomata*, due to the presence of epigynous glands, lack of coma bracts and bracts fused only at the base, and production of open-form of flowers. This plant did not match any existing species after careful morphological examination and comparison of all allied species in the genus *Curcuma*, especially in subgenus *Ecomata*. Therefore, we described it here as a new species to science in the name of *Curcuma nakhonphanomensis* Boonma, Saensouk & P. Saensouk. The specific epithet is named according to the province's name of the type locality. The morphological characteristics description, illustrations, vernacular name, ecology, phenology, distribution, utilization, conservation status, and map of distribution are present. The comparison table of the new species and its allies species, including a revised key to 41 species of *Curcuma* subgenus *Ecomata* is provided.

**Keywords:** *Curcuma nakhonphanomensis*, *Ecomata*, Nakhon Phanom Province, taxonomy, Zingiberaceae

## INTRODUCTION

Thailand has an abundant region with subtropical and tropical climates when combined with the specific geography of the country consequently the diversity of plants. Particularly effective in the diversity of species of plants in the Zingiberaceae family, comprised of about 29 native accepted genera (Kew Science 2022), especially the genus *Curcuma* L. It comprised over 70 species distributed throughout the country (Sirirugsa 1966; Larsen and Larsen 2006; Sirirugsa et al. 2007; Boonma and Saensouk 2019; Maknoi et al. 2021; Saensouk et al. 2021a, b, c, d; Saensouk et al. 2022a; Rakarcha et al. 2022). Thailand is considered to be the diversity center of the *Curcuma* subgenus *Ecomata* (Záveská et al. 2012; Leong-Škorničková et al. 2015) with the most reported species diversity throughout the country. *Curcuma* subgenus *Ecomata* is dominantly characterized by the presence of epigynous glands, which usually produce an open form of flowers, lacking coma bracts, and the bracts fused almost or only at the base.

Recently, ten new endemic species have been described from Thailand, comprised of *Curcuma chantaranothaii* Boonma & Saensouk, *C. rangsimae* Boonma & Saensouk (Saensouk et al. 2021a), *C. pitukii* Maknoi, Saensouk, Rakarcha & Thammar, *C. aruna* Maknoi & Saensouk (Maknoi et al. 2021), *C. siamensis* Saensouk & Boonma (Saensouk et al. 2021d), *C. achrae* Saensouk & Boonma (Saensouk et al. 2022a), *C. lampangensis* Saensouk,

Maknoi & Rakarcha and *C. sabhasrii* Saensouk, Maknoi, Wongnak & Rakarcha (Rakarcha et al. 2022), *C. suphanensis* P. Saensouk, Boonma, Rakarcha, Maknoi, Wongnak & S. Saensouk, and *C. rosea* P. Saensouk, S. Saensouk & Boonma (Saensouk et al. 2022b). The number of species in *Curcuma* subgenus *Ecomata* in Thailand was found about 27 species. If including two species reported from Vietnam namely *C. sixsensesensis* D.D. Nguyen & T.A. Le, and *C. vinhlinhensis* D.D. Nguyen & T.A. Le (Nguyen et al. 2022), will be bringing the number of species in this subgenus worldwide to 40 species.

Herein, the new species of *Curcuma* L. was collected from Nakhon Phanom Province, Northeastern Thailand. The morphological characteristic of this species makes it fall into *Curcuma* subgenus *Ecomata*, due to the presence of epigynous glands, lack of coma bracts and bracts fused only at the base, and production of open-form of flowers. This species is similar to *Curcuma peramoena* Souvann. & Maknoi (Souvannnakhoummane and Maknoi 2014; Saensouk et al. 2021a) by many morphological characteristics. Nevertheless, after morphological examination and comparison of all allied species in the *Curcuma* genus, this plant did not match any existing species. Therefore, we described it here as a new species to science and named it after Nakhon Phanom Province, the type locality where this plant was found as "*Curcuma nakhonphanomensis*". Its morphological description, illustrations, vernacular name, ecology, phenology, utilization, conservation status, map of distribution, and

comparison table to its allies species, including a revised key to 41 species of *Curcuma* subgenus *Ecomata* are provided.

## MATERIALS AND METHODS

Plant materials were collected from Nakhon Phanom Province, Northeastern Thailand in 2021 (Figure 1). About 20 living specimens, including herbarium materials, were used in this study. Measurements were recorded from living and spirit specimens collected from the natural habitats, taken with a ruler, vernier-caliper, and morphologically examined under a stereoscopic microscope (Stemi 2000-C, ZEISS, Oberkochen, Germany) and deposited at Khon Kaen University Herbarium (KKU). Additional spirit specimens soaking in 70% ethyl alcohol and living specimens were kept and planted at Brio Garden (Nakhon Nayok Province, Central Thailand). The protologues of morphologically similar species were compared and verified. The morphological descriptions in all species of accepted species, especially *Curcuma* subgenus *Ecomata*, available digital images and information online, for instance, online photographs of herbarium specimens with details from Aarhus University Herbarium (AAU), The Forest Herbarium (BKF), Royal Botanic Garden Edinburgh Herbarium (E), Royal Botanic Gardens Herbarium (K), National Museum of Natural History (P), Queen Sirikit Botanical Garden Herbarium

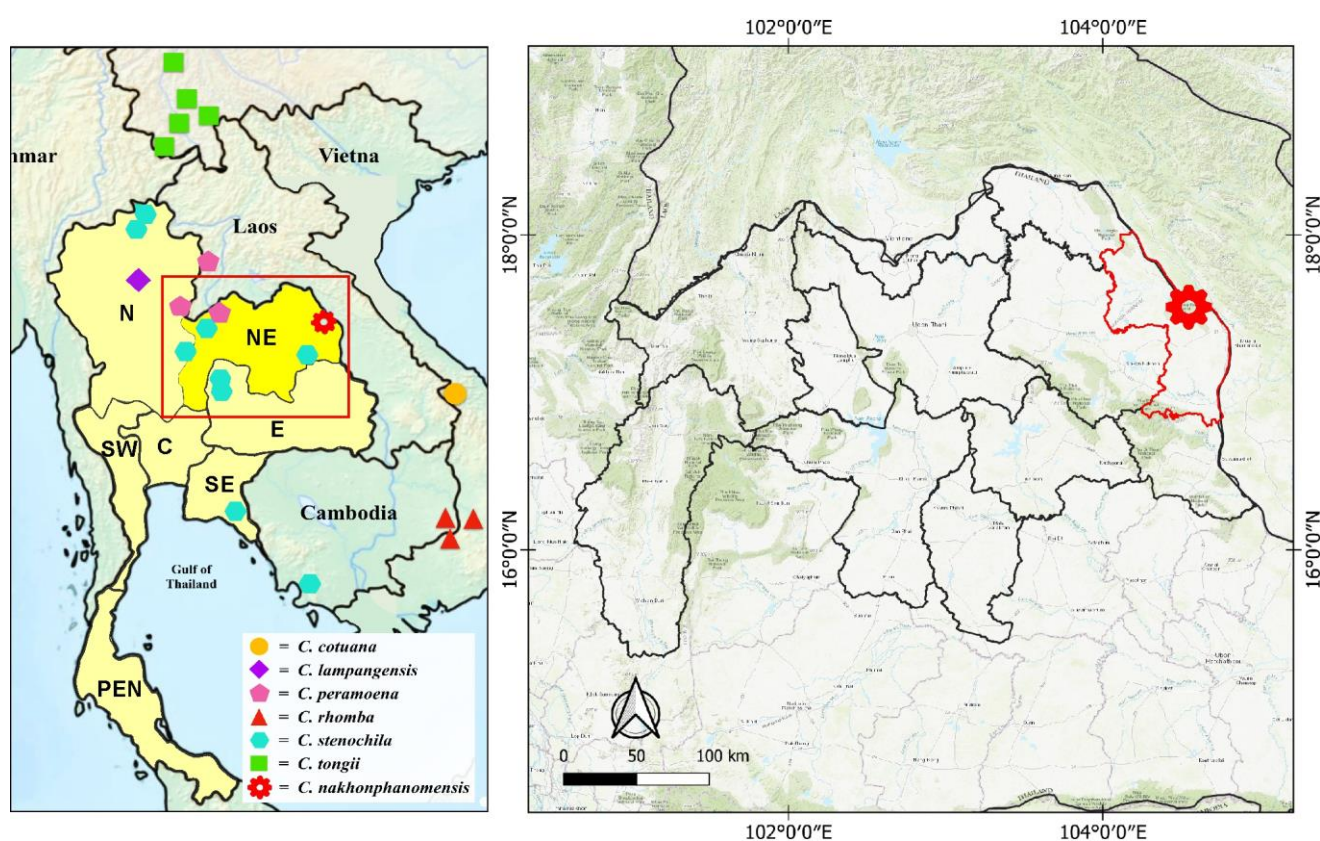
(QBG), Singapore Botanic Gardens Herbarium (SING), including existing published literature of *Curcuma* were also compared in this study.

## RESULTS AND DISCUSSION

### Taxonomic treatment

*Curcuma nakhonphanomensis* Boonma, Saensouk & P. Saensouk sp. nov. – Figures 1–3, Table 1–Subgen. *Ecomata*

The new species is similar to *Curcuma peramoena* Souvann. & Maknoi but differ in having leaf sheath, ligule, and petiole green with a brownish red tinge, lamina broader 8–13 cm wide, leaves base cordate to slightly rounded, leaves midrib usually with red patches, pubescent on both surfaces; peduncle pubescent; fertile bracts pubescent; flower 6.2–6.5 cm long; calyx 22–25 mm long; corolla lobes sparsely hairy; labellum obovate, labellum apex trilobed, sides lobe rounded, middle lobe emarginate with an acute tip, incision up to 12 mm long, labellum white with yellow distal half of median band to yellowish orange, white basal half median band, with dark red lines in the mid lobes and dark red lines along both sides of the white median band from basal to 1/4 of the labellum length; staminodes asymmetrical broadly elliptic-rhombic; filament c. 6 × 4 mm, white; anther 11–12 mm long; spurs c. 2 mm long; crest c. 2 mm long; epigynous glands c. 8 mm long, apex sharp.



**Figure 1.** Distribution map of *Curcuma nakhonphanomensis* Boonma, Saensouk & P. Saensouk sp. nov. and its allies species. Map of Thailand showing floristic regions: N: Northern, NE: Northeastern, E: Eastern, C: Central, SE: Southeastern, SW: Southwestern, and PEN: Peninsular, refer to the map of floristic regions of the Flora of Thailand project. The location of Thailand in Southeast Asia shows in the upper right frame. (Map created with "Pixelmator Pro", designed by Thawatphong Boonma)

*Type: Thailand*, Nakhon Phanom Province, 158 m asl., *Boonma 830*, 07 August 2021 (holotype KKU!).

Perennial herb, *Primary rhizome* ovoid, brownish externally, pale yellowish-white internally, 0.8–1.5 × 0.7–1.2 cm, slightly aromatic; with slender branches rhizome, creeping both sideways and downwards (0.3–0.5 cm in diam.), white internally, slightly aromatic. *Root* fibrous with tuberous roots placed near the rhizome (0.5–3 cm apart), tuber ovoid, white internally. *Leafy shoot* 35–50 cm tall. *Sheathing bracts* 1–3 in number, usually wilt while growing, 2–15 cm long, dark red or green with a dark reddish tinge, white underground part, apex mucronate, pubescent. *Leaf-sheaths* 2–4 in number, usually 2 at anthesis 5–7 cm long, distichous, dark green with various dark red tinge, pubescent; *ligule* bilobed, 0.4–0.6 cm long, dark reddish tinge, apex acute, pubescent; *petiole* canaliculate, 6.5–15 cm, green with brownish-red tinge, pubescent. *Lamina* ovate to narrowly ovate, 16–30 × 8–13 cm, apex acuminate with slightly mucronate tip, c. 1 mm long, base cordate to slightly rounded, margin entire, translucent white or with a reddish tinge, adaxially dark green, usually with red patches along the midrib (red patches may fade on some leaves), prominently embossed veins; abaxially paler green, pubescent on both surfaces. *Inflorescence* terminal and emerges between the leaf sheaths near the base of the pseudostems; *thyrses* 5–6 cm long, 2–4 cm in diam. in the broadest part; *peduncle* 3–6 cm long, 0.3–0.5 cm in diam., pale green or white, pubescent. Lack of coma bract. *Fertile bracts* 7–12 in number, 2.5–4 × 1.2–1.7 cm, apex acute with slightly cucullate tip, dark red, or with green at distal part, fused almost only at the base, pubescent, lowest bracts are the broadest and longest, margin hyaline, semitranslucent. *Bracteole* filiform, 10–12 mm long, translucent white, pubescent. *Flower* open form, 6.2–6.5 cm, cincinni with 3–5 flowers. *Calyx* tubular 22–25 mm long, apex 3-lobed, with unilateral incision up to 9 mm long, two lobes apex obtuse, another one apex acute, translucent white with red tinge at the distal part, sparsely hairy. *Floral tube* tubular and enlarged to conical at distal part, 4.0–4.1 cm long, white, pubescent; *dorsal corolla lobe* 1, narrowly triangular-lanceolate, 20–21 × 6–7 mm, apex cucullate with mucronate tip (mucro 2.5–3 mm long), white, sparsely hairy; *lateral corolla lobes* 2, narrowly triangular-lanceolate, 17.5–18 × 6–7 mm, apex obtuse, cucullate, white, sparsely hairy. *Labellum* obovate, 2.1–2.3 cm long, 1.8–1.9 cm at the broadest part, c. 7 mm wide at the base, apex trilobed, sides lobe rounded, middle lobe emarginate with an acute tip, with an incision up to 12 mm long, white with yellow distal half of median band to yellowish orange, white basal half median band, with dark red lines in the mid lobes and dark red lines along both sides of the white median band from basal to 1/4 of the labellum length, pubescent. *Lateral staminodes* 2, asymmetrical broadly elliptic-rhombic, 2.1–2.3 × 1.4–1.5 cm, apex acute, pubescent, white, with a dark red spot at the base, pubescent. *Stamen* 1; *filament* flat, c. 6 × 4 mm, white, pubescent; *anther* 11–12 mm long (measurement in side view including crest and spurs), 3.7–3.9 mm at the broadest part, white, pubescent, with two blunt knobs at the basal of

the thecae; *anther thecae* c. 8 mm long, with white pollen; *spurs* conical, c. 2 mm long, pointing downwards; *crest* c. 2 mm long above the anther lobes, apex rounded, pubescent. *Stigma* conical with flattened end, c. 2 × 1.7–2.0 mm, white, ostiole ciliate. *Epigynous glands* 2, filiform, c. 8 mm long, apex sharp, pale yellow. *Ovary* ellipsoid, 3.6–4.0 × 2.5–2.7 mm, whitish, pubescent. *Ovules* axile placentation. *Fruits and seeds* are not seen.

**Vernacular name:**—"Maha Udom Nakhon Phanom" ("Maha Udom" means a very plentiful and "Nakhon Phanom" named after the type locality in Nakhon Phanom Province. Some villagers call this species in the name of "Krachiao Mekong"; *Krachiao* is a word used to call plants in the *Curcuma* genus, while "Mekong" refers to its natural habitat in the Mekong River Basin, and is also called "Saneh Nakhon Phanom" which "Saneh" meaning fascination, based on the type of use in beliefs to increase the fascination and enchantment.

**Etymology:**—The specific epithet name "*nakhonphanomensis*" is named after the type locality where this new species was found in Nakhon Phanom Province.

**Distribution:**—**Thailand**, Nakhon Phanom Province, present known only from the type locality.

**Ecology:**—In a mixed deciduous forest on rich humus soil, 146–165 m asl., associated with *Globba globulifera* Gagnep., and *Zingiber mekongense* Gagnep.

**Phenology:**—Flowering in late June to September; produced terminal inflorescence appearing between the innermost leaves sheaths, emerges almost at the base of pseudostems, flowers fully open in the early morning, anthesis time in the morning, and last a single day. Leafy shoot emerges in April and dormancy begins in November.

**Utilization:**—This species is cultivated as an auspicious ornamental plant among Thai sacred plant collectors usually used in belief to increase fascination and enchantment when they bring flowers or any part of the plant with them. The flowers were usually soaked in sandalwood oil. Some villagers bring young inflorescences to eat fresh or boiled and eat as a side dish or served with chili paste like they eat *Curcuma singularis* Gagnep. and *C. angustifolia* Roxb.

**Conservation status.**—The new species was found in 2021. We propose ranking this species as Data Deficient (DD) category, following the IUCN (2022) criteria due to the insufficient information on its distribution range, and we expect that this species may be found distributed in Laos PDR in the area opposite the Mekong River of Nakhon Phanom Province, Thailand.

A morphological comparison summary of *C. nakhonphanomensis* Boonma, Saensouk & P. Saensouk sp. nov. and its allies species is presented in Table 1.

#### Specimens examined:

*Curcuma cotuana* Luu, Škorničk. & H.Đ.Trần

**VIETNAM:**—Quảng Nam Province, Tây Giang District, Axan Commune, 15°49'57.75"N, 107°17'42.99"E, 1100 m asl., *Luu et al. TG-009*, 25 Aug 2013 (holotype: SGN, isotype: SING, VNMN).

***Curcuma lampangensis* Saensouk, Maknoi & Rakarcha**

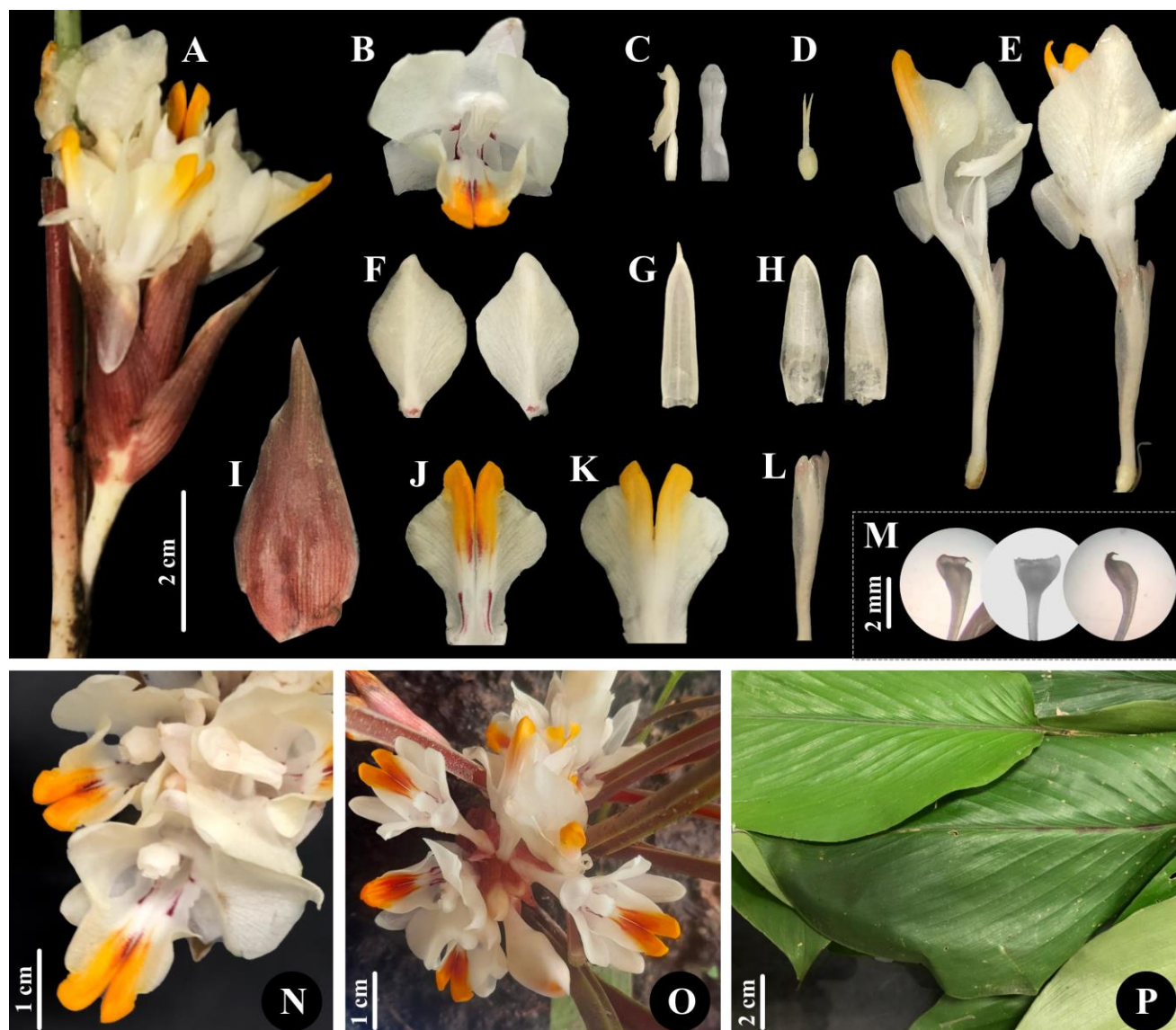
**THAILAND:** —Lampang Province, Mae Mo District, Ban Dong Subdistrict, Ban Tha Si village, Doi Pha Kan, W. Thammarong, S. Rakarcha, S. Yokyo & M. Tabut 2991, 23 August 2021 (holotype QBG!; isotypes BKF!, KKU!)

***Curcuma peramoena* Souvann. & Maknoi**

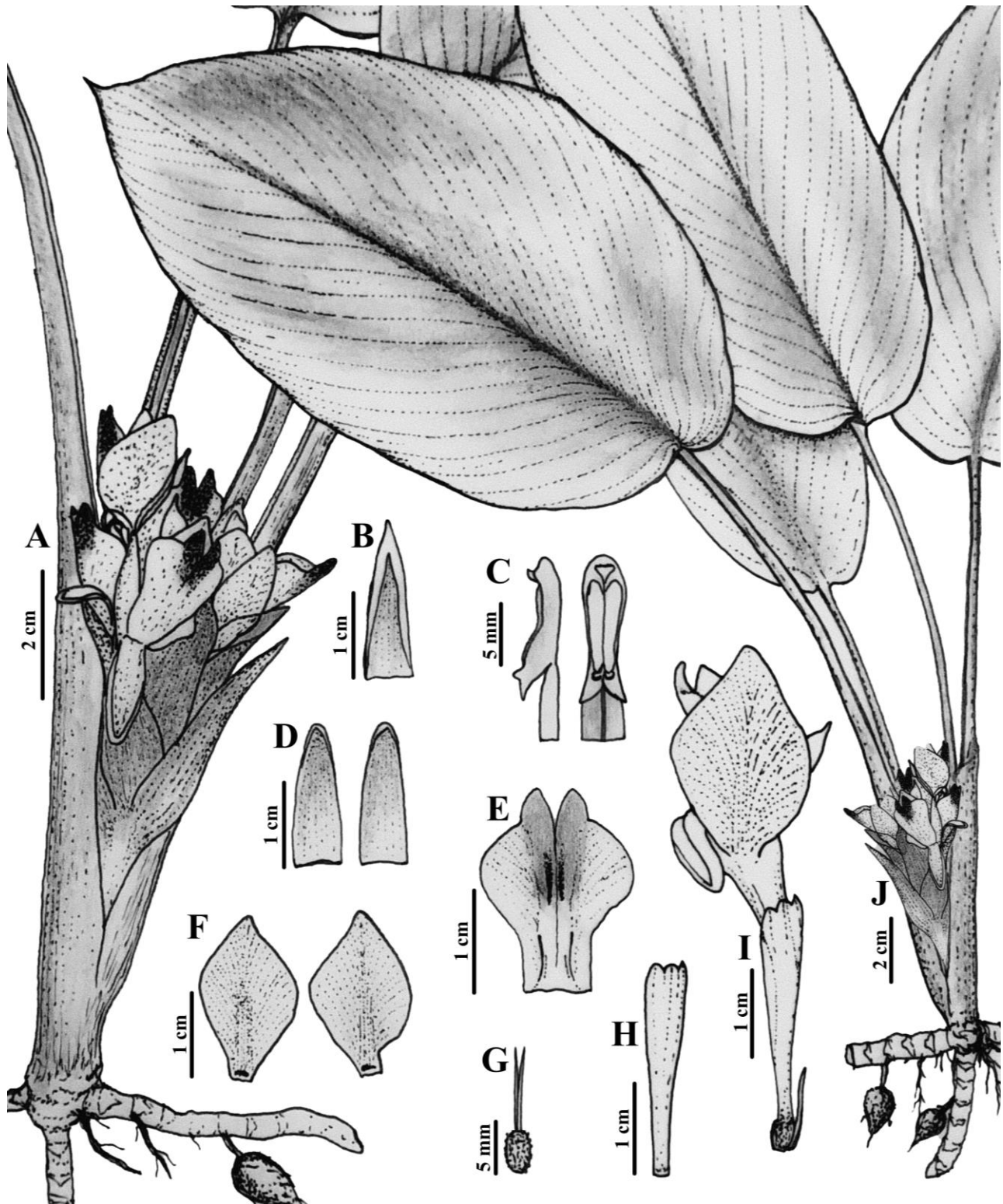
**LAOS:** —Xaignaboury Province, Phieng District, along the road from Nakhanyang to Vangkhamane village, Nam

Phouy National Protected Area, alt. c. 323 m asl., P. Srisanga, M. Norsaengsri, W. Laongsri, S. Sukieam, K. Phouthavong & K. Souvannakhoummane L2-294, 26 May 2014 (holotype QBG!; isotypes HNL!, Pha Tad Ke Botanical Garden Herbarium!)

**THAILAND:** —Uttaradit Province, *Boonma* 16 and no. 31, 9 May 2019 (KKU). —Loei Province (living specimens planted at Brio Garden (Nakhon Nayok Province, Central Thailand)).



**Figure 2.** *Curcuma nakhonphanomensis* Boonma, Saensouk & P. Saensouk sp. nov. (A) side view of inflorescence with flowers, (B) front view of flower, (C) side and front view of the anther, (D) side view of an ovary with epigynous glands, (E) side view of two flowers – left flower was taken a staminode out one side to show the anther and filament, (F) lateral staminodes, (G) dorsal corolla lobe, (H) lateral corolla lobes, (I) bract, (J) upper side of the labellum, (K) lower side of the labellum, (L) calyx, (M) oblique-side view, front view and side view of stigma, (N) oblique view of flowers, (O) top view of inflorescence with flowers, (P) leaves. Photographs and designs by Thawatphong Boonma



**Figure 3.** *Curcuma nakhonphanomensis* Boonma, Saensouk & P. Saensouk sp. nov. (A) side view of inflorescence with flowers, (B) dorsal corolla lobe, (C) side and front view of the anther, (D) lateral corolla lobes, (E) labellum, (F) staminodes, (G) ovary with epigynous glands, (H) calyx, (I) side view of flower, (J) habit. Drawn and designed by Thawatphong Boonma

**Table 1.** Morphological comparison of *Curcuma nakhonphanomensis* Boonma, Saensouk & P. Saensouk sp. nov. and its allies species

Characters	<i>C. nakhonphanomensis</i>	<i>C. peramoena</i>	<i>C. stenochila</i>	<i>C. tongii</i>
Branches	White internally	Light yellow internally	White internally	Cream white internally
Leafy shoot	35–50 cm tall	Up to 35 cm tall	30–50 cm tall	Up to 50 cm tall
Leaf-sheaths	2–4 in number, Dark green with various dark red tinge	2–3 in number, Green	4–6 in number, Green	2–4 in number, Green
Ligule	4–6 mm long, Dark reddish tinge	2–5 mm long, Greenish white	2–5 mm long, Green	4–5 mm long, Greenish white to pale red
Petiole	Green with brownish-red tinge, Pubescent	Green, Glabrous	Green, Pubescent	Green, Glabrous
Lamina	Ovate to narrowly ovate, 16–30 × 8–13 cm, Apex acuminate with slightly mucronate tip (mucro c. 1 mm), Base cordate to slightly rounded, Adaxially midrib usually with red patches, Pubescent on both surfaces	Narrowly elliptic to elliptic- ovate, 15–19 × 5–8 cm, Apex acute, Base cuneate to attenuate, sometimes oblique, Adaxially midrib green, Adaxially glabrous, abaxially pubescent	Oblong to lanceolate, 21–28 × 6.5–12 cm, Apex acuminate, Base broadly cuneate, Adaxially midrib green, Adaxially with hairs along secondary nerves, abaxially glabrous	Slightly unequal elliptic, 20–26 × 8.5–10 cm, Apex attenuate to acuminate, Base unequal cuneate to attenuate, Adaxially midrib green, Adaxially glabrous, except sparsely puberulent, along the secondary raised veins, abaxially sparsely puberulent
Inflorescence	Terminal	Terminal	Terminal	Lateral
Peduncle	Pale green or white, Pubescent	Creamy white, Glabrous	Whitish with reddish tinge, Pubescent	Cream white to pinkish, Glabrous
Fertile bracts	2.5–4 × 1.2–1.7 cm, Pubescent	2–5 × 1–3 cm, Glabrous	c. 4 × 1.5 cm, Pubescent	4.5–5.0 × 3.0–3.5 cm, Glabrous
Flower	6.2–6.5 cm long	4–5 cm long	5.8–6 cm long	5.5–6.0 cm long
Calyx	22–25 mm long, White with red tinge at distal part, Sparsely hairy	13–15 mm long, White, Sparsely hairy or glabrous	15–20 mm long, Reddish, Hairy along veins	16–18 mm long, White, Sparsely puberulent
Floral tube	4.0–4.1 cm long	2–3.5 cm long	c. 3.5 cm long	3.5–4.0 cm long
Dorsal corolla lobe	20–21 × 6–7 mm, Sparsely hairy, Apex mucronate, mucro 2.5–3 mm, White	12–17 × 4–7 mm, Glabrous, Apex mucronate, mucro c. 1 mm, White-pink on lower half gradually turning red upwards	c. 20 × 5–6 mm, Glabrous, Apex acuminate, Red to dark red	22–24 × 6–7 mm, Glabrous, except tip puberulous, Apex acuminate, Cream white with pink tinge

Labellum	Obovate, 2.1–2.3 × 1.8–1.9 cm, Apex trilobed, sides lobe rounded, middle lobe emarginate with an acute tip, incision up to 12 mm long, White with yellow distal half of median band to yellowish orange, white basal half median band, with dark red lines in the mid lobes and dark red lines along both sides of the white median band from basal to 1/4 of the labellum length	Diamond shaped, 1.5–1.8 × 1.2–1.4 cm, Apex bilobed with an incision up to 6 mm long, White with yellow patch in center and red spots at base	Obovate, 2.0 × 1.5 cm, Shalowly trilobed, apex of mid lobe emarginate, Yellowish orange	Obovate, 2.0–2.2 × 1.2–1.3 cm, Apex bi-lobed with an incision up to 8–9 mm long, Cream white, sometimes pale pinkish basally with two bright yellow swollen bands running along the median and two 6-7 mm long, deep purple red or dark red bands placed next to the yellow bands
Lateral staminodes	Asymmetrical broadly elliptic-rhombic, 2.1–2.3 × 1.4–1.5 cm, White with a dark red spot at the base	Ovate-rhombic, 12–15 × 8–10 mm, White with dark purple spots at the base	Ovate, c. 20 × 10 mm, Yellow	Irregularly obovate, 22–23 × 12–13 mm, Cream white
Filament	c. 6 mm long, c. 4 mm broad at the base, White	6–8 mm long, 2–3 mm broad at the base, White with red tinge	c. 7 mm long, c. 4 mm broad at the base, Yellow	8–10 mm long, 4–6 mm broad at the base, Cream white
Anther	11–12 mm long, White	8–10 mm long, Pale yellow to white	c. 10 mm long, Yellow	6–6.5 mm long, Cream white
Anther thecae	c. 8 mm long	c. 9 mm long	c. 5 mm long	5–5.5 mm long
Anther spurs	c. 2 mm long	c. 2.5 mm long	c. 2 mm long	4–5 mm long
Anther crest	c. 2 mm long	c. 1 mm long	c. 1.5 mm long	1.2–1.5 mm long
Epigynous glands	c. 8 mm long, Apex sharp, Pale yellow	1–2 mm long, Apex blunt, Creamy white	c. 9 mm long, Apex acuminate, Yellowish	5–6 mm long, Apex slightly bilobed, Cream white
Ovary	3.6–4.0 mm long	2–3 mm long	c. 3 mm long	2.5–3 mm long

**Key to 41 species of *Curcuma* subgen. *Ecomata* worldwide; species found in Thailand (28 species) are denoted by bolded the species' name**

- 1a. Floral tube longer than bracts; petiole very distinct from leaf blade ..... *C. supraneeana*
- 1b. Floral tube shorter than bracts; leaf-blade tapering into the petiole ..... 2
- 2a. Anther spurs < 2 mm long or filamentous ..... 3
- 2b. Anther spurs  $\geq$  2 mm long or conical or cylindrical ..... 15
- 3a. Stamines with purple color ..... 4
- 3b. Stamines without purple color ..... 7
- 4a. Inflorescence lateral ..... 5
- 4b. Inflorescence terminal ..... 6
- 5a. Labellum orbicular-rhombic; stamines ovate-rhomboid with apex acute ..... *C. pambrosima*
- 5b. Labellum obovate; stamines elliptic with apex rounded ..... *C. vinhlinhensis*
- 6a. Stamines white with dark purple at the apex ..... *C. pierreana*
- 6b. Stamines white with orange dots at the top and purple dots at the base ..... *C. woodii*
- 7a. Leaves puberulous on both surfaces ... *C. chantaranothaii*
- 7b. Leaves adaxially glabrous or glabrous on both surfaces... 8
- 8a. Stamines yellow-orange with light yellow at the base ..... *C. vitellina*
- 8b. Stamines white, or with yellow in the center or at the apex ..... 9
- 9a. Rhizome crawling ..... *C. cochinchinensis*
- 9b. Rhizome ovoid ..... 10
- 10a. Leaf adaxially usually green with dark red midrib..... *C. rosea*
- 10b. Leaf adaxially usually green with green midrib ..... 11
- 11a. Calyx pale purple ..... *C. pitukii*
- 11b. Calyx white ..... 12
- 12a. Filament > 5 mm long ..... *C. sixsensesensis*
- 12b. Filament < 5 mm long ..... 13
- 13a. Bracts pubescent ..... *C. suphanensis*
- 13b. Bracts glabrous ..... 14
- 14a. Anther crest pure white, apex rounded, 1.5–2 mm long ..... *C. eburnea*
- 14b. Anther crest yellow, apex obtuse, 1.0–1.5 mm long ..... *C. arida*
- 15a. Inflorescence terminal ..... 16
- 15b. Inflorescence lateral ..... 29
- 16a. Anther like an L-shape with an obtuse angle in side view ..... 17
- 16b. Anther almost straight in the side view ..... 18
- 17a. Stamines yellow at the base gradually fade to whitish-yellow at the margin and distal part, or with various shades of pale yellow on both sides ..... *C. siamensis*
- 17b. Stamines white with a pinkish tinge, with a pale yellow middle line along the mid lobe from the base to about 1/3 of the length of the stamine internally, outer white with a pink tinge, and white midrib ..... *C. pulcherrima*
- 18a. Flowers closed-form ..... 19
- 18b. Flowers opened-form ..... 20
- 19a. Thyse < 8 cm long; bracts green; leaf midrib red ..... *C. stolonifera*
- 19b. Thyse > 8 cm long; bracts red; leaf midrib green ..... *C. cinnabarina*
- 20a. Stamines white or white with reddish purple ..... 21
- 20b. Stamines yellow or light orange ..... 23
- 21a. Labellum reddish purple with yellow median band with reddish purple mottling on yellow median band of lower half ..... *C. sabhasrii*
- 21b. Labellum white with yellow median band ..... 22
- 22a. Leaf base cuneate to attenuate; leaf midrib green; epigynous glands 1–2 mm long ..... *C. peramoena*
- 22b. Leaf base cordate to slightly rounded; leaf midrib usually with red patches; epigynous glands c. 8 mm long ..... *C. nakhonphanomensis*
- 23a. Leaves adaxially glabrous ..... 24
- 23b. Leaves adaxially with hairy along the veins or pubescent ..... 25
- 24a. Stamines rhomboid, with dark red dot at the base..... *C. rhomba*
- 24b. Stamines asymmetrical trullate to ovate, without red dot at the base ..... *C. rangsima*
- 25a. Leaves base cuneate to attenuate ..... *C. putii*
- 25b. Leaves base oblique, rounded or cordate ..... 26
- 26a. Stamines upper half orange-yellow, lower half red to dark red ..... 27
- 26b. Stamines yellow ..... 28
- 27a. Inflorescence almost sessile with peduncles c. 1.5 cm long; bracts light green with a more or less reddish tinge and prominent veins; labellum yellowish orange with reddish to purple margins ..... *C. bicolor*
- 27b. Inflorescence with longer peduncles up to 13 cm long; bracts white, pink to dark red; labellum bright orange with various degrees of red ornamentation ..... *C. flammea*
- 28a. Anther spurs c. 5 mm long; bracts glabrous.. *C. kayahensis*
- 28b. Anther spurs c. 2 mm long; bracts pubescent.. *C. stenochila*
- 29a. Stamines purple or with purple at base ..... 30
- 29b. Stamines white or yellow or orange ..... 32
- 30a. Leaf base cuneate; labellum pale pink to dark purple with yellow median band ..... *C. ecomata*
- 30b. Leaf base cordate or rounded; labellum white with yellow or light orange ..... 31
- 31a. Labellum apex strongly recurved horn-like lobes, light orange with the deep orange median band; stamines bright orange with dark purple tinge at the base ..... *C. corniculata*
- 31b. Labellum apex curved inwards, white with yellow margins, and golden yellow median band; stamines lower half white, upper half golden yellow, and a purple patch at the base ..... *C. glans*
- 32a. Labellum yellow or orange with slightly darker median band ..... 33
- 32b. Labellum white or cream white with a yellow median band ..... 37
- 33a. Anther almost straight in the side view; stamines golden yellow gradually fades to pale yellow at the base, with a reddish V-shaped or triangular patch at the base ..... *C. achrae*
- 33b. Anther L-shape; stamines yellow without reddish patch at the base as above ..... 34
- 34a. Leaves base cuneate; sheath and petiole pubescent ..... *C. flaviflora*
- 34b. Leaves base obtuse or rounded to cordate; sheath and petiole glabrous ..... 35
- 35a. Epigynous glands 14–15 mm long; anther thecae 3–4 mm long ..... *C. xanthella*
- 35b. Epigynous glands 4–6 mm long; anther thecae 6–7 mm long ..... 36
- 36a. Anther crest apex emarginate; long peduncle; bract with various degrees of red tinge ..... *C. sahuynhensis*
- 36b. Anther crest apex obtuse to rounded; short peduncle; bract green ..... *C. aruna*
- 37a. Leaves adaxially green with red patch along the midrib .... 38
- 37b. Leaves adaxially green without red patch along the midrib ..... 39
- 38a. Anther almost straight in the side view ..... *C. candida*

- 38b. Anther L-shape (obtuse angle) in the side view ..... *C. newmanii*  
 39a. Labellum white with a yellow median band, without red ..... *C. singularis*  
 39b. Labellum white with yellow median band, with red ..... 40  
 40a. Staminodes white with red-brown spots at the base..... *C. lampangensis*  
 40b. Staminodes cream white without red-brown spots at the base ..... *C. tongii*

### *Curcuma rhomba* J. Mood & K. Larsen

**CAMBODIA:** —Mondulkiri Province, Bousra Waterfall, 12°33'59"N, 107°22'2"E, alt. 491 m asl., *Christophe Long, K.C. Cheng & M. Leti CL432, P00626286*, 2 November 2006 (P)

**VIETNAM:** —Dac Lac Province, Dray Sup area, secondary forest, *Mood97p147* (holotype AAU).

### *Curcuma stenochila* Gagnep.

**CAMBODIA:** —Kampot Province, Mountains Kamchay, alt. 500 m asl., *Geoffray 409, P032710*, 12 July 1904 (holotype P). —Kampot Province, Mountains Kamchay, alt. 500 m asl., *Geoffray 409, P032712*, 12 July 1904 (isotype P).

**THAILAND:** —Chiang Rai, Koon Gohn Falls, Muang, *Maxwell 92-440*, 20 August 1992 (AAU, CMU, P). —Chiang Rai, Doi Tung, *Iwatsuki et al. T13271*, 26 September 1967 (BKF).—Pitsanulok Province, Thung Salaeng Luang NP, *Larsen et al. 703*, 22 July 1966 (AAU, P). —Pitsanulok Province, Thung Salaeng Luang NP, *Larsen et al. 902*, 25 July 1966 (AAU). —Loei Province, Phuang Luang, *Bunchuai s.n.* (BKF). —Loei Province, Phu Luang, *Phusomsaeng 26*, 1 September 1966 (BKF). —Sakon Nakhon Province, Phu Pan NP, Ngamriabsakul 63, 1 August 1999 (BKF, E). —Chaiyaphum Province, near Chulaporn Dam, *Larsen et al. 31438*, 5 August 1972 (AAU, K, P). —Chaiyaphum Province, Phu Khieo, *Smitinand 11871*, 22 July 1973 (BKF). —Chantaburi Province, Khao Kum Pang, *Pudjaa & Cholkulchana 590*, 14 July 1999 (BKF). —Chantaburi Province, Hin Lat, Khlawng Lamphong, Pong Namrawn, *Smitinand 3458*, 30 August 1956 (AAU, BKF).

### *Curcuma tongii* Y.H. Tan & L.X. Zhang

**CHINA:** —Yunnan: Menghai, Bulang mountain conifer-broadleaf forests or evergreen broad-leaved forests, alt. 948 m asl., 21°38'09.84" N, 100°18'01.68" E, 24 May 2013, *Yun-Hong Tan 7168* (holotype HITBC!, isotype IMDY!).—Yunnan: Menghai, Bulang mountain, 24 May 2012, *Menghai Expeditions 5328220387* (HITBC, IMDY); Pu'er, Simao, Yunxian, 22 May 2018, *Ji-Dong Ya 18CS16773* (KUN); Pu'er, Jinggu, Minle, 6 July 2018, *Yun-Hong Tan T0158* (HITBC).

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