

Two new species of *Curcuma* subgenus *Ecomata* (Zingiberaceae: Zingibereae), from Central and Southwestern Thailand

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Manuscript received: 5 August 2022. Revision accepted: 5 September 2022.

Abstract. Saensouk P, Boonma T, Rakarcha S, Maknoi C, Wongnak M, Saensouk S. 2022. Two new species of *Curcuma* subgenus *Ecomata* (Zingiberaceae: Zingibereae), from Central and Southwestern Thailand. *Biodiversitas* 23: 4578-4588. Two new species of *Curcuma* L. are described. The first species, *Curcuma suphanensis* P. Saensouk, Boonma, Rakarcha, Maknoi, Wongnak & S. Saensouk sp. nov. was found in Suphan Buri province, Central Thailand, and the second species namely *C. rosea* P. Saensouk, S. Saensouk & Boonma sp. nov. was found in Uthai Thani province, Southwestern Thailand. Both species fall into the subgenus *Ecomata* because of the lack of conspicuous coma bract, and the presence of epigynous glands. This brings the number of species in this subgenus worldwide to 37 species. Living specimens and spirit specimens of both new species were collected from their natural habitats, morphological attributes measured, and compared to all existing species. Neither species match any previously-described species, therefore, both of them are new species to science. The first was named *Curcuma suphanensis* based on its province of origin (Suphan Buri Province), and the second species was named *Curcuma rosea*, on account of its pinkish bracts. Morphological descriptions along with their illustrations, notes on their ecology, etymology, and distributions, are presented along with a revised key to species of *Curcuma* subgenus *Ecomata* worldwide to facilitate identification.

Keywords: *Curcuma eburnea*, *pitukii*, Suphan Buri, Uthai Thani, taxonomy, Zingiberales

INTRODUCTION

Zingiberaceae is a very large family in the flora of Thailand with about 30 accepted genera found distributed throughout the country (Larsen and S.S. Larsen 2006; Kew Science 2022). The plants in this family have a long history of economic importance (for instance in Table 2) being used as food, a spice, medicine, cosmetics and perfumery, as ornamental, both in their own right and as part of folklore, including enhancing the prosperity and good fortune of the grower. Moreover, these species produce a large variety of colorful and beautiful inflorescences and many species have been selected to produce hybrid cultivars for both the domestic market in Thailand and internationally. Two good examples of this from the genus *Curcuma* are the well-known varieties.

Curcuma L. belongs to the Zingiberaceae family, which is distributed throughout South and Southeast Asia, extending from southern China to Australia and South Pacific with more than 130 species worldwide (Leong-Škorničková and Newman 2015; Kew Science 2022). Thailand is one of the richest diversity of species of this genus with more than 70 species, within three sub-genera (*Hitcheniopsis* (Baker) K. Schum.; *Curcuma*; *Ecomata* Škorničk. & Šída f.). The three *Curcuma* sub-genera are

easily distinguished: subgenus *Hitcheniopsis* is easily distinguishable from the other two as it lacks epigynous glands, whereas the glands are present in the other two subgenera. Subgenus *Curcuma* can usually be characterized by well-developed coma bracts, a closed form of flowers like a bell shape compared to subgenus *Ecomata* Škorničk. & Šída f. Which usually lacks coma bracts and has an opened flower form (Schumann 1904; Závěská et al. 2012; Leong-Škorničková et al. 2015).

Recently, six new species of *Curcuma* subgen. *Ecomata* were described from Thailand, namely *Curcuma chantaranothaii* Boonma & Saensouk, *C. rangsimae* Boonma & Saensouk (Saensouk et al. 2021a), *C. aruna* Maknoi & Saensouk, *C. pitukii* Maknoi, Saensouk, Rakarcha & Thammar (Maknoi et al. 2021), *C. siamensis* Saensouk & Boonma (Saensouk et al. 2021), and *C. achrae* Saensouk & Boonma (Saensouk et al. 2022), bringing the number of species in this subgenus in Thailand to 24 species. Moreover, two new species have recently been described from Vietnam, namely *C. sixsensesensis* D.D. Nguyen & T.A. Le, and *C. vinhlinhensis* D.D. Nguyen & T.A. Le (Nguyen et al. 2022).

In this study, two new species found in Thailand belonging to the *Curcuma* subgenus *Ecomata* are described. We present morphological descriptions of both

species along with their illustrations and notes on their ecology, etymology, and distributions. We also present a key to all 37 species of *Curcuma* subgenus *Ecomata* worldwide to facilitate identification. We have named these species "*Curcuma suphanensis*" based on its province of origin (Suphan Buri Province, Thailand), and the second species "*Curcuma rosea*" on account of its pinkish bracts.

MATERIALS AND METHODS

Living plant materials for both species were collected from the type localities in Suphan Buri province, Central Thailand, and from Uthai Thani province Southwestern Thailand, according to the floristic regions of the Flora of Thailand (Figure 1). Examples of both species were planted and kept as spirit specimens (70% ethyl alcohol) at both QBG and at Brio Garden (Nakhon Nayok Province, Central Thailand). Morphological measurements were made using both living and spirit specimens with Vernier-calipers, rulers, and specimens were examined under a stereoscopic microscope (Stemi 2000-C, ZEISS, Oberkochen, Germany). All samples were deposited at QBG.

The protologues of morphologically-similar species were compared and verified. The morphological descriptions in all species within the *Curcuma* subgenus *Ecomata* are available as digital images and online, including online photographs of herbarium specimens (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)). This information and all existing published literature of *Curcuma* were compared in this study. The most allied species are compared in Table 1.

RESULTS AND DISCUSSION

Two new species of *Curcuma* L. including *Curcuma suphanensis* P. Saensouk, Boonma, Rakarcha, Maknoi, Wongnak & S. Saensouk have been found and collected from Suphan Buri province, Central Thailand, and the second species, namely *C. rosea* P. Saensouk, S. Saensouk & Boonma from Uthai Thani province, Southwestern Thailand are belonging to *Curcuma* subgenus *Ecomata* due to the production of terminal inflorescences between the innermost leaf sheaths, emerge at the base of the pseudostems, lack of conspicuous coma bract, presence of epigynous glands. Detailed descriptions along with illustrations, photographs, ecology, phenology, distribution (Figure 5), utilization, and conservation status, including the comparison of the morphological characteristics with their allies species in Table 1, followed by a revised key to species of *Curcuma* subgenus *Ecomata* worldwide to facilitate identification (those species only found in Thailand are 24 species and are also denoted).

Taxonomic treatment

Curcuma suphanensis P. Saensouk, Boonma, Rakarcha, Maknoi, Wongnak & S. Saensouk, **sp. nov.**

—Figures 1–2, Table 1 —**Subgen. *Ecomata***

This species is similar to *C. eburnea* but differs in having lanceolate lamina, base cuneate-oblique, midrib sparsely hairy (vs. elliptic to elliptic-ovate, base rounded to subcordate-oblique, midrib glabrous); ligule 16.5–18 mm long, pubescent (vs. c. 8 mm long, glabrous but with short hairs at the margin); fertile bracts white with a reddish tinge at distal part, pubescent, connate almost only at the base to lower 1/4 (vs. cream white or pale greenish, glabrous, connate at the lower 1/2 to 1/3); bracteole present (vs. absent); flowers 4.0–4.1 cm, cincinnus 3–4 flowers (vs. 5–5.5 cm, cincinnus 1–3 flowers); calyx c. 13 mm long, sparsely hairy at distal part (vs. 8–10 mm long, glabrous); floral tube 2.4–2.5 cm long, glabrous, except for a furrow on the same side as the dorsal corolla lobe has sparsely hairy (vs. c. 3.5 cm long, glabrous); dorsal corolla lobe 13–14 × 9–10 mm, white with pale pink tinge at distal part, glabrous except for a few hairs at the tip (vs. c. 18 × 12 mm, pure white, glabrous); lateral corolla lobes apex obtuse, white with pale pink tinge at distal part, glabrous except a few hairs at the tip (vs. apex rounded, pure white, glabrous); staminodes adaxially with short glandular hairs densely at the center and dispersal sparsely at the margin, abaxially sparsely puberulent to glabrous (vs. glabrous on both sides); labellum with short white glandular hairs along both sides of the median band and dispersal sparsely between median band to margin (vs. glabrous on both sides); anther spurs c. 0.5 mm long (vs. 1–1.5 mm long); anther crest white with a yellow dot at the front side of the tip (vs. white); ovary pubescent (vs. glabrous).

Type: Thailand, Suphan Buri province, U Thong district, Chorakhe Sam Phan sub-district, *S. Rakarcha & M. Wongnak 1347*, alt. 185 m.a.s.l., 2 October 2021 (holotype QBG).

Perennial herb, *Primary rhizome* ovoid to subglobose, brownish externally, yellowish internally, 1.5–2 × 1.5–2 cm, sympodial with a very short neck, with a few slender branched rhizome pointing downward (0.8–1 cm in diameter). *Root* fibrous with tuberous roots, tuber broadly ellipsoid, 2.5–2.8 × 1.6–1.8 cm, two white layers internally. *Leafy shoot* 50–60 cm tall. *Leafless sheaths* 2–4 in number, (2–)5–18.5 cm long, brownish-red with white at underground part, apex mucronate, pubescent. *Leaf-sheaths* 2–4 in number, 14–16 cm long, distichous, green with a reddish brown tinge at the base, underground part white, pubescent; *ligule* bilobed, each lobe triangular, 16.5–18 mm long, green, apex acute, pubescent; *petiole* green, canaliculate, 3.5–9 cm long, pubescent. *Lamina* lanceolate, 21–30 × 9–12.5 cm (the first leaf usually shortest), apex acuminate with mucronate tip (mucro c. 1.5 mm long), base cuneate-oblique, margin entire with translucent white hyaline, adaxially green, glabrous, midrib light green, sparsely hairs, lower midrib green, pubescent, abaxially paler green, fine short hairs. *Inflorescence* terminal between the leaf sheaths, emerge at the base of the pseudostems; *thyrses* 6–7 cm long, 4–5 cm in diam. in the broadest part; *peduncle* 6–9 cm long, 0.5–0.7 cm in

diameter, white, finely hairy. Lack of coma bract. *Fertile bracts* 15–18 in number, ovate to broadly ovate, $1.5\text{--}3.5 \times 1.2\text{--}3.0$ cm, apex broadly acute with slightly mucronate tip, fused almost only at the base to $1/4$ of labellum length, the lowest bracts are the largest, white with a reddish tinge at distal part, pubescent. *Bracteole* obovate, one per flower, $15\text{--}18 \times 8\text{--}10$ mm wide, apex acute, hooded, keeled, pubescent. *Flowers* open form, $4.0\text{--}4.1$ cm, cincinnus with 3–4 flowers. *Calyx* tubular c. 13 mm long, apex 3-lobed with unilaterally incision up to 5 mm long, white, sparsely hairy at distal part. *Floral tube*, tubular and enlarged to conical at distal part, $2.4\text{--}2.5$ cm long, white, glabrous, except for a furrow on the same side as the dorsal corolla lobe has sparsely hairy; *dorsal corolla lobe* 1, triangular-ovate, $13\text{--}14 \times 9\text{--}10$ mm, apex mucronate (mucro $1\text{--}1.5$ mm long), cucullate, white with pale pink tinge at distal part, glabrous except few hairs at tip; *lateral corolla lobes* 2, triangular-ovate, $12\text{--}13 \times 7.5\text{--}8$ mm, apex obtuse, slightly cucullate, white with pale pink tinge at distal part, glabrous except few hairs at the tip. *Lateral staminodes* 2, uniquely narrowly ovate, $16.5\text{--}17 \times 9\text{--}10$ mm, apex acute to narrowly obtuse, white with yellow at distal part and yellow line along mid lobe, adaxially with short glandular hairs densely at the center and dispersal sparsely at the margin, abaxially sparsely puberulent to glabrous. *Labellum* ovate, $14\text{--}15 \times 12\text{--}13$ mm, and c. 7 mm wide at the base, apex emarginate, c. 5 mm long, white with yellow at distal part, short white glandular hairs along both sides of the median band and dispersal sparsely between median band to margin. *Stamen* 1; *filament* flat $2.5\text{--}3$ mm long and c. 5 mm wide at the base, pubescent. *Anther* c. 7.8 mm long (measurement in side view including crest and spurs), c. 2.5 mm wide at the center and distal part, c. 3 mm wide at the base, white, short glandular hairs; anther thecae $5\text{--}5.5$ mm long, white, dehiscing along their entire length, pollen white; *spurs* flattened triangular c. 0.5 mm long, white, curved; *crest* short c. $1.5 \times 2.0\text{--}2.2$ mm wide, apex rounded, white, usually with a yellow dot at the front side of the tip, and short glandular hairs. *Stigma* slightly flattened capitate, facing forwards, c. 1.5×1 mm, white, sparsely hairs, ostiole ciliate, facing forwards. *Epigynous glands* 2, c. 4 mm long, apex blunt, yellowish. *Ovary* subglobose, c. 3×3 mm, white, pubescent. *Ovule* axile placentation. *Fruit* subglobose to obovoid $10\text{--}12 \times 10\text{--}10$ mm, whitish, pubescent. *Seeds* obovoid to subglobose, c. 3×2.5 mm, brownish, with white arils.

Vernacular name:—*Krachiao Suphan* or *Khamin Suphan* in Thai language, which "Krachiao" or "Khamin" are the local name used as prefixes to call species in the *Curcuma* genus in Thailand, and "Suphan" refers to the province's name of the type locality.

Etymology:—The specific epithet name "*suphanensis*" is named after Suphan Buri Province, the type locality.

Distribution:—Thailand; natural habitat in Suphan Buri province, and cultivated throughout the country.

Ecology:—In the mixed deciduous forest on rich humus soil, 100–200 meters above sea level.

Phenology:—Flowering in July to October; flowers fully open in the early morning, anthesis time in the morning, and last a single day. Leafy shoot emerges in late April and dormancy begins in November.

Utilization:—Ornamental plant.

Provisional IUCN conservation assessment:—This new species was found in 2021 and there is still a lack of sufficient information on its distribution in nearby areas. Therefore, we consider ranking this species as Data Deficient (DD) category, following the IUCN criteria (IUCN 2022). However, we suggest treating them as rare and endemic species due to this species is still found and reported its distribution only in its type locality in Suphan Buri province, Central Thailand for sustainable conservation, and we hopefully find more populations in a nearby area to further change its conservation status in the nearly future for suitable conservation.

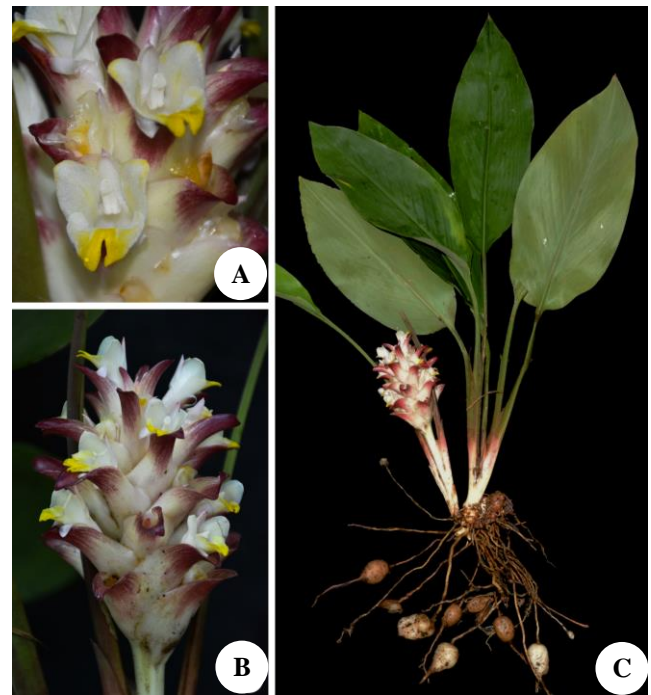


Figure 1. *Curcuma suphanensis* P. Saensouk, Boonma, Rakarcha, Maknoi, Wongnak & S. Saensouk sp. nov. (A) Close up front view of flowers on the side view of inflorescence, (B) Side view of inflorescence, (C) habit. (Photograph by Sarayut Rakarcha, Designed by Thawatphong Boonma)

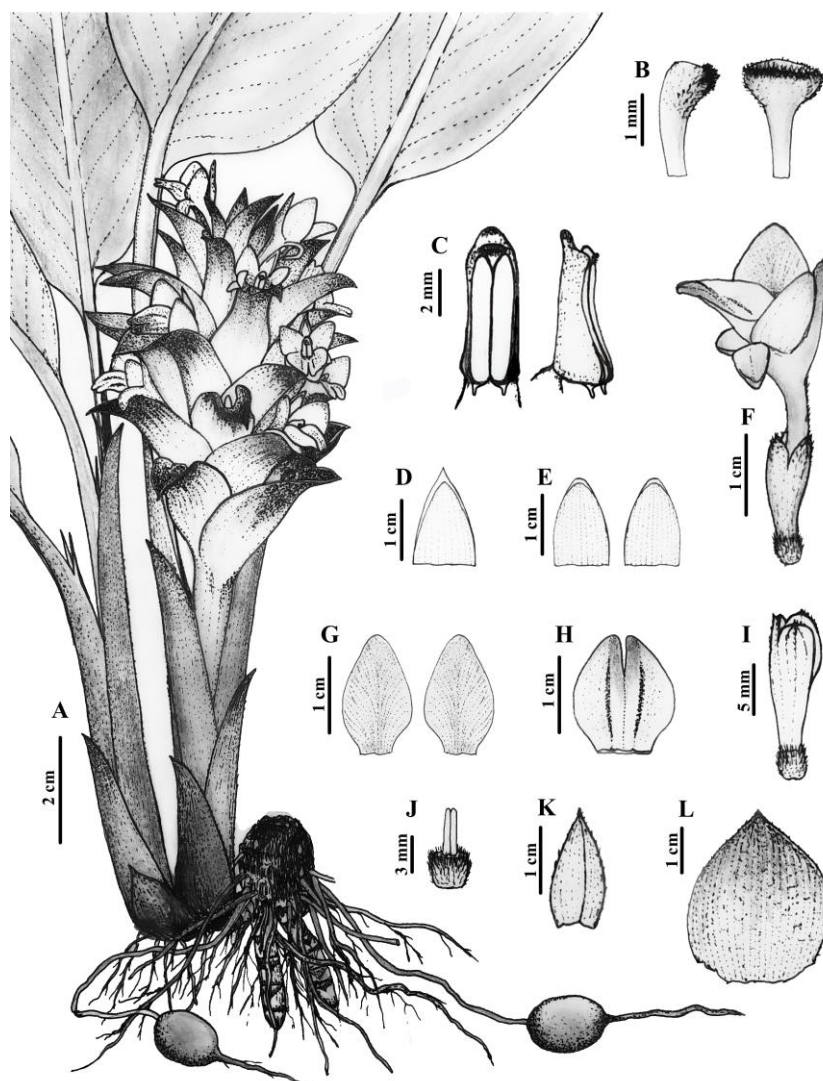


Figure 2. *Curcuma suphanensis* P. Saensouk, Boonma, Rakarcha, Maknoi, Wongnak & S. Saensouk sp. nov. (A) Side view of inflorescence, leafless sheaths, leaf sheaths, ligule, petiole, and leaf base, including rhizome and roots, (B) Side view and front view of stigma, (C) Front and side view of the anther, (D) Dorsal corolla lobe, (E) Lateral corolla lobes, (F) Side view of flower with calyx and ovary, (G) Lateral staminodes, (H) Labellum, (I) Another side view of calyx and ovary, (J) Epigynous glands and ovary, (K) Bracteole, (L) Bract. (Drawn by Thawatphong Boonma)

Curcuma rosea P. Saensouk, S. Saensouk & Boonma, sp. nov. —Figures 3-4, Table 1 —**Subgen.** *Ecomata* This species is similar to *C. pitukii* but differs in having leaves with a midrib with a dark reddish patch, glabrous, adaxially glabrous, base rounded to cordate, slightly oblique (vs. midrib green, puberulent, adaxially densely puberulent, base cuneate to rounded); calyx 11–12 mm long, white (14–18 mm long, pale purple); ligule 12–14 mm long (c. 2 mm long); bracteole absent (vs. present); floral tube white (vs. purplish-white or pale purple); staminodes apex rounded, glabrous on both sides (vs. apex acute, adaxially puberulent, abaxially sparsely puberulent to glabrous); labellum white with pale yellow at tip gradually to white median band (vs. white with a yellow median band from base to apex, divided into two patches at the base like a Y-shape); filament 1.5–1.8 mm long (vs. 5–8 mm long).

Type: Thailand, Uthai Thani province, Lan Sak district, Boonma 221, alt. 224 m.a.s.l., 16 July 2021 (holotype QBG),

Perennial herb, *Primary rhizome* ovoid to narrowly ovoid, brownish externally, yellowish internally, sympodial, aromatic, 1.5–3.5 × 1.0–1.4 cm, with slender branched rhizome pointing downward (0.7–0.8 cm in diameter). *Root* fibrous with tuberous roots. *Leafy shoot* 50–65 cm tall. *Leafless sheaths* 2–3 in number, (2–)6–18 cm long, green with brownish-red tinge, apex mucronate, pubescent. *Leaf-sheaths* 3–4 in number, 9–16 cm long, distichous, green with a reddish brown tinge, pubescent; *ligule* bilobed, each lobe triangular, 12–14 mm long, pale green with reddish tinge, apex acute, margin ciliate, pubescent; *petiole* green with a reddish brown tinge, canaliculate, 3.7–9 cm long, pubescent. *Lamina* ovate to narrowly ovate, 22–36 × 9–14 cm (the first leaf usually

shortest), apex acuminate with mucronate tip (mucro c. 5 mm long), base rounded to cordate, slightly oblique, margin entire with translucent white hyaline, adaxially green, glabrous, usually with a dark reddish patch along the midrib, glabrous, abaxially paler green, pubescent. *Inflorescence* terminal between the leaf sheaths, emerge at the base of the pseudostems; *thyrs*e 6–8 cm long, 4–5 cm in diam. in the broadest part; *peduncle* 4–10 cm long, 0.5–0.7 cm in diameter, whitish, finely hairy. Lack of coma bract. *Fertile bracts* 17–24 in number, 1.2–3.5 × 1.7–4.0 cm, upper bracts apex acute with slightly mucronate and fused almost only at base, lower bracts obtuse to rounded with slightly mucronate tip, fused almost only at the base to 1/3 of labellum length, the lowest bracts are the largest, apex pink gradually to pinkish white at base, pubescent. *Bracteole* absence. *Flowers* open form, 4.3–4.5 cm, cincinni 3–4 flowers. *Calyx* tubular 11–12 mm long, apex 3-lobed with unilaterally incision up to 5 mm long, white, sparsely hairs. *Floral tube* tubular and enlarged to conical at distal part, 2.85–2.9 cm long, whitish, short fine hairy; *dorsal corolla lobe* 1, triangular-ovate, 13–14 × 9–10 mm, apex mucronate (mucro c. 2 mm long), cucullate, pink tip gradually to whitish at the base, sparsely hairy; *lateral corolla lobes* 2, triangular-ovate, 11–12 × 8–9 mm, apex obtuse, slightly cucullate, pink tip gradually to whitish at the base, sparsely hairy. *Lateral staminodes* 2, uniquely ovate, 12–13.5 × 9–10 mm, apex rounded, white. *Labellum* rectangular, 14–15 × 14–15 mm, and c. 5 mm wide at the base, apex retuse less than 1 mm long, white with pale yellow at tip gradually to white median band, short pale brownish white hairs arranged as short lines along both side of the median band, sparsely hairy (denser near the midline and sporadic or too less at the edges and tip). *Stamen* 1; *filament* flat 1.5–1.8 mm long and c. 3 mm wide at the base, pubescent. *Anther* 6–6.5 mm long (measurement in side view including crest and spurs), c. 2.4 mm wide, white, short glandular hairs; anther thecae 4–4.5 mm long, white, dehiscing along their entire length, pollen white; *spurs* c. 1 mm long, white, curved inward; *crest* thick, short c. 1 mm long, 2.0–2.2 mm wide, apex obtuse, whitish, pubescent. *Stigma* conical, c. 0.8 × 1 mm, whitish, pubescent, ostiole ciliate, facing forwards. *Epigynous glands* 2, c. 3 mm long, apex blunt, yellowish. *Ovary* subglobose, 2.7–3.0 × 2.7–3.0 mm, whitish, pubescent. *Ovule* axile placentation. *Fruit* subglobose to obovoid 8–10 × 8–10 mm, whitish, pubescent. *Seeds* obovoid, c. 3.5 × 2.5 mm, brownish, with white arils.

Vernacular name:—*Chor Chom Phu* refers to its pinkish inflorescence; *Krachiao Uthai* or *Khamin Uthai* in the Thai language which "*Krachiao*" or "*Khamin*" are the local name used as a prefix to call species in *Curcuma* genus in Thailand, and "*Uthai*" refers to the province's name of the type locality. Among the group of Thai sacred plant collectors called this species "*Wan Maha Udom Umawadi*" (Wan is a rhizomatous or perennial herb that

among Thai sacred plant collectors usually used in folklore, for instance, used to increase enchantment when they bring flowers or any part of the plant with them, the flowers were usually soaking in the sandalwood oil, "*Maha Udom*" meaning a very plentiful, while "*Umawadi*" referred to "*Uma*" the Hindu Devi Lord of abundance and love (the pink bracts of this species represent love and are used to link to the name of Devi Uma).

Etymology:—The specific epithet name "*rosea*" refers to its pinkish bracts.

Distribution:—Thailand; natural habitat in Uthai Thani Province, and cultivated throughout the country.

Ecology:—In the mixed deciduous forest on rich humus soil, 200–400 meters above sea level.

Phenology:—Flowering in July to September; flowers fully open in the early morning, anthesis time in the morning, and last a single day. Leafy shoot emerges in late April and dormancy begins in November.

Utilization:—Ornamental plant.

Conservation status:—This new species was found in 2021 and there is still a lack of sufficient information on its distribution in nearby areas. Therefore, we consider ranking this species as Data Deficient (DD) category, following the IUCN criteria (IUCN 2022). However, we suggest treating them as rare and endemic species due to this species is still found and reported its distribution found only in its type locality in Uthai Thani province, Southwestern Thailand for sustainable conservation, and we hopefully find more populations in a nearby area to further change its conservation status in the nearly future for suitable conservation.



Figure 3. *Curcuma rosea* P. Saensouk, S. Saensouk & Boonma sp. nov. (A) Front view of habit, (B) Front view of inflorescence and flowers. (Photographs and designed by Thawatphong Boonma)

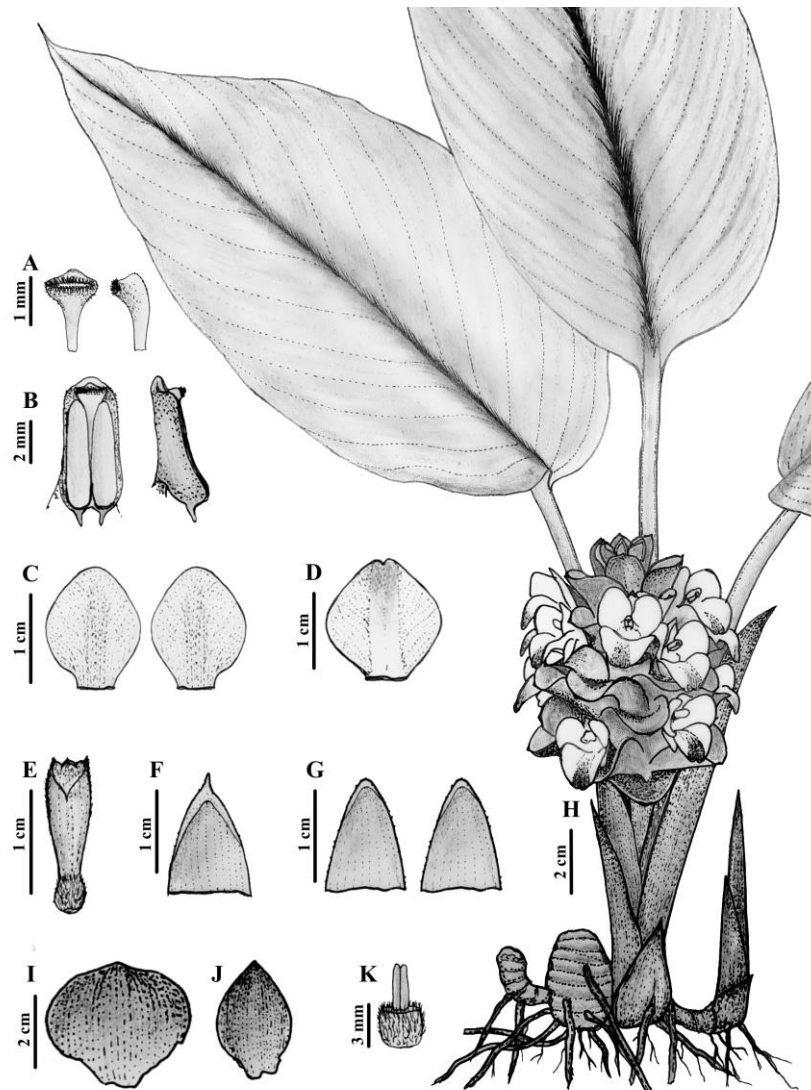


Figure 4. *Curcuma rosea* P. Saensouk, S. Saensouk & Boonma sp. nov. (A) Front and side view of stigma, (B) Front and side view of the anther, (C) Lateral staminodes, (D) Labellum, (E) Calyx with ovary, (F) Dorsal corolla lobe, (G) Lateral corolla lobes, (H) Front-oblique view of habit, (I–J) Lower bracts and upper bracts respectively, (K) Side view of epigynous glands and ovary. (Drawn by Thawatphong Boonma)

Key to species identification

Key to 37 species of *Curcuma* subgen. *Ecomata* worldwide; species found in Thailand (24 species) are denoted by bolded the species' name

- | | |
|--|------------------------------|
| 1a. Corolla tube longer than bracts; petiole very distinct from leaf blade | <i>C. supraneeana</i> |
| 1b. Corolla tube shorter than bracts; leaf-blade tapering into the petiole | 2 |
| 2a. Anther spurs < 2 mm long or filamentous | 3 |
| 2b. Anther spurs ≥ 2 mm long or conical or cylindrical | 15 |
| 3a. Staminodes with purple color | 4 |
| 3b. Staminodes without purple color | 7 |
| 4a. Inflorescence lateral..... | 5 |
| 4b. Inflorescence terminal..... | 6 |
| 5a. Labellum orbicular-rhombic; staminodes ovate-rhomboid with apex acute..... | <i>C. pambrosima</i> |
| 5b. Labellum obovate; staminodes elliptic with apex rounded | <i>C. vinhlinhensis</i> |
| 6a. Staminodes white with dark purple at the apex ... | <i>C. pierreana</i> |
| 6b. Staminodes white with orange dots at the top and purple dots at the base | <i>C. woodii</i> |
| 7a. Leaves puberulous on both surfaces | <i>C. chantaranothaii</i> |
| 7b. Leaves adaxially glabrous or glabrous on both surfaces | 8 |
| 8a. Staminodes yellow-orange with light yellow at the base | <i>C. vitellina</i> |
| 8b. Staminodes white, or with yellow in the centre or at the apex | 9 |
| 9a. Rhizome crawling..... | <i>C. cochinchinensis</i> |
| 9b. Rhizome ovoid | 10 |
| 10a. Leaf adaxially usually green with dark red midrib ... | <i>C. rosea</i> |
| 10b. Leaf adaxially usually green with green midrib | 11 |
| 11a. Calyx pale purple | <i>C. pitukii</i> |
| 11b. Calyx white | 12 |
| 12a. Filament > 5 mm long | <i>C. sixsensesensis</i> |
| 12b. Filament < 5 mm long | 13 |
| 13a. Bracts pubescent | <i>C. suphanensis</i> |
| 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 26
 16a. Leaves adaxially glabrous 17
 16b. Leaves adaxially with hairy along the veins or pubescent 21
 17a. Staminodes white *C. peramoena*
 17b. Staminodes yellow or light orange 18
 18a. Leaf adaxially usually green with red patch along the midrib 19
 18b. Leaf adaxially green without red patch along the midrib 20
 19a. Flowers opened-form; peduncle < 10 cm long *C. siamensis*
 19b. Flowers closed-form; peduncle > 10 cm long *C. stolonifera*
 20a. Staminodes rhomboid, with dark red dot at the base *C. rhomba*
 20b. Staminodes asymmetrical trullate to ovate, without red dot at the base *C. rangsimae*
 21a. Corolla lobes whitish-green to pale green; leaf base cuneate to attenuate *C. putii*
 21b. Corolla lobes pink, red or purple; leaf base oblique, rounded or cordate 22
 22a. Staminodes lower half red to dark red, upper half orange-yellow 23
 22b. Staminodes pale yellow to yellow 24
 23a. Inflorescence almost sessile with peduncles c. 1.5 cm long; bracts light green with more or less reddish tinge and prominent veins; labellum yellowish orange with reddish to purple margins *C. bicolor*
 23b. Inflorescence with longer peduncles upto 13 cm long; bracts white, pink to dark red; labellum bright orange with various degrees of red ornamentation *C. flava*
 24a. Thyrse > 8 cm long; staminodes pale yellow; corolla lobes white to pale yellow *C. cinnabarina*
 24b. Thyrse < 8 cm long; staminodes yellow; corolla lobes red 25
 25a. Anther spurs c. 2 mm long; bracts pubescent on both surfaces *C. stenochila*
 25b. Anther spurs c. 5 mm long; bracts glabrous on both surfaces *C. kayahensis*
 26a. Staminodes purple or with purple at base 27
 26b. Staminodes white or yellow or orange 29
 27a. Leaf base cuneate; labellum pale pink to dark purple with yellow median band *C. ecomata*
 27b. Leaf base cordate or rounded; labellum white with yellow or light orange 28
 28a. Labellum apex strongly recurved horn-like lobes, light orange with the deep orange median band; staminodes bright orange with dark purple tinge at the base *C. corniculata*
 28b. Labellum apex curved inwards, white with yellow margins, and golden yellow median band; staminodes lower half white, upper half golden yellow, and a purple patch at the base *C. glans*
 29a. Labellum yellow or orange with slightly darker median band 30
 29b. Labellum white or cream white with a yellow median band 34
 30a. Anther almost straight in the side view; staminodes golden yellow gradually fades to pale yellow at the base, with reddish V-shaped or triangular patch at the base *C. achrae*
 30b. Anther L-shape; staminodes yellow without reddish patch at the base as above 31
 31a. Leaves base cuneate; sheath and petiole pubescent *C. flaviflora*
 31b. Leaves base obtuse or rounded to cordate; sheath and petiole glabrous 32
 32a. Epigynous glands 14–15 mm long; anther thecae 3–4 mm long *C. xanthella*
 32b. Epigynous glands 4–6 mm long; anther thecae 6–7 mm long 33
 33a. Anther crest apex emarginate; long peduncle; bract with various degrees of red tinge *C. sahuynhensis*
 33b. Anther crest apex obtuse to rounded; short peduncle; bract green *C. aruna*
 34a. Leaves adaxially green with red patch along the midrib ... 35
 34b. Leaves adaxially green without red patch along the midrib 36
 35a. Anther almost straight in the side view *C. candida*
 35b. Anther L-shape (obtuse angle) in the side view *C. newmanii*
 36a. Bracts red; labellum with dark red bands placed next to the yellow median band *C. tongii*
 36b. Bracts green; labellum with yellow median band, without red bands as above *C. singularis*

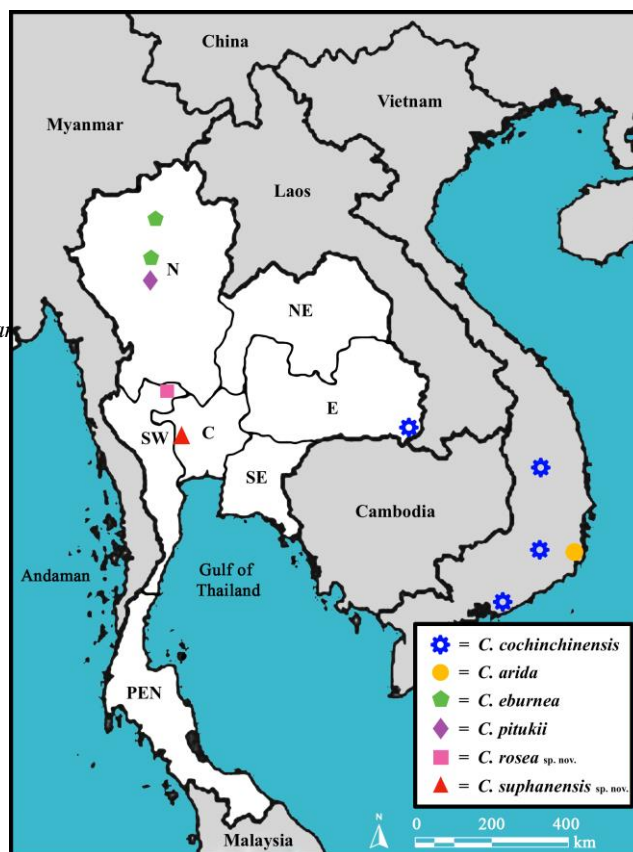


Figure 5. Distribution map of *Curcuma suphanensis* P. Saensouk, Boonma, Rakarcha, Maknoi, Wongnak & S. Saensouk sp. nov., *C. rosea* P. Saensouk, S. Saensouk & Boonma sp. nov. and their allies species. and its allies. Abbreviations in the map are the floristic region after the "Flora of Thailand" project which N: Northern; NE: Northeastern; SW: Southwestern; C: Central; E: East; SE: Southeastern; and PEN: Peninsular. (Designed by Thawatphong Boonma)

Table 1. Morphological comparison of *Curcuma suphanensis*, *C. rosea*, and their allies species

Characters	<i>C. suphanensis</i> sp.nov.	<i>C. eburnea</i>	<i>C. rosea</i> sp.nov.	<i>C. pitukii</i>
Ligule	16.5–18 mm long, pubescent	C. 8mm long, glabrous, but with short hairs at margins	12–14 mm long, pubescent, margin ciliate	C. 2 mm long, densely puberulent
Petiole	3.5–9 cm long, green, pubescent	9–18 cm long green, very shortly sparsely puberulent	3.7–9 cm long, green with a reddish brown tinge, pubescent	9–15 cm long, green to reddish, puberulent
Lamina	Lanceolate, 21–30 × 9–12.5 cm, apex acuminate with mucronate tip (mucro c. 1.5 mm long), base cuneate-oblique, adaxially glabrous, midrib light green, sparsely hairs, abaxially with fine short hairs	Elliptic to elliptic-ovate, 20–40 × 8–13 cm, apex acute to acuminate, base rounded to subcordate-oblique, adaxially glabrous, midrib green, glabrous, abaxially puberulent	Ovate to narrowly ovate, 22–36 × 9–14 cm, apex acuminate with mucronate tip (mucro c. 5 mm long), base rounded to cordate, slightly oblique adaxially glabrous, midrib with dark reddish patch, glabrous, abaxially pubescent	Elliptic, 22–32 × 9–12 cm, apex acute, base cuneate to rounded, adaxially densely puberulent, midrib green, puberulent, abaxially glabrescent with sometimes densely puberulent
Fertile bracts	1.5–3.5 × 1.2–3.0 cm, white with a reddish tinge at the distal part, pubescent, connate almost only at the base to lower 1/4	2.5–3 × 2.25–3.2 cm, cream white or pale greenish, glabrous, connate at the lower 1/2 to 1/3	1.2–3.5 × 1.7–4.0 cm, pink gradually to pinkish white at base, pubescent, connate almost only at the base to lower 1/3	1.8–3.5 × 2.5–4.5 cm, purplish-white to purple, puberulent, connate at lower 1/7 to 1/4
Bracteole	Present, obovate, 15–18 × 8–10 mm	Absent,	Absent,	Present (sometimes absent), narrowly triangular, c. 4 × 2 mm,
Flowers	4.0–4.1cm, cincinnus 3–4 flowers	5–5.5 cm, cincinnus 1–3 flowers	4.3–4.5 cm, cincinnus 3–4 flowers	4–5 cm long, cincinnus 2–4 flowers
Calyx	C. 13 mm long, unilaterally incision up to 5 mm long, white, sparsely hairy at the distal part	8–10 mm long, unilaterally incision 3–4 mm, white, glabrous	11–12 mm long, unilaterally incision up to 5 mm long, white, sparsely hairs	14–18 mm long, unilaterally incision 3–6 mm long, pale purple, puberulent
Floral tube	2.4–2.5 cm long, white, glabrous, except for a furrow on the same side as the dorsal corolla lobe has sparsely hairy	C. 3.5 cm long, white, glabrous	2.85–2.9 cm long, white, short fine hairy	2.2–3 cm long, purplish-white or pale purple, puberulent
Dorsal corolla lobe	13–14 × 9–10 mm, apex mucronate, mucro 1–1.5 mm long, white with pale pink tinge at the distal part, glabrous except few hairs at the tip	C. 18 × 12 mm, apex mucronate, mucro c. 1.5 mm long, pure white, glabrous	13–14 × 9–10 mm, apex mucronate, mucro c. 2 mm long, pink tip gradually to white at base, sparsely hairy	16–22 × 5–8 mm, apex mucronate, mucro c. 1 mm long, purplish-white to pale purple at basal part, glabrous at basal part with sparsely puberulent at the apex
Lateral corolla lobes	12–13 × 7.5–8 mm, apex obtuse, white with pale pink tinge at the distal part, glabrous except few hairs at the tip	14–18 × 10 mm, apex rounded, pure white, glabrous	11–12 × 8–9 mm, apex obtuse, pink tip gradually to white at base, sparsely hairy	12–19 × 4–7 mm, apex broadly acute, purplish to pale purple at basal part, glabrous at basal part with sparsely puberulent at the apex
Lateral staminodes	Uniquely narrowly ovate, 16.5–17 × 9–10 mm, apex acute to narrowly obtuse, white with yellow at the distal part and yellow line along midlobe, adaxially with short glandular hairs densely at the center and dispersal sparsely at the margin, abaxially sparsely puberulent to glabrous	Irregularly ovate to rhomboid, c. 15 × 12 mm, apex acute white or with a yellowish patch in the center and the apex, glabrous on both sides	Uniquely ovate, 12–13.5 × 9–10 mm, apex rounded, white, glabrous on both sides	Irregularly elliptic, 12–17 × 7–12 mm, apex acute, white, adaxially puberulent, abaxially sparsely puberulent to glabrous

Labellum	Ovate, 14–15 × 12–13 mm, apex emarginate, sinus c. 5 mm long, white with yellow at the distal part, short white glandular hairs along both sides of the median band and dispersal sparsely between median band to margin	Obscurely trilobed, 18–20 × 17–18 mm, apex emarginate, sinus up to 5 mm long, white with a bright yellow median band running through the center, glabrous on both sides	Rectangular, 14–15 × 14–15 mm, apex retuse, sinus less than 2 mm long, white with pale yellow at tip gradually to white median band, short pale brownish white hairs arranged as a short line along both sides of the median band, sparsely hairy (more dense near the midline and sporadic or too less at the edges and tip)	Irregularly obovate-rhomboid, 14–20 × 8–14 mm, apex emarginate, sinus 2–3 mm long, white with a yellow median band from base to apex (divided into two patches at the base like a y-shape), minutely puberulent on either side of the median band
Filament	2.5–3 mm long, c. 5 mm wide at base	C. 2 mm long, c. 5 mm wide at base	1.5–1.8 mm long, C. 3 mm wide at base	5–8 mm long C. 3 mm wide at base
Anther (measurement in side view including crest and spurs)	C. 7.8 mm long	8–9 mm long	6–6.5 mm long	C. 6 mm long
Anther thecae	5–5.5 mm long	6–6.5 mm long	4–4.5 mm long	C. 4 mm long
Anther spurs	Flattened triangular, c. 0.5 mm long	Narrowly triangular to filiform, 1–1.5 mm long	Flattened triangular C. 1 mm long	Filiform c. 0.8 mm long
Anther crest	C. 1.5 mm long, 2.0–2.2 mm wide, apex rounded, white with a yellow dot at the front side of the tip	1.5–2 mm long, c. 3 mm wide, apex rounded, white	C. 1 mm long, 2.0–2.2 mm wide, apex obtuse, white	1–3 mm long, c. 2 mm wide, apex slightly emarginate, white
Epigynous glands	C. 4 mm long, yellowish	C. 3 mm long, cream white	C. 3 mm long, yellowish	3–6 mm long, pale yellow
Ovary	Subglobose, c. 3 × 3 mm, pubescent	Cylindrical, 2 × 2 mm, glabrous	Subglobose, 2.7–3.0 × 2.7–3.0 mm, pubescent	Oblong, 3–6 × 1.5–2 mm, densely puberulent or rarely sparsely puberulent
Fruits	Subglobose to obovoid 10–12 × 10–12 mm, white, pubescent	Not seen	Subglobose to obovoid 8–10 × 8–10 mm, white, pubescent	Obovoid, 8–12 × 6–8 mm, Pure white with red dots towards the apical part, glabrous
Seeds	Obovoid, c. 3 × 2.5 mm	Not seen	Obovoid, c. 3.5 × 2.5 mm	Elliptic, 3–5 × 2–3 mm

Table 2. Some of the economics and cultural utilization of plants in the Zingiberaceae family in Thailand

Utilization	Species	Authority	References
Food & Spice	<i>Alpinia galanga</i>	(L.) Willd.	Sirirugsa (1999), Maknoi et al. (2016)
	<i>Alpinia siamensis</i>	K. Schum.	Maknoi et al. (2016)
	<i>Amomum foetidum</i>	Boonma & Saensouk	Boonma et al. (2020a)
	<i>Boesenbergia rotunda</i>	(L.) Mansf.	Maknoi et al. (2016)
	<i>Curcuma longa</i>	L.	Sirirugsa (1999), Maknoi et al. (2016)
	<i>Curcuma mangga</i>	Valeton & Zijp.	Maknoi et al. (2016)
	<i>Wurfbainia testacea</i>	(Ridl.) Škorničk. & A.D.Poulsen	Maknoi et al. (2016)
	<i>Zingiber officinale</i>	Roscoe.	Maknoi et al. (2016)
Medicinal herb	<i>Curcuma comosa</i>	Roxb.	Maknoi et al. (2016)
	<i>Curcuma longa</i>	L.	Sirirugsa (1999), Maknoi et al. (2016)
	<i>Curcuma rangjued</i>	Saensouk & Boonma	Saensouk et al. (2021c)
	<i>Curcuma wanenlueanga</i>	Saensouk, Thomudtha & Boonma	Saensouk et al. (2021b)
	<i>Kaempferia parviflora</i>	Wall.	Maknoi et al. (2016)
	<i>Zingiber pupureum</i>	Roscoe.	Sirirugsa (1999)
	<i>Curcuma achrae</i>	Saensouk & Boonma	Saensouk et al. (2022)
	<i>Curcuma alismatifolia</i>	Gagnep.	Sirirugsa (1999), Maknoi et al. (2016)
Ornamental plants	<i>Curcuma cordata</i>	Wall.	Saensouk et al. (2021c)
	<i>Curcuma petiolata</i>	Roxb.	Sirirugsa (1999)
	<i>Curcuma roscoeana</i>	Wall.	Sirirugsa (1999), Maknoi et al. (2016)
	<i>Etlingera elatior</i>	(Jack) R.M. Sm.	Sirirugsa (1999), Maknoi et al. (2016)
	<i>Globba williamsiana</i>	M.F. Newman & Sangvir.	Sangvirotnjanapat et al. (2020)
	<i>Kaempferia takensis</i>	Boonma & Saensouk	Boonma et al. (2020b)
	<i>Amomum wandokthong</i>	(Picheans. & Yupparach) Škorničk. & Hlavatá	Picheansoonthon & Yupparach 2010)
	<i>Curcuma chantaranothaii</i>	Boonma & Saensouk	Saensouk et al. (2021a)
Ornamental/ Folklore	<i>Curcuma phrayawan</i>	Boonma & Saensouk	Saensouk et al. (2021a)
	<i>Curcuma puangpeniae</i>	Boonma & Saensouk	Saensouk et al. (2021a)
	<i>Curcuma saraburiensis</i>	Boonma & Saensouk	Boonma & Saensouk 2019)
	<i>Curcuma siamensis</i>	Saensouk & Boonma	Saensouk P. et al. (2021)
	<i>Kaempferia maculifolia</i>	Boonma & Saensouk	Boonma et al. (2020b)
	<i>Kaempferia napavarniae</i>	Saensouk P., Saensouk & Boonma	Saensouk P. et al. (2022)
	<i>Kaempferia nigrifolia</i>	Boonma & Saensouk	Boonma et al. (2021)
	<i>Kaempferia rotunda</i>	L.	Sirirugsa (1999), Maknoi et al. (2016)
	<i>Kaempferia sakonensis</i>	Saensouk P., Saensouk & Boonma	Saensouk P. et al. (2022)
	<i>Wurfbainia biflora</i>	(Jack) Škorničk. & A.D.Poulsen.	Maknoi et al. (2016)
	<i>Hedychium coronarium</i>	J. Koenig	Sirirugsa (1999), Maknoi et al. (2016)
	<i>Hedychium flavescens</i>	Carey ex Roscoe	Suksathan et al. (2014), Maknoi et al. (2016)
Cosmetics/ Perfumes	<i>Kaempferia galanga</i>	L.	Sirirugsa (1999), Maknoi et al. (2016)

Additional specimens examined: used to refer to a location on a map (Figure 5)

Curcuma arida Škorničk. & N.S.Lý

VIETNAM: Ninh Thuận province, Ninh Hải District, Vĩnh Hải Commune, Thái An village, Núi Chúa National Park, 75 m, *Jana Leong-Škorničková, Nguyễn Quốc Bình, Aung Thame & Edward Ong JLS-2575* (holotype SING (inclusive spirit), isotypes E, P, VNM, VNMN (inclusive spirit)).

Curcuma cochinchinensis Gagnep.

THAILAND: Ubon Ratchathani province, *C. Maknoi* 1682, *QBG31724*, 9 August 2007 (QBG). VIETNAM: Lâm Đồng province, Lang Biang, Dans la chaîne annamitique - Entre Dran & Dang Lo, *P01673930*, 24 June 1922 (P). Baria province, *Talmy 122, P032709*, 1867 (syntype – P!). Gia Lai province, Mang Yang, Hana, *Willis F, Boyce P, Van Dzu N, 11*, 63688, altitude 1000 m., 13 May 1998 (spirit specimens – K!).

Curcuma eburnea Škorničk., Suksathan & Soonthornk.

THAILAND: Northern; Chiang Rai province, Khun Jae National Park, *Leong-Škorničková, J. GRC-179*, 24 September 2013, Made in the living collections of Singapore Botanic Gardens, plants received from Queen Sirikit Botanic Garden (holo SING, including flowers preserved in spirit; iso QBG, including flowers preserved in spirit); Lampang province, Hangchat, Ban Mae Yam Nai, about 2 km from the village, *Leong-Škorničková, J. GRC-193*, 8 January 2014, living collections of Singapore Botanic Gardens, plants received from Queen Sirikit Botanic Garden, originally collected from Thailand.

Curcuma pitukii Maknoi, Saensouk, Rakarcha & Thamma THAILAND: Northern; Lampang province, Sop Prap District, *S. Rakarcha, W. Thammarong, S. Wongwan & M. Tabut 940*, 20 August 2020 (holotype QBG!; isotypes BKF!, KCU!).

Curcuma sixsensesensis D.D. Nguyen & T.A. Le

VIETNAM: Khanh Hoa province, Ninh Hoa District, Ninh Van Commune, 150–200 m a.s.l., 10 September 2021, *Le Tuan Anh, Hoang Quoc Huy, Le Quoc Thuong, Emmy Nguyen No LTA-1220* (holotype VNMN!).

ACKNOWLEDGEMENTS

This research project was financially supported by Mahasarakham University. We would like to thank Queen Sirikit Botanical Garden (QBG), Walai Rukhavej Botanical Research Institute (WRBRI), Mahasarakham University, and Brio Botanical Research Garden (BBRG), for their facilities during our research and the herbarium curators who assisted us.

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