

Curcuma ubonensis (Zingiberaceae), a new species of *Curcuma* subgen. *Hitcheniopsis* from Eastern Thailand

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Abstract

Curcuma ubonensis Boonma, Saensouk, Maknoi & P. Saensouk sp. nov. (Zingiberaceae) was recently discovered in Ubon Ratchathani Province, Eastern Thailand. Specimen identification involves comparing their morphology with descriptions in similar species' protologues. We performed measurements on specimens collected from their natural habitats, both living and preserved. Despite its resemblances with *Curcuma prasina* Škorničk. in having greenish inflorescence with small purple flowers that lack of epigynous glands, yet this novel species displays distinct features of a brownish-red margin of petiole (vs. *C. prasina* has green margin), lamina elliptic, 3.8-7.0 cm wide, margin brownish red (vs. narrowly elliptic, 1.5-3.2 cm wide, margin green); coma bract present (vs. absent), fertile bracts uniquely triangular-obovate, apex rounded (vs. almost orbicular, apex acute), and labellum reddish purple with four white stripes by two stripes rarely pale yellow extending from the basal to half of the sinus, and another two stripes from the basal along the longitudinally of each lobe to half the length of the lobe, with yellow at the middle groove of the labellum almost to the base (vs. 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). Meticulous examination and morphological comparison of *Curcuma ubonensis* with related species within the *Curcuma* genus reveals its novelty. We comprehensively accounted for its morphological traits, including illustrations, vernacular name, ecological preferences, phenology, distribution, traditional uses, conservation status, distribution map, and a comparative table to its ally species. Furthermore, we present an updated identification key for differentiating species within the *Curcuma* subgenus *Hitcheniopsis* in Thailand.

Keywords: *Curcuma*; taxonomy; Ubon Ratchathani; Zingiberales; Zingibereae

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Introduction

The Zingiberaceae family, commonly known as the ginger family, comprises of a diverse group of flowering plants distributed worldwide throughout tropical and subtropical areas, including Africa, the Americas, and Asia. With approximately 57 accepted genera and over 1,900 species (POWO, 2023), Zingiberaceae has a wide range of morphology terrestrial, and certain species are epiphytic species such as *Cautleya gracilis* (Sm.) Dandy, and various ecological characteristics, in instance of evergreen, dry evergreen, and deciduous forests (Larsen and Larsen, 2006). Some endemic species grow in a specific area, including *Curcuma supraneaana* (W. J. Kress & K. Larsen) Škorničk. (Kress and Larsen, 2001; Leong-Škorničková *et al.*, 2015) that grows along the limestone terraces found only in Phra Phutthabat District, Saraburi Province, and neighboring contact areas.

Thailand boasts one of the richest diversities of Zingiberaceae plants, with the family being notably abundant and diverse in the country's flora. Thailand is home to approximately 29 accepted genera and over 400 species of Zingiberaceae (Larsen and Larsen, 2006; Saensouk *et al.*, 2007; Maknoi *et al.*, 2011; Saensouk and Saensouk, 2014; Saensouk *et al.*, 2016; Škorničková *et al.*, 2017; Saensouk *et al.*, 2018; Boonma and Saensouk, 2019; Saensouk and Saensouk, 2019a, b; Sangvirotjanapat *et al.*, 2019a, b; Boonma and Saensouk, 2020; Boonma *et al.*, 2020a, b; Saensouk and Saensouk, 2020a, b; Boonma *et al.*, 2021; Leong-Škorničková *et al.*, 2021; Saensouk and Saensouk, 2021a, b, c, d; Saensouk *et al.*, 2021a, b, c, d, e; Sangvirotjanapat *et al.*, 2021; Ye *et al.*, 2021; Boonma *et al.*, 2022; Ragsasilp *et al.*, 2022; Rakarcha *et al.*, 2022; Saensouk *et al.*, 2022a, b, c, d, e, f; Boonma *et al.*, 2023; POWO, 2023). The tropical climate and diverse ecosystems found in Thailand create favorable conditions for the growth and proliferation of Zingiberaceae species. Consequently, Thailand holds significant importance as a region for studying the extensive diversity and evolutionary patterns within this fascinating plant family.

Within the Zingiberaceae family, the *Curcuma* genus is one of the most prominent and well-known genera. *Curcuma* encompasses numerous species valued highly for their medicinal, culinary, and ornamental properties. Many of these species have been previously reported from Thailand (Siriruga, 1998; Khamtang *et al.*, 2014; Maknoi *et al.*, 2016; Saensouk *et al.*, 2018, 2021a, c, d, e; Boonma *et al.*, 2023; Inta *et al.*, 2023). Among the subgenera within the *Curcuma* genus, a classification proposed by Siriruga *et al.* (2007) divided the species into five groups based on characteristics such as the absence or presence of epigynous glands, anther shape, and the production of coma bracts. Subsequent studies by Závěská *et al.* (2012) and Leong-Škorničková *et al.* (2015) supported the classification of *Curcuma* into three subgenera. The first subgenus, *Hitcheniopsis* (Baker) K. Schum., is characterized by the absence of epigynous glands. The other two subgenera have epigynous glands, with the subgenus *Curcuma* L. typically having well-developed coma bracts, and the subgenus *Ecomatae* Škorničk. & Šida f. typically lacking coma bracts.

There are 25 species within the *Curcuma* subgenus *Hitcheniopsis* found in Thailand, which encompass *Curcuma alismatifolia* Gagnep., *C. bella* Maknoi, K. Larsen & Siriruga, *C. campanulata* (Kuntze) Škorničk., *C. charanii* Boonma & Saensouk, *C. clovisii* Škorničk., *C. fimbriata* Škorničk. & Soonthornk., *C. gracillima* Gagnep., *C. harmandii* Gagnep., *C. involucrata* (King ex Baker) Škorničk., *C. lithophila* Škorničk. & Soonthornk., *C. macrochlamys* (Baker) Škorničk., *C. micrantha* Škorničk. & Soonthornk., *C. papilionacea* Soonthornk., Ongsakul & Škorničk., *C. parviflora* Wall., *C. pedicellata* (Chaveer. & Mokkamul) Škorničk., *C. prasina* Škorničk., *C. puangpeniae* Boonma & Saensouk, *C. purpurata* Boonma & Saensouk, *C. rhabdota* Siriruga & M. F. Newman, *C. rufostriata* Škorničk. & Soonthornk., *C. saraburiensis* Boonma & Saensouk, *C. sparganiifolia* Gagnep., *C. spatulata* Škorničk. & Soonthornk., *C. stablianthoides* Škorničk. & Soonthornk., and *C. thorelii* Gagnep. (Wallich, 1830; Gagnepain, 1902; Gagnepain, 1907; Larsen, 1996; Siriruga and Newman, 2000; Larsen and Larsen, 2006; Maknoi *et al.*, 2011; Leong-Škorničková *et al.*,

2015; Leong-Škorničková *et al.*, 2017; Leong-Škorničková *et al.*, 2021; Boonma and Saensouk, 2019; Soonthornkalump *et al.*, 2020; Soonthornkalump *et al.*, 2021; Soonthornkalump *et al.*, 2022; Saensouk *et al.*, 2021d).

In addition to the extensive list of known species within the *Curcuma* subgenus *Hitcheniopsis* in Thailand, our study focuses on a newly identified species. This recent discovery, found in Ubon Ratchathani Province, Eastern Thailand, prompted us to describe its morphological characteristics comprehensively. For providing more information about this species, we compared it to other closely related species that exhibit similar morphological traits. Through detailed descriptions, our research aims to shed light on various aspects of this new species, including its distribution, ecological preferences, phenology, vernacular name, conservation status, and traditional uses. Furthermore, we have revised the species identification key, specifically tailored to distinguish this newly discovered species within the *Curcuma* subgenus *Hitcheniopsis* in Thailand.

Materials and Methods

This study conducted in the fieldwork collection missions of Ubon Ratchathani Province, Eastern Thailand, in 2022 (Figure 1). Measurements were performed on the living and preserved specimens collected from their natural habitats. To accurately record morphological characteristics, we utilized tools, such as rulers and vernier calipers and conducted thorough examinations under a stereoscopic microscope (Stemi 2000-C, ZEISS, Oberkochen, Germany). Holotype specimens were appropriately deposited at the Khon Kaen University Herbarium (KKU). Some specimens preserved using 70% ethyl alcohol. The remaining living specimens cultivated at Brio Garden in Nakhon Nayok Province, Central Thailand. For precise identification, we compared the characteristics of our specimens with those documented in the protologues of morphologically similar species. We extensively referenced available digital images and information from herbarium collections such as 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), and Singapore Botanic Gardens Herbarium (SING). Furthermore, we thoroughly reviewed published literature on *Curcuma*, emphasizing the morphological descriptions of all accepted species within the *Curcuma* subgenus *Hitcheniopsis*.

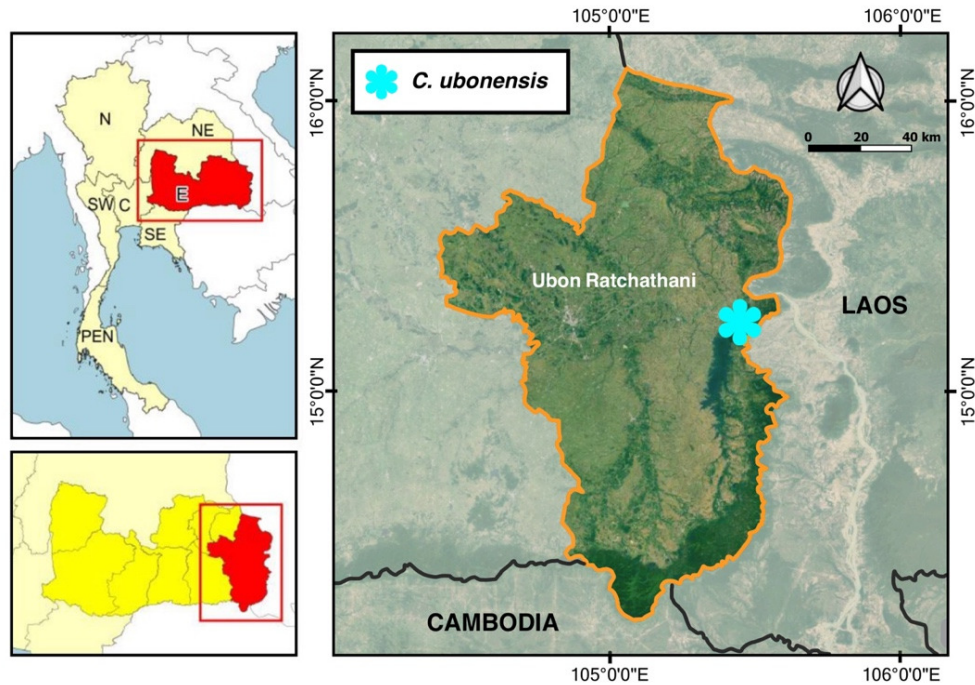


Figure 1. Distribution map of *Curcuma ubonensis* Boonma, Saensouk, Maknoi & P. Saensouk sp. nov. Map of Thailand showing floristic regions: N: Northern, NE: Northeastern, E: Eastern, C: Central, SE: Southeastern, SW: Southwestern, and PEN: Peninsular, refer to map of floristic regions of the Flora of Thailand project (Map created with "Pixelmator Pro", designed by Thawatphong Boonma).

Results

In this study, we presented the description of a new species, *Curcuma ubonensis* Boonma, Saensouk, Maknoi & P. Saensouk (Zingiberaceae: Zingibereae) discovered in Ubon Ratchathani Province, Eastern Thailand, belonging to the *Curcuma* subgenus *Hitcheniopsis*. Our description includes detailed information on its morphological characteristics and is supported by illustrations. We also provide the vernacular name, ecological attributes, phenology, utilization, conservation status, distribution map, and a comparative table to correlate it with other allied species. Additionally, we offer a revised key encompassing 26 species within the *Curcuma* subgenus *Hitcheniopsis*.

Taxonomic treatments

Curcuma ubonensis Boonma, Saensouk, Maknoi & P. Saensouk sp. nov. (Figures 1-4, Table 1)

The new species is similar to *Curcuma prasina* Škorničk. in having greenish inflorescence with small purple flower that lack of epigynous glands. But there are some differences between them. *Curcuma ubonensis* Boonma, Saensouk, Maknoi & P. Saensouk having larger rhizome, brownish externally, white internally (vs. *Curcuma prasina* having pale yellow externally, pale yellow internally); petiole with brownish-red margin (vs. green margin); lamina elliptic, 3.8-7.0 cm wide, apex acute with slightly mucronulate tip, margin brownish red (vs. narrowly elliptic, 1.5-3.2 cm wide, apex attenuate, margin green); coma bract present, 4-6 in numbers (vs. absent); fertile bracts uniquely triangular-obovate, apex rounded (vs. almost orbicular, apex acute); bracteoles 7-10 × c. 7 mm (vs. 3-5 × 1.5-2.5 mm); calyx c. 7 mm long with unilateral incision up to 2-2.5 mm long (vs. c. 5 mm long without unilateral incision); dorsal corolla lobe apex mucronulate (vs. apex rounded); labellum broader, 7-7.5 × 8 mm, bilobed, each lobe pointing away from one another, with incision 3.5-4 mm long,

various shade of reddish purple, four white stripes by two stripes extending from the basal to half of the sinus, and another two stripes from the basal along the longitudinally of each lobe to half the length of the lobe, with yellow at the middle groove of the labellum almost to the base (vs. c. 8×6 mm, bilobed, each lobe not pointing away from one another, with incision 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 two-thirds the length of the labellum towards the apex, sides of the labellum with paler lines radiating towards the margin); anther crest not obvious (vs. present).

Type: Thailand, Ubon Ratchathani Province, Sirindhorn District, 158 m a.s.l., Boonma 902, 01 July 2022 (holotype KKU!).

Perennial herb, *leafy shoot* 25-40 cm tall. *Primary rhizome* ovoid, brownish externally, white internally, $2.0-2.7 \times 1.8-2.4$ cm, mild aroma (if scraping the surface of the rhizome, it smells like raw mango), new shoot arises from the buds of the old rhizome and growing close to the old rhizomes, without branched rhizome. *Root* fibrous with tuberous roots. Tuber ellipsoid or ovoid, $2-4 \times 1.2-1.5$ cm, white internally, three internally layers can be distinguished when cross-section, the outer and core layers appear similar to clear agar, while the second layer resembles a powdery white substance, forming a clearly visible white ring, tuberous roots placed closed to rhizome (0.5-2 cm apart). *Pseudostem* 8-15 cm. *Sheathing bracts* 1-3 in number, 2-10 cm long, green, sometime with a dark reddish tinge, white underground part, apex mucronulate, glabrous. *Leaf-sheaths* 2-4 in number, 6-11 cm long, distichous, green, or green with various dark red tinge, glabrous; ligule membranous, very short, 0.10-0.15 cm long, translucent white or very pale green, almost truncate, glabrous. *Petiole* canaliculate, 1.0-6.5 cm long, green with brownish-red margin, glabrous. *Lamina* elliptic to oblanceolate, $12-25 \times 3.8-7.0$ cm, apex acute with slightly mucronulate tip, base attenuate, margin entire, red margin, and some parts of the margin with delicate waves, adaxially dark green, midrib usually green, rarely with dark reddish tinge, thick blade, not prominently veins; abaxially pale green, glabrous on both surfaces. *Inflorescence* terminal; thyrses 4.8-8.6 cm long, 2.5-4.0 cm in diam. in the broadest part; peduncle 7.5-9.2 cm long, 0.4-0.5 cm in diameter, pale green, glabrous. *Coma bract* 5-8 in numbers, elliptic to obovate, $1.0-2.2 \times 0.5-1.3$ cm, pale green or white with pale green tip and margin, apex acute to obtuse, glabrous. *Fertile bracts* 10-13 in number, $2.5-4 \times 1.2-1.7$ cm, uniquely triangular-obovate, bulbous with a curved downward distal part, apex rounded, green with darker green at distal part and margin, connate to other bracts about half of the length, glabrous, lowest bracts are the broadest and longest, cincinni with 4-5 flowers. *Bracteoles* ovate, carinate, $0.7-1.0 \times c. 0.7$ cm, very pale green to white, apex acute, glabrous, one bracteole subtending a single flower. *Flowers* 2.3-2.5 cm. *Calyx* tubular c. 0.7 cm long, apex 3-lobed, with unilateral incision up to 2-2.5 mm long, semi-translucent white, glabrous. *Floral tube* tubular, 1.3-1.4 cm long, white with yellowish tinge at distal part, glabrous; *dorsal corolla* lobe 1, c. 7×4 mm, apex cucullate with mucronulate tip, very pale yellow sometimes with purplish tinge at tip, glabrous; *lateral corolla* lobes 2, c. 6×3 mm, apex obtuse, cucullate, very pale yellow, glabrous. *Lateral staminodes* 2, obovate, c. 7×4 mm at broadest part, 2 mm at base, apex rounded to truncate with erose margin, various shade of pale purplish with yellowish at the base, glabrous. *Labellum* 7-7.5 mm long, 8.0-8.5 mm at the broadest part, 3.5-4 mm wide at the base, deep incision 3.5-4 mm long, bilobed, each lobe pointing away from one another, various shade of reddish purple, four white stripes by two stripes extending from the basal to half of the sinus, and another two stripes from the basal along the longitudinally of each lobe to half the length of the lobe, with red and yellow at the middle groove of the labellum, pale yellow at the base, erose margin, glabrous. *Stamen* 1; filament flat, c. $2 \times 1.4-1.6$ mm, reddish purple with yellowish at the base; anther ecalcarate, 2-2.4 mm long, c. 1.7 mm at the broadest part, very pale yellow with purplish tinge at distal part, pubescent; anther thecae c. 1.2 mm long, with white pollen; crest not obvious. *Stigma* c. 0.5×0.6 mm, white. *Epigynous glands* absent. *Ovary* subglobose, c. 2.5×2.5 mm, very pale green, glabrous. *Ovule* axile placentation. *Fruits* trilocular, $0.7-0.9 \times 0.8-1.0$ cm, green (will turn darker when old), glabrous. *Seeds* $3-4 \times 1.9-2.2$ mm, yellowish brown (will turn dark brown when old), glabrous, with white arils.

Vernacular name: "Krachiao Ubon" (Krachiao is an Isan word used to call plants in the *Curcuma* genus, while "Ubon" is named after the type locality in Ubon Ratchathani Province.

Etymology: The specific epithet of "ubonensis" is named after the type locality where this naturalized in Ubon Ratchathani Province.

Distribution: Thailand, Ubon Ratchathani Province, known only from the type locality (Figure 1).

Ecology: In a deciduous forest on rich humus sandy soil, 120-170 meters above sea level.

Phenology: Flowering in June to September, fruiting in July to September; produced terminal inflorescence appearing between the innermost leaf sheaths, 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: Auspicious ornamental plant.

Conservation status: The newly discovered species was encountered in 2022. Based on the available information and in accordance with the IUCN criteria (2022), we recommend classifying this species as Data Deficient (DD) due to insufficient data on its distribution range. While it is possible that this species found in Laos PDR, we understand the importance of its conservation, considering the limited numbers found in its natural habitats. Therefore, we suggest treating this species as an endangered plant to prioritize its conservation efforts until further research better understand its distribution and population status. This proactive approach will help to ensure the preservation of this newly discovered species and its habitat.

Table 1. Morphological comparison of *Curcuma ubonensis* Boonma, Saensouk, Maknoi & P. Saensouk sp. nov. and its ally's species

Characteristics	<i>Curcuma ubonensis</i> Boonma, Saensouk, Maknoi & P. Saensouk	<i>Curcuma prasina</i> Škorničk.
Rhizome	2.0-2.7 × 1.8-2.4 cm, white internally	c. 1.5 × 1.0-1.5 cm, pale yellow internally
Tuber root	2-4 × 1.2-1.5 cm	c. 2 × 0.6 cm
Petiole	1.0-6.5 cm long, green with brownish red margin	2-12 cm long, green with green margin
Lamina	Elliptic to oblanceolate, 12-25 × 3.8-7.0 cm, Apex acute with slightly mucronulate tip, Margin brownish red	Narrowly elliptic, 11-19 × 1.5-3.2 cm, Apex attenuate, Margin green
Thyrse	4.8-8.6 × 2.5-4.0 cm	2.5-6 × 1.8-3.7 cm
Peduncle	7.5-9.2 cm long	10-20 cm long
Coma bract	5-8 in numbers, elliptic to obovate, 1.0-2.2 × 0.5-1.3 cm, pale green or white with pale green tip and margin, apex acute to obtuse, glabrous.	Absent
Fertile bracts	Uniquely triangular-obovate, 2.5-4 × 1.2-1.7 cm, apex rounded	Almost orbicular, 1.5-2.1 × 1.5-2 cm, apex acute
Bracteoles	7-10 × c. 7 mm, very pale green to white	3-5 × 1.5-2.5 mm, translucent-white
Calyx	c. 7 mm long, with unilateral incision up to 2-2.5 mm long	c. 5 mm long, no obvious unilateral incision
Floral tube	White with yellowish tinge at distal part	White
Dorsal corolla lobe	c. 7 × 4 mm, apex mucronulate, very pale yellow sometimes with purplish tinge at tip	c. 6 × 3.5 mm, apex rounded, white
Lateral corolla lobes	c. 6 × 3 mm, apex obtuse, very pale yellow	c. 5.5 × 2.5 mm, apex rounded, white
Labellum	7-7.5 × 8.0-8.5 mm, Incision 3.5-4 mm long, Various shade of reddish purple, four white stripes by two stripes rarely pale-yellow extending from the basal to half of the sinus, and another two stripes from the basal along the longitudinally of each lobe to half the length of the lobe, with red and yellow at the middle groove of the labellum, pale yellow at the base	c. 8 × 6 mm, Incision c. 3 mm long, 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	c. 2 × 1.4-1.6 mm, Reddish purple with yellowish at the base	c. 2 × 2 mm, Very pale pink
Anther	2-2.4 mm long, c. 1.7 mm wide	c. 3 mm long, c. 1.5 mm wide
Anther thecae	c. 1.2 mm long	c. 1.7 mm long
Anther crest	Not obvious	Obtuse, c. 1.3 × 1.1 mm, pale pink, glabrous
Ovary	c. 2.5 × 2.5 mm	1.5-2 × c. 1.5 mm



Figure 2. *Curcuma ubonensis* Boonma, Saensouk, Maknoi & P. Saensouk. sp. nov.; (A) coma bracts; (B) seeds; (C) fruit with calyx; (D) staminodes; (E) labellum; (F) dorsal corolla lobe; (G) lateral corolla lobes; (H) side view of the secund flower with its cincinni; (I) fertile bract; (J) front view of anther; (K) semi-side view of anther with filament, floral tube, calyx, and ovary; (L) habit; (M) top view of inflorescence; (N) side view of inflorescence; (O) bracteole; (P) cross section of rhizome with tuberous roots; (Q) cross section of tuberous root (Photographed and designed by Thawatphong Boonma)

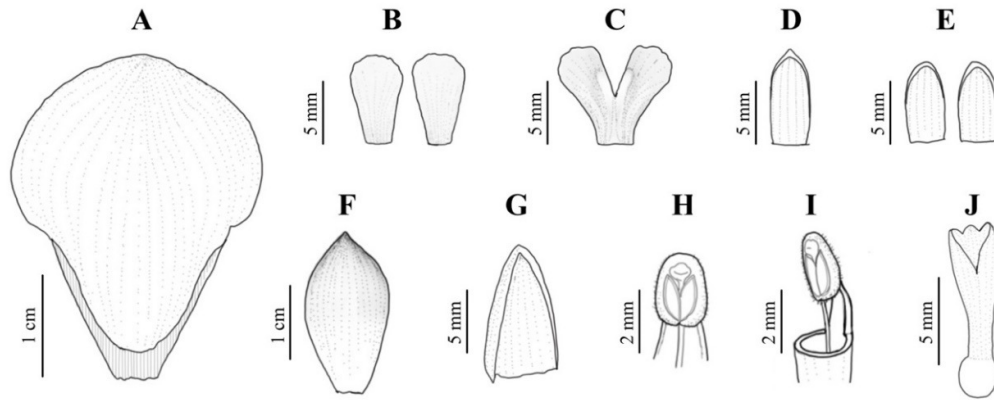


Figure 3. *Curcuma ubonensis* Boonma, Saensouk, Maknoi & P. Saensouk. sp. nov.; (A) fertile bract; (B) lateral staminodes; (C) labellum; (D) dorsal corolla lobe; (E) lateral corolla lobes; (F) coma bract; (G) bracteole; (H) front view of anther; (I) semi-side view of anther with filament; (J) calyx with ovary (Drawn by Thawatphong Boonma)



Figure 4. *Curcuma ubonensis* Boonma, Saensouk, Maknoi & P. Saensouk. sp. nov.; (A) close-up front view of the flower; (B) inflorescence with flower and some part of lamina with red margin (Photographs by Thawatphong Boonma)

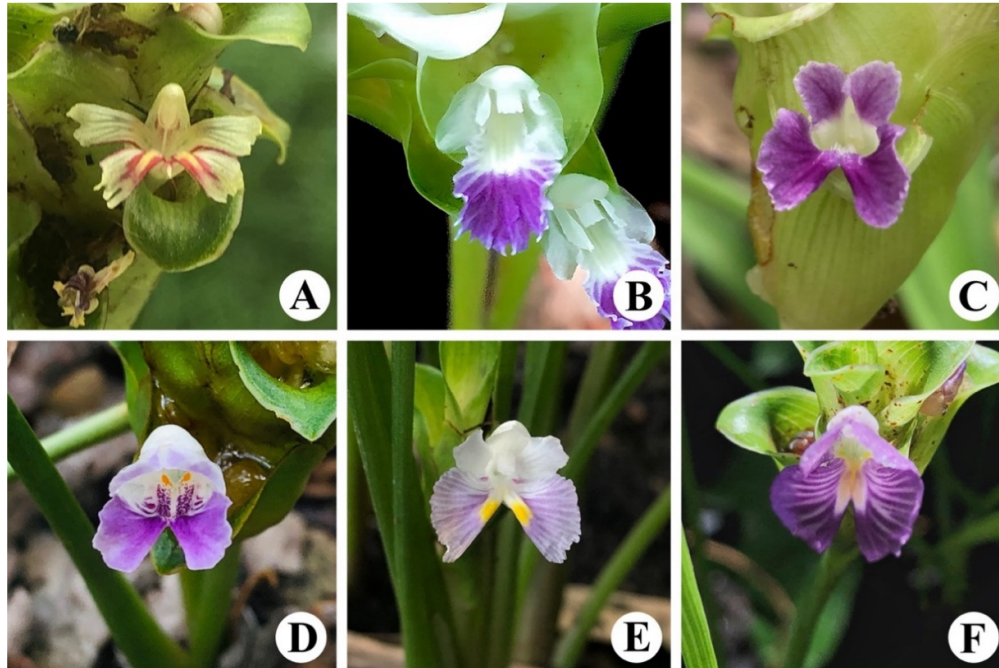


Figure 5. Some species of *Curcuma* subgenus *Hitcheniopsis*; The upper row are species with well-developed coma bract, namely (A) *Curcuma gracillima* Gagnep., (B) *C. parviflora* Wall., (C) *C. thorelii* Gagnep.; The lower row are species lacking coma bract, namely (D) *C. charanii* Boonma & Saensouk, (E) *C. puangpeniae* Boonma & Saensouk; (F) *C. prasina* Škorničk. (Photographs and designed by Thawatphong Boonma)

Key to 26 species of *Curcuma* subgen. *Hitcheniopsis* in Thailand.

1a. Inflorescence campanulate thyrses, with two or three fertile bracts	2
1b. Inflorescence cylindrical thyrses, with more than five fertile bracts	6
2a. Young lamina with rich red tinge on both surfaces	<i>Curcuma macrochlamys</i>
2b. Young lamina green or with very narrow red patch along the midrib	3
3a. Involucral bracts are green throughout	4
3b. Involucral bracts are red or have a green apex	5
4a. Pseudostem with 2-3 leaves, inflorescence cincinni with 15-20 flowers	<i>Curcuma campanulata</i>
4b. Pseudostem with 4-5 leaves, inflorescence cincinni with 6-8 flowers	<i>Curcuma involucrata</i>
5a. Labellum without red	<i>Curcuma clovisii</i>
5b. Labellum with red	<i>Curcuma pedicellata</i>
6a. Anther prominently calcarate	7
6b. Anther ecalcarate	8
7a. Fertile bracts brownish red with light green, two pink patches	<i>Curcuma rufostriata</i>
7b. Fertile bracts green with pale green venation, two greenish-white patches	<i>Curcuma papilionacea</i>
8a. Lamina pubescent on the abaxial surface	9
8b. Lamina glabrous on the abaxial surface	11
9a. Coma bract absent; flower without purple; calyx pubescent	<i>Curcuma stablianthoides</i>
9b. Coma bract present; flower with purple; calyx glabrous	10
10a. Stamines plain white; fertile bracts plain green, pubescent	<i>Curcuma purpurata</i>
10b. Stamines white with red stripes; fertile bract green with pale green or white longitudinal lines with two white patches, glabrous	<i>Curcuma saraburiensis</i>
11a. Fertile bracts with pinkish, reddish, or brownish tinge	12
11b. Fertile bracts green or green with white	16
12a. Coma bract absent	13

12b. Coma bract present	15
13a. Labellum without yellow; sheaths and calyx pubescent	<i>Curcuma lithophila</i>
13b. Labellum with yellow; sheaths and calyx glabrous	14
14a. Lamina ovate, base rounded	<i>Curcuma bella</i>
14b. Lamina narrowly elliptic, base attenuate	<i>Curcuma sparganiifolia</i>
15a. Labellum with red	<i>Curcuma rhabdota</i>
15b. Labellum without red	<i>Curcuma micrantha</i>
16a. Staminodes without purple	17
16b. Staminodes with purple	22
17a. Filament pubescent; labellum with pink	<i>Curcuma harmandii</i>
17b. Filament glabrous; labellum without pink	18
18a. Flower with red	19
18b. Flower without red	20
19a. Lamina base attenuate; labellum with yellow	<i>Curcuma gracillima</i>
19b. Lamina base obtuse; labellum without yellow	<i>Curcuma spatulata</i>
20a. Coma bracts pink with greenish brown tinge at tip	<i>Curcuma alismatifolia</i>
20b. Coma bracts absent	21
21a. Labellum obscurely bifid apex, with prominently fimbriate margin, curly	<i>Curcuma fimbriata</i>
21b. Labellum prominently bifid apex, without fimbriate margin as above	<i>Curcuma puangpeniae</i>
22a. Filament glabrous; lamina base attenuate	23
22b. Filament pubescent; lamina base obtuse	25
23a. Margin of lamina red; coma bract present	<i>Curcuma ubonensis</i>
23b. Margin of lamina green to white; coma bract absent	24
24a. Labellum with bright yellow median band to the base	<i>Curcuma prasina</i>
24b. Labellum without yellow median band but two dark yellow spots at the base	<i>Curcuma charanii</i>
25a. Coma bract white with green tip	<i>Curcuma parviflora</i>
25b. Coma bract pure white	<i>Curcuma thorelii</i>

Discussion

Curcuma ubonensis Boonma, Saensouk, Maknoi & P. Saensouk classifies under the *Curcuma* subgenus *Hitcheniopsis* due to the absence of epigynous glands in its flowers, unlike the other two subgenera, *Curcuma* and *Ecomatae*, which have epigynous glands. Furthermore, when comparing its morphology to other species within the same subgenus *Hitcheniopsis*, particularly those found in Thailand, several common characteristics are observed, including the presence of tuberous roots and bracteoles, as well as a glabrous ovary.

The *Curcuma* subgenus *Hitcheniopsis* in Thailand can be divided into two distinct groups based on the characteristics and position of the inflorescence. The first group characterized by producing lateral inflorescence and campanulate thyse, consisting of two or three fertile bracts. The members of this group were previously classified in the former *Stahlianthus* genus but are now nested within *Curcuma* subgenus *Hitcheniopsis*, including *C. campanulata* (Kuntze) Škorničk., *C. clovisii* Škorničk., *C. involucrata* (King ex Baker) Škorničk., *C. macrochlamys* (Baker) Škorničk., and *C. pedicellata* (Chaveer. & Mookamul) Škorničk. (Leong-Škorničková *et al.*, 2015). The second group, in contrast, produces terminal inflorescences with cylindrical thyse and more than five fertile bracts, including *C. bella* Maknoi, K. Larsen & Siriruga, *C. charanii* Boonma & Saensouk, *C. fimbriata* Škorničk. & Soonthornk., *C. gracillima* Gagnep., *C. harmandii* Gagnep., *C. lithophila* Škorničk. & Soonthornk., *C. micrantha* Škorničk. & Soonthornk., *C. papilionacea* Soonthornk., Ongsakul & Škorničk., *C. parviflora* Wall., *C. prasina* Škorničk., *C. puangpeniae* Boonma & Saensouk, *C. purpurata* Boonma & Saensouk, *C. rhabdota* Siriruga & M. F. Newman, *C. rufostriata* Škorničk. &

Soonthornk., *C. saraburiensis* Boonma & Saensouk, *C. sparganiiifolia* Gagnep., *C. spathulata* Škorničk. & Soonthornk., *C. stablianthoides* Škorničk. & Soonthornk., and *C. thorelii* Gagnep.

When examining *Curcuma ubonensis*, one notable distinction is its ecalcarate anther, which makes it different from *C. papilionacea* Soonthornk., Ongsakul & Škorničk. (Soonthornkalump *et al.*, 2020) and *C. rufostriata* Škorničk. & Soonthornk. (Soonthornkalump *et al.*, 2021) that exhibit prominently calcarate anther. Additionally, the glabrous abaxial surface of the lamina in *C. ubonensis* serves as a distinguishing feature from species like *C. purpurata* Boonma & Saensouk (Saensouk *et al.*, 2021d), *C. saraburiensis* Boonma & Saensouk (Boonma and Saensouk, 2019), and *C. stablianthoides* Škorničk. & Soonthornk. (Soonthornkalump *et al.*, 2022).

Another notable characters that make *Curcuma ubonensis* different from related species is the presence of green bracts. This contrasts with species, such as *Curcuma bella* Maknoi, K. Larsen & Siriruga (Maknoi *et al.*, 2011), *C. lithophila* Škorničk. & Soonthornk. (Soonthornkalump *et al.*, 2021), *C. micrantha* Škorničk. & Soonthornk. (Leong-Škorničková *et al.*, 2021), *C. rhabdota* Siriruga & M. F. Newman (Siriruga and Newman, 2000), and *C. sparganiiifolia* Gagnep. (Gagnepain, 1902), which exhibit pink, red, or reddish-brown bracts.

When considering the flower color, an interest distinction arises when comparing the staminodes of various species. In particular, species of *Curcuma alismatifolia* Gagnep. (Gagnepain, 1902), *C. fimbriata* Škorničk. & Soonthornk. (Leong-Škorničková *et al.*, 2021), *C. gracillima* Gagnep. (Maknoi and Jenjittikul, 2006; Leong-Škorničková *et al.*, 2015), *C. harmandii* Gagnep. (Gagnepain, 1907), *C. puangpeniae* Boonma & Saensouk (Saensouk *et al.*, 2021d), and *C. spathulata* Škorničk. & Soonthornk. (Leong-Škorničková *et al.*, 2021) do not possess a purple hue in their staminodes color. In contrast, *Curcuma ubonensis* has staminodes color displaying a delicate pale purple. This difference in staminode color adds to the distinctiveness of *C. ubonensis* among the compared species.

While species that exhibit purple staminodes or similar purple tinges, akin to *C. ubonensis*, include *C. charanii* Boonma & Saensouk (Saensouk *et al.*, 2021d), *C. parviflora* Wall. (Wallich, 1830), *C. prasina* Škorničk. (Leong-Škorničková *et al.*, 2017), and *C. thorelii* Gagnep. (Gagnepain, 1907). However, *Curcuma ubonensis* differs in several aspects by the stable, prominently red lamina margin, a characteristic absent in other species within the *Curcuma* subgenus *Hitcheniopsis*. Additionally, *C. ubonensis* lacks the two dark yellow spots at the base of the labellum, which are present in *C. charanii*, further highlighting their differences. Furthermore, while both *C. thorelii* and *C. parviflora* share the white coloration of the coma bracts similar to *C. ubonensis*, their lamina has an obtuse base, and their filaments are pubescent, contrasting with *C. ubonensis*, which has an attenuate base of the lamina and glabrous filaments. And although *C. ubonensis* may look similar to *C. prasina* when viewed from the side of the inflorescence (Figure 4B), it differs from *C. prasina* in several characteristics, as shown in Table (1), and close-up flower photographs of some similar species are provided in Figure (5).

In addition to the species in the same genus found in Thailand, it is importance to consider the comparison with another similar species of *Curcuma pygmaea* Škorničk. & Šída f. (Leong-Škorničková *et al.*, 2014) that is native to Vietnam and has not discovered in Thailand. Despite of the geographical difference, comparing *C. pygmaea* with *C. ubonensis* reveals several distinct characteristics. Notably, *C. pygmaea* typically possesses a lamina with a red midrib, a trait that is very rarely in *C. ubonensis*. On the other hand, the lamina margin of *C. pygmaea* lacks the red color that observes prominently in *C. ubonensis*. Furthermore, *C. pygmaea* lacks coma bracts, distinguishing it from *C. ubonensis*, which exhibits white coma bracts.

Conclusions

Curcuma ubonensis Boonma, Saensouk, Maknoi & P. Saensouk is notably distinguished as a unique entity within the *Curcuma* genus, particularly within the subgenus *Hitcheniopsis*. Its classification is substantiated by the lack of epigynous glands in its flowers, a characteristic shared with other constituents of the same subgenus. Consequently, Thailand is home to 26 species belonging to the *Hitcheniopsis* subgenus.

Authors' Contributions

Conceptualization PS, SS and TB; Data curation TB; Formal analysis PS, SS, CM and TB; Funding acquisition SS; Investigation TB; Methodology PS, SS, CM and TB; Project administration PS and SS; Resources TB; Software TB; Supervision PS, SS, and CM; Validation PS, SS, CM, TB; Visualization TB; Writing - original draft TB; Writing - review and editing PS, SS, CM and TB. All authors read and approved the final manuscript.

Ethical approval (for researches involving animals or humans)

Not applicable.

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Conflict of Interests

The authors declare that there are no conflicts of interest related to this article.

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