

Curcuma pulcherrima (Zingiberaceae), a new rare species of *Curcuma* subgen. *Ecomata* from eastern Thailand

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Abstract. Saensouk P, Boonma T, Saensouk S. 2022. *Curcuma pulcherrima* (Zingiberaceae), a new rare species of *Curcuma* subgen. *Ecomata* from eastern Thailand. *Biodiversitas* 23: 6635-6644. *Curcuma pulcherrima* Boonma, Saensouk & P. Saensouk sp. nov. (Zingiberaceae: Zingiberaceae, belonging to *Curcuma* subgenus *Ecomata*) distributed in Ubon Ratchathani Province, the eastern part of Thailand. The morphological characteristic of this species causes it to fall into *Curcuma* subgenus *Ecomata* due to the presence of epigynous glands, lack of coma bracts, bracts fused only at the base, and production of open-form flowers. Furthermore, this species is similar to *Curcuma pierreana* Gagnep., due to its similar color flowers with a pink tinge, but lighter (vs. *C. pierreana* maroon tip), and similar to *Curcuma siamensis* Saensouk & Boonma due to its characteristics of the anther and spurs. Nevertheless, after careful morphological examination and comparison of all allied species in the *Curcuma* genus, especially in subgenus *Ecomata*, it was found that this plant did not match any existing species. Therefore, we describe it here as a new species to science with the name of *Curcuma pulcherrima*, according to this species's very beautiful inflorescences and flowers. In contrast, its morphological characteristics description, illustrations, vernacular name, ecology, phenology, distribution, utilization, conservation status, map of distribution, and comparison table of the new species and its ally species, including a revised key to the species of *Curcuma* subgenus *Ecomata* are provided.

Keywords: *Curcuma pierreana*, *C. siamensis*, taxonomy, Ubon Ratchathani, Zingiberales

INTRODUCTION

Thai people have traditional beliefs about the plants they grow that are passed from one generation to the next for a long time. This tradition can be seen in many collections of old Thai textbooks that cover "Wan", with each book describing the plants' characteristics, related beliefs, utilization, and information about their cultivation, which has details about the day and planting time. The characteristics of the plants listed and related beliefs in many old Thai textbooks may need to be referenced scientifically. In addition, many species of plants have utilization as medicines for the treatment of various diseases and pain listed. All of these data are worthy of preserving traditional wisdom and beliefs so they will not be lost over time. Some old formulas have been studied, examined, and developed, leading to actual use in traditional Thai medicine. Many species of "Wan" are plants belonging to the Zingiberaceae family, especially in the genus *Curcuma*.

Thailand is very rich in species diversity of *Curcuma* L., with more than 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; Saensouk et al. 2021; Saensouk et al. 2022). Therefore, this genus is proposed and classified into three sub-genera: subgenus

Hitcheniopsis (Baker) K.Schum., which is distinguished by the absence of epigynous glands. At the same time, the other two subspecies have epigynous glands, namely subgenus *Curcuma* that usually produces a closed-form of flower, such as bell-shaped, with well-developed coma bracts, and subgenus *Ecomata* Škorničk. & Šída f. that usually produces open-form flowers that lack coma bracts (Schumann 1904; Závěská et al. 2012; Leong-Škorničková et al. 2015). The relative recognized genera, including *Laosanthus* K. Larsen & Jenjitt., *Smithatris* W.J. Kress & K. Larsen, and *Stahlianthus* Kuntze, were transferred within the *Curcuma* genus, and two species previously classified in the genus *Hitchenia* Wall. (*C. caulina* J. Graham and *C. glauca* (Wall.) Škorničk.) were also transferred to be nested within the genus *Curcuma*, causing an increase in species in this genus. Eleven new species of *Curcuma* subgenus *Ecomata* were recently described from the Indochinese Peninsular; eleven new species are rare and endemic species from Thailand including *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. rosea* P. Saensouk, S. Saensouk & Boonma, and *C. suphanensis* P. Saensouk, Boonma, Rakarcha, Maknoi, Wongnak & S. Saensouk (Saensouk et al. 2022b), and *C. nakhonphanomensis* Boonma, Saensouk & P. Saensouk (Saensouk et al. 2022c), and two new 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), thereby bringing the number of species in this subgenus worldwide to 41.

Herein, the undescribed species was first discovered by Mr. Anuphong Sukpheng and Mr. Thawat Saisang in a mixed deciduous forest in Buntharik District, Ubon Ratchathani Province, Eastern Thailand. According to an old Thai belief, and due to its rhizome and inflorescence characteristics, it was classified as "Wan Maha Udom Group" This name is very well known among Thai sacred plant collectors. While in taxonomy and scientific study, the morphological characteristic of this species causes it to fall into *Curcuma* subgenus *Ecomata*, due to the presence of epigynous glands, lack of coma bracts, bracts fused only at the base, and production of open-form flowers. This species is similar to *Curcuma pierreana* Gagnep. (Gagnepain 1907; Maknoi 2007) due to its similar color of flowers with a pink tinge but lighter (vs. maroon), and also similar to *Curcuma siamensis* Saensouk & Boonma (Saensouk et al. 2021d) due to many characteristics, especially the anther and spurs. Nevertheless, after careful morphological examination and comparison of all allied species in the *Curcuma* genus, especially in subgenus *Ecomata*, it was found that this plant did not match any existing species. Therefore, we described it here as a new species to science with the name *Curcuma pulcherrima*, according to the very beautiful inflorescences and flowers of this species, along with describing its morphological characteristics, illustrations, vernacular name, ecology, phenology, distribution, utilization, conservation status, map of its distribution, a comparison table of new species and its ally species, including a revised key to the species of *Curcuma* subgenus *Ecomata*.

MATERIALS AND METHODS

Plant material was collected from Ubon Ratchathani Province, eastern Thailand, according to the floristic regions of Thailand after the Flora of Thailand (Figure 1). Measurements were recorded from living and preserved specimens collected from their natural habitats, taken with a ruler, Vernier-caliper, and morphologically examined under a stereoscopic microscope (Stemi 2000-C, ZEISS, Oberkochen, Germany), and they were deposited at KKU. Additional living specimens were planted and preserved specimens soaked in 70% ethyl alcohol were kept at Brio Garden (Nakhon Nayok Province, Central Thailand). The protologues of morphologically similar species were compared and verified. In addition, the morphological descriptions of all accepted species, especially *Curcuma* subgenus *Ecomata*, with digital images available 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), and Singapore Botanic Gardens Herbarium (SING), including existing published literature of *Curcuma*, were also compared in this study.

Specimens examined: used to refer to a location on a map (Figure 1).

Curcuma cochinchinensis Gagnep.

THAILAND: Eastern-Ubon Ratchathani Province, *C. Maknoi* 1682, QBG31724, 9 August 2007 (QBG). VIETNAM: Southeastern-Baria - Vung Tao Province, *Talmy* 122 (Holotype-P). -Baria - Vung Tao Province, 107°10'0"E, 10°30'0"N, *Talmy* 122, P032709, August 1867 (Syntype-P). -Baria - Vung Tao Province, 107°10'0"E, 10°30'0"N, *Talmy* 122, P032711, August 1867 (Syntype-P). *Pierre L.*, P00292621 (Syntype-P). *Pierre L.*, P00686559 (Syntype-P). *Pierre L.*, P00686560 (Syntype-P). *Thorel C.*, P00292622, 1862/1866 (Syntype-P). -Gia Lai; Ha Na, 108°21"E, 14°1'N, *Willis F. II*, 1,000 m, 13 May 1998 (K).

Curcuma pierreana Gagnep.

CAMBODIA: Northern;-Preah Vihear Province (photographs of specimens in their natural habitat but no samples collected).

THAILAND: Eastern;-Si Sa Ket Province, Kantarak District, Dongrak Range at Chong Bat Lak, 550 m, *Maxwell* 76-545.-Si Sa Ket Province, *C. Maknoi* 5893, QBG104660, 20 June 2013 (QBG).-Ubon Ratchathani Province, Buntharik District, *C. Ngamriabsakul* 66, E00211410, 5 August 1999 (E).-Ubon Ratchathani Province, Phu Cong Nayoy National Park, *C. Nhamriabsakul* 68, E00097711, 6 August 1999 (E).-Ubon Ratchathani Province, *C. Maknoi* 295, 25758, 15 July 2002 (QBG).-Ubon Ratchathani Province, *C. Maknoi* 1681, 31723, 9 August 2007 (QBG).-Ubon Ratchathani Province, *C. Maknoi* 5881, QBG104648, 19 June 2013 (QBG).

VIETNAM: Southeastern-Baria - Vung Tao Province, 20 m, *Kuznetsov A.N. & Kuznetsova S.P. MW* s0749955, SING 0215780, 04 June 2014 (MW, SING).-Baria - Vung Tao Province, Núi Dinh Mountain, 104 m, *Tran Huu Dang & Nguyen Ngoc Sang no. 81*, E00348432, 15 July 2008 (E). Associated material: liquid collection at SING, VNM. Duplicates: E, SING, VNM.-Tây Ninh Province, Chàng Riê forest, 30 m, *Tran Huu Dang with Nguyen Xuan Minh Ai, Vo Thi Phi Giao, Nguyen Thi Kim Hue, Jana Škorničková, Lammai Phiphakhavong, Loic Cecilio, Mark Newman, Thi Thuan Phuoc, Dang Quoc Quan, Ho Phan Minh Uyen, Vichith Lamxay no. 26*, E00375667, 14 June 2008 (E) and associated material: liquid collection at E, SING. Duplicates: E, P, RUPP, SING, VNM, National University of Laos. -Tây Ninh Province, Lò Gò-Xa Mát National Park, Dipterocarp forest grassland, *Tran Huu Dang with Nguyen Xuan Minh Ai, Vo Thi Phi Giao, Nguyen Thi Kim Hue, Jana Škorničková, Lammai Phiphakhavong, Loic Cecilio, Mark Newman, Thi Thuan*

Phuoc, Dang Quoc Quan, Ho Phan Minh Uyen, Vichith Lamxay no. 19, E00375688, 14 June 2008 (E) and associated material: liquid collection at E, SING. Duplicates: E, P, RUPP, SING, VNM, National University of Laos.-Lâm Đồng Province, Annam, canton de Laouan de Djyrinh province du Haut Donai (11.55132 108.34453), 1000-1,200 m alt., E. Poilane no. 22520, P02184086, 29 May 1933 (P).-Lâm Đồng Province, Annam, canton de Laouan délégation de Djyrinh pro: du Haut Donai (11.55132 108.34453), E. Poilane, P02184087, 30 May 1933 (P).-Lâm Đồng Province, Annam, Lahouan pro. du haut Donai (11.53333 108.36667), 1000 m alt., E. Poilane no.30437, P02184084, 21 September 1940 (P).-Lâm Đồng Province, Lahouan pro. du haut Donai, 1000 m alt., E. Poilane no.30437, P02184085 (P). Central-Thừa Thiên Hu é province, région de Hué, L. Cadière, P00950544 (P).

Curcuma siamensis Saensouk & Boonma

THAILAND: Southeastern-Chachoengsao Province, Phanom Sarakham District, 172 m alt., *Boonma 39*, 10 August 2018 (Holotype KKU; iso BK!).

RESULTS AND DISCUSSION

Herein, we describe a new species of *Curcuma* subgenus *Ecomata*, namely *Curcuma pulcherrima* Boonma, Saensouk & P. Saensouk (Zingiberaceae: Zingibereae), which was collected from its natural habitat in Buntharik District, Ubon Ratchathani Province. Its specific epithet, "*pulcherrima*" refers to its spectacular and sweet-smelling flowers and inflorescences. In addition, detailed descriptions along with photographs (Figure 2), illustrations (Figure 3), vernacular names, distribution map

(Figure 1), ecology, phenology, utilization, including a provisional IUCN conservation assessment, morphological comparison with its allied species, followed by a revised key to worldwide species of *Curcuma* subgenus *Ecomata* were also prepared for facilitating its identification.

Taxonomic treatment

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

The new species is similar to *C. siamensis* but differs. *C. pulcherrima* has pubescent sheathing bracts, leaf-sheaths, petiole, peduncle, and ovary (vs. *C. siamensis* has glabrous), ligule 5-8 mm long (vs. 3-4 mm long), leaf blade with base cuneate to slightly rounded, abaxially tinged with various shades of brownish-red, glabrous except hairy at margin, tip, and sparsely hairy at midrib (vs. base attenuate, abaxially pale green, glabrous on both sides), floral tube 3.6-3.8 cm long, white (vs. 3.28-3.3 cm long, pale yellow), lateral staminodes asymmetrical narrowly elliptic, apex acute, margin slightly undulate, white with pinkish tinge, inner side with pale yellow middle line along mid lobe from base to about 1/3 of length of staminodes, outer white with pinkish tinge, and white midrib (vs. uniquely obovate-rhombic, apex obtuse, margin entire, yellow at base gradually fading to whitish-yellow at margin and distal part or with various shades of pale yellow on both sides), labellum obovate (vs. ovate-trullate), epigynous glands 7.0-7.2 mm long (vs. 4.2 mm long), and ovary ellipsoid (vs. obovoid).

Type: Thailand, Ubon Ratchathani Province, Buntharik District, 168 m elevation, *Boonma 351*, 22.07.2020 (holo KKU!)

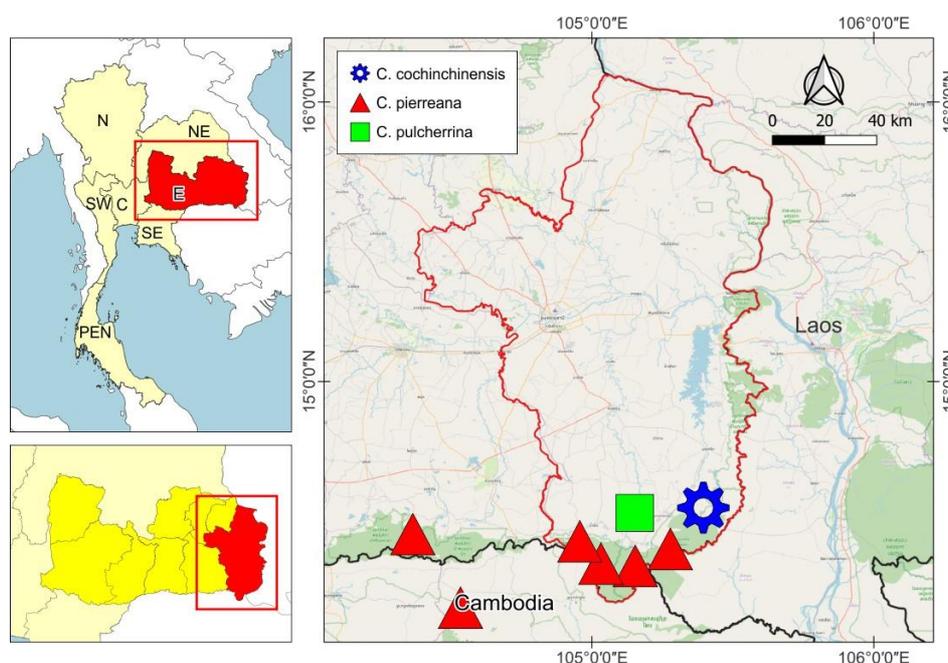


Figure 1. Distribution map of *Curcuma pulcherrima* Boonma, Saensouk & P. Saensouk sp. nov. and its ally species. Map of Thailand showing floristic regions: N: Northern, NE: Northeastern, E: Eastern, C: Central, SE: Southeastern, SW: Southwestern, and PEN: Peninsular. Refer to the map of floristic regions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

Perennial herb, *Primary rhizome* ovoid, brownish externally, yellowish internally, 2-3 × 1-2 cm, main primary rhizome with slender branches rhizome (0.6-1.2 cm in diameter). *Root* fibrous with tuberous roots. *Leafy shoot* 40-60 cm tall. *Sheathing bracts* 3-4 in number, 2-15 cm long, dark red or brownish-red, or green, white underground part, apex mucronate, pubescent. *Leaf-sheaths* 2-4 in number at anthesis, 8-14 cm long, distichous, green or with various brownish-red tinge, pubescent; *ligule* bilobed, 5-8 mm long, dark reddish tinge, apex acute to obtuse (sometimes not emarginated to bilobed but truncate slightly trilobed curves), pubescent; *petiole* green or with brownish-red tinge, canaliculate, up to 12 cm, pubescent. *Lamina* narrowly elliptic, 28-34 × 8.5-10 cm, apex acuminate with mucronate tip (mucro c. 2 mm long), base cuneate to slightly rounded, margin entire, translucent white or with a reddish tinge, adaxially green with red patch along the midrib, abaxially tinged with various shades of brownish-red, lower midrib green, both surfaces of blade glabrous except hairy at the margin, tip, and sparsely hairy at the midrib, especially at the basal part of lower midrib that connects to the pubescent petiole. The first leaf is usually sessile or with the shortest petiole. *Inflorescence* terminal between leaf sheaths, emerging at the base of pseudostems; *spike* 5-7 cm long, 4.5-5.5 cm in diameter in broadest part; *peduncle* 3-6 cm long, 0.6-1 cm in diameter, green or pale green with white at base, pubescent. Lack of coma bract. *Fertile bracts* 10-19 in number, 3.5-5 × 1.8-2.5 cm, apex acute with mucronate tip, green, red, or green with various reddish tinge, fused 1/5 at basal part, pubescent on both surfaces, lowest bracts are broadest and longest, margin hyaline, semitranslucent. *Bracteole* filiform, 10-13 mm long, pubescent. *Flower* open form, 5.3-5.5 cm, cincinni with 3-5 flowers. *Calyx* tubular 18-22 mm long, apex 3-lobed, with unilateral incision up to 8-9 mm long, each lobe apex obtuse with a mucronate tip at outer-distal part, and only left lobe usually with a short pointed protrusion at lateral edge. Translucent white, sparsely hairy. *Floral tube* tubular and enlarged to conical at distal part, 3.6-3.8 cm long, white, pubescent; *dorsal corolla lobe* 1, triangular-ovate, 16-18 × 7-8 mm, apex mucronate (mucro c. 1.5-2 mm long), cucullate, white with pale pink tinge at the tip, sparsely hairy; *lateral corolla lobes* 2, triangular-ovate, 16-18 × 7-8 mm, apex obtuse-slightly mucronate, slightly cucullate, white or with a pale pink tinge, sparsely hairy. *Lateral staminodes* 2, asymmetrical narrowly elliptic, 1.9-2.1 × 1.2-1.3 cm, apex acute with slightly undulating margin, pubescent, white with a pinkish tinge, with a pale yellow middle line along mid lobe from base to about 1/3 of the length of staminode internally, outer white with a pinkish tinge, and white midrib. *Labellum* obovate, 1.9-2.1 × 1.6-1.7 cm at the broadest part, apex emarginate to bilobed with incision up to 8 mm long, white with yellow to a deep yellow median band from tip to base (divided into two patches at base), pubescent. *Stamen* 1; *filament* flat, c. 4.5 × 5 mm, white, pubescent. *Anther* 9-10 mm long (measurement in side view including crest and spurs), 1.75-1.8 mm broad at the center, white or with a pale pink tinge, pubescent, with two blunt knobs at basal of thecae before pointing out and

forwards with two spurs; *anther thecae* c. 7 mm long, with white pollen; *spurs* slightly flattened conical, 3-3.5 mm long, pointing forwards and outwards; *crest* not obvious, equal to anther lobes. *Stigma* conical with flattened end, c. 1 × 1 mm, pubescent, ostiole ciliate. *Epigynous glands* 2, filiform, 7.0-7.2 mm long, apex sharp, pale yellow. *Ovary* ellipsoid, 4.5-5 × 3.5-4 mm, whitish to very pale green, pubescent. *Ovule* axile placentation. *Fruits* and *seeds* are not seen.

Vernacular name: - "*Wan Maha Udom*" (Wan is a rhizomatous or perennial herb that among Thai people is regarded as sacred, for instance, it 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, while "Maha Udom" means very plentiful. There is also a sub-specific name in the group of Thai sacred plant collectors; the red bracts variant of this species was called "*Wan Maha Udom Phaya Prai*" and the green bracts variant was called "*Wan Maha Udom Sabai Kaew*". Some villagers called this species "*Krachiao Buntharik*"; *Krachiao* is an Isan word used to refer to plants in the *Curcuma* genus, while "*Buntharik*" is the district name where this plant was discovered. In addition, the word "*Buntharik*" is also a synonym of "*Lotus*" in the Thai language, and the inflorescence of this species is similar to the inflorescence of the lotus.

Etymology: The specific epithet name "*pulcherrima*" is a Latin word meaning "*prettiest*" referring to its spectacular and sweet-smelling flowers and inflorescences.

Distribution: Thailand, Ubon Ratchathani Province, known only from the type locality.

Ecology: In a mixed deciduous forest on rich humus soil, 230-260 meters above sea level.

Phenology: Flowered June to August; terminal inflorescence appeared between the innermost leaf sheaths, emerged almost at the base of pseudostems, flowers fully open in the early morning, anthesis time in the morning, and lasting a single day. Leafy shoot emerges in April, and dormancy begins in November.

Utilization: This species was cultivated as an auspicious ornamental plant among Thai sacred plant collectors, believed to increase enchantment when bringing 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, as a side dish or served with chili paste, like eating *Curcuma singularis* Gagnep, *C. angustifolia* Roxb. and *C. pierreana* Gagnep.

Conservation status: New species were recently found in 2020. Due to limited surveying, there is still a lack of sufficient information on its distribution in nearby areas, so it could be found to be more populous, especially in Phu Chong Na Yoi national park, Ubon Ratchathani Province and on the border of neighboring countries (Southern Laos PDR and Northern Cambodia). Therefore, we consider ranking this species as Data Deficient (DD), following the IUCN criteria (2022). However, we suggest treating it as a rare and endemic species and an endangered species for sustainable conservation. We hope to find more populations in nearby areas to further change its conservation status in the near future for suitable conservation.



Figure 2. *Curcuma pulcherrima* Boonma, Saensouk & P. Saensouk sp. nov. (A) young inflorescence in side view, (B) side view of mature inflorescence with flowers, (C) front view of flowers to show a front view of the anther, (D) side view of inflorescence with flowers to show green bracts variant, (E) adaxially side of lamina green with red patch along the midrib, (F) abaxial side of lamina reddish with green midrib, (G) *C. cochinchinensis* Gagnep., (H) *C. siamensis* Saensouk & Boonma, and (I) *C. pierreana* Gagnep. Photographs A-F by Anuphong Sukpheng, photographs G-I, and all figures designed by Thawatphong Boonma

Discussion

Curcuma pulcherrima Boonma, Saensouk & P. Saensouk produced open-form flowers with epigynous glands, lack of coma bracts, and fertile bracts fused only at the base, and these characteristics mean it falls into the *Curcuma* subgenus *Ecomata* (Zingiberaceae).

The color of the flowers of this new species could be mistaken for that of *Curcuma pierreana* Gagnep., which is also found in the vicinity of the natural habitat. Notwithstanding, when carefully considering the morphological characteristics, especially the flowers and

anthers of the new species, it is very different. *C. pulcherrima* has lamina that are narrowly elliptic (vs. *C. pierreana* having ovate-lanceolate to ovate-oblong lamina), base cuneate to slightly rounded (vs. base attenuate), adaxially green usually with red patch along the midrib (vs. pale dull green, rarely with red patch along the midrib), abaxially tinged with various shades of brownish-red, lower midrib green (vs. paler green with red patch along the basal midrib); ligule 5-8 mm long (vs. 2 mm long); fertile bracts narrowly ovate to lanceolate, apex acute with mucronate tip (vs. broadly ovate, apex obtuse); floral tube

3.6-3.8 cm long (vs. c. 3.2 cm long); lateral staminodes asymmetrical narrowly elliptic (vs. broadly elliptic), apex acute (vs. apex obtuse), margin slightly undulate (vs. margin entire), white with pinkish tinge, inner side with a pale yellow middle line along the mid lobe from the base to about 1/3 of the length of the staminode, outer white with a pinkish tinge, and white midrib (vs. white with maroon tip on both sides); labellum without maroon tinge at distal part (vs. with maroon tinge at distal part); filament c. 4.5 mm long (vs. 2 mm long); and anther 9-10 mm long (vs. 6 mm long), spurs 3-3.5 mm long (vs. 1 mm long), slightly flattened conical (vs. filamentose), pointing out and forwards (vs. curved inwards). Moreover, this new species cannot be a natural hybrid of *C. pierreana* Gagnep. and *C. cochinchinensis* Gagnep. because both species have anthers with filamentous spurs, short (c. 1 mm long), and curved inwards, while *C. pulcherrima* produces conical anther spurs (3.0-3.5 mm long), slightly flattened, pointing

forwards in the side view like an L-shape at an obtuse angle, and each spur points sideways when looking in the front view. In addition, the natural habitat of the new species in Ubon Ratchathani Province, there is also *Curcuma singularis* Gagnep nearby. However, the anther character of the new species supports that it cannot be a natural hybrid between *C. pierreana* and *C. singularis*, and by the condition that *C. singularis* Gagnep. in nature produces early inflorescences before new leafy shoots from March to May while *C. pierreana* produces terminal inflorescences between the innermost leaf sheaths and emerges at the base of the pseudostem from late June to September. Furthermore, *C. cochinchinensis* is usually found in dry evergreen forests, while *C. pierreana* and *C. singularis* are usually found in deciduous dipterocarp forests, and *C. pulcherrima* is found in mixed deciduous forests.

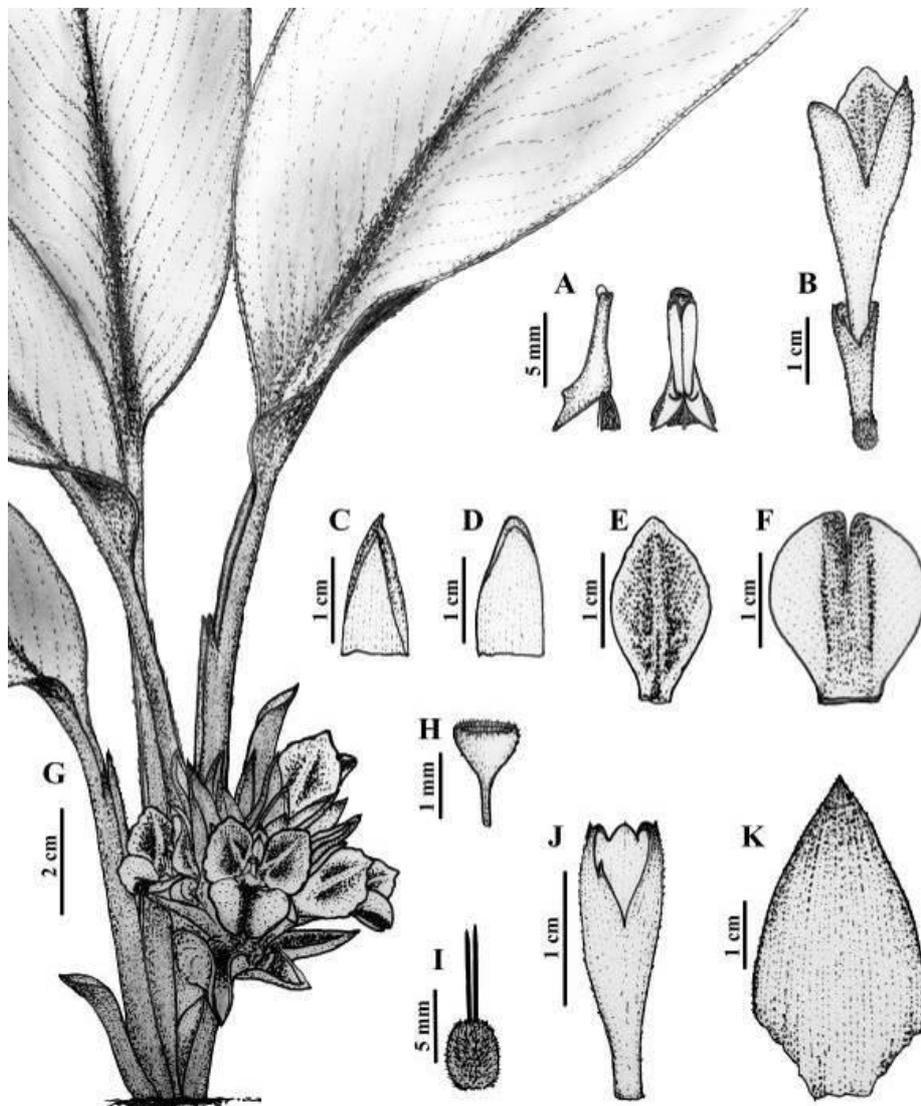


Figure 3. *Curcuma pulcherrima* Boonma, Saensouk & P. Saensouk sp. nov. (A) side and front views of anther with filament, (B) side view of flower, (C) dorsal corolla lobe, (D) lateral corolla lobe, (E) lateral staminode, (F) labellum, (G) habit, (H) front view of stigma, (I) epigynous glands with ovary, (J) calyx, and (K) bract. Drawn by Thawatphong Boonma

Considering a comparison with the most similar species, *Curcuma siamensis* Saensouk & Boonma, which we recently described in 2021, the new species is similar in having a yellowish rhizome internally, leaf blade narrowly elliptic, adaxially usually has a red patch along the midrib, produces terminal inflorescences between the leaf sheaths, lacks coma bracts, flower form is open, and similar shape of anther with anther spurs pointing out and forwards, nevertheless many characteristics differ. *C. pulcherrima* has pubescent sheathing bracts, leaf-sheaths, petiole, peduncle, and ovary (vs. in *C. siamensis* glabrous); ligule 5-8 mm long (vs. 3-4 mm long); leaf blade with base cuneate to slightly rounded, abaxially tinged with various shades of brownish-red, glabrous except hairy at the margin, tip and sparsely hairy at midrib (vs. base attenuate, abaxially pale green, glabrous on both sides); floral tube 3.6-3.8 cm long, white (vs. 3.28-3.3 cm long, pale yellow); lateral staminodes asymmetrical narrowly elliptic, apex acute, margin slightly undulate, white with pinkish tinge, inner side with a pale yellow middle line along the mid lobe from the base to about 1/3 of the length of the staminodes, outer white with a pinkish tinge, and white midrib (vs. uniquely obovate-rhombic, apex obtuse, margin entire, yellow at base gradually fades to whitish-yellow at the margin and distal part with various shades of pale yellow on both sides); labellum obovate (vs. ovate-

trullate); epigynous glands 7.0-7.2 mm long (vs. 4.2 mm long), and ovary ellipsoid (vs. obovoid). The chance of natural hybrids between *C. siamensis* and *C. pierreana* in the wild is unlikely since the habitat of *C. siamensis* is found only in forest areas of Chachoengsao Province. There are no reports of species found in Ubon Ratchathani forests. The new species was found only in Ubon Ratchathani, eastern Thailand, about 400 kilometers from the area where *C. siamensis* was found in southeast Thailand, and *C. siamensis* was not distributed in the eastern forests of Thailand (the floristic regions divided according to the Flora of Thailand project).

The morphological characteristics differ markedly from the reported and existing species. Thus, we reported this species as new to science and named this new plant following the plant nomenclature rules under *Curcuma pulcherrima* Boonma, Saensouk & P. Saensouk. Our exploration of the diversity of plants in Zingiberaceae continues due to existing suitable areas, and surveys in Thailand still need to be completed. We look forward to finding further populations and wider distribution for this new species in neighboring areas and in neighboring countries that share borders to further change its conservation status in the near future for suitable conservation.

Table 1. Morphological comparison of *Curcuma pulcherrima* and its ally species

Characters	<i>Curcuma pulcherrima</i> Boonma, Saensouk & P. Saensouk	<i>Curcuma siamensis</i> Saensouk & Boonma	<i>Curcuma pierreana</i> Gagnep.
Rhizome internal	Yellowish	Pale yellow	Pale brown
Sheathing bracts	Pubescent	Glabrous	Densely short hairy
Leaf-sheaths	Pubescent	Glabrous	Densely fine hairy
Ligule	5-8 mm long	3-4 mm long	2 mm long
Petiole	Up to 12 cm long, Pubescent	8-10 cm long, Glabrous	0-4 cm long, Densely short hairy
Lamina	Narrowly elliptic, 28-34 × 8.5-10 cm, Base cuneate to slightly rounded, Adaxially green with a red patch along the midrib, Abaxially tinged with various shades of brownish-red, lower midrib green, Glabrous on both surfaces except hairy at the margin and tip and sparsely hairy at the midrib	Narrowly elliptic, 18-36 × 6-8.5 cm, Base attenuate, Adaxially green with a red patch along the midrib, Abaxially paler green, Glabrous on both surfaces	Ovate-lanceolate to ovate-oblong, 20-25 × 3.5-7 cm, Base attenuate, Adaxially pale dull green, rarely with a red patch along the midrib Abaxially paler green with a red patch along the basal midrib, Lower surface densely short hairy
Peduncle	Pubescent	Glabrous	Densely fine hairy
Fertile bracts	3.5-5 × 1.8-2.5 cm, Apex acute with mucronate tip, Green, red, or green with various reddish tinges, Pubescent on both surfaces	3.5-5.4 × 1-2.8 cm, Apex mucronate, Whitish to pale green or with various reddish tinges, Puberulent especially at the distal part	3-4 × 3-3.5 cm, Apex obtuse, Whitish with a slightly yellowish hue, Scattered fine hairy

Floral tube	3.6-3.8 cm long, White, Pubescent	3.28-3.3 cm long, Pale yellow, Glabrous except at distal part puberulent	c. 3.2 cm long, White, Scattered fine hairy
Lateral staminodes	Asymmetrical, narrowly elliptic, 1.9-2.1 × 1.2-1.3 cm, Apex acute, Margin slightly undulate, White with a pinkish tinge, inner side with a pale yellow middle line along the mid lobe from the base to about 1/3 of the length of the staminode, outer white with a pinkish tinge, and white midrib	Uniquely obovate-rhombic, 16.2-16.8 × 9.5-10 mm, Apex obtuse, Margin entire, Yellow at the base gradually fading to whitish-yellow at the margin and distal part, or with various shades of pale yellow on both sides	Broadly elliptic, c. 15 × 12 mm, Apex obtuse, Margin entire, White with a maroon tip on both sides
Labellum	Obovate, 1.9- 2.1 × 1.6-1.7 cm, White with yellow to the deep yellow median band from the tip to the base	Ovate-trullate, 1.78-1.82 × 1.45-1.5 cm, Various shades of pale yellow with yellow to a deep yellow median band from the tip to the base	Broadly obovate, c. 1.5 × 1.2 cm, White with yellow median band, with maroon tinge at the distal part
Filament	c. 4.5 mm long c. 5 mm wide	c. 4.5 mm long, c. 4.5 mm wide	c. 2 mm long, c. 5 mm wide
Anther	9-10 mm long	c. 8 mm long	c. 6 mm long
Anther spurs	3-3.5 mm long, Slightly flattened conical, Pointing out and forwards	3-4 mm long, Conical, Pointing out and forwards	c. 1 mm long, Filamentose, Curved inwards
Epigynous glands	7.0-7.2 mm long, Apex sharp	c. 4.2 mm long, Apex acute	c. 5 mm long, Apex blunt
Ovary	Ellipsoid, Pubescent	Obovoid, Glabrous	Subglobose, Fine hairs

Key to species of *Curcuma* subgen. *Ecomata*

- 1a. Floral tube longer than bracts; petiole very distinct from leaf blade *C. supraneaana*
- 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 ≥ 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 *C. pambrosima*
- 5b. Labellum obovate; staminodes elliptic with apex rounded *C. vinhlinhensis*
- 6a. Staminodes white with dark purple at the apex *C. pierreana*
- 6b. Staminodes 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. Staminodes yellow-orange with light yellow at the base *C. vitellina*
- 8b. Staminodes 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. Staminodes 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. Staminodes 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 staminode internally, outer white with a pink tinge, and white midrib *C. pulcherrima*
- 18a. Flowers closed-form 19
- 18b. Flowers opened-form 20
- 19a. Thyrses < 8 cm long; bracts green; leaf midrib red *C. stolonifera*
- 19b. Thyrses > 8 cm long; bracts red; leaf midrib green *C. cinnabarina*

- 20a. Staminodes white or white with reddish purple 21
 20b. Staminodes yellow or light orange 23
 21a. Labellum reddish purple with yellow median band with reddish purple molting on yellow median band of lower half *C. sabhasrii*
 21b. Labellum white with yellow median band22
 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 glabrous24
 23b. Leaves adaxially with hairy along the veins or pubescent 25
 24a. Staminodes rhomboid, with dark red dot at the base *C. rhomba*
 24b. Staminodes asymmetrical trullate to ovate, without red dot at the base *C. rangsinae*
 25a. Leaves base cuneate to attenuate *C. putii*
 25b. Leaves base oblique, rounded or cordate26
 26a. Staminodes upper half orange-yellow, lower half red to dark red27
 26b. Staminodes yellow28
 27a. 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*
 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. Staminodes purple or with purple at base 30
 29b. Staminodes 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; staminodes 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; staminodes 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; staminodes golden yellow gradually fades to pale yellow at the base, with reddish V-shaped or triangular patch at the base *C. achrae*
 33b. Anther L-shape; staminodes yellow without reddish patch at the base as above34
 34a. Leaves base cuneate; sheath and petiole pubescent *C. flaviflora*
 34b. Leaves base obtuse or rounded to cordate; sheath and petiole glabrous35
 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 long36
 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 midrib39
 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 yellow median band, without red *C. singularis*
 39b. Labellum white with yellow median band, with red40
 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*

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REFERENCES

- Boonma T, Saensouk S. 2019. *Curcuma saraburiensis* (Zingiberaceae), a new species from Thailand. *Taiwania* 64 (3): 245-248. DOI: 10.6165/tai.2019.64.245.
- IUCN. 2022. Guidelines for Using the IUCN Red List Categories and Criteria. Version 15 Prepared by the Standards and Petitions Committee. Available at: <https://www.iucnredlist.org/documents/RedListGuidelines.pdf>.
- Larsen K, Larsen SS. 2006. *Gingers of Thailand*. Queen Sirikit Botanic Garden, The Botanical Garden Organization, Chiang Mai, Thailand.
- Leong-Škorničková J, Šida O, Závěská E, Marhold K. 2015. History of infrageneric classification, typification of supraspecific names, and outstanding transfers in *Curcuma* (Zingiberaceae). *Taxon* 64 (2): 362-373. DOI: 10.12705/642.11.
- Maknoi C, Saensouk S, Saensouk P, Rakarcha S, Thammarong W. 2021. Two new species of *Curcuma* L. (Zingiberaceae) from Thailand. *Biodiversitas* 22 (9): 3910-3921. DOI: 10.13057/biodiv/d220937.
- Nguyen DD, Le TA, Hoang QH, Le QT, Nguyen E. 2022. Two new taxa of *Curcuma* subgen. *Ecomata* (Zingiberaceae: Zingibereae), from coastal Central Vietnam. *Biodiversitas* 23 (5): 2512-2519. DOI: 10.13057/biodiv/d230531.
- Rakarcha S, Saensouk S, Maknoi C, Wongnak M, Thammarong W, Saensouk P. 2022. *Curcuma lampangensis* and *C. sabhasrii* (Zingiberaceae), two new species from northern Thailand. *Biodiversitas* 23 (9): 4448-4459. DOI: 10.13057/biodiv/d230910.
- Saensouk P, Boonma T, Rakarcha S, Maknoi C, Wongnak M, Saensouk S. 2022b. Two new species of *Curcuma* subgenus *Ecomata* (Zingiberaceae: Zingibereae), from Central and Southwestern

- Thailand. Biodiversitas 23 (9): 4578-4588. DOI: 10.13057/biodiv/d230925.
- Saensouk P, Boonma T, Saensouk S. 2021d. *Curcuma siamensis* (Zingiberaceae, Zingibereae), a new species of *Curcuma* subgen. *Ecomata* from Southeastern Thailand. Biodiversitas 22 (12): 5239-5246. DOI: 10.13057/biodiv/d221201.
- Saensouk P, Boonma T, Saensouk S. 2022c. *Curcuma nakhonphanomensis* (Zingiberaceae), a new species from the lower Mekong River basin, northeastern Thailand. Biodiversitas 23 (11): 6040-6048. DOI: 10.13057/biodiv/d231159.
- Saensouk S, Boonma T, Saensouk P. 2021a. Six new species and a new record of *Curcuma* L. (Zingiberaceae) from Thailand. Biodiversitas 22 (4): 1658-1685. DOI: 10.13057/biodiv/d220410.
- Saensouk S, Boonma T, Saensouk P. 2021c. A new species and a new record of *Curcuma* subgen. *Curcuma* (Zingiberaceae) from Northern Thailand. Biodiversitas 22 (9): 3617-3626. DOI: 10.13057/biodiv/d220903.
- Saensouk S, Boonma T, Saensouk P. 2022a. *Curcuma achrae* (Zingiberaceae), a new species from Central Thailand. Rheedeana 32(1): 30-45. DOI: 10.22244/rheedeana.2022.32.01.03.
- Saensouk S, Boonma T, Thomudtha A, Thomudtha P, Saensouk P. 2021b. *Curcuma wanenlueanga* (Zingiberaceae), a new species of subgenus *Curcuma* in Thailand. Biodiversitas 22 (7): 2988-2994. DOI: 10.13057/biodiv/d220752.
- Schumann KM. 1904. Zingiberaceae in Engler, Das Pflanzenreich IV, 46 (Heft 20): 1-458.
- Sirirugsa 1966. The genus *Curcuma* L. (Zingiberaceae) in Thailand. Prince of Songkla University, Thailand.
- Sirirugsa 1999. Thai Zingiberaceae: Species diversity and Their Uses, <http://www.iupac.org/symposia/proceedings/phuket97/sirirugsa.html>
- Sirirugsa P, Larsen K, Maknoi C. 2007. The genus *Curcuma* L. (Zingiberaceae): Distribution and classification with reference to species diversity in Thailand. Gard Bull Singap 59 (1&2): 203-220.
- Záveská E, Fér T, Šída O, Krak K, Marhold K, Leong-Škorničková J. 2012. Phylogeny of *Curcuma* (Zingiberaceae) based on plastid and nuclear sequences: Proposal of the new subgenus *Ecomata*. Taxon 61 (4): 747-763. DOI: 10.1002/tax.614004.