doi: 10.1017/S0960428620000049

CURCUMA CINNABARINA AND *C. EBURNEA* (ZINGIBERACEAE: ZINGIBEROIDEAE), TWO NEW SPECIES FROM THAILAND

J. Leong-Škorničková[1], S. Soonthornkalump[2] & P. Suksathan[3]

Curcuma cinnabarina and *C. eburnea* (*Curcuma* subg. *Ecomatae*, Zingiberaceae), two new species from Thailand, are described and illustrated here. They are compared with the morphologically closest species *Curcuma rubrobracteata* and *C. pierreana*, respectively. Detailed descriptions, colour plates, and information on their distribution, ecology, phenology and uses are also provided. Preliminary IUCN conservation assessments of these species are proposed.

Keywords. *Curcuma pierreana*, *Curcuma rubrobracteata*, *Curcuma* subg. *Ecomatae*, Lampang province, Nong Bua Lam Phu province, Udon Thani province.

Introduction

Curcuma L. is one of the largest genera of Zingiberaceae and is widely distributed in South and Southeast Asia and South China, with a few species extending to Northern Australia and the South Pacific (Záveská *et al*., 2012). The exact number of *Curcuma* species remains unknown, but with many new recent descriptions, it certainly exceeds the estimate of 120 species projected by Leong-Škorničková *et al.* (2007, 2015b).

The most recent phylogeny of the genus established subgenus *Ecomatae* Škorničk. & Šída f. (Záveská *et al.*, 2012), in addition to the two traditionally recognised subgenera *Curcuma* L. and *Hitcheniopsis* (Baker) K.Schum. (Schumann, 1904). Numerous new *Curcuma* species from the mainland of Southeast Asia have been described in recent years, particularly in subgenus *Ecomatae* (e.g. Leong-Škorničková & Lý, 2010; Leong-Škorničková *et al*., 2010; Leong-Škorničková & Trần, 2013; Leong-Škorničková *et al*., 2014; Souvannakhoummane & Maknoi, 2014; Chen *et al.*, 2015; Leong-Škorničková *et al*., 2015a; Luru *et al.*, 2017; Maknoi *et al.*, 2019; Tanaka & Aung, 2019; Zhang *et al*., 2019), which currently contains 21 species and has its centre of diversity in Cambodia, Laos, Thailand and Vietnam.

Thailand is a diversity hotspot for Zingiberaceae and is also one of the richest areas in terms of number of *Curcuma* taxa (Larsen & Larsen, 2006), with all three subgenera well represented and more than 40 species reported (Maknoi, 2006, Sirirugsa *et al*., 2007; Leong-Škorničková *et al*., 2017).

[1] Singapore Botanic Gardens, National Parks Board, 1 Cluny Road, Singapore 259569. E-mail: jana_skornickova@nparks.gov.sg
[2] Department of Biology, Faculty of Science, Prince of Songkla University, Kho Hong, Hat Yai, Songkhla 90110, Thailand.
[3] Queen Sirikit Botanic Garden, Mae Rim, Chiang Mai 50180, Thailand.

The existence of the two species from *Curcuma* subg. *Ecomatae*, which we describe here as *Curcuma cinnabarina* and *C. eburnea*, has been known for over 10 years. Plants of *Curcuma cinnabarina* are occasionally sold under name *torch curcuma* (Wannakrairoj, 1996), and *C. eburnea* also occasionally appears in the horticultural market under the Thai name *thep prasit* (Wannakrairoj, 1996).

The descriptions are based on living flowering material and specimens from the type collections. The style of description follows recent works of Leong-Škorničková cited above. The general plant terminology follows Beentje (2016). The preliminary conservation assessments follow the guidelines of the International Union for Conservation of Nature (IUCN, 2017).

Curcuma cinnabarina Škorničk. & Soonthornk., **sp. nov.**

Similar to *Curcuma rubrobracteata* Škorničk., M.Sabu & Prasanthk. by ecomate inflorescence composed of dark red bract with rounded tips, but differs by ovoid rhizome with occasional short branch, broadly ovate to elliptic-ovate and abaxially densely pubescent lamina with rounded base, inflorescence composed of 35–50 bracts puberulent on both sides, and pale yellow to yellow flower (compared with slender creeping rhizome, elliptic to narrowly elliptic and abaxially glabrous lamina with attenuate base, inflorescence composed of 20–30 bracts glabrous on both sides, and bright warm yellow to yellow–orange flower in *C. rubrobracteata*). – Type: Thailand, Nong Bua Lam Phu province, Nong Bua subdistrict, Muang district, 18 ix 2019, *Soonthornkalump, S.* Sutt-209 (holo BKF!, including flowers preserved in spirit as part of a single specimen; iso SING!, including flowers preserved in spirit as part of a single specimen). **Figs 1, 2.**

Rhizomatous herb 70–85 cm tall. *Rhizome* ovoid, 5–6 × 2–2.6 cm, held upright, occasionally with lateral branches 3–4.5 × 1.2–2 cm, cream to brown externally, covered with rusty-coloured and decayed scales, white internally, slightly aromatic, with slightly hot and bittersweet taste; *root tubers* ovate to fusiform, 2.5–3 × 1–2.5 cm, light brown externally, white internally. *Leafy shoot* with 2–5(–7) leaves when flowering; *pseudostem* up to 10–15 cm long, composed of leaf sheaths which soon disengage; *leafless sheaths* 1 or 2, decayed at anthesis; *leaf sheaths* green with reddish tinge at base, puberulous; *ligule* to 5 mm long, bilobed, hyaline, greenish white, semitranslucent, turning papery with age, glabrous, but with a few stipitate hairs c.0.1 mm long along the margin; *petiole* 20–40 cm long, canaliculate, green with red tinge basally, sparsely puberulous to glabrescent; *lamina* broadly ovate to elliptic-ovate, 38–52 × 11–24 cm, prominently plicate, adaxially dark green, shiny, puberulous along the raised veins, abaxially somewhat paler, densely puberulous, midrib green, adaxially glabrous, abaxially pubescent, base oblique, rounded to subcordate (obtuse in dry material), apex acuminate, margin hyaline, semitranslucent white, c.0.3 mm wide, glabrous. *Inflorescence* central, many flowered; *peduncle* to c.12 cm long, to 7 mm in diameter, white to light green, puberulous, embedded basally within the pseudostem; *thyrse* 10–15(–16.5) cm long, 5–7 cm in diameter in the middle, without coma; *fertile bracts* 38–50 per inflorescence, 3.55–4 × 2.64–4.24 cm (larger at the base of

FIG. 1. *Curcuma cinnabarina* Škorničk. & Soonthornk., sp. nov. A, Habit; B, base of the plant, with emerging inflorescence; C, entire plant; D and F, inflorescence; E, rhizome and root tubers. From *Soonthornkalump, S.* Sutt-209. (Photographs: W. Thongbai and S. Soonthornkalump.)

FIG. 2. *Curcuma cinnabarina* Škorničk. & Soonthornk., sp. nov.: flower dissection. From left to right: flower in side view, ovary with floral tube and stamen attached, calyx, dorsal corolla lobe, two lateral corolla lobes, two lateral staminodes and labellum. Inset, from left to right: close-up of stamen from front, back and side. From *Soonthornkalump, S.* Sutt-209. (Photographs: S. Soonthornkalump.)

the inflorescence), broadly obovate to bluntly trullate, apex broadly acute to obtuse, reflexed, bright red, puberulent on both sides, hairy margin, hairs c.0.1 mm long, connate in the lower 1/2 to 1/3 (to 1/4); enclosing cincinni with up to 4 flowers at the base of the inflorescence, 1 or 2 flowers at the top; *bracteoles* one per flower, ovate to triangular, boat-shaped, up to 14 × 9 mm (outer ones larger, inner ones gradually smaller), hyaline, semitranslucent white with pinkish tinge distally, almost glabrous, with a few sparse hair along the keel. *Flowers* 4–4.5 cm long, exserted from the bracts; *calyx* 7–8.5 mm long, 3-toothed, with unilateral incision c.2 mm, semitranslucent white, puberulent throughout; *floral tube* c.3.2 cm long, narrowly cylindrical at base for c.1.7 cm above the ovary, narrowly funnel-shaped distally, externally pale yellow to yellow, glabrous, internally pale yellow, glabrous at basal part, with ring of dense hair positioned c.1.3 cm from the base, funnel-shaped part puberulent, groove holding the style positioned dorsally from the base up to the constricted area; *dorsal corolla lobe* 14–16 × 8–10 mm, triangular ovate, concave, hooded, white to pale yellow with pink to reddish tinge distally, glabrous, apex mucronate, mucro c.1–1.5 mm long, sparsely hairy; *lateral corolla lobes* 12–14 × 6–8 mm, strongly reflexing soon after anthesis, elliptic to slightly triangular with subobtuse, slightly concave apex, white to pale yellow with pink to reddish tinge distally, glabrous; *labellum* 13–14 × 13–14 mm, almost round, sides folding upwards, apex obscurely bifid with an incision 1–2 mm, cream to yellow, with a bright yellow and slightly swollen median band running through the centre, glabrous on both sides; *lateral staminodes* c.12–13 × 7–8 mm, oblique obovate, pale yellow, glabrous on both sides; *stamen* c.6 mm long; *filament* 2–3 × 3.55–3.57 mm, c.4.5 mm broad at base, less than c.2 mm at the point of attachment, yellow, glabrous; *anther* c.6–7 mm long, spurred, conective yellow, glabrous, anther spurs c.2 mm long, triangular with sharp inward-facing apices, anther crest present, obtuse c.0.4–0.5 mm long, c.1 mm broad at base, glabrous, cream white; *anther thecae* 4–4.5 mm long,

dehiscing along their entire length, pollen white; *epigynous glands* two, 2.5–3 mm long, c.0.8 mm in diameter, cream to yellow, cylindrical, with irregularly blunt apex; *style* white, glabrous; *stigma* capitate c.1 mm long, c.1.5 mm wide, white; *ostiole* with irregularly puberulent to serrulate margin, facing forwards; *ovary* ovoid c.2.3–2.5 × 1.5 mm, trilocular, white, pubescent. *Fruit* a globose trilocular capsule, 1–1.5 cm in diameter (almost ripe), white with reddish patch at base, pubescent, dehiscing irregularly; *seeds* irregularly obovoid, 4–5 × 1.6–2 mm, brown (almost ripe), shiny, enclosed in semitranslucent white, laciniate aril.

Distribution. Known only from Nong Bua Lam Phu and Udon Thani provinces in Northeastern Thailand. It grows in sandy clay loam in the bamboo forest and deciduous dipterocarp forest at 200–400 m a.s.l.

Ecology and phenology. Flowering starts in the rainy season and lasts from late July to September. Fruiting occurs from mid-September to October. The plants enter dormancy in December.

Provisional IUCN Red List category. Two local informants reported that *Curcuma cinnabarina* occurs in the Phu Phan Noi Range and surrounding area. This area is part of the Phu Phan Range, which lies from the east of Nong Bua Lam Phu City towards the Phu Khao Ranges, in Non Sang district, in the south. The informants reported the existence of a single population in Nong Wua So district in Udon Thani province, as well as one population in each of Nong Bua subdistrict and Non Sang district of Nong Bua Lam Phu province.

Although the precise locations remain unknown, based on approximate locations, the estimated extent of occurrence is less than 150 km^2 and the area of occupancy is estimated at 12 km^2. The extent of the populations remains unknown, except that the population in Non Sang district was reported to be large, consisting of many hundreds of mature individuals.

Because only one of the populations might partially occur within the protected area of Phu Kao–Phu Phan Kham National Park, and given that the local demand for medicinal as well as ornamental purposes is likely to be supplied by wild-collected material, we propose to treat this species provisionally as Vulnerable (VU D2).

Etymology. The specific epithet is derived from Latin *cinnabarinus*, referring to the dark red colour of the bracts of this species.

Vernacular names and uses. Usa (ù-săa) (อุษา) (*usa* = dawn). The rhizomes are used in local medicine as an ingredient in balm, and plants are occasionally also sold as ornamentals.

With its dark red inflorescence and absence of coma bracts, *Curcuma cinnabarina* resembles *Curcuma rubrobracteata* Škorničk., M.Sabu & Prasanthk. somewhat in morphology (Leong-Škorničková *et al.*, 2003), although the latter belongs in subgenus

Curcuma. These two species can be easily distinguished, however, by their rhizome structure and the shape and indumentum of their leaves, as well as by differences in floral morphology as outlined in the diagnosis. The overall anther shape is also very distinctive (for details of the anther of *Curcuma rubrobracteata*, see Leong-Škorničková *et al.*, 2003).

Curcuma rubrobracteata, originally described from India, is a fairly widespread species known to occur in Bangladesh, Myanmar, South China and Thailand. In Thailand, it has been reported from various provinces of Northern and Southwestern Thailand whereas the newly described *Curcuma cinnabarina* seems to be much more restricted in its occurrence to Northeastern Thailand.

Revision of the herbarium material at AAU, BK, BKF, CMU, K, P, QBG and SING did not reveal any specimens that could be referred to this species with certainty.

Curcuma eburnea Škorničk., Suksathan & Soonthornk., **sp. nov.**

Similar to *Curcuma pierreana* Gagnep. by its ecomate inflorescence composed of cream-white bracts and anthers with small filiform anther spurs but differing by leaves with round to subcordate bases, 30–40 bracts, white staminodes, anther spurs facing straight forwards (compared with attenuate to obtuse leaf bases, 10–20 bracts, staminodes with dark purple tips, anther spurs curved inwards in *C. pierreana*). – Type: Made in the living collections of Singapore Botanic Gardens, 24 ix 2013, *Leong-Škorničková, J.* GRC-179 (holo SING, including flowers preserved in spirit; iso QBG, including flowers preserved in spirit); plants received from Queen Sirikit Botanic Garden, originally collected from Thailand, Chiang Rai province, Khun Jae National Park. **Figs 3, 4**.

Herb to 60 cm tall. *Rhizome* ovoid, c.2.5–4 × 1–2 cm, with thin branches c.5–8 mm in diameter, brown externally, light yellow internally, slightly aromatic, with slightly bittersweet taste; *root tubers* ovoid to fusiform, c.2.5 × 1.5 cm, light brown externally, pure white internally with translucent white centre. *Leafy shoot* with 3–6 leaves when flowering; *pseudostem* up to 15 cm long, composed of leaf sheaths which soon disengage; *leafless sheaths* decayed at anthesis; *leaf sheaths* green, sparsely and very shortly puberulent; *ligule* to 8 mm long, prominently bilobed, hyaline, greenish white, semitranslucent, turning papery with age, glabrous, but with short hairs at margins; *petiole* 9–18 cm long (petiole of first leaf shortest, innermost leaves longest), green, very shortly sparsely puberulent; *lamina* elliptic to elliptic-ovate, 20–40 × 8–13 cm, prominently plicate, adaxially bright green, glabrous, abaxially lighter green, puberulent, midrib green, glabrous, base oblique, rounded to subcordate, apex acute to acuminate, margin hyaline, semitranslucent white, c.0.5 mm wide, glabrous. *Inflorescence* central, many-flowered; *peduncle* to c.8 cm long, to 6 mm in diameter, light green, very sparsely puberulent to glabrous, embedded mostly within the pseudostem; *thyrse* c.7.5 cm long, 4–4.5 cm in diameter in the middle, without coma; *fertile bracts* 30–40, larger at the base of the inflorescence, 25–3 × 2.25–3.2 cm (larger at the base of the inflorescence), broadly ovate to trullate, smaller and ovate at the apex, apex broadly acute to obtuse, reflexed, cream white or pale greenish, glabrous on both sides, connate in the lower 1/2 to 1/3; enclosing cincinni with 2 or 3 flowers at the base

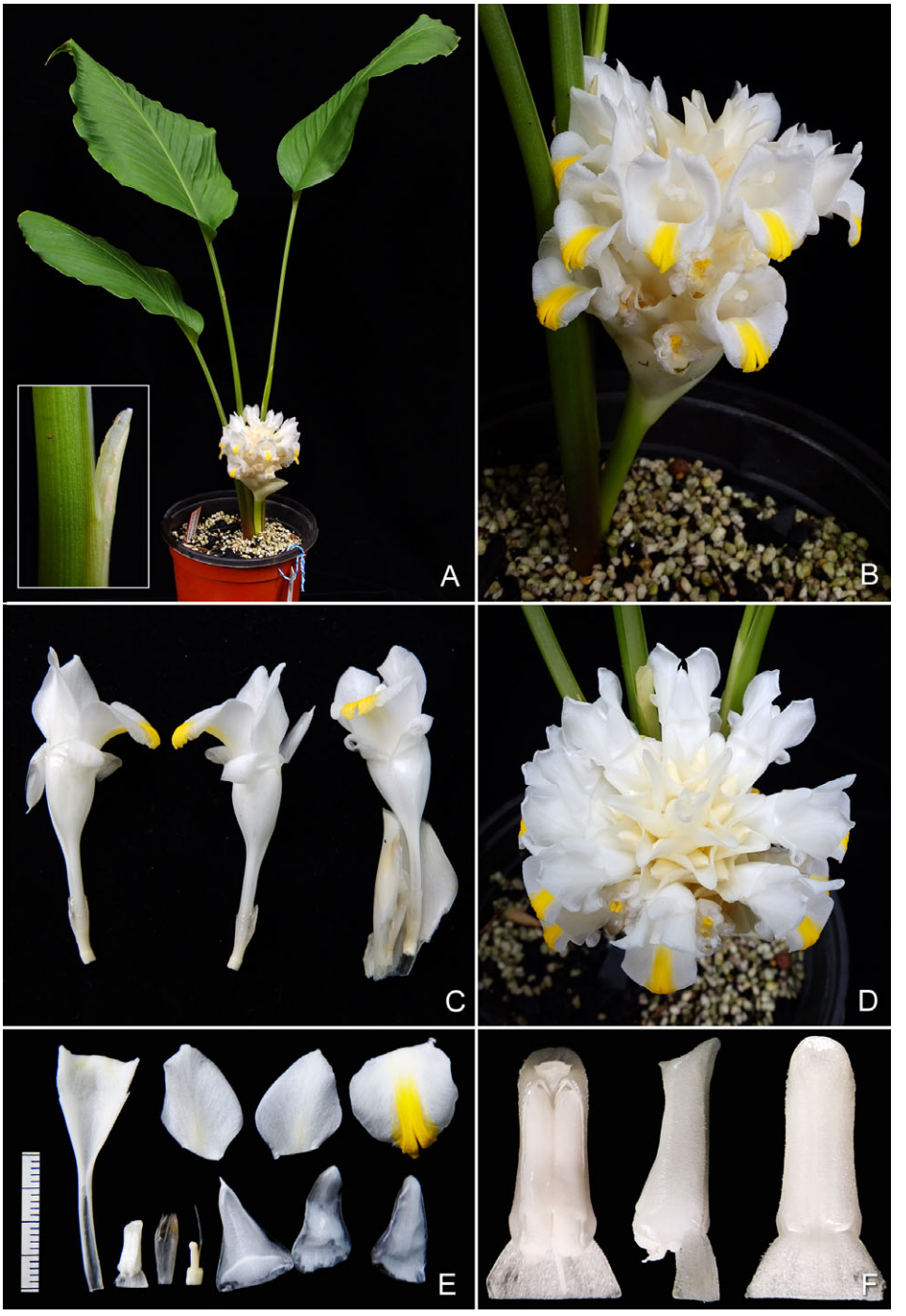

FIG. 3. *Curcuma eburnea* Škorničk., Suksathan & Soonthornk., sp. nov. A, Habit (inset: detail of ligule); B, base of the plant, with emerging inflorescence; C, flowers; D, inflorescence (from above); E, flower dissection (from left to right, top to bottom: floral tube in longitudinal section, two lateral staminodes and labellum, stamen, calyx, ovary with epigynous glands, dorsal corolla lobe, two lateral corolla lobes); F, stamen (front, side and back views). All from *Leong-Škorničková, J.* GRC-179. (Photographs: J. Leong-Škorničková.)

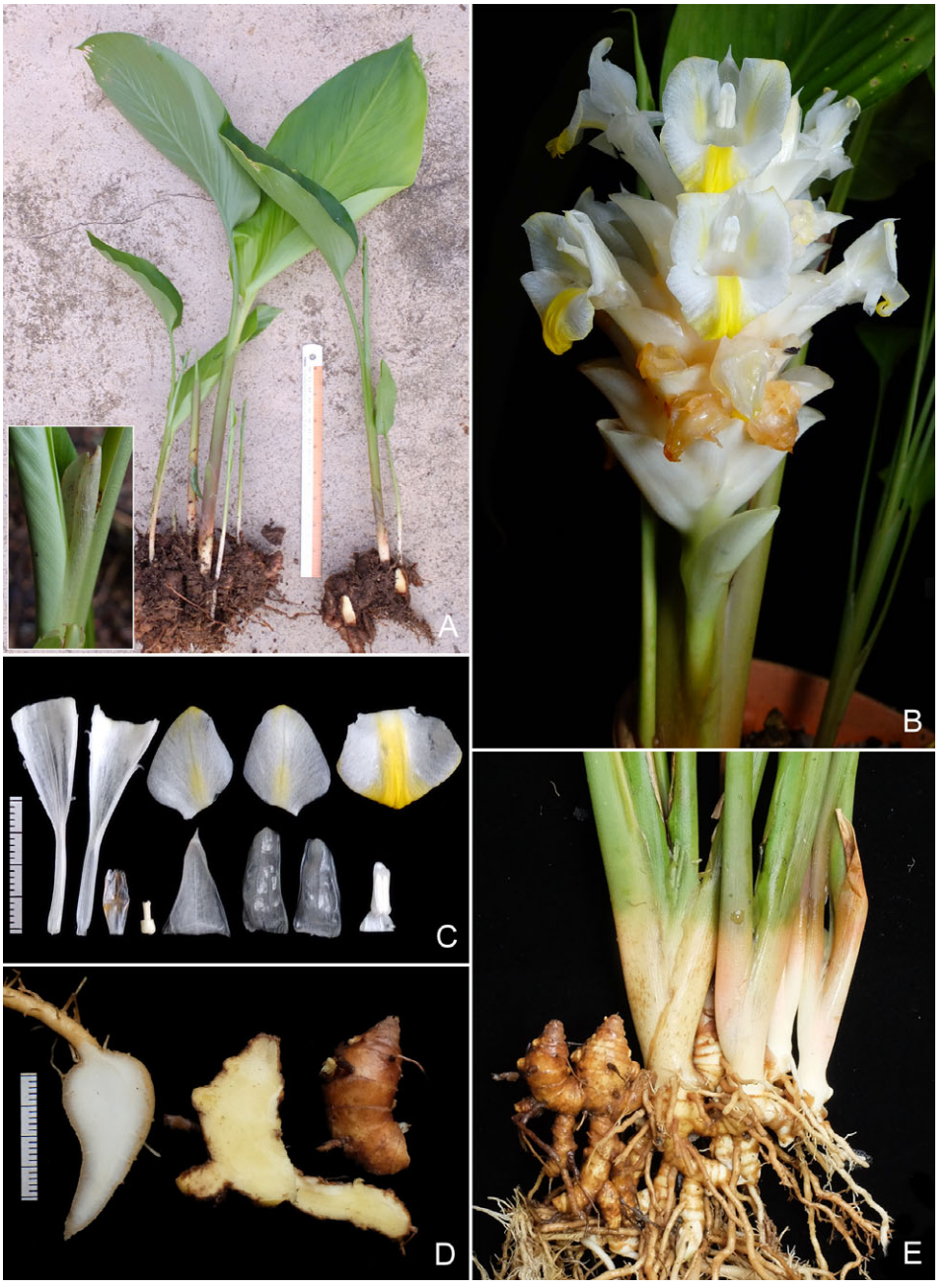

FIG. 4. *Curcuma eburnea* Škorničk., Suksathan & Soonthornk., sp. nov. A, Habit (inset: detail of ligule); B, inflorescence; C, flower dissection (from left to right, top to bottom: floral tube in longitudinal section, two lateral staminodes and labellum, calyx, ovary with epigynous glands, dorsal corolla lobe, two lateral corolla lobes, stamen); D, root tuber and rhizome; E, base of pseudostems, with rhizome. A–C from *Leong-Škorničková, J.* GRC-193, D and E from *Leong-Škorničková, J.* GRC-179. (Photographs: J. Leong-Škorničková.)

of the inflorescence (third flower often underdeveloped or aborted), 1 or 2 flowers at the top; *bracteoles* absent. *Flowers* 5–5.5 cm, exserted from the bracts; *calyx* 8–10 mm long, 3-toothed, with unilateral incision 3–4 mm, semitranslucent white, glabrous; *floral tube* c.3.5 cm long, narrowly cylindrical at base for c.2 cm above the ovary, funnel-shaped distally, externally white, glabrous, internally white, mostly glabrous, but pubescent around the constricted area, groove holding the style positioned dorsally from the base up to the constricted area; *dorsal corolla lobe* c.18 × 12 mm, triangular ovate, concave, hooded, pure white, glabrous, apex mucronate, mucro c.1.5 mm long, glabrous; *lateral corolla lobes* 14–18 × 10 mm, strongly reflexing soon after anthesis, triangular with rounded, slightly concave apex, pure white, glabrous; *labellum* 18–20 × 17–18 mm, obscurely trilobed, side lobes folding upwards, apex of middle lobe emarginate with an incision up to 5 mm long, white with a bright yellow median band running through the centre, glabrous on both sides; *lateral staminodes* c.15 × 12 mm, irregularly ovate to rhomboid, white or with yellowish patch in the centre and the apex, glabrous on both sides; *stamen* 8–9 mm long; *filament* c.2 mm long, 5 mm broad at base, 2 mm broad at apex, white, sparsely puberulent dorsally (glandular hairs); *anther* 8–9 mm long, spurred, connective white, densely puberulent with very short glandular hairs, anther spurs 1–1.5 mm long, narrowly triangular to filiform, anther crest thick, rounded, 1.5–2 mm long and c.3 mm broad at base, pure white; *anther thecae* 6–6.5 mm long, white, dehiscing along their entire length, pollen white; *epigynous glands* two, c.3 mm long, c.0.8 mm in diameter, cylindrical, cream white, with blunt apex; *style* white, glabrous; *stigma* capitate, c.1 mm long, c.1.5 mm wide, white; *ostiole* densely ciliate, facing forwards; *ovary* cylindrical, 2 × 2 mm, trilocular, white, glabrous. *Fruits* not seen.

Distribution. Occurring in Northern Thailand, Chiang Rai and Lampang provinces. Photographs seen indicate that the species also occurs in Tak province.

Ecology and phenology. This species grows in mixed deciduous forests as well as in secondary disturbed habitat around villages, and flowers between July to September.

Provisional IUCN Red List category. This species is currently known from only two locations, with no reliable information about number or size of the populations. We therefore propose here to treat this species provisionally as Data Deficient (DD). The type locality is within the protection of a National Park.

Etymology. The specific epithet derives from Latin *eburneus* and refers to the ivory/cream-white colour of the bracts of this species.

Vernacular names and uses. In Lampang province, the plant is known as *kai laen* (**ไข่แลน**) (= monitor lizard eggs, referring to the colour of the bracts), and young inflorescences are eaten by the locals as a vegetable. According to Wannakrairoj (1996), the common name of this species in Thailand is *thep prasit* (theph prāsiṭhi) (**เทพประสิทธิ**) (= plant created by an angel). Dried flowers are used in the composition of Buddhist amulets and usually soaked in sandalwood oil for the tattooing ritual.

Additional specimens examined. Living collections of Singapore Botanic Gardens, 8 i 2014, *Leong-Škorničková, J.* GRC-193, plants received from Queen Sirikit Botanic Garden, originally collected from Thailand, Lampang province, Hangchat, Ban Mae Yam Nai, c.2 km from the village.

Curcuma pierreana is the closest species to *C. eburnea* morphologically. The typical form of *Curcuma pierreana* has lateral staminodes with dark purple tips, but occasionally a form with pure white staminodes is seen in some populations, and these plants may be harder to distinguish from *C. eburnea*. However, the differences in the shape of lamina, the number of bracts forming the spike and the anther spurs as outlined in the diagnosis distinguish the two species fairly easily. Additionally, *Curcuma eburnea* is only known to occur in Northern Thailand, whereas *C. pierreana*, which was originally described from Vietnam, is only known to extend to two provinces (Si Sa Ket and Ubon Rathchathani) in the easternmost part of Thailand. *Curcuma vitellina* Škorničk. & H.Đ.Trần from southern Vietnam is also somewhat similar in its ecomate inflorescence composed of cream-white bracts, but *C. vitellina* has bright warm yellow to yellow-orange flowers.

According to Wannakrairoj (1996), this species is sometimes called *Curcuma cochinchinensis* Gagnep. in Thailand. Maknoi (2006) and Maknoi & Sirirugsa (2012) also applied the name *Curcuma cochinchinensis* to this species, at least in part, although it is likely that they also included other taxa in their broad concept of *C. cochinchinensis*. Although the true identity of *Curcuma cochinchinensis* remains poorly understood and is under further investigation by the first author, it is not identical to *C. eburnea* because the protologue of *C. cochinchinensis* (Gagnepain, 1907) and original specimens refer to a species with running rhizomes, negligible ligule and inflorescences composed of fewer than 20 bracts.

Photographs taken in Northern Thailand indicate that some populations of *Curcuma eburnea* may have light pink bracts, although the definitive determination of these populations can be confirmed only after examining fresh flowering material.

Acknowledgements

We thank the curators of AAU, BK, BKF, CMU, K, P, QBG and SING for letting us examine and photograph *Curcuma* specimens in their care. S. S. thanks all local informants and the Department of Biology, Faculty of Science, Prince of Songkla University, for facilities and support. We thank the staff of Queen Sirikit Botanic Garden and Singapore Botanic Gardens for taking care of the living collections, and W. Thongbai for letting us use some of her photographs of *Curcuma cinnabarina*. We thank two anonymous reviewers for their constructive comments. The research of J. L.-Š. is supported by the National Parks Board, Singapore.

References

Beentje, H. (2016). *The Kew Plant Glossary, an Illustrated Dictionary of Plant Terms*, 2nd edition. Richmond: Royal Botanic Gardens Kew.

Chen, J., Lindstrom, J. A. & Xia, N. H. (2015). *Curcuma woodii* (Zingiberaceae), a new species from Thailand. *Phytotaxa* 227(1): 75–82. doi: 10.11646/phytotaxa.227.1.8

Gagnepain, F. (1907). Zingibéracées, Marantacées et Musacées nouvelles de l'herbier du Muséum (19e note). *Bull. Soc. Bot. France* 54: 403–413.

IUCN Standards and Petitions Subcommittee (2017). *Guidelines for Using the IUCN Red List Categories and Criteria*, version 13. Online. Available: http://www.iucnredlist.org/documents/RedListGuidelines.pdf (accessed 4 September 2019).

Larsen, K. & Larsen, S. S. (2006). *Gingers of Thailand*, 184 pp. Chiang Mai: Queen Sirikit Botanic Garden.

Leong-Škorničková, J. & Lý, N. S. (2010). *Curcuma pambrosima* sp. nov. (Zingiberaceae) from central Vietnam. *Nordic J. Bot.* 28(6): 652–655. doi: 10.1111/j.1756-1051.2010.00861.x

Leong-Škorničková, J. & Trần, H. Đ. (2013). Two new species of *Curcuma* subgen. *Ecomata* (Zingiberaceae) from southern Vietnam. *Gard. Bull. Singapore* 65(2): 169–180.

Leong-Škorničková, J., Sabu, M. & Prasanthkumar, M. G. (2003). A new species of *Curcuma* L. (Zingiberaceae) from Mizoram, India. *Gard. Bull. Singapore* 55: 89–95.

Leong-Škorničková, J., Šída, O., Jarolímová, V., Sabu, M., Fér, T., Trávníček, P. & Suda, J. (2007). Chromosome numbers and genome size variation in Indian species of *Curcuma* (Zingiberaceae). *Ann. Bot.* 100(3): 505–526. doi: 10.1093/aob/mcm144

Leong-Škorničková, J., Trần, H. Đ. & Newman, M.F. (2010). *Curcuma vitellina* (Zingiberaceae), a new species from Vietnam. *Gard. Bull. Singapore* 62: 111–117.

Leong-Škorničková, J., Šída, O., Bouamanivong, S. & Souvannakhoummane, K. (2014). Three new ginger species (*Zingiberaceae*) from Laos. *Blumea* 59(2): 106–112. doi: 10.3767/000651914X685221

Leong-Škorničková, J., Lý, N. S. & Nguyen, Q. B. (2015a). *Curcuma arida* and *C. sahuynhensis*, two new species from subgenus *Ecomata* (Zingiberaceae) from Vietnam. *Phytotaxa* 192(3): 181–189. doi: 10.11646/phytotaxa.192.3.4

Leong-Škorničková, J., Šída, O., Záveská, E. & Marhold, K. (2015b). History of infrageneric classification, typification of supraspecific names and outstanding transfers in *Curcuma* (Zingiberaceae). *Taxon* 64(2): 362–373. doi: 10.12705/642.11

Leong-Škorničková, J., Middleton, D. J., Triboun, P. & Suddee, S. (2017). *Curcuma prasina* (Zingiberaceae), a new species from Thailand. *Edinburgh J. Bot.* 74(2): 245–250. doi: 10.1017/S0960428617000117

Lưu, H. T., Trần, H. Đ., Nguyễn T. Q. T. & Leong-Škorničková, J. (2017). *Curcuma cotuana* sp. nov. (Zingiberaceae: Zingibereae) from central Vietnam. *Nord. J. Bot.* 35(5): 552–556. doi: 10.1111/njb.01594

Maknoi, C. (2006). *Taxonomy and phylogeny of the genus* Curcuma *L.* (Zingiberaceae) *with particular reference to its occurrence in Thailand*. Dissertation, Prince of Songkla University, Songkhla, Thailand.

Maknoi, C. & Sirirugsa, P. (2012). *The genus* Curcuma *L. (Zingiberaceae) in Thailand*, 160 pp. Chiang Mai: The Botanical Garden Organization (in Thai).

Maknoi, C., Ruchisansakun, S. & Jenjittikul, T. (2019). *Curcuma putii* (Zingiberaceae), a new species from Thailand. *Ann. Bot. Fenn.* 56(4–6): 351–353. doi: 10.5735/085.056.0420

Schumann, K. (1904). Zingiberaceae. In: Engler, A. (ed.) *Das Pflanzenreich*, IV, 46, pp. 1–458. Leipzig: W. Engelmann.

SIRIRUGSA, P., LARSEN, K. & MAKNOI, C. (2007). The genus *Curcuma* L. (Zingiberaceae): distribution and classification with reference to species diversity in Thailand. *Gard. Bull. Singapore* 59(1–2): 203–220.

SOUVANNAKHOUMMANE, K. & MAKNOI, C. (2014). *Curcuma peramoena* Souvann. & Maknoi (Zingiberaceae): a new species from Lao PDR. *Thai J. Bot.* 6(2): 125–130.

TANAKA, N. & AUNG, M. M. (2019). Taxonomic studies on Zingiberaceae of Myanmar I: a new species of *Curcuma* (subgenus *Ecomatae*) from Myanmar. *Phytotaxa* 387(2): 241–248. doi: 10.11646/phytotaxa.387.3.4

WANNAKRAIROJ, S. (1996). *Pathumma lae Kra-Chiew (Curcuma): Mai Dok Mai Pradab [Pathumma and Kra-Chiew (Curcuma): Ornamentals]*, 1st edition, 128 pp. Bangkok: Amarin Printing and Publishing Public Co. (in Thai).

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.

ZHANG, L.-X., DING, H.-B., LI, H.-T., ZHANG, Z.-L. & TAN, Y.-H. (2019). *Curcuma tongii*, a new species of *Curcuma* subgen. *Ecomatae* (Zingiberaceae) from southern Yunnan, China. *Phytotaxa* 395(3): 241–247. doi: 10.11646/phytotaxa.395.3.9

Received 20 November 2019; accepted for publication 4 March 2020; first published online 30 April 2020