



Curcuma arida and *C. sahuynhensis*, two new species from subgenus *Ecomata* (Zingiberaceae) from Vietnam

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Abstract

Two new *Curcuma* species are described and illustrated from Vietnam. They are compared to their closest allies from subgenus *Ecomata*. *Curcuma arida* from Núi Chúa National Park, Ninh Thuận Province, is compared to *Curcuma pambrosima* and *C. vitellina*, while *Curcuma sahuynhensis* from Quảng Ngãi Province is compared to *Curcuma xanthella*.

Key words: *Curcuma pambrosima*, *Curcuma vitellina*, *Curcuma xanthella*, Ninh Thuận Province, Núi Chúa National Park, Quảng Ngãi Province

Introduction

The Indochinese region is one of the diversity hotspots for the family Zingiberaceae (Leong-Škorničková *et al.* 2010). However, the Zingiberaceae flora is not well studied with the last account being over a century old (Gagnepain 1908). During our extensive explorations of Zingiberaceae for the Flora of Cambodia, Laos and Vietnam, numerous interesting ginger species including a new genus *Newmania* N.S.Lý & Škorničk. (in Leong-Škorničková *et al.* 2011: 1390) from Vietnam have been recently described (Lý *et al.* 2010, Lamxay & Newman 2012, Nguyen & Leong-Škorničková 2012) including eight *Curcuma* species from Laos and Vietnam. Six of these are from the recently recognised subgenus *Ecomata* Škorničk. & Šída f. (in Závěská *et al.* 2012: 758)—*C. vitellina* Škorničk. & H.Đ. Trần (in Leong-Škorničková *et al.* 2010: 111), *C. pambrosima* Leong-Škorničková & Lý (2010: 652), *C. newmanii* Škorničk. and *C. xanthella* Škorničk. (both in Leong-Škorničková & Trần 2013: 170, 172), *C. corniculata* Škorničk. and *C. flammea* Škorničk. (both in Leong-Škorničková *et al.* 2014: 106, 108), while two species are from subgenus *Hitcheniopsis* Schumann (1904: 101)—*Curcuma pygmaea* Škorničk. & Šída f. (in Leong-Škorničková *et al.* 2013: 639) and *Curcuma leonidii* Leong-Škorničková & Luru (2013: 37).

The species, named below as *Curcuma arida*, was noticed by the second author several years ago, and new collections including spirit material were made recently by the first and third authors. The second novelty, named below as *C. sahuynhensis*, has been collected by the second author in 2010 along with ample spirit material and detailed photographic documentation. With the progressing revision of the genus *Curcuma* for Indochina by the first author, it is clear these collections represent new species and therefore are described and illustrated below. *Curcuma arida* is by its inflorescence shape and colour of the bracts somewhat similar to *C. pambrosima*, but the shape of the anther also suggests affinity to *Curcuma vitellina*. *Curcuma sahuynhensis* has a distinct L-shaped anther, somewhat similar to *C. xanthella*, but this species is otherwise different in the shape of the inflorescence and flowers. The differences are further discussed in notes for each species. Descriptions are based on living flowering material. Terminology used here follows Beentje (2012) and the recent ginger works cited above.

Taxonomy

Curcuma arida Škorničk. & N.S.Lý, *sp. nov.*

Similar to *C. pambrosima* (subgenus *Ecomata*) by the shape of the inflorescence, but differs in shape and colour of the anther (anthers white with bright yellow anther crest and two filamentous, hook-shaped spurs in *C. arida* versus light yellowish anther with prominent 1.5 mm long thick spurs which are curved inwards in *C. pambrosima*).

Type—VIETNAM. Ninh Thuận Province: Ninh Hải Dist., Vĩnh Hải Commune, Thái An village, Núi Chúa National Park, 11°41'16.0"N, 109°09'25.2"E, 75 m, *Jana Leong-Škorničková, Nguyễn Quốc Bình, Aung Thame & Edward Ong JLS-2575* (holotype SING (inclusive spirit), isotypes E, P, VNM, VNMN (inclusive spirit)). **Fig. 1 & 2.**

Small rhizomatous herb to 0.5 m tall. *Rhizome* ovoid, 3–4 × ca 1 cm, occasionally with a thin branch pointing downwards, light brown externally, yellow internally, strongly aromatic; *root tubers* ovate to fusiform, 2.4–4.8 × 0.9–2.3 cm, externally brown, internally whitish, buried deeply in the ground. *Leafy shoots* with usually 3–4 leaves at the time of flowering; *pseudostems* to 15 cm long, green, composed of sheathing bracts and leaf sheaths; *sheathing bracts* 2–3, green, soon turning papery dry and decaying, glabrous; *leaf sheaths* green, glabrous; *ligule* up to 5 mm long, bilobed (lobes acute to acuminate), hyaline, greenish white, translucent, glabrous; *petiole* 1–9 cm long (petiole of first leaf shortest, innermost leaves longest), canaliculate, green, glabrous; *lamina* slightly unequal, ovate to elliptic, up to 35 × 13 cm, slightly coriaceous, smooth (very obscurely plicate), adaxially green, glabrous, abaxially lighter green, glabrous, midrib green, glabrous on both sides, base rounded, slightly oblique, apex attenuate, puberulent. *Inflorescence* central, with peduncle obscured within pseudostem; *peduncle* up to 20 cm long, up to 7 mm in diameter, light green in parts exposed to light; *spike* 10–20 cm long, 4–6 cm in diameter (measured at the middle part), with no obvious coma, composed of 15–35 bracts; *bracts* 3–5 × 2.0–4.5 cm, broadly to narrowly ovate to trullate, broader at base, narrower towards the apex, whitish to light green at basal half with increasing purple tinge towards the apices, both sides glabrous, connate in lower 1/3–1/4, apices acute to narrowly acute, reflexed; *cincinni* with 4 flowers at the base of the inflorescence, 1–2 flowers at the top; *bracteoles* small, narrowly triangular and curved, up to 2 mm wide at base, up to 9 mm long, white with purple–pink tinge at apex, sometimes fully reduced (missing). *Flowers* 4–5 cm long, exerted from bracts; *calyx* 10–13 mm long, 3-toothed, with 5–6 mm long unilateral incision, glabrous, semi-translucent white, apices of teeth convex, tinged with dark pink; *floral tube* 2.2–3.0 cm long, narrowly cylindrical at base for ca 1.5–2.0 cm above the ovary, funnel-shaped at apex, white externally and internally, externally glabrous at base, puberulent at funnel-shaped part, internally puberulous, with dorsally placed loose groove holding the style; *dorsal corolla lobe* ca 15 × 11–13 mm, triangular-ovate, concave, white or with slight purple tinge at the apex, glabrous, apex mucronate, mucro ca 1 mm; *lateral corolla lobes* ca 12 mm long, 7–9 mm wide at base, triangular with obtuse, slightly concave apex, white or with slight purple tinge at the apex, glabrous; *labellum* ca 15–17 × 14 mm, slightly obovate, with an incision up to 7 mm long, cream white at base, turning yellow at apex with bright yellow band running through the apical part of the centre; *lateral staminodes* 14–16 × 11 mm, unequally ovate to rhombic, white at base, yellow towards apex, glabrous on both sides. *Stamen* 9–10 mm long; *filament* 3–5 mm long, 5–6 mm wide at base, ca 1.5 mm wide at the point of connection to connective, white, puberulent (glandular hair); *anther* spurred, connective sparsely puberulent (glandular hair), anther spurs ca 0.5 mm long, filamentous, hook-shaped, white, anther crest present, 1.0–1.5 mm long, with obtuse apex, yellow; anther thecae 5 mm long, dehiscing along entire length, pollen white. *Epigynous glands* two, cream-coloured, 3 mm long, ca 0.8 mm in diameter, with blunt apex. *Style* white, glabrous; *stigma* capitate, ca 1 mm wide, creamy white, ostiole ciliate, facing forward. *Ovary* 2–3 × 2 mm, trilocular, creamy white, glabrous. *Fruit* a globular trilocular capsule, ca 1.1 cm in diameter (almost ripe), white, glabrous; *seeds* irregularly obovoid, ca 5 mm long, creamy white to light brown (almost ripe), shiny, enclosed in translucent white, lacinate aril.

Ecology and phenology—So far known only from the Núi Chúa National Park, where it is restricted in semi-arid forest, growing on rocky slopes in open places or in the undergrowth of shrubby vegetation. *Curcuma arida* flowers from September to November and fruits from October to December, unlike the majority of other *Curcuma* species in Vietnam which flower in April to July. This pattern, however, corresponds well with the occurrence of the rainy season in the semi-arid climatic zone of southern Vietnam (Averyanov *et al.* 2003).

Distribution and IUCN preliminary assessment—*Curcuma arida* is as yet only known from the type locality, where we have counted about 200 adult individuals. Local people informed us that they have seen this species growing also in other lowland locations with similar vegetation type within Núi Chúa NP. They have also shared that they do not

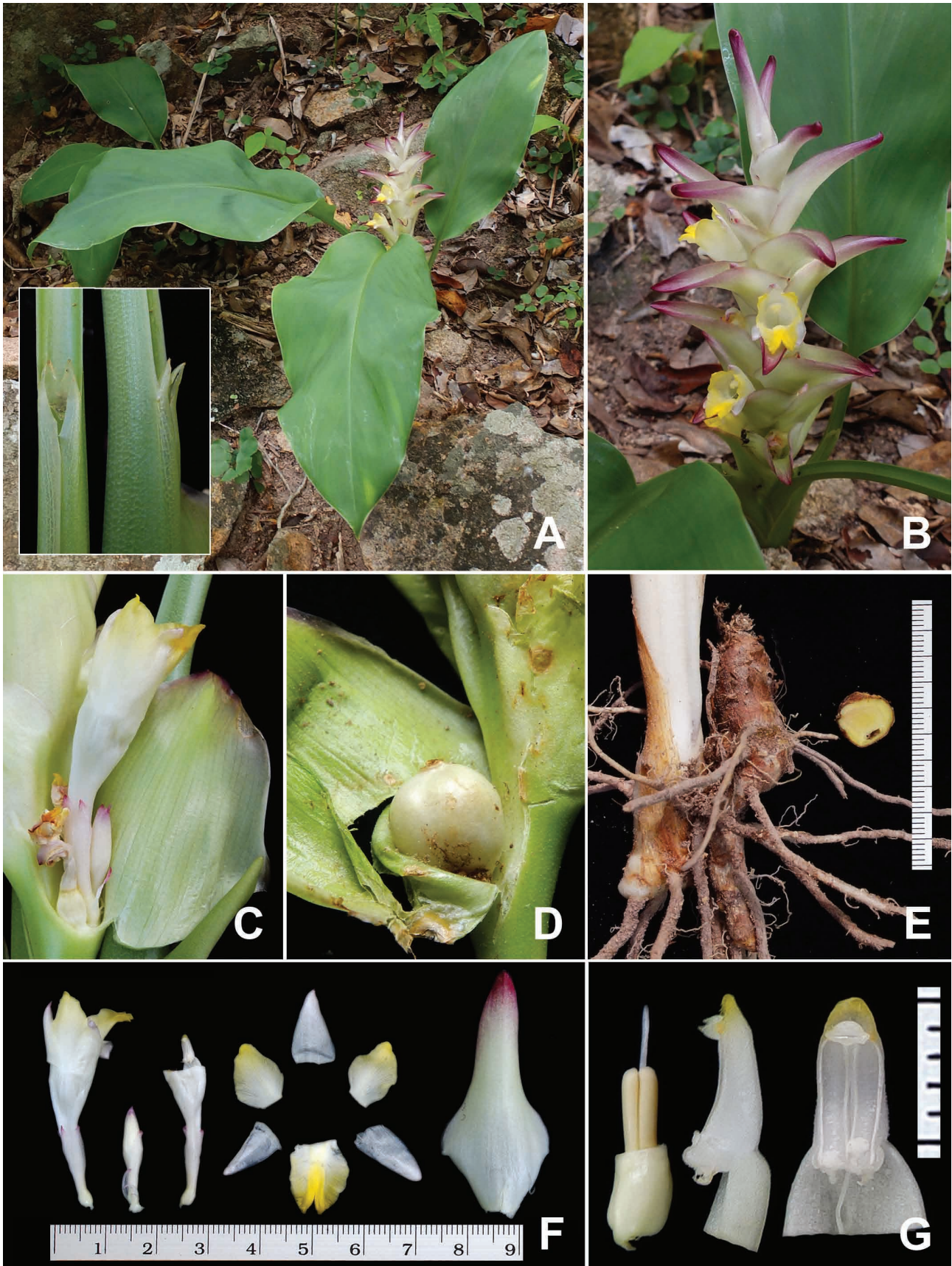


FIGURE 1. *Curcuma arida*. A. Habit and detail of ligule (inset). B. Inflorescence. C. Cincinnus. D. Young fruit. E. Rhizome (scale bar in mm). F. Flower dissection: flower in side view, flower bud, floral tube (with ovary, calyx and stamen attached), corolla lobes, staminodes and labellum, fertile bract (scale bar in cm). G. Epigynous glands, anther (side and front view; scale bar in mm). From type *JLS-2575*. Photos: *J. Leong-Škorničková*

use this species economically. With no imminent threat and with the protection given by the National Park status, we suggest treating this species as Data Deficient (DD) until the lack of data on the extent of its occurrence and population sizes can be satisfactorily addressed.

Etymology:—This species grows in one of the driest parts of Vietnam, often intermingled with succulent members of Euphorbiaceae (Fig. 2) and hence the specific epithet ‘*arida*’.

Additional specimens examined (paratypes):—VIETNAM. Ninh Thuận Province: Ninh Hải Dist., Vĩnh Hải Commune, Thái An village, 11°42′14.67″N, 109°09′26.45″E, 120 m, 20 September 2009, *Lý Ngọc Sâm* 450 (SING, VNM); *ibid.* 11°41′27″N, 109°11′14″E, 35 m, 1 November 2010, *Lý Ngọc Sâm* 489 (E, P, SING, VNM).

Notes:—*Curcuma arida* is similar to *C. pambrosima* by its inflorescence composed of ovate to trullate bracts that are green to white at the base, gradually tinged pink towards the acute to narrowly acute and reflexed apices, as well as their lack of clear distinction between fertile and coma bracts. The major difference between the two species lies in the floral features of which most conspicuous is the shape of the anthers. *Curcuma pambrosima* has a light yellowish anther with prominent 1.5 mm long thick spurs that are curved inwards (see Fig. 1D in Leong-Škorničková & Lý 2010), while *C. arida* has a white anther with a bright yellow anther crest and two filamentous hook-shaped spurs (see Fig. 1G).

The anther of *Curcuma arida* is in shape very similar to that of *C. vitellina* (see Fig. 1D in Leong-Škorničková *et al.* 2010) and likely catering to a similar pollinator, but the general appearance of the two species is different in leaves (thin and prominently plicate lamina in *C. vitellina* vs. somewhat coriaceous smooth lamina in *C. arida*) as well as the overall inflorescence shape and colour (inflorescence composed of 15–60 creamy white or greenish bracts with obtuse, mildly reflexed apices in *C. vitellina* vs. inflorescence composed of 15–35 bracts that are green to white at base, gradually tinged by pink towards the acute to narrowly acute and strongly reflexed apices (compare Fig. 1 in Leong-Škorničková *et al.* 2010 and Fig. 1 presented here).



FIGURE 2. *Curcuma arida* in the typical dry habitat at the type locality where it grows on stony slopes under the shrubby vegetation often intermingled with succulent members of *Euphorbia*. Photo: J. Leong-Škorničková

A revision of extensive herbarium material of *Curcuma* in various herbaria resulted in a possible match of two specimens deposited in the in the MNHN herbarium in Paris (P). One of them was collected near Phan Rang, while the other near Nha Trang (ca 20 and 60 km air distance respectively). While the conclusive determination is not possible due to lack of flowers/detailed notes (and therefore these specimens are not listed above), it is likely that both specimens represent *Curcuma arida*.

Curcuma sahuynhensis Škorničk. & N.S.Lý, *sp. nov.*

Similar to *Curcuma xanthella* (subgenus *Ecomata*) in its elliptic-lanceolate, plicate laminae and L-shaped anther, but differs in the shape and size of the spike that appears above ground (6–15 × 5–9 cm; composed of 10–23 bracts with prominently reflexed apical halves arranged on an elongated rachis), overall smaller flowers (3.5–4.5 cm long), shorter (4 mm) and stouter anther spurs, longer anther thecae (6–7 mm long) and shorter epigynous glands (5–6 mm long) (versus spike 4–5 × 1.5–2 cm, composed of 4–8 bracts with a reduced rachis, basal part of spike often partly subterranean; flowers to 7.5 cm long, longer and more slender anther spurs (6 mm), shorter anther thecae (3–4 mm) and longer epigynous glands (ca 15 mm) in *C. xanthella*).

Type:—VIETNAM. Quảng Ngãi Province: Đức Phổ Dist., Phổ Thạnh commune, Đồng Vân Village, Núi Đồng Đế, Núi Đồng Vân, 14°39'28"N, 109°02'22"E, 183 m asl., 4 September 2010, Lý Ngọc Sâm, Phan Thế Cường, Lý-486 (holo SING (incl. spirit), iso E, P, VNM (incl. spirit)). **Fig. 3 & 4.**

Small rhizomatous herb to 0.8 m tall. *Rhizome* ovoid to narrowly ovoid, 1.5–4.0 × 0.5–1.0 cm, occasionally with a thin branch pointing downwards, light brown externally, creamy white to pale yellow internally, slightly aromatic, root tubers fusiform, 2–6 × 0.8–1.8 cm, light brown externally, pure white internally, buried deeply in the ground (distanced 8–15 cm from the main rhizome). *Leafy shoots* with ca 1–2 leaves at the time of flowering, with up to 10 leaves on mature plants past flowering; *pseudostems* 10–15(–20) cm long, green, composed of sheathing bracts and leaf sheaths; *sheathing bracts* 3–5, green, glabrous or sparsely puberulent, turning dry and papery with age; *leaf sheaths* green, glabrous; *ligule* up to 5 mm long, bilobed, hyaline, greenish white, translucent, glabrous, margin sparsely hairy; *petiole* 2–20(–24) cm long (petiole of first leaf shortest, innermost leaves longest), canaliculate, green, glabrous; *lamina* slightly unequal, ovate to elliptic, 20–38 × 9–16(–18) cm (measured in mature plants in late stage of flowering), plicate, adaxially bright green, glabrous, abaxially lighter green, glabrous but sparsely puberulous along midrib and near margin in apical part of lamina; midrib green, glabrous above, very sparsely puberulous below (hairs restricted to sides of midrib); base obtuse to rounded, slightly oblique; apex attenuate to acuminate, puberulent. *Inflorescence* lateral, arising at the same time as first 1–2 leaves; *peduncle* 6–16 cm long, to 8 mm in diameter, light green in parts exposed to light, sheathed by 3–5 leafless, light green, glabrous sheaths (turning dry and papery with age); *spike* to 6–15 cm long, 5–9 cm in diam. at the middle, with no obvious coma, composed of 10–23 bracts; *bracts* 3.0–5.5 × 1.5–4.0 cm, broadly to narrowly ovate to rhombic (broader at base, narrower at the apex), whitish to pale green at base with various degree of coral pink or red tinge, both sides glabrous, connate in lower 1/3–1/4, apices acute to narrowly acute, reflexed; *cincinni* with 3–5 flowers at the base of the inflorescence, 1–2 flower at the top; *bracteoles* subulate, 1–5 mm long, semi-translucent white, glabrous, often fully reduced. *Flowers* 3.5–5.5 cm long, exerted from bracts; *calyx* 14–19 mm long, 3-toothed, with unilateral incision, 5–8 mm, glabrous, semi-translucent white or with pink tinge; *floral tube* 1.8–2.8 cm long, narrowly cylindrical at base for ca 1.3–1.8 cm above the ovary, funnel-shaped at apex, externally white or with pink tinge, externally puberulous (less so in basal part), internally white, turning pale yellow towards apical part, densely hirsute at apical part, sparsely hirsute towards the base, with dorsally placed loose groove holding the style; *dorsal corolla lobe* 15–22 × 6–11 mm, triangularly ovate, concave, white or pale yellow with various degree of pink or red tinge, glabrous, apex mucronate, mucro ca 1 mm, sparsely puberulous; *lateral corolla lobes* 15–20 × 6–9 mm, triangular, apex broadly acute to obtuse, slightly concave, white or pale yellow with various degree of pink or red tinge, glabrous; *labellum* 15–23 × 12–18 mm, slightly obovate, with an incision 2–7 mm long, cream white at base, warm rich yellow at apex with bright yellow-orange band running through the centre; *lateral staminodes* 15–22 × 10–14 mm, unequally ovate to obovate to rhomboid, warm rich yellow, lighter towards base, covered with short glandular hair adaxially. *Stamen* 11–12 mm long; *filament* 4–5 mm long, cream-white to pale yellow, 3–4 mm broad at base, 2.0–2.5 mm broad at apex (the point of attachment to the connective), densely puberulent (glandular hair); *anther* L-shaped (angle ca 110°–120°), spurred, connective tissue pale yellow to pale yellow-orange, densely puberulent (glandular hair), anther spurs 3.5–5.0 mm long, stout, parallel with acute apices slightly divergent, creamy white to pale yellow, anther crest 0.3–1.0 mm long (almost negligible in some plants), apex emarginate, pale yellow; *anther*

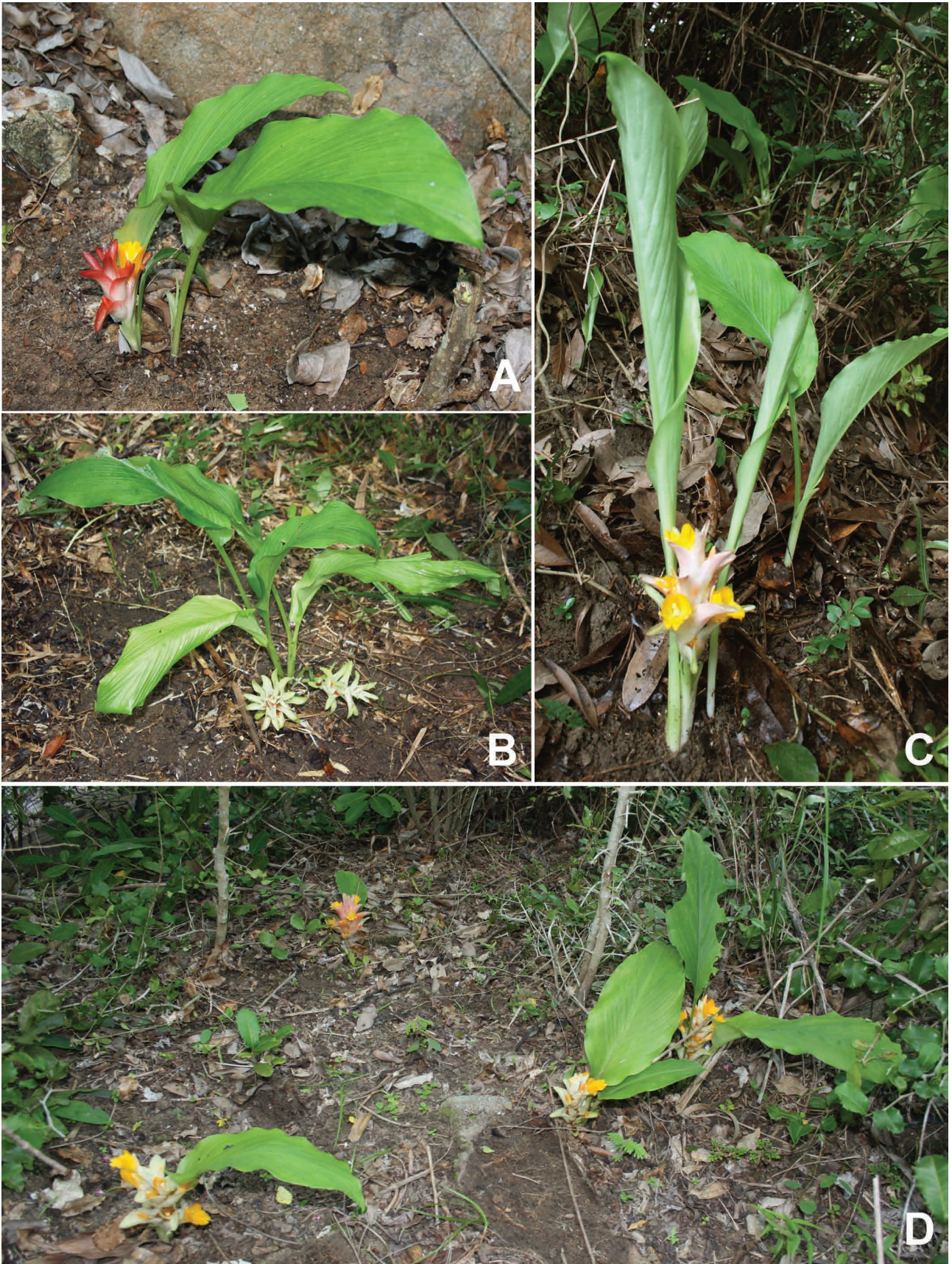


FIGURE 3. *Curcuma sahuynhensis*. A–C. Plants with various degree of coloration of the bracts. D. Natural habitat. From type *Lý-486*.
 Photos: *Lý Ngọc Sâm*

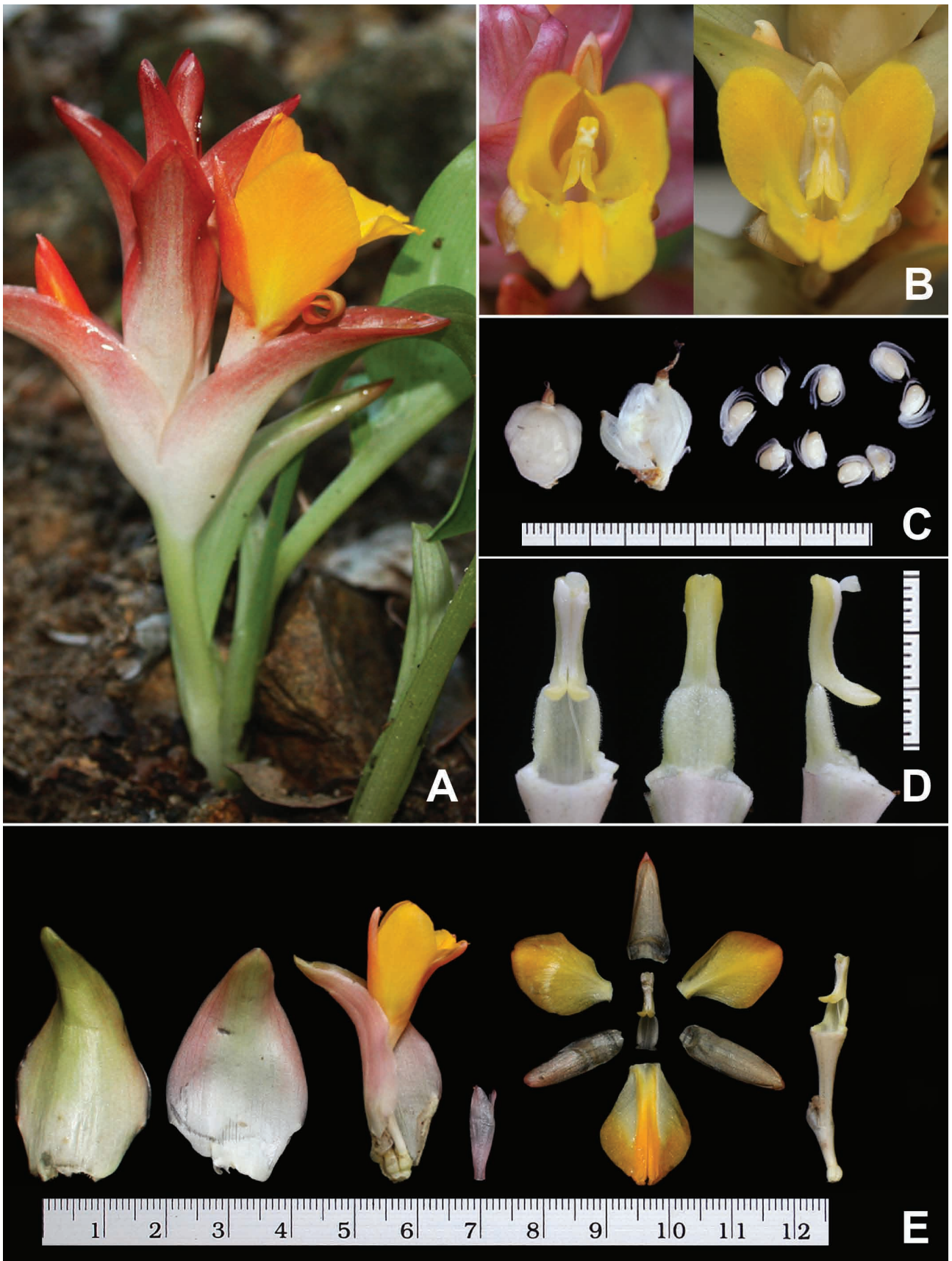


FIGURE 4. *Curcuma sahuynhensis*. A. A small inflorescence with a flower in side view. B. Flowers in front view. C. Fruits and seeds (scale bar in mm). D. Detail of stamen in front, back and side views. E. Flower dissection: Fertile bracts, flower in fertile bract, calyx, corolla lobes, staminodes and labellum with stamen in the centre, floral tube (with ovary, calyx and stamen attached). From type *Lý-486*. Photo: *Lý Ngọc Sâm*

thecae 6–7 mm long, dehiscing along entire length, pollen white. *Epigynous glands* two, creamy yellow, 4–6 mm long, ca 0.6 mm in diameter, with blunt apices. *Style* white, glabrous; *stigma* capitate, ca 1 mm wide, creamy white; *ostiole* shortly ciliate facing forward. *Ovary* 3–5 × 2–4 mm, trilocular, creamy white, usually glabrous (rarely sparsely hairy at apical part). *Fruit* a globular trilocular capsule (with locules visibly bulging in ripe fruit), 11–15 mm in diameter, white, glabrous; *seeds* irregularly obovoid, 4–5 × 2–3 mm, light brown, shiny, enclosed in translucent white, lacinate aril.

Ecology and phenology:—Growing in coastal lowland forests, on gravelly infertile soil in open spaces, shrubby vegetation as well as *Acacia* plantations. *Curcuma sahuynhensis* flowers from August to October and fruits from September to November. This flowering pattern corresponds with the beginning of the rainy season in central to northern Vietnam.

Etymology:—The specific epithet *sahuynhensis* is derived from Sa Huỳnh town, hometown of the second author, where this species was first collected. Sa Huỳnh area is well-known for its ancient rich culture dating to 1000 BC to 200 AD.

Vernacular names and uses:—The species is locally called Rau Nghệ [Rau = vegetable, Nghệ = Turmeric (*Curcuma*)]. The name reflects the fact that *C. sahuynhensis* is often harvested as a local vegetable. Inflorescences and young leafy shoots are sold in the local market when in season and are used for preparation of boiled vegetable or soup (usually mixed with another wild vegetable: Lá Giang - *Aganonerion polymorphum* Pierre ex Spire (1905: 43), Apocynaceae).

Distribution and IUCN preliminary assessment:—*Curcuma sahuynhensis* is currently only known from Quảng Ngãi Province. During the field work conducted by the second author, many populations/subpopulations each consisting of 10–100 adult individuals were noticed growing naturally in open places or shrubby vegetation of the coastal lowland forests around Đồng Vân and Đồng Đèo villages. Its occurrence in the wild as well as in local vegetable markets have been also reported to us from Đức Phở town. While the young shoots and inflorescences are harvested in the wild by local people as a seasonal vegetable, the rhizomes remain deep in the ground and regular harvesting does not seem to pose any threat to population sizes. While we have seen images from various sources of likely identical species from central Vietnam (without precise localities), we have also seen images of closely related, but likely distinct species from adjacent provinces. We therefore suggest treating this species as Least Concern (LC) until more comprehensive data on the extent of its occurrence and population sizes as well as relationships to other potentially distinct species will suggest the necessity for re-evaluation.

Additional specimens examined (paratypes):—VIETNAM. Quảng Ngãi Province: Đức Phở District, Phở Khánh commune, Diên Trường Village, Núi Đồng Đèo, 14°41'23.54"N, 109° 2'27.60"E, 95 m, 5 September 2010, *Lý Ngọc Sâm, Phan Thế Cường, Lý-488* (SING, VNM).

Notes:—*Curcuma sahuynhensis* is fairly distinct from other species of subgenus *Ecomata* in Vietnam by its character combination of an L-shaped anther and an inflorescence composed of bracts arranged on an elongated rachis resulting in less overlapping bracts. The L-shaped anthers are not unusual in subgenus *Ecomata* and were observed in *C. flaviflora* Tong (1986: 37), *C. newmanii*, *C. singularis* Gagnepain (1907: 407) and *C. xanthella* (for details of anthers see Fig. 5. in Leong-Škorničková & Trần 2013), but all these species have spikes composed of few bracts arranged around a strongly reduced rachis, resulting in a fusiform to narrowly cupuliform shape of the inflorescence. Of the four species, *C. xanthella* has been selected for diagnostic purposes because of its plicate leaf blades, bright warm yellow flowers, and the fact that this species occurs in Vietnam, but mistaking these species is not likely (for comparison see detailed description Fig. 2 & 3 in Leong-Škorničková & Trần 2013).

No other herbarium collections revised by the first author in numerous herbaria could be determined with certainty as this species, although a single specimen deposited in the MNHN herbarium in Paris (P), collected by Couderc from Hue between 1883 and 1885, is a possible match for *C. sahuynhensis*. Re-collection of material from Hue is needed to confirm the identity of this specimen.

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References

- Averyanov, L.V., Phan, K.L., Nguyen, T.H. & Harder, D.K. (2003) Phytogeographic review of Vietnam and adjacent areas of Eastern Indochina. *Komarovia* 3: 1–83.
- Beentje, H. (2012) *The Kew Plant Glossary, an illustrated dictionary of plant terms* (revised edition). Royal Botanic Gardens Kew: Kew Publishing.
- Gagnepain, F. (1907) Zingiberacées, Marantacées et Musacées nouvelles de l'herbier du Muséum (19^e note). *Bulletin de la Société Botanique de France* 54: 403–413.
<http://dx.doi.org/10.1080/00378941.1907.10831283>
- Gagnepain, F. (1908) Zingibéracées. In: Lecomte, H. (ed.), *Flore Générale de l'Indo-Chine*, vol. 6. Masson & Co., Paris, pp. 25–121.
- Lamxay, V. & Newman, M.F. (2012) A revision of *Amomum* (Zingiberaceae) in Cambodia, Laos and Vietnam. *Edinburgh Journal of Botany* 69: 99–206.
<http://dx.doi.org/10.1017/s0960428611000436>
- Leong-Škorničková, J., Tran, H.Đ., & Newman, M.F. (2010) *Curcuma vitellina* (Zingiberaceae), a new species from Vietnam. *Gardens' Bulletin Singapore* 62: 111–117.
- Leong-Škorničková, J., Lý, N.S., Poulsen, A.D., Tosh, J. & Forrest, A. (2011) *Newmania*: a new ginger genus from central Vietnam. *Taxon* 60: 1386–1396.
- Leong-Škorničková, J. & Lý, N.S. (2010) *Curcuma pambrosima* sp. nov. (Zingiberaceae) from central Vietnam. *Nordic Journal of Botany* 28: 652–655.
<http://dx.doi.org/10.1111/j.1756-1051.2010.00861.x>
- Leong-Škorničková, J. & Luru, H.T. (2013) *Curcuma leonidii*, a new species from southern Vietnam. *Phytotaxa* 126: 37–42.
<http://dx.doi.org/10.11646/phytotaxa.126.1.4>
- Leong-Škorničková, J. & Trần, H.Đ. (2013) Two new species of *Curcuma* subgen. *Ecomata* (Zingiberaceae) from southern Vietnam. *Gardens' Bulletin Singapore* 65: 169–180.
- Leong-Škorničková, J., Šída, O. & Trần, H.Đ. (2013) *Curcuma pygmaea* sp. nov. (Zingiberaceae) from Vietnam and notes on the two related species *C. parviflora* and *C. thorelii*. *Nordic Journal of Botany* 31: 639–647.
<http://dx.doi.org/10.1111/j.1756-1051.2012.01749.x>
- Leong-Škorničková, J., Šída, O., Bouamanivong, S., Souvannakhoummane, K. (2014) Three new ginger species (Zingiberaceae) from Laos. *Blumea* 59: 106–112.
<http://dx.doi.org/10.3767/000651914X685221>
- Lý, N.S., Hul, S. & Leong-Škorničková, J. (2010) *Siliquamomum oreodoxa* (Zingiberaceae): a new species from Southern Vietnam. *Gardens' Bulletin Singapore* 61: 359–367.
- Nguyễn, Q.B. & Leong-Škorničková, J. (2012) *Distichochlamys benenica* (Zingiberaceae), a new species from Vietnam. *Gardens' Bulletin Singapore* 64: 195–200.
- Schumann, K. (1904) Zingiberaceae. In: Engler, A. (Ed.) *Das Pflanzenreich*, IV, vol. 46. Engelmann, Leipzig, pp. 1–458.
- Spire, C. (1905) *Contribution à l'étude des Apocynées; en particulier des lianes indo-chinoises*. A. Challamel, Paris.
- Tong, S.Q. (1986) Some new taxa of Zingiberaceae from Yunnan. *Acta Botanica Yunnanica* 8: 37–44.
- 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: 747–763.