

Revision of the genus *Cornukaempferia* Mood & K. Larsen (Zingiberaceae), and a new species from Thailand

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Abstract. Saensouk P, Boonma T, Saensouk S. 2022. Revision of the genus *Cornukaempferia* Mood & K. Larsen (Zingiberaceae), and a new species from Thailand. *Biodiversitas* 23: 5718-5729. *Cornukaempferia* Mood & K. Larsen (Zingiberaceae) is revised. Seven species of *Cornukaempferia* have been recognized with their updated nomenclature including *C. aurantiiflora* Mood & K. Larsen, *C. longipetiolata* Mood & K. Larsen, *C. larsenii* P. Saensouk, *C. chayanii* Yupparach & Wongsuwan, *C. kamolwanianae* Pichens., Yupparach & Wongsuwan, *C. argentifolia* Boonma & Saensouk, and a new species, namely *C. srisumoniae* P. Saensouk, S. Saensouk & Boonma sp. nov. A new species is found during our exploration of the diversity of Zingiberaceae in Thailand. After comparison to all previously existing species in the genus, the morphological characteristics of a new species are the most similar to *C. argentifolia*, but different in certain morphological characteristics. Therefore, we claim it as a new species to science under the name *C. srisumoniae* P. Saensouk, Saensouk & Boonma sp. nov. This new species is described here along with its illustrations, photographs, ecology, etymology, and distribution are provided. Six species are endemic and native to Thailand, while one species, namely *C. larsenii* P. Saensouk is native to Thailand and Laos PDR. A revised key to 7 species and descriptions is also presented.

Keywords: *Cornukaempferia srisumoniae*, new species, revision, Thailand, Zingiberaceae

INTRODUCTION

The Zingiberaceae or the ginger family belongs to the order Zingiberales which was previously called Scitamineae. This family is divided into 4 subfamilies, namely Alpinioideae, Siphonochiloideae, Tamijioideae, and Zingiberoideae (Kress et al. 2002). The Zingiberaceae is distributed in tropical and humid regions around the world and has been used for a long time and passed down for centuries in human cultures, especially in Southeast Asia. The diversity of species and traditional uses were reported in many research articles and books, e.g. Sirirugsa (1999), Larsen et al. (1999), Larsen and Larsen (2006), Leong-Škorničková and Newman (2015), Ujang et al. (2015), Saensouk et al. (2016), Dalisay et al. (2018), Pitopang et al. (2019), and Ragsasilp et al. (2022).

The revision studies and notes of the genera in the Ginger family have been reported, such as the genus *Roscoea* Sm. (Cowley 1982), *Boesenbergia* Kuntze (Sirirugsa 1992), *Vanoverberghia* Merr. (Docot et al. 2019), and *Geostachys* (Baker) Ridl. (Saensouk and Saensouk 2021). Some genera continue to report the discovery of new species continuously in recent years, especially *Curcuma* and *Kaempferia* (Boonma and Saensouk 2019; Maknoi et al. 2019; Leong-Škorničková et al. 2020; Saensouk et al. 2021a, b, c, d, 2022a, b; Boonma et al. 2022; Rakarcha et al. 2022).

The *Cornukaempferia* Mood & K. Larsen is a small genus belonging to the Zingiberaceae family, with a

strikingly distinguishable yellowish orange flower with a long horn-shaped yellow anther crest as in the genus *Zingiber*. The genus had been known to horticulturists for years as an ornamental plant that originated habitat in Thailand before it was described as a new genus to science from Thailand. The plant was also sold abroad, even advertised as *Boesenbergia aurantiaca*, an illegitimate name for a species that has been described from Borneo. It was also sold in the USA under the name "Velvet Butterfly". When a photograph of the plant was shown to John Mood, he regarded it as a practical joke, one "kind" person having placed a *Zingiber* flower among the leaves of *Kaempferia*. Later, notwithstanding, John Mood in Hawaii was successful in growing the plant and it was immediately clear that it could not belong to any known genus of Zingiberaceae, thus Mood and K. Larsen placed the genus tentatively in the *Hedychieae* (Larsen and Larsen 2006), and published the plant as a new genus from Thailand with *Cornukaempferia aurantiiflora* Mood & K. Larsen as a type species in 1997 (Mood and Larsen 1997).

In this study, a new species of *Cornukaempferia* are found distributed in Loei province, Northeastern Thailand. We present morphological descriptions of the new species along with its illustrations, ecology, phenology, and distribution, including a revised key to 7 species is also present to facilitate identification. The revision of taxonomic study and the utilization of the genus *Cornukaempferia* is, therefore, an important part of verifying the accuracy and providing a basis for

information for use in other studies such as palynology, phytochemistry, medicinal properties, chromosomes, and genetic relationships among the species.

MATERIALS AND METHODS

Living plant materials were collected from field trips in the natural habitat in Thailand and Laos, and spirit specimens were soaked in 70% alcohol and deposited at the Mahasarakham University Herbarium, Thailand. Living materials were planted at Saensouk Garden (Maha Sarakham Province, Thailand) and Brio Botanical Research Garden (Banna District, Nakhon Nayok Province, Thailand). The plant materials also include dry specimens and photographs of specimens deposited in some herbaria, such as AAU, BK, BKF, E, HNL, KKU, PSU, QBG, and US.

Measurements were recorded from living and spirit specimens taken with a ruler, vernier-caliper and morphologically examined under a stereoscopic microscope (Stemi 2000-C, ZEISS, Oberkochen, Germany). The morphological characteristics of new species were compared to all existing species by putting their information on each part in a table and putting the data in a numerical to calculate the similarity by using the Past4 program in helping in analyzing to distinguished characters and to find the most similar characters to a new species but not present here. Later checking the table of comparison about their similarity and differences in writing diagnosis, the table of the two similarities species was selected to present as herein. An illustration is drawn by hand and scanned to edit on MacBook to add the figures and scale bar lines.

General characteristics of *Cornukaempferia* are written from their shared morphological characters and the morphological characteristics of new species and were compared to all existing species by putting their information on each part in a table and putting the data in a numerical to calculate the similarity by using the Past4 program to help in decision about the difference and similarities.

RESULTS AND DISCUSSIONS

Taxonomy of *Cornukaempferia*

Seven species of *Cornukaempferia* have been recognized with their updated nomenclature, including *C. aurantiiflora* Mood & K. Larsen, *C. longipetiolata* Mood & K. Larsen, *C. larsenii* P. Saensouk, *C. chayanii* Yupparach & Wongsuwan, *C. kamolwaniae* Pichens., Yupparach & Wongsuwan, *C. argentifolia* Boonma & Saensouk, and a new species namely *C. srisumoniae* P. Saensouk, S. Saensouk & Boonma.

Taxonomic treatment of *Cornukaempferia*

Mood & Larsen K. The Natural History Bulletin of the Siam Society 45: 217-221 (1997); Mood & Larsen K. The New Plantsman 6: 196-205 (1999); Saensouk P, Theerakulpisut P, & Chantaranothai P. The Natural History

Journal of Chulalongkorn University 7 (2): 115-119 (2007); Yupparach P, Wongsuwan P, Phokham B, Sangnark S, & Pichansoonthon C. Journal of Japanese Botany 94 (2): 82-89 (2019); Rakarcha S, Maknoi C, Saensouk P, & Saensouk S. Journal of Japanese Botany 95 (4): 235-237 (2020); Saensouk P, Saensouk S, & Boonma T. Rheedia 31 (4): 260-266 (2021b).

General characteristic of *Cornukaempferia*

Perennial rhizomatous herb. *Rhizome* sympodial, with 2-3 layers internally, slightly aromatic, and bitter. *Root* fibrous with tuberous roots. *Leaves* are usually 2 (-3) at anthesis. *Leafsheaths* 3-10 cm long, canaliculate, distichous, sparsely hairy, or finely hairy. *Ligule* short, 1-4 mm long, membranous, apex emarginate, each lobe rounded to truncate. *Petiole* sessile or up to 13 cm long. *Lamina* is slightly asymmetric broadly ovate, elliptic, or suborbicular, 15.5-32 × 7.7-21.6 cm, abaxially surface pubescent. *Inflorescence* terminal between the innermost leaf sheaths, with few-flowered or up to 13 flowers. *Peduncle* sessile or up to 2.5 cm long. *Bracts* lanceolate to ovate, apex acute to acuminate, up to 5.7 cm long, diminishing upwards. *Calyx* tubular, up to 4 cm long, with unilateral incision, apex bilobed, or tridentate. *Floral tube* tubular, (2-)2.5-3(-4.3) cm long. *Corolla lobe* lanceolate to oblong, apex hooded. *Staminodes* narrowly obovate to oblanceolate, apex rounded to obtuse, yellow to orange. *Labellum* broadly deltoid, broadly suborbicular, or obovate to broadly obovate, yellowish-orange to orange with red lines at the base, apex rounded, or emarginate. *Stamen* with short filament; *Filament* flattened, 2-9 mm long, pale yellow to yellow. *Anther* opening longitudinally, connective productive produced into a long, narrow, forwards curved crest, yellow. *Stigma* ciliate. *Ovary* ellipsoid to obovoid, pubescent. *Fruit* ellipsoid, trilocular with axile placentation. *Seeds* globose with lacerate arillus.

History of *Cornukaempferia* Mood & Larsen K.

John Mood and Kai Larsen introduced the name of *Cornukaempferia* as a new genus in 1997 with *C. aurantiiflora* as a prototype, the name of the genus *Cornukaempferia* is a combination of the greek name "*Cornu*" which referred to the horn-shaped-like anther and the similarity of the vegetative parts with the genus *Kaempferia* (Mood and Larsen 1997), and two years later publish the second species namely *C. longipetiolata* (Mood and Larsen 1999). These two species were later reported to be found distributed in Nam Nao National Park, Phetchabun Province, Thailand (Saensouk et al. 2016). After Kress et al. (2002) studied phylogeny and made a new classification of plants in the Zingiberaceae from the molecular data, the genus *Cornukaempferia* was later classified in the subfamily Zingiberoideae Haask., and in the tribe Zingibereae Meisn.

The third species of *Cornukaempferia* was found in Phu Ruea and Na Haeo national parks, Loei province, Thailand, published in 2007 under the name *C. larsenii*, named after Professor Kai Larsen (Saensouk et al. 2007). Three species namely *C. aurantiiflora*, *C. longipetiolata*, and *C. larsenii* were studied in the pollen morphology by light microscopy

and scanning electron microscopy by Saensouk et al. (2009) and they proposed to divide *Cornukaempferia* into two types based on their exine sculptures. This observation helps support the taxonomic status of *C. larsenii* which is different from the other two species; the first type included *C. aurantiiflora* and *C. longipetiolata* by the exine sculpture echinate with psilate between spines. While the second type of exine sculpture is echinate with the regulated between spines in *C. larsenii*. However, more research in studying the pollen morphology and using molecular evidence and population genetic studies is needed to evaluate their relationship among all species of the genus *Cornukaempferia*.

Cornukaempferia chayanii and *C. kamolwaniae* were reported as new species in 2019 from northern Thailand (Yupparach et al. 2019). All species were endemic to Thailand until Rakarcha et al. (2020) reported the distribution of *C. larsenii* in Laos PDR making one species of this genus, *C. larsenii* native to Thailand and Laos PDR, while other species are still native and endemic to Thailand. Recently in 2021, *C. argentifolia*, a plant that is strikingly different from other species produces whole silver leave without markings, sometimes with a reddish tinge along the midrib was reported from Thailand as a new species to science (Saensouk et al. 2021b) bringing the number of this genus becomes 6 species worldwide, they are 5 species endemic to Thailand and only one species *C. larsenii* native to Thailand and Laos PDR.

Plant species within the genus have been used in daily life for a variety of purposes, specially cultivated as ornamental plants due to their beautiful foliage pattern and lovely yellowish-orange flowers. Besides of used as an ornamental plant, *C. aurantiiflora* has been reported to be

used by local people in northeastern Thailand to treat infected hemorrhoids and laryngitis in children (Saensouk 2011). For some groups of collectors in Thailand, it is also planted for belief or as a talisman that brings good things to life or houses where such plants are grown. These also make the plants within this genus have high market demand. While in their natural habitat, the plants are conventionally propagated via rhizomes and seeds. Due to the long dormancy period, it is difficult to fulfill the market demand for raw materials, and the propagated via rhizomes and seeding has a very high risk of systemic infections, e.g. root-knot nematodes and bacterial wilt, including *Fusarium* from the propagules. To overcome these problems and to reduce the removal of plants from their natural habitats, the application of tissue culture is the one propagation tool for conservation and produces large amounts of disease-free plantlets. This method was studied in many genera of the plants in the Zingiberaceae, such as *Zingiber officinale* L. (Ilahi and Jabeen 1987); *Curcuma caesia* Roxb. (Shahinozzaman et al. 2013); *Kaempferia parviflora* Wall. ex Baker (Khairudin et al. 2020) etc. For the *C. aurantiiflora* was studied the callus induction and plant regeneration from leaf explant by growing the callus on Murashige Skoog medium supplemented with 3% of sucrose and various concentration of 2,4-dichlorophenoxyacetic acid (2,4-D) under the light by the first author (Saensouk 2011). The shoots were successfully regenerated on the medium with concentrations of 2,4-D and BA added. Based on the results of the study, the same method may be used to experiment with other plants in this genus to find a suitable method for each species for conservation and further proliferation.

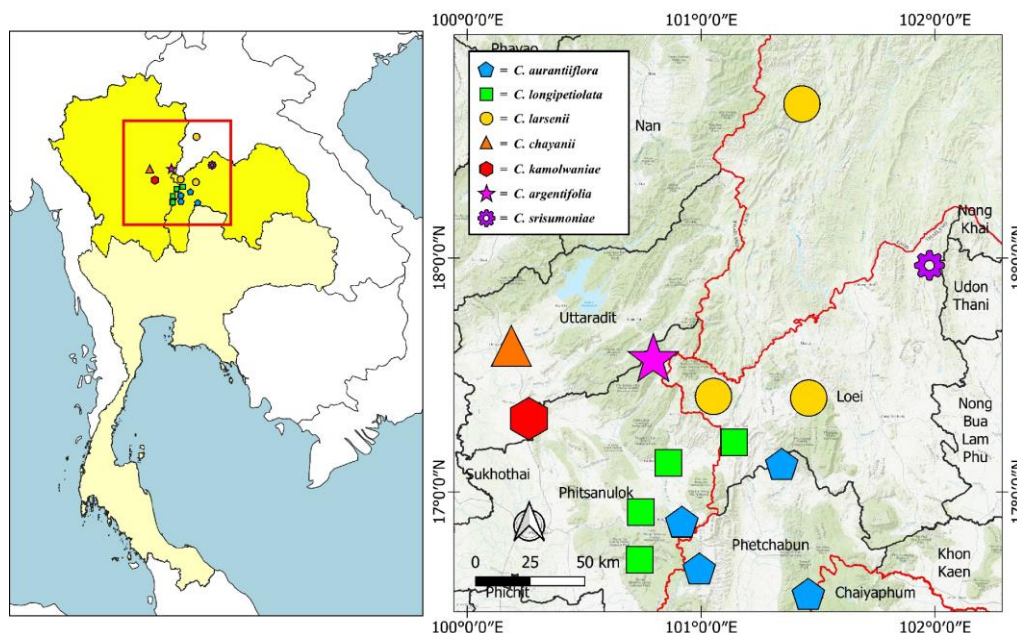


Figure 1. Distribution map of species of *Cornukaempferia* in Thailand and Laos. An enlarged view of the distribution area is on the right-hand side. The map of Thailand with the abbreviation of floristic regions and the enlarged view with the name of provinces, were both drawn in reference to the map of Thailand after the “Flora of Thailand Project”; the abbreviation of regions: N: Northern; NE: Northeastern; E: Eastern; SW: Southwestern; C: Central; SE: Southeastern; PEN: Peninsular (Larsen & Larsen, 2006). Each species distribution location is based on the protologue of all species in *Cornukaempferia* (Mood and Larsen 1997, 1999; Saensouk et al. 2007, 2021b; Yupparach et al. 2019), and specimens deposited at QBG including a new species *Cornukaempferia srisumoniae* P. Saensouk, Saensouk & Boonma sp. nov. from northern of Loei province (KKU)

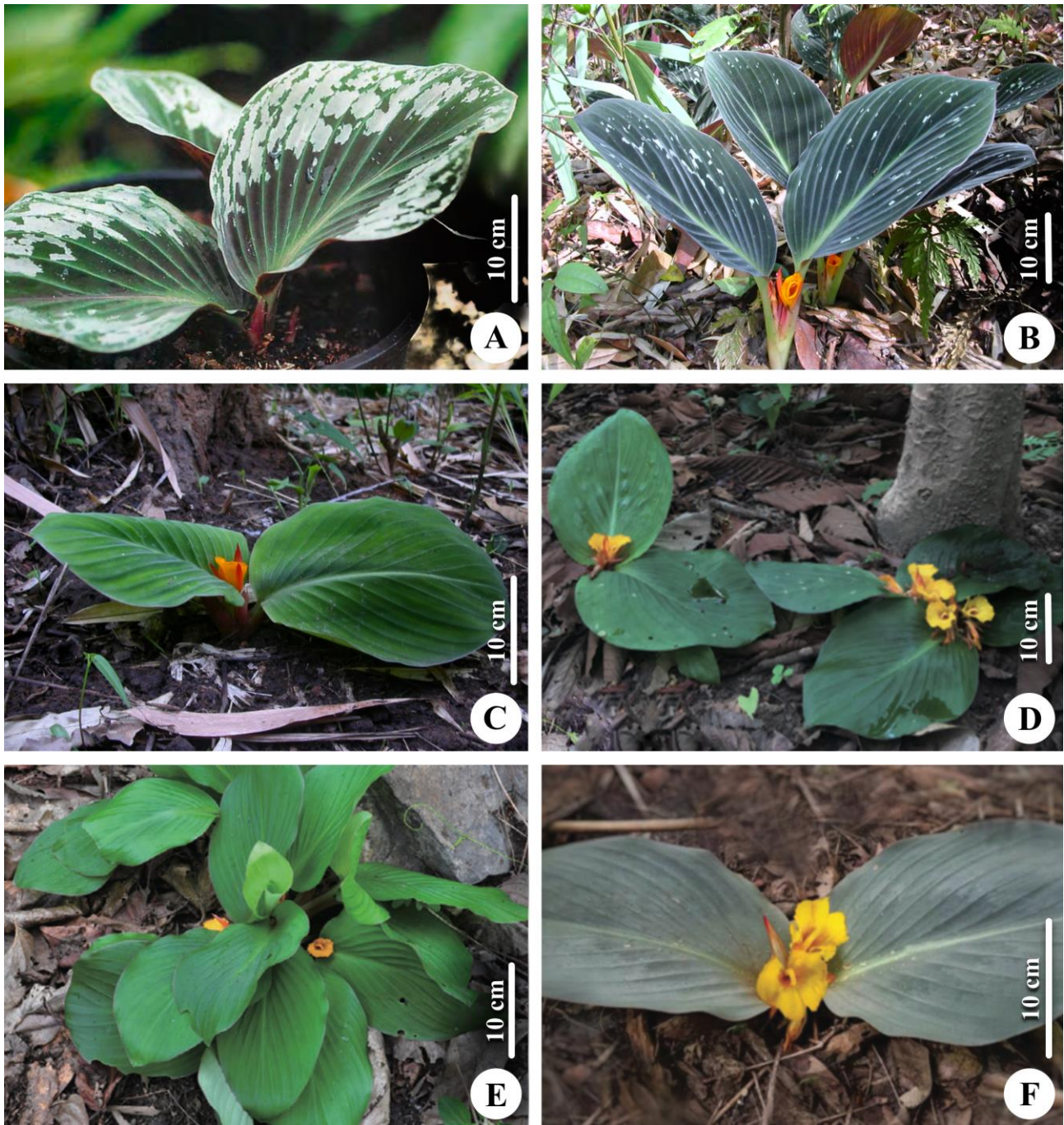


Figure 2. Photographs of *Cornukaempferia* spp.: A. *C. aurantiiflora* (Mood and Larsen 1997), B. *C. longipetiolata* (Mood and Larsen 1999), C. *C. larsenii* (Saensouk et al. 2007), D. *C. chayanii* (Yupparach et al. 2019), E. *C. kamolwaniae* (Yupparach et al. 2019), F. *C. argentifolia* (Saensouk et al. 2021b). Designed by Thawatphong Boonma

Taxonomic Treatments of *Cornukaempferia*

Cornukaempferia aurantiiflora Mood & K. Larsen

Cornukaempferia aurantiiflora Mood & K. Larsen, Nat. Hist. Bull. Siam Soc. 45: 217-221. 1997: Type: Mood 96P24 (holotype AAU). Cultivated plant from Bangkok Market: **Thailand**; Northeastern: Phetchabun M. Sizemore & J. Banta 96-810, South of Route 12 between Lom Sak and Khon San, 765 m asl. (AAU).

Perennial rhizomatous herb. *Rhizome* c. 1.5-2.0 cm in diam., white with a yellow core; tubers c. 1 × 8 cm, yellow with a light brown core, slightly aromatic and bitter. *Leaves*

2-3, initially developing vertically, later becoming more horizontal to the soil, but elevated. *Leaf sheath* c. 3-10 cm; *ligule* short, 2-4 mm emarginate; *petiole* 5-11 cm long, green with a medium purple band; *lamina* broadly ovate to suborbicular, 20-25 × 14-15 cm; upper surface green with silvery markings between the veins, glabrous with raised veins, lower surface dark purple with long, white hairs, margin undulating. *Inflorescence* terminal with few-flowered. *Bracts* lanceolate, acuminate, greenish with pink apex, lower one c. 5 cm diminishing upwards; *calyx* tube c. 13 mm, teeth 7-9 mm; *floral tube* 25-30 mm; *lobes* dark

reddish-orange; *lateral lobes* 40×7 mm, *dorsal c.* 50 mm long, 10 mm at the base, gradually tapering to the cucullate apex, margin incurved; *lateral staminodes* orange, oblanceolate with undulating margin, 30×13 mm; *labellum* orange with red lines at base, broadly deltoid, saccate, with undulating margin; *stamen* with very short filament, *anther* c. 15 mm long, opening longitudinally, connective produced into a long, narrow, forwards curved crest, 10-13 mm long similar to the crest found in *Zingiber*. *Epigynous glands* 2, c. 5 mm long, yellow. *Ovary* ellipsoid, shortly hairy, c. 10 mm long. *Ripe fruits* not seen.

Vernacular name:- Proa Thong.

Distribution:-Endemic to Thailand: Northeastern: Phetchabun (Figure 1).

Etymology:-"*aurantiiflora*" is derived from two Latin words, "*aurantia*" meaning "orange", and "*flora*" meaning "flower" which refers to its yellowish orange flower.

Ecology: In the mixed deciduous forest on humus-rich soil, at alt. 700 m asl.

Phenology: Flowering in May to June; anthesis time in the morning; normally flower starts to open around 9 am

and is closed and withered by 10 pm, occasionally opening as late as 3 pm and closing after 2 am.

Utilization: the plant is used as an ornamental plant and to treat infected hemorrhoids and laryngitis in children.

Conservation status: According to IUCN (2022), the species falls under the category of Data Deficient (DD).

Cornukaempferia longipetiolata Mood & K.Larsen

Cornukaempferia longipetiolata Mood & K.Larsen, New Plantsman 6 (4): 198. 1999: Type: Mood 97P139, Phetchabun (holotype AAU): Thailand; Northern: Phitsanulok, Chattrakarn District, Phu Soi Dao National Park; Northeastern: Phetchabun (type, Mood 97P139, holo AAU), Loei Province: Cultivation; USA, Maryland, Suitland, NMNH Botany Research Greenhouses, W.J. Kress 04-7674, 14 June 2004 (US): Scotland, Royal Botanic Garden Edinburgh (originally collected from Thailand, shady mixed deciduous forest, Newman, M.F. 939), Newman, M.F. & Leong-Škorničková J. coll. no. 1979, 12 May 2006 (E).

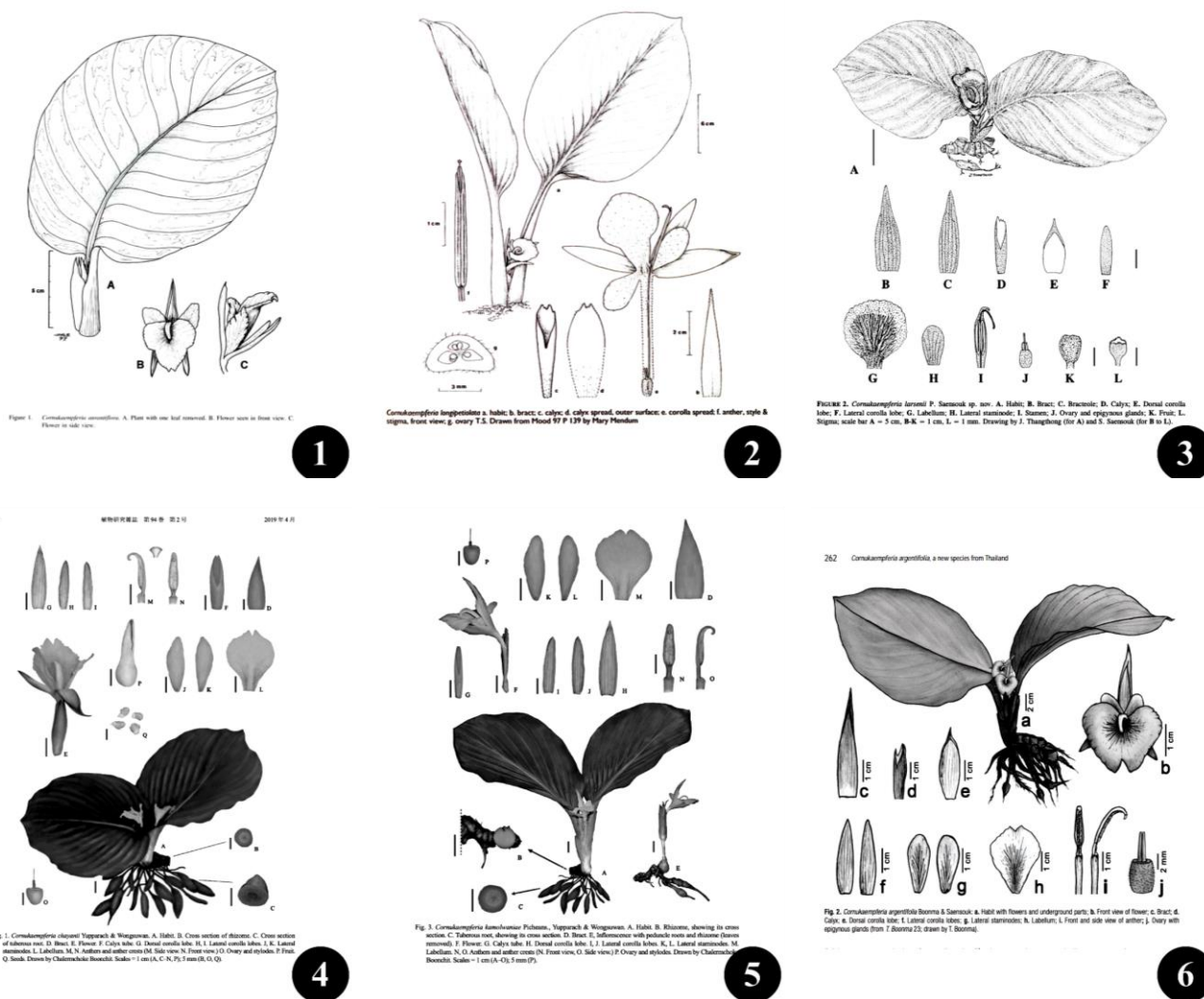


Figure 3. Illustrations of *Cornukaempferia* spp.: 1. *C. aurantiiflora* (Mood and Larsen 1997), 2. *C. longipetiolata* (Mood and Larsen 1999), 3. *C. larsenii* (Saensouk et al. 2007), 4. *C. chayanii* (Yupparach et al. 2019), 5. *C. kamolwanai* (Yupparach et al. 2019), 6. *C. argentifolia* (Saensouk et al. 2021b). Designed by Thawatphong Boonma

Perennial rhizomatous herb. *Leafy shoot* 28-60 cm tall. *Rhizome* growth linear, c. $1.5\text{--}2.0 \times 2$ cm in diam., surface light brown with two layers internally; inner core yellow-orange, outer (c. 3 mm) orange, aromatic, with a slightly bitter taste resembling turmeric, staining paper yellow; *tubers* many, c. 4×1.5 cm, light yellow, in cross-section of 3 concentric circles, outer light yellow, middle yellow, light core orange, aromatic with similar taste as a rhizome. *Leaves* 2 during flowering, later non-flowering stems with 3 leaves, outer leaf smaller than the inner 2; all leaves initially upright, later flattening to c. 30 degrees of the petiole axis. *Leaf sheath* 6-10 cm long; *ligule* c. 2 mm, emarginate; *petiole* $9\text{--}13 \times 1.5$ cm long, U-shaped in cross-section, winged at the base for c. 10 cm, striate, light green with darker green cross-reticulations, pubescent with short white hairs; *lamina* widely elliptical, slightly asymmetric, $30\text{--}32 \times 21$ cm, sometimes slightly wider just above the middle, the upper surface mostly glabrous with occasional long white hairs, texture thick and stiff, velvety green with a few random silver spots, and 14-16 lighter colored, raised veins; lower surface dark purple with long white, matted hairs; margins undulate, entire. *Inflorescence* terminal with few-flowered, 5-10 flowers spirally arranged, opening from base to apex; *bracts* lanceolate, acuminate, apex red, lighter towards the base, lower one c. 5 cm, decreasing upwards. *Calyx* tube c. 13 mm, teeth 7-9 mm. *Floral tube* 25-30 mm; lobes dark red, veined with iridescent flecks; *lateral lobes* 40×7 mm, longer than the labellum, *dorsal* erect, 50-60 mm long, 10 mm at the base, tapering to a cucullate apex, margin incurved; *labellum* broadly deltoid, slightly saccate, orange with a red throat, covered throughout with short, white, erect hairs, and with red veins spreading upward to within 1 cm of the labellum edge, the upper 1 cm margin flattened, 90° to the throat, 40×30 mm, tapering from the midpoint, sinuate, slightly widening at the junction of the floral tube, c. 10 mm; margin undulates, frilled; lower 25 mm involute, forming an open tube, lower surface hairy with iridescent flecks. *Lateral staminodes* orange, lower surface with iridescent flecks, short white hairs, oblanceolate with undulating margin, 30×13 mm, mostly hidden within the dorsal lobe. *Stamen* with a very short filament; *anther* 15-25 mm long, dehiscent longitudinally, full length, connective a long, narrow, arching crest, c. 1.5 mm beyond the thecae, longitudinally ridged, orange with red markings at the apex, short, white hairs throughout. *Style* curved with the filament and crest, white-yellow, *stigma* rounded, sticky. *Epigynous glands* 2, c. 5 mm long, yellow. *Ovary* ellipsoid, shortly hairy. *Fruit* not seen.

Vernacular name: Proa Thong Gan Bai Yaw.

Etymology: "*longipetiolata*" named referred to its distinguishing long petiole from other species.

Distribution: Endemic to Thailand: Northern: Phitsanulok. Northeastern: Phetchabun and Loei (Figure 1).

Ecology: An evergreen forest with low light conditions and dark, loamy, organic soil, at alt. 400-900 m asl.

Phenology: Flowering in early June through mid-July; anthesis time in the evening; normally flower starts to open around 4 pm, fully open by 5 pm, and is withered the next morning at about 7 am, a few times it has opened earlier, but closed about the same time.

Utilization: the plant is used as an ornamental plant.

Conservation status: According to IUCN (2022), the species falls under the category of Data Deficient (DD).

Cornukaempferia larsenii P. Saensouk

Cornukaempferia larsenii P. Saensouk, The Natural History Journal of Chulalongkorn University 7 (2): 115-119. 2007: Type: Thailand, Loei Province, Phu Rua National Park, S. Saensouk and P. Saensouk 145. 22 May 2005 (Holotype KKU; isotypes AAU, BK, BKF, K, QBG, PSU): Thailand; Northeastern: Loei Province, Phurua National Park, S. Saensouk & P. Saensouk 145, 22 May 2005. Later, this species was also found distributed in Laos PDR (Rakarcha et al. 2020)-Lao PDR, Phu Pha Daeng, Botane District, Xayaburi Province, C. Maknoi, S. Rakarcha, P. Phaosrichai & K. Intamma L17-003, 29 May 2019 (QBG, HNL).

Perennial rhizomatous herb with appressed leaves, c. 28-40 cm tall. *Roots* yellowish, fibrous with terminal globular to fusiform storage tubers; *tuber* yellow with a light brown core, slightly aromatic and bitter. *Rhizome* with 2 layers internally (outer layer yellowish white, inner core yellow), 1.5-2 cm in diam. *Bladeless sheaths* 3, green to reddish, sparsely hairy. *Leaf sheaths* 5-10 cm long, green to reddish, sparsely hairy; *ligule* short, membranous; *petiole* 3-8 cm long, green to reddish, glabrescent or sparsely hairy; *lamina* broadly ovate to suborbicular $17\text{--}26 \times 11.8\text{--}17$ cm; upper surface green, sometimes with few silvery markings between veins, sparsely hairy; lower surface greenish with few white hairs; margin undulates. *Inflorescence* terminal with 3-5 flowers; *bracts* ovate, c. 5.2×1.4 cm, apex acute, sparsely hairy; *calyx* tube c. 3.5×0.5 cm, split 1 cm on one side, apex tridentate, white, pubescent; *floral tube* 2-3.2 cm long, white, glabrous on both sides; *dorsal corolla lobe* lanceolate to oblong, c. 3×1.2 cm, apex hooded, glabrous, red; *lateral corolla lobes* oblong, c. 3×0.6 cm, apex rounded, glabrous, red; *lateral staminodes* oblanceolate, $1.8\text{--}2.3 \times 1\text{--}1.4$ cm, glabrous, yellow to orange; *labellum* campanuloid, deflexed, yellow to orange with red lines at central, broadly suborbicular, $3\text{--}3.5 \times 2.5\text{--}3$ cm, with undulating margin, glabrous. *Filament* c. 5 mm long, yellow, glabrous; *anther* c. 20×5 mm, yellowish, opening longitudinally, connective produced into a long, narrow, forwards curved crest. *Style* curved with the filament and crest. *Stigma* c. 1×1 mm, apex 3-lobed, ciliate. *Ovary* ellipsoid, sparsely hairy. *Epigynous glands* 2, c. 4 mm long, glabrous. *Immature fruit* reddish, subglobose, c. 12×8 mm, glabrous.

Vernacular name: Proa Thong Larsen.

Etymology: Named after Professor Dr. Kai Larsen, who initiated the research of Zingiberaceae in Thailand

Distribution: Thailand: Northeastern: Loei Province, Laos PDR: Xayaburi Province (Figure 1).

Ecology: In the mixed deciduous forest on soil rich in humus, at alt. 1,200 m asl.

Phenology: Flowering in May to July; anthesis time in the morning; normally flower starts in the early morning, fully open around 6-7 am, and is withered around midday.

Utilization: the plant is used as an ornamental plant.

Conservation status: According to IUCN (2022), the species falls under the category of Data Deficient (DD).

***Cornukaempferia chayanii* Yupparach & Wongsuwan**

Cornukaempferia chayanii Yupparach & Wongsuwan, Journal of Japanese Botany 94 (2): 82-89. 2019: Type: Thailand, Uttaradit Province, Lub Lae District, alt. 100 m asl., *Yupparach & Wongsuwan 120616-1*, 12 June 2016 (Holotype BK).

Perennial rhizomatous herb. *Rhizome* cylindrical and horizontal, tuberous, 1.2-1.4 cm in diam., inside with 2 layers, outer layer purple, inner core reddish brown. *Roots* tuberous, brownish, slightly aromatic, and bitter. *Bladeless sheath* 1-2, greenish-white or reddish, pubescent. *Leaves* 2(-3), sessile or with petiole 0.8-3.6 cm long; *sheaths* 3.4-4.5 cm long, green to reddish, pubescent; *ligule* membranous, 1-2 mm long, pubescent; *lamina* spreading over the ground, broadly ovate-elliptic to suborbicular, 15.5-30.5 × 7.7-21.6 cm, base cuneate, apex acute to rounded, upper surface dark green without silvery markings, sparsely hairy, lower surface greenish, pubescent; margin entire to undulate, reddish. *Inflorescence* terminal with 6-13 flowers; *peduncle* c. 1.3 cm long, sparsely hairy; *bract* ovate, lanceolate to broadly lanceolate, 2.2- 5.7 × 0.7-2.3 cm, greenish or reddish, apex acute to acuminate, pubescent. *Calyx* tubular 2.2-4 × 0.5-1.1 cm, greenish or reddish, apex tri-dentate, sparsely pubescent. *Floral tube* 2.7-4.3 cm long, white, sparsely pubescent; *dorsal corolla lobe* lanceolate to oblong, 4.2-4.8 × 1.1-1.2 cm, apex hooded, sparsely hairy, reddish or greenish; *lateral corolla lobes* oblong, 3.6-3.9 × 0.8-1 cm, apex acute, glabrous, reddish. *Lateral staminodes* obovate to oblanceolate, 2-3.4 × 0.7-1.3 cm, apex rounded, yellow to orange, pubescent on both sides. *Labellum* broadly obovate, 3.3-4.8 × 2.4-4.2 cm, clawed at the base, slightly 2-3-lobed or irregularly repand, yellow to orange basally with finely branched red stripes, and red spotted, margin undulate, hairy on both sides. *Stamen* 1; *filament* 2-5 mm long, yellow, lower glabrous, upper pubescent; *anther* 13-22 × 2-3 mm, yellow; *anther crest* curved forward, pubescent. *Pistil* 1; *style* curved with the filament and crest; *stigma* cup-shaped, c. 1 × 1 mm, apex ciliate; *Epigynous glands* 2, slender, 2-4 × c. 1 mm; *ovary* ellipsoid, 8-9 × 5-7 mm, pubescent. *Immature fruit* obovate, 1.4-1.5 × 1-1.2 cm, pubescent, greenish-white. *Immature seed* ovate-suborbicular, 4-5 × c. 2 mm, greenish with white aril.

Vernacular name:- Proa Thong Chayan.

Etymology:-Named after Professor Dr. Chayan Picheansoonthon, a fellow of the Royal Society (Thailand).

Distribution:-Endemic to Thailand; Northern: Uttaradit Province (Figure 1).

Ecology: Sandy soil under the shade of dry dipterocarp forest, at alt. 100 m asl.

Phenology: Flowering June, fruiting from June to July; anthesis time in the morning; normally flower starts in the early morning and is withered around midday or in the afternoon.

Utilization: the plant is used as an ornamental plant.

Conservation status: According to IUCN (2022), the species falls under the category of Data Deficient (DD).

***Cornukaempferia kamolwaniae* Picheans., Yupparach & Wongsuwan**

Cornukaempferia kamolwaniae Picheans., Yupparach & Wongsuwan, Journal of Japanese Botany 94 (2): 82-89. 2019: Type: Thailand, Uttaradit Province, Phichai District, alt. 100 m asl., *Yupparach & Wongsuwan 030716-1*, 3 July 2016 (Holotype BK).

Perennial rhizomatous herb. *Rhizomes* short, erect, fusiform, tuberous, 0.8-1.3 cm in diam., with 2 layers, yellowish. *Roots* tuberous with 3 layers, the outer layer is yellow-oak, the middle layer orange-brownish, and the inner core brownish, slightly aromatic, and bitter. *Bladeless sheath* 3, white-greenish or reddish, sparsely pubescent. *Leaves* 2(-3), *petiole* 0.5-6.1 cm long, reddish or red-greenish; *ligule* membranous, 1-2 mm long, pubescent; *leaf blades* spreading over the ground, broadly ovate to broadly ovate-elliptic, 19.3-22.2 × 12.1-14.0 cm, base cuneate, apex acute, upper surface dark green without silvery markings, sparsely hairy, lower surface greenish or purple-greenish, sparsely hairy; margin entire to undulate, reddish. *Inflorescence* terminal with 2-5 flowers; *peduncle* 1.7-2.5 cm long, sparsely hairy. *Bract* lanceolate to broadly lanceolate, 3.2-5.2 × 0.4-1.6 cm, glabrous, greenish; apex acute to acuminate, greenish or reddish, pubescent. *Calyx* tubular, 3.1-3.7 × 0.5-0.8 cm, greenish, apex 2(-3)-dentate, sparsely pubescent. *Floral tube* 2.5-3.9 cm long, white, glabrous; *dorsal corolla lobe* lanceolate to oblong, 3.8-4.2 × 1.0-1.1 cm, apex hooded, sparsely hairy, yellow-reddish; *lateral corolla lobes* oblong, 3.2-3.9 cm × 6-9 mm, apex acute, glabrous, yellow-reddish. *Lateral staminodes* obovate to oblanceolate, 2.2-2.9 × 0.7-0.9 cm, apex rounded, yellow to orange, pubescent on both sides. *Labellum* broadly obovate, 3.4-4.4 × 2.7-3.4 cm, apex rounded, slightly emarginate, yellow to orange with red stripes, basally red-spotted, margin undulate, hairy on both sides. *Stamen* 1; *filament* 7-9 mm long, yellow, glabrous; *anther* 15-18 × 2-3 mm, yellow; anther crest curved forward, pubescent. *Style* curved with the filament and crest; *stigma* cup-shaped, c. 1 × 1 mm, apex ciliate; *Epigynous glands* 2, slender, 1-2 × c. 1 mm; *ovary* ellipsoid, 4-6 × 3-4 mm, pubescent.

Vernacular name: Proa Thong Kamolwan.

Etymology:-Named after Ms. Kamolwan Bumphenphol, a Thai ginger enthusiast.

Distribution:- Endemic to Thailand; Northern: Uttaradit Province (Figure 1).

Ecology: Sandy soil under the shade of the deciduous forest, at alt. 100 m asl.

Phenology: Flowering June, fruiting from June to July; anthesis time in the afternoon, start opening after midday.

Utilization: the plant is used as an ornamental plant.

Conservation status: According to IUCN (2022), the species falls under the category of Data Deficient (DD).

***Cornukaempferia argentifolia* Boonma & Saensouk**

Cornukaempferia argentifolia Boonma & Saensouk, Rheedeia 31(4): 260-266. 2021: Type: Thailand, Phitsanulok province, Chattrakarn district, 420 m a.s.l., *T. Boonma* 23 (Holotype KKU; isotype QBG, BKF, BK): Thailand, [cultivated] Nakhon Nayok Province, Ban Na

District, 53 M. 5 Ban Mai Village, Phikun Ok, 21.07.2019, T. Boonma 231 (Brio Garden).

Perennial rhizomatous herbs, up to 20 cm tall. *Rhizome* subglobose to obovoid, sympodial, slightly aromatic, with 2 layers, both layers yellow (when fresh) and brownish (when dry), 1-1.8 cm in diam. *Roots* fascicle tuberous with fibrous roots; *tubers* ellipsoid, 1-1.5 mm diam. *Bladeless sheaths* 1-2(-3), 6-9 cm long, apex acute to slightly mucronate with ciliate margins, sparsely hairy, reddish-brown with white at the base, decaying while the pseudostem grows up. *Leaf sheaths* distichous, 7-8 cm long, finely hairy, reddish-brown mixed with green. *Ligules* membranous, c. $2.5 \times 6-7$ mm, apex rounded to truncate, glabrous, translucent white. *Leaves* 2-3; *petioles* 2.5-4.5 cm long, finely hairy, reddish-brown; *lamina* ovate, asymmetrical $23-27 \times 12-15$ cm, apex mucronate, base attenuate, margins entire, translucent red, adaxially silver without marking, midrib lighter silver, sometimes with a reddish tinge at midrib, clearly embossed veins, abaxially surface red, both surfaces pubescent. *Inflorescence* terminal. *Peduncles* very short, less than 1 cm long. *Bract* lanceolate, $4.5-5 \times 1$ cm, apex acute, glabrous. *Flowers* 2 or 3 per inflorescence, c. 4.7 cm long; *calyx* tubular, 3.3-3.5 cm long, apex bilobed with the deepest incision c. 1.5 cm, sparsely hairy, translucent white to pale yellow with red tinge; *Floral tube* $2.9-3.2 \times 0.23-0.25$ cm, finely hairy, white to pale yellowish-white; *dorsal corolla lobe* lanceolate, c. 3.4×1.1 cm, apex mucronate with slightly hooded, glabrous on both surfaces, yellow with a red tinge or yellow with red apex; *lateral corolla lobes* 2, lanceolate, c. 3×0.7 cm, apex acute, glabrous on both surfaces, yellow with a red tinge. *Staminodes* narrowly obovate, c. 2.5×1 cm, apex rounded to obtuse, sparsely hairy, yellowish orange gradually fading to pale yellow at the base. *Labellum* obovate, $3.4-3.6 \times 2.6-2.8$ cm, apex emarginate (incision 5-6 mm), with finely undulate margins, sparsely hairy, upper surface yellowish orange gradually fade to pale yellow at the base with red veins from base to half of the length, lower surface yellowish orange gradually fade to pale yellow without red veins. *Stamen* 22.8-23.2 mm long; *filament* c. 3.8×2 mm, pale yellowish white, finely hairy; *anther* 28-30 \times 2-3 mm, yellow, opening longitudinally, connective produced into a long, narrow, forwards curved crest, pubescent. *Epigynous glands* 2, c. 4 mm long, c. 0.6 mm in diam., yellow, apex blunt. *Ovary* ellipsoid-cylindrical, c. 3.6 mm long, c. 4.2 mm in diam., pubescent; *style* white, glabrous; *stigma* pale yellow, c. 0.7×1.4 mm, flattened-inverted cone, ciliate. *Fruits* not seen.

Vernacular name:- Proa Thong Bai Ngern.

Common name:- "Hazy" in reference to its silver leaves.

Etymology:- "*argentifolia*" is derived from two Latin words, "*argenti*" meaning "silver", and "*folia*" meaning "leaves" which refers to its silvery leaves.

Distribution:- Endemic to Thailand; Northern: Phitsanulok Province (Figure 1).

Ecology:- Sandy loam soil, moist and close to the watercourse in a deciduous forest, at alt. 420 m asl.

Phenology:- Flowering from July to early September; anthesis time in the morning.

Utilization:- the plant is used as an ornamental plant.

Conservation status:- According to IUCN (2022), the species falls under the category of Data Deficient (DD).

***Cornukaempferia srisumoniae* P. Saensouk, Saensouk & Boonma sp. nov.**

Cornukaempferia srisumoniae P. Saensouk, Saensouk & Boonma sp. nov: Figures 3-5, Table 1

Cornukaempferia srisumoniae is similar to *C. argentifolia*, but different in having sessile to subsessile petiole up to 0.7 cm long (vs. *C. argentifolia* has petiole 2.5-4.5 cm long); leaf sheath 4-5 cm long (vs. 7-8 cm long); lamina broadly ovate (vs. ovate), leaves upper surface green, sometimes with few silvery marking, midrib green (vs. upper silver without marking, midrib lighter silver, sometimes with reddish tinge along the midrib); leaves lower surface green (vs. red); bracts sparsely hairy (vs. glabrous); labellum broadly obovate, $4.2-4.3 \times 4.0-4.2$ cm, apex rounded (vs. obovate, $3.4-3.6 \times 2.6-2.8$ cm, apex emarginate, each lobe acute with incision 5-6 mm long); filament 6.9-7.3 mm long (vs. 3.8 mm long); anther 2.3-2.4 cm long (vs. 2.8-3.0 cm long).

Type: Thailand, Loei province, Pak Chom district, 490 m a.s.l., Saensouk 3708 (Holotype KKU).

Perennial rhizomatous herbs, produced rolled and erected young leaves before unfolding and flattened on the ground. *Rhizome* subglobose to ovoid, sympodial, slightly aromatic, with 2 layers, both layers yellow (when fresh, yellowish brown when old or dry), 1-1.6 cm in diam. *Roots* fascicle tuberous with fibrous roots; *tubers* ellipsoid, 1-1.5 mm in diam., yellow with a light brown core. *Bladeless sheath* 1-2, 3-6 cm long, apex acute to slightly mucronate with ciliate margins, sparsely hairy, green. *Leaf sheaths* distichous, 4-5 cm long, pubescent, green or dark red. *Ligules* membranous, 2-4 mm long, emarginate, apex rounded, pubescent, translucent white. *Leaves* usually 2; *petioles* sessile or subsessile, up to 7 mm long, green; *lamina* broadly ovate, asymmetrical $21-25 \times 15-18$ cm, apex mucronate, base rounded, margins entire, adaxially green, sometimes with few silvery marking, midrib lighter green, slightly embossed veins, abaxially surface green (veins green, but red veins at apex), both surfaces pubescent. *Inflorescence* terminal, 3-5 flowers. *Peduncles* very short, less than 1 cm long. *Bract* lanceolate, $4.5-5 \times 1-1.2$ cm, apex acute, sparsely pubescent. *Calyx* flattened tubular, 3.0-3.2 cm long, apex bi-lobed with incision up to 1.7 cm, sparsely hairy, ciliate, semi-translucent pale green at the apex to white at the base with a reddish tinge at apex and edges; *floral tube* c. 3 cm long, sparsely hairy, pale yellowish-white; *dorsal corolla lobe* lanceolate, $3.6-3.7 \times 1.30-1.35$ cm, apex mucronate, hooded, glabrous on both surfaces, yellow with a pale reddish tinge; *lateral corolla lobes* 2, lanceolate, $3.5-3.6 \times 0.87-0.92$ cm, apex acute-mucronate, c. 0.6 cm long, hooded, glabrous on both surfaces, yellow with a pale reddish tinge. *Staminodes* narrowly obovate, $3.0-3.2 \times 1.35-1.5$ cm, apex rounded, pubescent, yellowish orange gradually fades to pale yellow at the base. *Labellum* broadly obovate, $4.2-4.3 \times 4.0-4.2$ cm, apex rounded (no incision at apex), with finely undulate margins, pubescent, upper surface deep yellowish

orange gradually fade to pale yellow at the base with red spots along the veins from base to about half of the length, lower surface yellowish orange gradually fade to pale yellow without red as the upper surface. *Stamen* 1, c. 24 mm long; filament 6.9-7.3 mm long, 1.7-2 mm wide, pale yellowish, pubescent; *anther* 23-24 × 3.5-3.6 mm, yellow, opening longitudinally, connective produced into a long, narrow, forwards curved crest, pubescent. *Epigynous glands* 2, c. 4 mm long, yellow, apex blunt. *Ovary* obovoid-cylindrical, c. 4 mm long, c. 3 mm in diam., pubescent; *style* white, glabrous; *stigma* pale yellow, c. 0.7 mm long, 1.3-1.4 mm wide, flatten-inverted cone, ciliate. *Fruits* not seen.

Vernacular name: Proa Thong Srisumon.

Etymology: The specific epithet "*srisumoniae*" is named after Associate professor Dr. Srisumon Sitathani, plant morphology and biology Specialist, and the founder of the Department of Biology, Faculty of Science, Khon

Kaen University, where the Khon Kaen University Herbarium (KKU) is located.

Distribution: Endemic to Thailand; Northern: Loei Province (Figure 1).

Ecology: Sandy loam soil, moist and close to the watercourse in a deciduous forest, at alt. 450-500 m asl.

Phenology: Flowering from July to early September; anthesis time in the morning.

Utilization: the plant is used as an ornamental plant.

Conservation status: The new species was collected in 2021. We propose ranking this species in Data Deficient (DD) category, following the IUCN (2022) due to the insufficient information on its distribution range, and we expect that this species may be found distributed in Laos PDR. However, we propose to treat this plant as an endangered plant until a further distribution is explored to further change its appropriate conservation status.

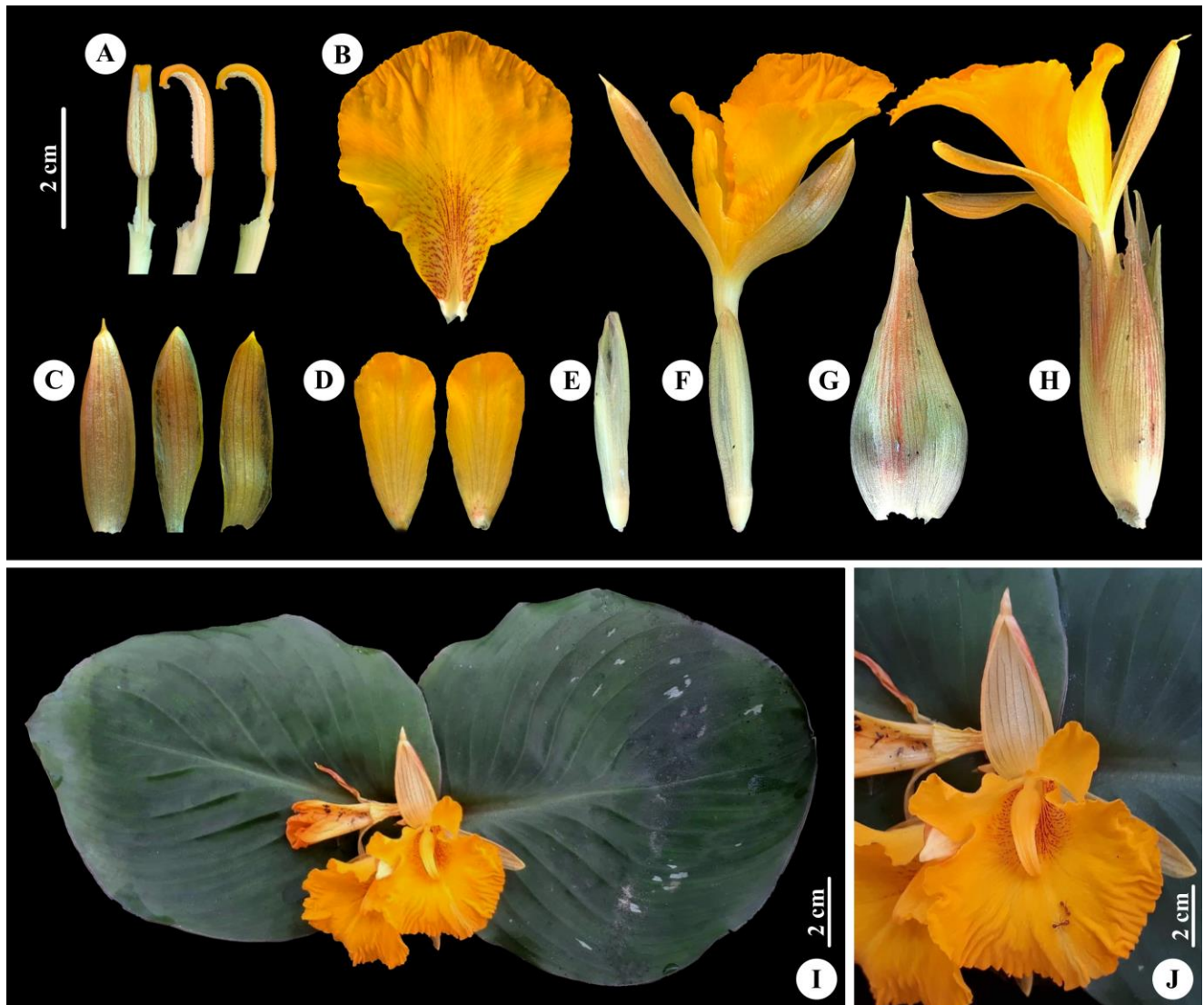


Figure 4. *Cornukaempferia srisumoniae* P. Saensouk, Saensouk & Boonma sp. nov.; A. front view, semi-side view, and side view of anthers, B. labellum, C. dorsal and lateral corolla lobes, D. lateral staminodes, E. calyx, F. side view of flower, G. bract, H. side view of inflorescence with flower, I. top view of habit, J. close up-top view of the flower. Photographs and designs by Thawatphong Boonma

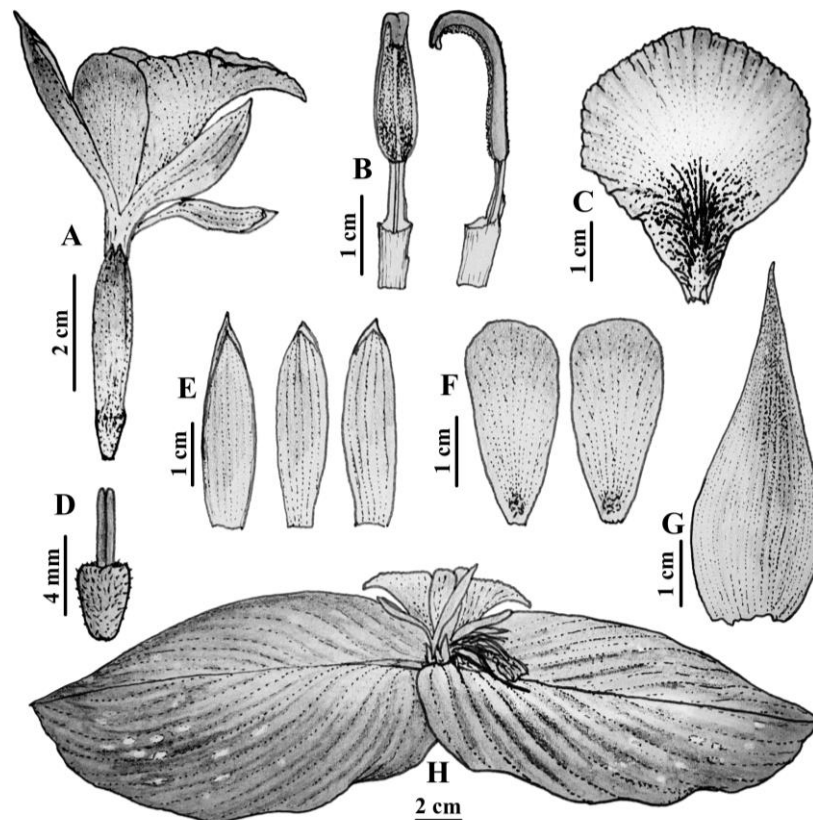


Figure 5. *Cornukaempferia srisumoniae* P. Saensouk, Saensouk & Boonma sp. nov.; A. side view of flower, B. front and side view of the anther, C. labellum, D. ovary with epigynous glands, E. dorsal and lateral corolla lobes, F. lateral staminodes, G. bract, H. habit in oblique-side view. Drawn and designed by Thawatphong Boonma

Table 1. Morphological comparison of *Cornukaempferia srisumoniae* sp. nov. and its allies species

Characters	<i>C. srisumoniae</i> sp. nov.	<i>C. argentifolia</i>	<i>C. larsenii</i>
Tuberous root layered in cross section	Ellipsoid	Ellipsoid	Globular to fusiform
Leaf sheath	4-5 cm long	7-8 cm long	5-10 cm long
Petiole	0-0.7 cm long, pubescent, green	2.5-4.5 cm long, finely hairy, reddish brown	3-8 cm long, glabrescent or sparsely hairy, green to reddish
Lamina shape	Assymmetrical broadly ovate, 21-25 × 15-18 cm, upper green, sometimes with few silvery marking	Ovate, 23-27 × 12-15 cm, upper silver without marking, midrib lighter silver, sometimes with reddish tinge at midrib	Broadly ovate to suborbicular, 17-26 × 11.8-17 cm, upper green, sometimes with few silvery markings between veins
Lower surface color	Green	Red	Green
Bracts	Sparsely hairy	Glabrous	Sparsely hairy
Calyx tube	3.0-3.2 cm long, bilobed	3.3-3.5 cm long, bilobed	c. 3.5 cm long, tridentate
Floral tube	c. 3.0 cm long, pale yellowish white, sparsely hairy	2.9-3.2 cm long, white to pale yellowish white, finely hairy	2-3.2 cm long, white, glabrous
Corolla lobe color	Yellow with a pale reddish tinge	Yellow with red thing or yellow with red apex	Red
Dorsal lobe (long)	3.6-3.7 cm long, 1.3-1.35 cm wide	c. 3.4 cm long, c. 1.1 cm wide	c. 3 cm long, c. 1.2 cm wide
Lateral lobes	3.5-3.6 cm long, 8.7-9.2 mm wide, apex acute-slightly mucronate	c. 3 cm long, c. 7 mm wide, apex acute	c. 3 cm long, c. 6 mm wide, apex rounded
Staminodes shape	Narrowly obovate, 3.0-3.2 cm long, 1.3-1.35 cm wide, pubescent	Narrowly obovate, c. 2.5 cm long, c. 1 cm wide, sparsely hairy	Oblanceolate, 1.8-2.3 cm long, 1-1.4 cm wide, glabrous
Labellum shape	Broadly obovate, 4.2-4.3 cm long, 4.0-4.2 cm wide, pubescent, apex rounded	Obovate, 3.4-3.6 cm long, 2.6-2.8 cm wide, sparsely hairy, apex emarginate, each lobe acute, incision 5-6 mm long	Broadly suborbicular, 3-3.5 cm long, 2.5-3.0 cm wide, glabrous, apex rounded
Filament	6.9-7.3 mm long	3.8 mm long	c. 5 mm long
Filament texture	Pubescent	Pubescent	Glabrous
Anther	2.3-2.4 cm long	2.8-3 cm long	c. 2 cm long

Key to 7 species of *Cornukaempferia*

Based on the morphological characteristics of 7 species of *Cornukaempferia* described above, the key to those species are as follows:

- 1a. Staminodes and labellum glabrous 2
- 1b. Staminodes and labellum pubescent 4
- 2a. Leaves abaxially greenish *C. larsenii*
- 2b. Leaves abaxially purplish 3
- 3a. Root tuber 2 layers; calyx c. 1.3 cm long; anther 1.5 cm long *C. aurantiiflora*
- 3b. Root tuber 3 layers; calyx 4.5-5 cm long; anther 2.8-3.3 cm long *C. longipetiolata*
- 4a. Leaves green without silvery 5
- 4b. Leaves silver or with silvery marking 6
- 5a. Rhizome purple with reddish brown core; floral tube pubescent; filament 2.5 mm long *C. chayanii*
- 5b. Rhizome yellowish with yellow core; floral tube glabrous; filament 7-9 mm long *C. kamolwaniae*
- 6a. Labellum apex emarginate; filament c. 3.8 mm long; leave adaxially silver without marking *C. argentifolia*
- 6b. Labellum apex rounded; filament 6.9-7.3 mm long; leave adaxially green with silvery marking *C. srisumoniae*

Based on our study, there are 7 species of *Cornukaempferia* worldwide including *C. aurantiiflora*, *C. longipetiolata*, *C. larsenii*, *C. chayanii*, *C. kamolwaniae*, *C. argentifolia*, and a new species namely *C. srisumoniae*, sorted by publication online released as the new species to science respectively. Six species are endemic to Thailand, while one species namely *C. larsenii* is native to Thailand and Laos PDR. All species are shared morphological characteristics, including producing sympodial rhizome with 2-3 layers internally, slightly aromatic and bitter. Root fibrous with tuberous roots. Leaf sheaths are canaliculate and distichous. Ligule short and membranous, apex emarginate, each lobe rounded to truncate. Leaf abaxially surface pubescent. Inflorescence terminal between the innermost leaf sheaths. Bracts lanceolate to ovate, apex acute to acuminate, diminishing upwards. The calyx is tubular with a unilateral incision. Floral tube tubular. Corolla lobe lanceolate to oblong, apex hooded. Staminodes narrowly obovate to oblanceolate, apex rounded to obtuse, yellow to orange. Labellum yellowish-orange to orange with red lines at the base, Stamen with short filament. Filament flattened, pale yellow to yellow. Anther opening longitudinally, connective productive produced into a long, narrow, forwards curved crest, yellow. Stigma ciliate. Ovary ellipsoid to obovoid, pubescent. Fruit is ellipsoid, trilocular with axile placentation. Seeds are globose with lacerate arillus. The Flowering time of each species, 5 species are fully open in the morning including *C. aurantiiflora*, *C. larsenii*, *C. chayanii*, *C. argentifolia*, and *C. srisumoniae*. While *C. kamolwaniae* is begin to bloom after midday and is fully open in the afternoon, and *C. longipetiolata* is night flowering.

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