

Two new species of *Kaempferia* subgenus *Kaempferia* (Zingiberaceae: Zingibereae) from Thailand

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Abstract. Saensouk P, Saensouk S, Boonma T. 2022. Two new species of *Kaempferia* subgenus *Kaempferia* (Zingiberaceae: Zingibereae) from Thailand. *Biodiversitas* 23: 4343-4354. Two new species of *Kaempferia* L., namely *Kaempferia napavarniae* Saensouk, P. Saensouk & Boonma, and *Kaempferia sakonensis* Saensouk, P. Saensouk & Boonma, are described here. The production of terminal inflorescences, covered by leaf sheaths, makes both species fall into the subgenus *Kaempferia*. The first species were found only in Nakhon Sawan Province, Northern Thailand, and the second species were found only in Sakon Nakhon Province, Northeastern Thailand. Living specimens and spirit specimens of both new species were compared to the existing allied species, but they differed and were never reported in taxonomic treatment before. Thus, we claimed both of them as new species to science and named the first species to honor Associate Professor Dr. Napavarn Noparatnaraporn (Director of Center for Research-driven in Natural Resources and Environment towards Utilization) who is a specialist in Biodiversity in Thailand. And named the second species according to its locality by using the province name as the epithet name. The descriptions with their illustrations, ecology, etymology, distributions, and a revised key to species of *Kaempferia* subgenus *Kaempferia* in Thailand for facilitating identification are also prepared.

Keywords: *Kaempferia roscoeana*, *larsenii*, *maculifolia*, Nakhon Sawan, *pardi*, Sakon Nakhon, taxonomy, Zingiberales

INTRODUCTION

The genus *Kaempferia* L. belongs to the family Zingiberaceae and comprises about 60 species distributed from India throughout Southeast Asia (Kress et al. 2002; Larsen and Larsen 2006; Kew Science 2022). Based on the position of the inflorescence, it is divided into two subgenera, namely subgenus *Kaempferia* which produces terminal inflorescences, and subgenus *Protanthium* which produces inflorescences directly from the rhizome before a new leafy shoot (Kiew 1980; Insisiengmay et al. 2018). Thailand is the richest in terms of species diversity of *Kaempferia* in which about 42 species have been reported throughout the country (Siriruga 1989, 1992; Larsen and Larsen 2006; Jenjittikul and Larsen 2020; Nopporncharoenkul et al. 2021; Saensouk and Saensouk 2021a, b; Boonma et al. 2020, 2021, 2022).

From the subgenus *Kaempferia* alone, currently, 28 species have been reported to have distribution in Thailand, consisting of *K. galanga* L. (Linnaeus 1753), *K. angustifolia* Roscoe (Roscoe 1807), *K. marginata* Carey ex Roscoe (Roscoe 1824), *K. roscoeana* Wall. (Wallich 1829), *K. elegans* Wall. (Wallich 1830), *K. parviflora* Wall. ex Baker (Baker J.G. 1890), *K. glauca* Ridl., *K. pulchra* Ridl. (Ridley H.N. 1899), *K. fallax* Gagnep. (Gagnepain 1903), *K. laotica* Gagnep. (Gagnepain 1907), *K. filifolia* Larsen (Larsen K. 1962), *K. larsenii* Siriruga, *K. siamensis* Siriruga, *K. spoliata* Siriruga (Siriruga 1989), *K. sisaketensis* Pichens. & Koonterm (Pichensoonthon and

Koonterm 2009), *K. koratensis* Pichens., *K. saraburiensis* Pichens. (Pichensoonthon 2011), *K. pichensoonthonii* Wongsuwan & Phokham (Phokham et al. 2013), *K. koontermii* Prasarn, Wongsuwan & Pichens (Wongsuwan et al. 2015), *K. mahasarakhamensis* Saensouk & P. Saensouk (Saensouk and Saensouk P. 2019a), *K. phuphanensis* Saensouk & P. Saensouk (Saensouk and Saensouk P. 2019b), *K. maculifolia* Boonma & Saensouk (Boonma et al. 2020), *K. minuta* Jenjitt. & K. Larsen, *K. pardi* Jenjitt. & K. Larsen (Jenjittikul and K. Larsen 2020), *K. nigrifolia* Boonma & Saensouk (Boonma et al. 2021), *K. isanensis* Saensouk & P. Saensouk, *K. unifolia* Saensouk & P. Saensouk (Saensouk P. and Saensouk 2021a), and *K. pseudoparviflora* Saensouk & Saensouk P. (Saensouk P. and Saensouk 2021b; Boonma et al. 2022),

Two undescribed species of *Kaempferia* L. were found during an exploration of the species diversity of the family Zingiberaceae in Thailand from 2018 to 2021. The first undescribed species was found in the deciduous forest in Nakhon Sawan Province, Northern Thailand. It is similar to *K. pardi* Larsen & Jenjitt. (Jenjittikul and Larsen 2020) in having numerous dark spots on the upper surfaces of leaves, and similar to *K. roscoeana* Wall. (Wallich 1829; Siriruga 1992) in having white flowers with pale yellow at the base of the labellum. After comparing and examining species with similar characteristics, this undescribed species did not match with any existing species, thus we treated it as a new species to science under the name of *Kaempferia napavarniae* Saensouk & Boonma. And the

second undescribed species is also in the subgenus *Kaempferia*. It was found in Sakon Nakhon Province, Northeastern Thailand. Its flowers are similar to *K. larsenii* Sirirugsa but differ in other characters. This undescribed species also did not match with any existing species, thus we treated it as a new species to science under the name of *Kaempferia sakonensis* Saensouk & Boonma, the specific epithet was named according to its natural habitat. Therefore, both new species are described, illustrated, and photographed. A revised key to the species of *Kaempferia* subgenus *Kaempferia* in Thailand for facilitating identification are also prepared.

MATERIALS AND METHODS

Plant materials were collected from the natural habitat in Nong Bua District, Nakhon Sawan Province, Northern Thailand, and Sakon Nakhon Province, Northeastern Thailand from 2018 to 2021 (Figure 1). Measurements were recorded from living and spirit specimens collected from the natural habitats using Vernier-caliper, ruler, and morphologically examined under a stereoscopic microscope (Stemi 2000-C, ZEISS, Oberkochen, Germany) and were deposited at Khon Kaen University Herbarium (KKU). Additional specimens were deposited at Diversity of Family Zingiberaceae and Vascular Plant for Its Applications Research Unit, Walai Rukhavej Botanical Research Institute, Mahasarakham University. The protologues of morphologically similar species were compared and verified. The morphological descriptions in all species of accepted species, especially *Kaempferia* subgen. *Kaempferia*, available digital images and information online e.g. photographs of Herbarium specimens with details from Kew's Herbarium or powo.science.kew.org (Kew Science 2022), Queen Sirikit Botanical Garden Herbarium (QBG), including existing published literature of *Kaempferia* were also compared in this study. The most similar species were compared in Tables 1–2.

RESULTS AND DISCUSSION

Here, we report two new species of *Kaempferia*, namely *Kaempferia napavarniae* Saensouk, P. Saensouk & Boonma, and *K. sakonensis* Saensouk, P. Saensouk & Boonma. Both species produce terminal inflorescences, thus they fall into the subgenus *Kaempferia*. The first species, namely *K. napavarniae* or "*Proh Napavarn*" was collected from Nakhon Sawan Province, Northern Thailand, its specific epithet "*napavarniae*" is chosen to honor Associate Professor Dr. Napavarn Noparatnaraporn (Director of Center for Research-driven in Natural Resources and Environment towards Utilization), who is a specialist in Biodiversity in Thailand. While the second new species, namely *K. sakonensis* or "*Proh Sakon*" was collected from natural habitat in Sakon Nakhon Province, Northeastern Thailand. Its specific epithet "*sakonensis*" is derived from the name of Sakon Nakhon Province where is

the natural habitat. Detailed descriptions, vernacular name, distribution, ecology, phenology, illustrations, photographs, and uses have been provided (Figures 1–5 and Tables 1–2). A revised key to 30 species of *Kaempferia* subgenus *Kaempferia* in Thailand for facilitating identification are also prepared.

Taxonomic treatment

Kaempferia napavarniae Saensouk, P. Saensouk & Boonma, **sp. nov.** –Figures 2–3, Table 1 –subgenus *Kaempferia*

Diagnosis: The new species is similar to *K. roscoeana* Wall. but differs in having pubescent leaf sheaths (vs. glabrous leaf sheath); leaf adaxially green with several deep dark green spots, pubescent on both surfaces (vs. leaf adaxially green with mottled dark green, glabrous on both surfaces); bracts triangular and pubescent (vs. oblong and glabrous); calyx 2.5–2.9 cm long, apex mucronate, sparsely hairy (vs. c. 2 cm long, apex bifid, glabrous); anther crest broadly ovate, c. 5.5 × 5 mm (vs. ovate, c. 1.5 × 1.5 mm); epigynous glands c. 10 mm long (vs. c. 3 mm long).

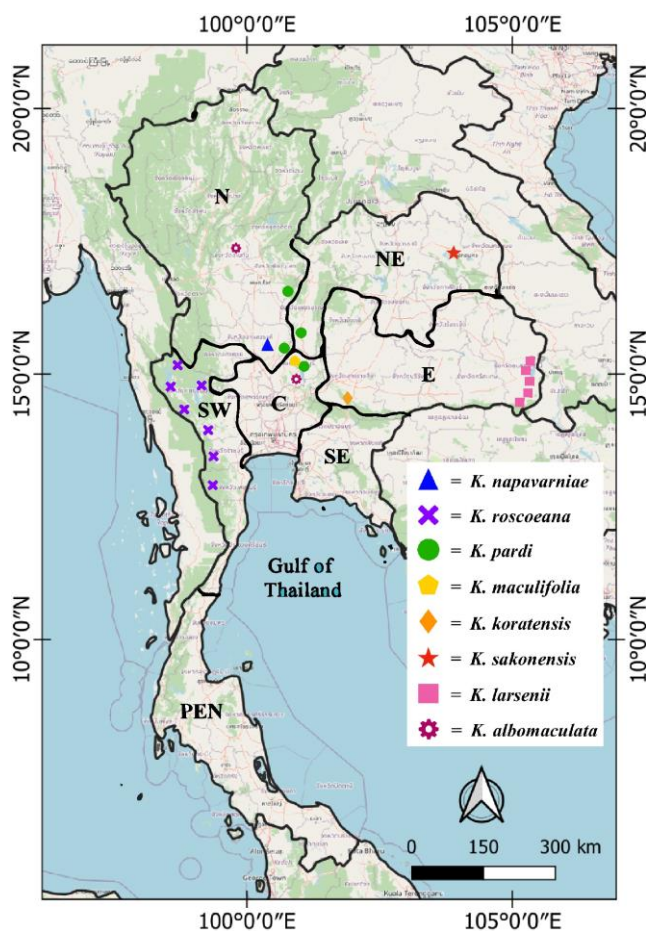


Figure 1. Distribution map of *Kaempferia napavarniae* Saensouk, P. Saensouk & Boonma sp. nov., *K. sakonensis* Saensouk & Boonma sp. nov. and their allies species. Map of Thailand showing floristic regions: N: Northern, NE: Northeastern, E: Eastern, C: Central, SE: Southeastern, SW: Southwestern, and PEN: Peninsular, refer to map of floristic regions of the Flora of Thailand Project. (Map created with "Pixelmator Pro" by Thawatphong Boonma)

Type: Thailand, Nakhon Sawan Province, Nong Bua District, 350 m elevation, *Saensouk* 4000, 12.06.2020 (holo KCU!)

Perennial herb. *Rhizome* ovoid, sympodial, brownish externally, yellowish internally, 1.5–2.4 × 1.0–1.2 cm, fragrant. *Root* fibrous with ovoid tuberous roots, 1.0–1.4 × 0.8–1.0 cm, tubers placed near the rhizome. *Leafy shoot* 2–3 cm tall, leaves are flattened on the ground. *Bladeless sheaths* 1–2, 3–5 cm long, green, apex mucronate, pubescent. *Leaf-sheaths* 2, green, canaliculate, 4–5 cm long, pubescent; *ligule* bilobed, 4–6 mm long, 6–8 mm broad, apex acute to obtuse, pubescent; *petiole* sessile. *Lamina* 2 leaves, ovate to suborbicular, 11.5–17.5 × 8–13 cm, apex mucronate, base rounded, margin entire, adaxially green with several deep dark green spots (spots 1–9 mm in diameter), abaxially surface pale green, pubescent on both surfaces. *Inflorescence* terminal, enclosed by the two leaf-sheaths; *peduncle* sessile. *Bracts* triangular, 8–12 in number, 2.8–3.5 × 1.2–2 cm, an outermost bract is the longest and broadest, an innermost bract is shortest and narrowed, apex acute, slightly mucronate, green with paler green to white at base (inner bracts paler), pubescent. *Flower* white, c. 4 cm long, lateral staminodes and labellum laid on the same plane. *Bracteoles* translucent white, narrowly lanceolate, 1.5–2.4 × 0.30–0.33 cm, apex acute, slightly mucronate, sparsely hairy. *Calyx* tubular, 2.5–2.9 cm long, apex mucronate with a unilateral incision 5–8 mm long, white, sparsely hairy. *Floral tube* tubular, 3.4–3.5 cm long, white, finely hairy; *dorsal corolla lobe* 1, narrowly lanceolate, 2.0–2.2 × 0.32–0.35 cm, apex acuminate-slightly mucronate, white, with sparsely fine hairs; *lateral corolla lobes* 2, narrowly lanceolate, 2.0–2.2 × 0.30–0.35 cm, apex acuminate, white, with sparsely fine hairs. *Lateral staminodes* 2, broadly obovate, 2.3–2.7 × 1.7–2.0 cm, apex rounded, white, glabrous. *Labellum* bilobed, with deeply divided almost the base, each lobe broadly obovate, 2.3–2.7 × 1.9–2.2 cm, apex rounded, white with a pale yellow spot from sinus to the base, glabrous. *Stamen* 1; *filament* sessile. *Anther* c. 10 mm long; anther thecae 3.8–4 mm long; *anther crest* broadly ovate, c. 5.5 × 5 mm, apex obtuse to rounded, white, glabrous. *Stigma* conical, c. 0.8 × 0.8 mm, glabrous, ostiole ciliate. *Epigynous glands* 2, filiform, c. 1 cm long, apex pointed, pale yellow. *Ovary* slightly flattened ovoid, 2.8–3.3 × 2.2–2.4 mm (flattened side 1.6–1.8 mm broad), white, glabrous. *Ovule* axile placentation. *Fruit and seeds* are not seen.

Vernacular name: Proh-Napavarn.

Phenology: Flowering in June to August; flowers fully open in the early morning and last a single day. Leafy shoot emerges in April and dormancy begins in November.

Distribution: Recently found only in the type locality in Nong Bua District, Nakhon Sawan Province, Northern Thailand (Figure 1).

Ecology: It grows in sandy loam soil, well-drained, in the mixed-deciduous forest, at an elevation 200–300 m above sea level.

Etymology: The specific epithet “*napavarniae*” is chosen to honor Associate Professor Dr. Napavarn Noparatnaraporn (Director of Center for Research-driven in Natural Resources and Environment towards Utilization),

who is a specialist in Biodiversity in Thailand.

Uses: Young leaves are used as food and vegetable. The whole plant was used as an ornamental plant.

Provisional IUCN conservation assessment: This species has been known only in Nong Bua District, Nakhon Sawan Province, which it may be found to be distributed in nearby areas, but the survey did not cover the entire area. Thus, we proposed to assign this species according to the IUCN criteria (IUCN, 2022) as a Data Deficient (DD), and expect to find more distribution of this species in nearby unexplored areas to further change its new conservation status to be suitable for further conservation of this plant.

Specimens examined:

***Kaempferia pardi* K. Larsen & Jenjitt.: Thailand:** Northeastern; Phetchabun Province; *Tiptabiankarn* 4402, 21 July 1999 (Holotype: BKF!, Isotype: AAU!, BK!, QBG!), Suwan Luang Rama IX Herbarium). Nakhon Sawan Province, 18 August 2016, *N. Nopporncharoenkul* 486 (cultivated) (Suwan Luang Rama IX Herbarium); Phitsanulok Province, 15 June 2018, *T. Tiptabiankarn* 24449 (Suwan Luang Rama IX Herbarium); Lopburi Province, 23 August 2019, *T. Tiptabiankarn* 25681 (Suwan Luang Rama IX Herbarium).

***Kaempferia roscoeana* Wall.: Thailand:** Southwestern; Kanchanaburi Province; La-ongsri W. With T. Pingyot, P. Tatiya, S. Satatha and S. Wongwan 5151, QBG No.108549, 333 m (QBG!), La-ongsri W. with P. Panyachan, P. Tatiya, S. Satata & S. Wongwan 5620, QBG No.110504, 612 m, 25 June 2018 (QBG!), La-ongsri W. with P. Panyachan, P. Tatiya, S. Satata & S. Wongwan 5702, QBG No.110587, 351 m, 20 August 2018 (QBG!), Maxwell J.F. 10–27, QBG No.50226, 50 m, 27 August 2010 (QBG!), Thammarong W., Rakarcha S., Muangyen N., Khattiyot W. & U. Thongnak 1678, QBG No.126947, 20 June 2020 (QBG!). Phetchaburi Province; Maxwell J.F. 07–413, QBG No.33841, 50 m, 4 July 2007 (QBG!). Ratchaburi Province; Maknoi C. 7930, QBG No.85282, 13 June 2015 (QBG!).

***Kaempferia maculifolia* Boonma & Saensouk:** **Thailand:** Central; Lopburi Province; *Boonma* T. 10, Sa Bot District, 98 m, 29 August 2018 (KKU!, QBG!, BKF!, BK!, TAI!).

***Kaempferia sakonensis* Saensouk, P. Saensouk & Boonma, sp.nov.** –Figures 4–5, Table 2 –subgenus *Kaempferia*

Diagnosis: The new species is similar to *K. larsenii* Sirirugsa in having leafless sheaths sparsely hairy (vs. glabrous); leaf sheaths pubescent (vs. glabrous); petiole sessile (vs. 1 cm long); ligule emarginate, 2.5–3.2 mm long, each lobe apex rounded to truncate, pubescent (vs. broadly triangular, c. 1 mm long, each lobe apex acute, glabrous); number of leaves 2 (vs. 2–4 leaves); lamina ovate, elliptic, or obovate, 12–17 × 4.5–8 cm, apex mucronate, base attenuate, upper surface dark red, midrib dark red, lower surface dark red, upper surface glabrous, lower surface pubescent (vs. elliptic-linear to linear, 6–9 × 0.5–1 cm, apex acute, base cuneate, upper surface green or

green with various shade of reddish tinged along the veins, midrib green or red, lower surface paler green, both surfaces glabrous); peduncle c. 1 cm long (vs. sessile); bracts lanceolate, 3.5–5 × 0.8–1.5 cm, apex mucronate, mucro c. 1–1.4 mm long, pubescent (vs. linear, c. 3 cm × 0.3 cm, apex acute, glabrous); bracteoles 2.3–3.4 cm long (vs. c. 1.5 cm long); calyx 3.5–3.7 cm long, apex mucronate, white with reddish tinge at apex (vs. c. 3 cm long, apex bifid, white); corolla lobe 2.1–2.4 × 0.38–0.5 cm (vs. c. 1.4 cm × 0.25 cm); dorsal corolla lobe apex mucronate (vs. apex blunt); lateral staminodes 1.67–1.75 × 1.1–1.2 cm (vs. c. 1.4 × 0.7 cm); labellum bilobed, deeply divided about 3/5 of the length, each lobe asymmetrical obcordate or broadly obovate, 2.1–2.2 × 1.55–1.76 cm, pale purple with white at the base, dark purple at sinus to base (vs. bilobed, divided to the base, each lobe obovate, c. 1.7 × 0.7 cm, purplish pink with white at base); filament subsessile, c. 1 mm long (vs. sessile); anther c. 5 mm long (vs. c. 2 mm long); anther thecae c. 3 mm long (vs. c. 1 mm long); anther crest suborbicular c. 5 × 5 mm, apex emarginate (vs. obovate, c. 3.7 × 2.7 mm, apex rounded); ovary 3.5–4 × 2.5–3 mm (c. 3 × 1 mm); epigynous glands c. 4 mm long (c. 2.5 mm long).

Type: **Thailand**, Sakon Nakhon Province, Akat Amnuay District, 200 m elevation, *Saensouk* 3600, 9.06.2019 (holo KKU!).

Perennial herb. *Rhizome* ovoid, brownish externally, yellowish internally, 1.5–2.0 × 1.2–1.5 cm. *Root* fibrous with ovoid tuberous roots. *Leafy shoot* 12–17 cm tall, erect pseudostem. *Bladeless sheaths* 1–3, 1.8–5.3 cm long, reddish, apex mucronate, sparsely hairy. *Leaf-sheaths* 2, dark red, except the area covered by leafless sheaths are green, canaliculate, 5–6.5 cm long, pubescent; *ligule* emarginate, 2.5–3.2 mm long, each lobe apex rounded to truncate 5–6 mm broad, pubescent; *petiole* sessile. *Lamina* 2 leaves, thick, ovate, elliptic, or obovate, 12–17 × 4.5–8 cm, apex mucronate, base attenuate, margin entire with red hyaline, broadly undulate, adaxially dark red, glabrous, midrib dark red, abaxially surface dark red, pubescent. *Inflorescence* terminal, enclosed by the two leaf-sheaths; *peduncle* short c. 1 cm long, white, pubescent. *Bracts* lanceolate, 7–13 in number, 3.5–5 × 0.8–1.5 cm, an outermost bract is the longest and broadest, an innermost bract is shortest and narrowed, apex mucronate, mucro c. 1–1.4 mm long, two outermost bracts dark red except the area covered by leaf sheaths pale green, inner bracts pale green with various paler reddish tinge at the apex, pubescent. *Flower* purple, lateral staminodes and labellum laid on the same plane. *Bracteoles* translucent white, linear, 2.3–3.4 × 0.18–0.20 cm, apex acute, slightly hooded, sparsely hairy. *Calyx* tubular, 3.5–3.7 cm long, apex mucronate with unilaterally incision 1.5 cm long, white with a reddish tinge at the apex, glabrous. *Floral tube* tubular, c. 5 cm long, white, glabrous; *dorsal corolla lobe* 1, narrowly oblanceolate, 2.3–2.4 × 0.36–0.38 cm, apex mucronate, mucro c. 2.5 mm long, white, glabrous; *lateral corolla lobes* 2, narrowly oblanceolate, 2.1–2.2 × 0.36–0.38 cm, apex acute, slightly hooded, white, glabrous. *Lateral staminodes* 2, obovate, 1.67–1.75 × 1.1–1.2 cm, apex rounded, pale purple, sometimes with darker purple

tinge along the mid lobe (lower side white with pale purplish tinged at apex and edge), glabrous. *Labellum* bilobed, with deeply divided about 3/5 of labellum length, each lobe asymmetrical obcordate or broadly obovate, 2.1–2.2 × 1.55–1.76 cm, pale purple with white at the base, dark purple at sinus to base, glabrous. *Stamen* 1; *filament* subsessile, c. 1 mm long. *Anther* white, c. 5.5 mm long (measurement in front and side view of the anther); anther thecae c. 3 mm long; *anther crest* suborbicular, emarginate to bilobed, each lobe apex rounded to truncate, crest bend to back side of the anther parallel almost the same plane of staminodes and labellum, purple with white at base connect to white anther, c. 5 × 5 mm, glabrous. *Stigma* conical, c. 0.8 × 0.8 mm, glabrous, ostiole ciliate. *Epigynous glands* 2, filiform, c. 4 mm long, apex pointed, white. *Ovary* ovoid, 3.5–4 × 2.5–3 mm, slightly flattened, white, glabrous. *Ovule* axile placentation. *Fruit and seeds* are not seen.

Vernacular name: Proh-Sakon or Wan Kai-Kook.

Phenology: Flowering in June to August; flowers fully open in the early morning and last a single day. Leafy shoot emerges in late April and dormancy begins in November.

Distribution: Recently found only in the type locality in Akat Amnuay District, Sakon Nakhon Province, Northeastern Thailand (Figure 1).

Ecology: It grows in sandy loam soil, well-drained, in the deciduous forest, at an elevation 200–400 m above sea level.

Etymology: The specific epithet is named according to the province name of their natural habitat in Akat Amnuay District, Sakon Nakhon Province, Northeastern Thailand.

Uses: Auspicious ornamental plants.

Provisional IUCN conservation assessment: This species has been known only in Akat Amnuay District, Sakon Nakhon Province, which it may be found to be distributed in nearby areas, but the survey did not cover the entire area. Thus, we proposed to rank this species according to the IUCN criteria (IUCN, 2022) as a Data Deficient (DD), and expect to find more distribution of this species in nearby unexplored areas to further change its new conservation status to be suitable for further conservation of this plant.

Specimens examined:

Kaempferia larsenii Sirirugsa: **Thailand:** Eastern; Ubon Ratchathani Province; *Nilviset* 19, Buntarik, 27 July 1951 (Holotype: C!, Isotype: BKF!), *Maknoi* C. 1644, *QBG* No. 31686, 8 August 2007 (QBG!), *Maknoi* C. 1661, *QBG* No. 31703, 9 August 2007 (QBG!), *Maknoi* C. 5849, *QBG* No. 70521, 17 June 2013 (QBG!), *Tanaros* M. 501, *QBG* No. 45099, 19 June 2010 (QBG!).

Discussion

Kaempferia napavarniae Saensouk, P. Saensouk & Boonma is belongs to *Kaempferia* subgenus *Kaempferia* due to it producing terminal inflorescence. In having leaves flattened on the ground, sessile petiole, peduncle and filament, produced white flowers, staminodes and labellum laid on the same plane, and labellum white with yellow at the base makes it similar to *K. roscoeana* Wall. But differs in having pubescent leaf sheaths; leaf adaxially green with

several deep dark green spots, pubescent on both surfaces; bracts triangular and pubescent; calyx 2.5–2.9 cm long, apex mucronate, sparsely hairy; anther crest broadly ovate, c. 5.5 × 5 mm; epigynous glands c. 10 mm long, while *K. roscoeana* has glabrous leaf sheath; leaf adaxially green with mottled dark green, glabrous on both surfaces; bract oblong and glabrous; calyx c. 2 cm long, apex bifid, glabrous; anther crest ovate, c. 1.5 × 1.5 mm; epigynous glands c. 3 mm long. Moreover, the natural habitats of *K. roscoeana* are in Southwestern Thailand, and no report on the distribution in the forest of Nong Bua District, Nakhon Sawan Province, Northern Thailand.

Considering the natural habitat, two species in the subgenus *Kaempferia*, namely *K. pardi* K. Larsen & Jenjitt., and *K. maculifolia* Boonma & Saensouk, were found distributed in Lopburi Province, Central Thailand, which is the neighboring province of Nakhon Sawan Province. The two species have similar dark spots on the leaves. We, therefore, compare their morphological characteristics in Table 1.

Kaempferia napavarniae differs from *K. pardi* in having a leafy shoot short, 2–3 cm tall (vs. 4–10(–20) cm tall); tuberous roots ovoid (vs. cylindroid); leaves apex mucronate (vs. rounded); bract pubescent (vs. glabrous); calyx apex mucronate (vs. apex acute with a pair of 2–3 mm long delicate teeth on the back side of tip); lateral staminodes and labellum laid on the same plane (vs. not laid on the same plane, upward angle, makes the fully bloomed flower still resemble a cone); floral tube shorter, 3.4–3.5 cm long (vs. 7.5–8 cm long); flowers of *K. napavarniae* have a smaller size than *K. pardi*; labellum bilobed, deeply divided almost the base (vs. divided about 1/2 of the length), labellum without purple (vs. two purple blotches along midvein from sinus to base); filament sessile (vs. 6 mm long); anther thecae 3.8–4 mm long (vs. 7–9 mm long); anther crest broadly ovate, c. 5.5 × 5 mm, apex obtuse to rounded (vs. suborbicular, 7 × 6 mm, apex shallowly trilobed, slightly recurved); epigynous glands c. 10 mm long (vs. 6–7 mm long).

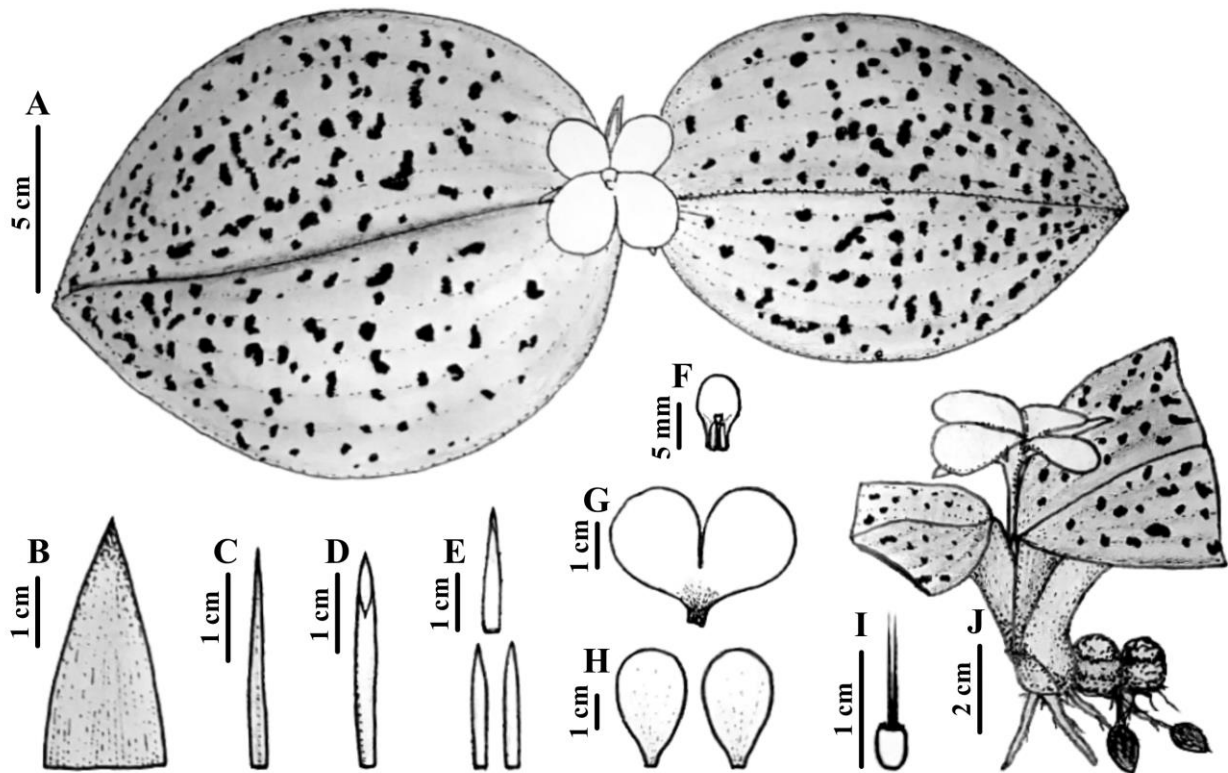


Figure 3. *Kaempferia napavarniae* Saensouk, P. Saensouk & Boonma sp. nov. (A) Top view of flowers and leaves, (B) Bract, (C) Bracteole, (D) Calyx, (E) Corolla lobes, (F) Front view of anther with thecae and crest, (G) Labellum, (H) Stamminodes, (I) Ovary and epigynous glands, (J) Oblique-side view of habit with flower and sympodial rhizomes. (Drawn by Thawatphong Boonma)

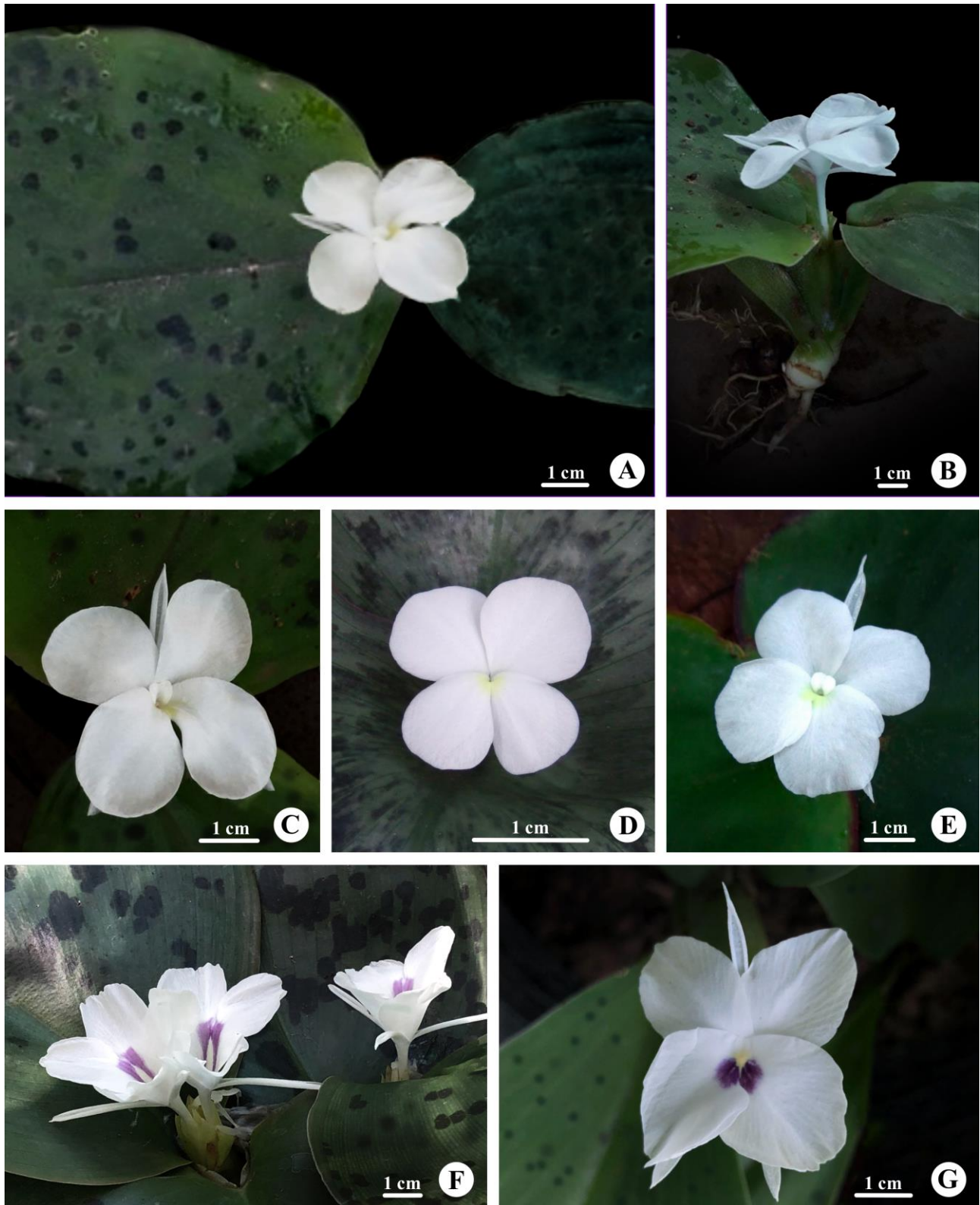


Figure 2. *Kaempferia napavarniae* Saensouk, P. Saensouk & Boonma sp. nov. (A) Top view of flowers and leaves, (B) Oblique-side view of flowers and leaves, (C) *K. napavarniae* Saensouk, P. Saensouk & Boonma – top view, (D) *K. roscoeana* Wall.–top view, (E) *K. koratensis* Picheans. – top view, (F) *K. pardi* Larsen K. & Jenjitt. – oblique view, (G) *K. maculifolia* Boonma & Saensouk – top view. (Photographs A–B by Surapon Saensouk; C–G and Design by Thawatphong Boonma)



Figure 4. *Kaempferia sakonensis* Saensouk, P. Saensouk & Boonma sp. nov. and its allies species (A) *K. sakonensis* – top view of flower and leaves, (B) *K. sakonensis* – top view of flowers, (C) *K. larsenii* Sirirugsa – oblique view of flower, (D) *K. larsenii* Sirirugsa – oblique view of leaves with red along the veins variant, (E) *K. larsenii* Sirirugsa – top view of flower, (F) *K. albomaculata* Jenjitt. & K.Larsen (nom. nud.) – oblique view of flowers and leaves, (G) *K. albomaculata* – top view. (Photographs A–E by Surapon Saensouk; F–G and design by Thawatphong Boonma)

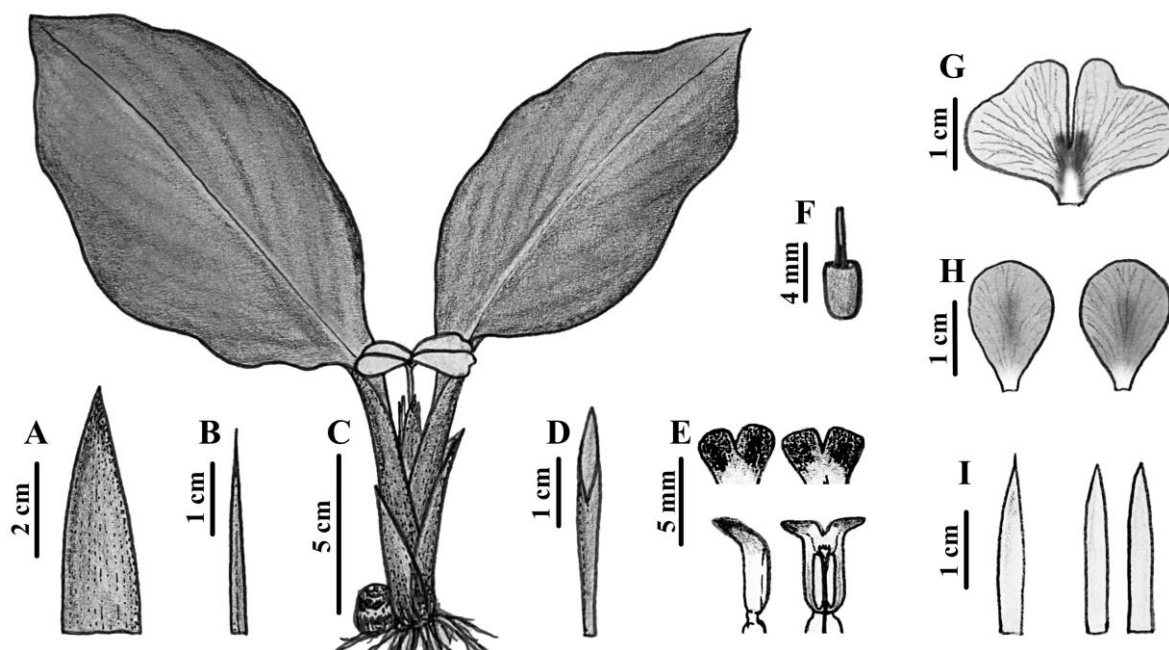


Figure 5. *Kaempferia sakonensis* Saensouk, P. Saensouk & Boonma sp. nov. (A) Bract, (B) Bracteole (C) Side view of habit, (D) Calyx, (E) Anther crest (each lobe rounded and truncate), side and front view of the anther, (F) Ovary and epigynous glands, (G) Labellum, (H) Stamines, (I) Corolla lobes. (Drawn by Thawatphong Boonma)

Compared to *K. maculifolia*, the new species is different in having leaves flattened on the ground (vs. *K. maculifolia* produced leaves erect and elongate pseudostem); leafy shoot 2–3 cm tall (vs. 20–35 cm tall); rhizome ovoid (vs. erect, narrowly ovoid); tuberous roots ovoid (vs. cylindroid); leaf sheaths 4–5 cm long (vs. 12–16 cm long); petiole sessile (vs. 0.5–1 cm long); leaves two, ovate to suborbicular, apex mucronate, base rounded (vs. (2–)3–4 leaves, oblanceolate to elliptic, apex acuminate, base attenuate); peduncle sessile (vs. 5–8 cm long); calyx 2.5–2.9 cm long, apex mucronate, sparsely hairy (vs. 3.7–4.8 cm long, apex 3-lobed, glabrous); floral tube 3.4–3.5 cm long (vs. 8–10 cm long); labellum without purple (vs. two purple patches at base); anther thecae 3.8–4 mm long (vs. 9–10 mm long); anther crest broadly ovate, c. 5.5 × 5 mm, white (vs. narrowly oblong to spatulate, c. 16.4 × 1.7 mm, white with light pale yellow at base); epigynous glands c. 10 mm long (vs. 5 mm long); ovary slightly ovoid, glabrous (vs. cylindrical, sparsely hairy).

Moreover, a comparison of *K. napavarniae* to *K. koratensis* Pichens. (Pichensoonthon 2011) shows differences in having leaves adaxially surfaces with several deep dark green spots, pubescent on both surfaces (without dark green spots, upper surfaces glabrous, lower surfaces pubescent); bracteole 1.5–2.4 cm long (vs. 2.4–3.6 cm

long); calyx 2.5–2.9 cm long, apex mucronate (vs. 3.1–4.5 cm long, apex bifid); anther crest broadly ovate, c. 5.5 × 5 mm, apex obtuse to rounded (vs. ovate, obovate, rectangular, 8–12 × 4–6 mm, apex rounded, bi-trilobed); epigynous glands c. 10 mm long (vs. 4 mm long). The natural habitats of *K. koratensis* are in Eastern Thailand and no report indicated distribution in the forest of Nakhon Sawan Province, Northern Thailand, even in Lop Buri Province (the province between Nakhon Sawan Province and adjacent to Nakhon Ratchasima Province). The distribution map of *Curcuma napavarniae* and its allied species is present in Figure 1.

Kaempferia sakonensis Saensouk, P. Saensouk & Boonma is also belongs to subgenus *Kaempferia* due to it producing terminal inflorescence. In producing erect pseudostem, and purple shade of flowers makes it similar to *Kaempferia larsenii* Sirirugsa but differs from other morphological characters as presented in Table 2. However, the flowers of this new species are also similar to *Kaempferia albomaculata* Jenjitt. & K.Larsen (nom. nud.) (Techaprasan et al. 2010) but differ and can be easily distinguished from each other due to *K. albomaculata* producing leaves flattened on the ground while *K. sakonensis* produced erect leaves and pseudostem.

Table 1. Morphological comparison of *Kaempferia napavarniae* and its allied species

Characters	<i>K. napavarniae</i> Saensouk & Boonma	<i>K. roscoeana</i> Wall.	<i>K. pardi</i> K. Larsen & Jenjitt.	<i>K. maculifolia</i> Boonma & Saensouk
Habit	Leaves flattened on the ground	Leaves flattened on the ground	Leaves flattened to the ground or slightly raise up from the ground	Leaves erect and elongate pseudostem
Leafy shoot	2–3 cm tall	2 cm tall	4–10(–20) cm tall	20–35 cm tall
Rhizome	Ovoid, 1.5–2.4 × 1.0–1.2 cm	Stout, subspherical, 1–1.5 × 1–1.5 cm	ovoid to ellipsoid, 2–4 × 1–1.8 cm	Erect, narrowly ovoid, 3–4 × 1.0–1.4 cm
Tuberous roots	Ovoid	Ovoid	Cylindroid	Cylindroid
Leaf sheaths	4–5 cm long, Pubescent	c. 2.5 cm long, Glabrous	2.5–3 cm long, Pubescent	12–16 cm long, Pubescent
Petiole	Sessile	Sessile	Sessile	0.5–1 cm long
Leaves	2 leaves, Ovate to suborbicular, 11.5–17.5 × 8–13 cm, Apex mucronate, Base rounded, Adaxially green with several deep dark green spots Pubescent on both surfaces	2 leaves, Suborbicular, 5–12 × 5–11.5 cm, Apex mucronate, Base rounded-cuneate, Adaxially mottled dark green Glabrous on both surfaces	2 leaves, Suborbicular to obovate, 20–30 × 15–20 cm, Apex rounded, Base rounded to acute, Adaxially dull green with dark blotches Upper surface sparsely hairy, Lower surface pubescent	(2–)3–4 leaves, Oblanceolate to elliptic, 14.5–30.1 × 5.2–11.3 cm, Apex acuminate, Base attenuate, Adaxially green with dark green spots Pubescent on both surfaces
Peduncle	Sessile	Sessile	Sessile	5–8 cm long
Bract	Triangular, 2.8–3.5 × 1.2–2 cm, Apex acute, slightly mucronate, Pubescent	Oblong, c. 2.2 × 0.35 cm, Apex acuminate, Glabrous	Lanceolate to narrowly ovate, c. 5.8 × 2.8 cm Apex acute, Glabrous	Lanceolate, 4.5– 7.6 × 0.8–3.5 cm Apex acuminate to mucronate, Pubescent
Bracteoles	Narrowly lanceolate, 1.5–2.4 × 0.30–0.33 cm, Sparsely hairy	Linear, 1–2.5 × 0.5 cm, Glabrous	Linear, 3.4 × 0.08–0.10 cm, Glabrous	Lanceolate, 2.8–5.2 × 0.4–0.5 cm, Glabrous
Calyx	2.5–2.9 cm long, Apex mucronate	c. 2 cm long, Apex bifid,	4.7–5 cm long, Apex acute with a pair of 2–3 mm long delicate teeth on back side of tip	3.7–4.8 cm long, Apex 3-lobed,
Floral plane	Sparsely hairy Lateral staminodes and labellum laid on same plane	Glabrous Lateral staminodes and labellum laid on same plane	Glabrous Lateral staminodes and labellum not laid on same plane (upward angle, makes the fully bloomed flower still resemble a cone)	Glabrous Lateral staminodes and labellum laid on same plane
Flora tube	3.4–3.5 cm long	c. 4 cm long	7.5–8 cm long	8–10 cm long
Dorsal corolla lobe	Narrowly lanceolate, 2.0–2.2 × 0.32–0.35 cm, Apex acuminate-slightly mucronate	Oblong, c. 1.5 × 0.3 cm, Apex acuminate	Linear, 4.7 × 1 cm, Apex aristate, arista ca. 5 mm long	Narrowly lanceolate, 2.4–2.7 × 0.25–0.3 cm, Apex caudate
Lateral corolla lobes	2–2.2 × 0.3–0.35 cm, Apex acuminate	c. 1.3 × 0.2 cm, Apex blunt	4–4.5 × 0.7–0.8 cm, Apex acute	2–2.4 × 0.25–0.3 cm, Apex acuminate
Staminodes	Broadly obovate, 2.3–2.7 × 1.7–2.0 cm, Apex rounded	Obovate, c. 1.7 × 0.8 cm, Apex rounded	Rounded to obovate, 3.5–4 × 2.8–3.2 cm, Apex rounded and undulate	Obovate to elliptic, c. 2.8 × 2 cm, Apex rounded to obtuse
Labellum	Bilobed, deeply divided almost the base, Each lobe broadly obovate, not imbricate, 2.3–2.7 × 1.9–2.2 cm, Apex rounded, White with pale yellow spot from sinus to the base	Bilobed, divided to the base, Each lobe obovate, not imbricate, c. 1.6 × 0.9 cm, Apex rounded White with yellow spot at the base	Bilobed, divided about 1/2 of the length, Each lobe rounded, imbricate, 4.5 × 2 cm, Apex undulate White with a pale yellow band from the base to sinus and two purple blotches along midvein from sinus to base	Bilobed, deeply divided about 2/3 of the length, Each lobe broadly obovate, partly imbricate, c. 2.8 × 2.3 cm, Apex rounded to obtuse White with two purple patches at base, with light pale yellow patch at base
Filament	Sessile	Sessile	6 mm long	Subsessile
Anther thecae	3.8–4 mm long	c. 3 mm long	7–9 mm long	9–10 mm long
Anther crest	Broadly ovate, c. 5.5 × 5 mm, White	Ovate, c. 1.5 × 1.5 mm, White	Suborbicular 7 × 6 mm, White	Narrowly oblong to spatulate c. 16.4 × 1.7 mm, White with light pale yellow at base
Epigynous glands	c. 10 mm long	c. 3 mm long	6–7 mm long	c. 5 mm long
Ovary	Slightly flattened ovoid, 2.8–3.3 × 2.2–2.4 mm, Glabrous	Ovoid c. 4 × 2 mm, Glabrous	Cylindrical, slightly angled, 7 × 3 mm, Glabrous	Cylindrical, c. 4 × 2.5–3 mm, Sparsely hairy

Table 2. Morphological comparison of *Kaempferia sakonensis* and its allied species

Characters	<i>K. sakonensis</i> Saensouk & Boonma	<i>K. larsenii</i> Sirirugs
Leafy shoot	12–17 cm tall	9–10 cm tall
Leafless sheaths	1.8–5.3 cm long, Sparsely hairy	c. 3.5 cm long, Glabrous
Leaf sheaths	5–6.5 cm long, Pubescent	3–4 cm long, Glabrous
Petiole	Sessile	c. 1 cm long
Ligule	Emarginate, 2.5–3.2 mm long, Each lobe apex rounded to truncate, Pubescent	Broadly triangular, c. 1 mm long, Each lobe apex acute, Glabrous
Number of Leaves	2 leaves	2–4 leaves
Lamina	Ovate, elliptic, or obovate, 12–17 × 4.5–8 cm, Apex mucronate, Base attenuate, Upper surface dark red, Midrib dark red, Lower surface dark red, Upper surface glabrous, lower surface pubescent	Elliptic-linear to linear, 6–9 × 0.5–1 cm, Apex acute, Base cuneate, Upper surface green or green with various shade of reddish tinged along the veins, Midrib green or red, Lower surface paler green, Both surfaces glabrous
Peduncle	Short c. 1 cm long	Sessile
Bract	Lanceolate, 3.5–5 × 0.8–1.5 cm, Apex mucronate, mucro c. 1–1.4 mm long, Pubescent	Linear, c. 3 cm × 0.3 cm, Apex acute, Glabrous
Bracteoles	2.3–3.4 cm long	c. 1.5 cm long
Calyx	3.5–3.7 cm long, Apex mucronate, White with reddish tinge at apex	c. 3 cm long, Apex bifid, White
Floral tube	c. 5 cm long	c. 5.5 cm long
Corolla lobe	Narrowly oblanceolate, 2.1–2.4 × 0.38–0.5 cm	Linear, c. 1.4 cm × 0.25 cm
Dorsal corolla lobe	Apex mucronate, mucro c. 2.5 mm long	Apex blunt
Lateral corolla lobe	Apex acute	Apex blunt
Lateral staminodes	1.67–1.75 × 1.1–1.2 cm	c. 1.4 × 0.7 cm
Labellum	Bilobed, deeply divided about 3/5 of the length, Each lobe asymmetrical obcordate, or broadly obovate 2.1–2.2 × 1.55–1.76 cm, Pale purple with white at the base, dark purple at sinus to base	Bilobed, divided to the base, Each lobe obovate, c. 1.7 × 0.7 cm, Pink with white at base
Filament	Subsessile, c. 1 mm long	Sessile
Anther	c. 5 mm long	c. 2 mm long
Anther thecae	c. 3 mm long	c. 1 mm long
Anther crest	Suborbicular, c. 5 × 5 mm, Apex emarginate	Obovate, c. 3.7 × 2.7 mm, Apex rounded
Ovary	3.5–4 × 2.5–3 mm	c. 3 × 1 mm
Epigynous glands	c. 4 mm long	c. 2.5 mm long

Key to 30 species of *Kaempferia* subgenus *Kaempferia* in Thailand

- 1a. Leaves erect from the ground 2
 1b. Leaves horizontal near the ground 13
 2a. Lamina filiform, linear or less than 4 cm broad 3
 2b. Lamina lanceolate to orbicular, broader than 4 cm ... 7
 3a. Leaves villous below *K. spoliata*
 3b. Leaves glabrous 4
 4a. Staminodes absent *K. sisaketensis*
 4b. Staminodes present 5
- 5a. Ligules present; leaves elliptic-linear to linear, 0.5–1 cm broad *K. larsenii*
 5b. Ligules absent; leaves filiform, less than 0.5 cm broad 6
 6a. Leaves up to 14 cm; anther-crest not divided or crenate *K. fallax*
 6b. Leaves 15–20 cm long; anther-crest divided *K. filifolia*
 7a. Petioles ≤ 1 cm long 8
 7b. Petioles > 2 to 10 cm long 10

- 8a. Adaxially surface with dark green spots above *K. maculifolia*
- 8b. Adaxially surface without dark spots above 9
- 9a. Stamines white, stamens upright with deflexed distal half of the labellum *K. angustifolia*
- 9b. Stamines pale purple, stamens and labellum laid on the same plane *K. sakonensis*
- 10a. Ovary glabrous; leaves glabrous on both surfaces with purple coloration at margins *K. mahasarakhamensis*
- 10b. Ovary hairy; leaves pubescent below 11
- 11a. Leaves tomentose on both surfaces; labellum pubescent *K. koontermii*
- 11b. Leaves glabrous above, pubescent below; labellum glabrous 12
- 12a. Labellum shallowly divided or emarginate; stamens oblong, 1–1.3 × c. 0.3 cm *K. parviflora*
- 12b. Labellum divided to the base; stamens broadly obovate or sub-orbicular, 1.5–2 × 1–1.7 cm *K. elegans*
- 13a. Leaf = 1 14
- 13b. Leaf ≥ 2 18
- 14a. Calyx bifid at apex 15
- 14b. Calyx acute at apex 16
- 15a. Anther crest white with red dots, apex acute *K. siamensis*
- 15b. Anther crest white without red dots, bilobed, apices rounded *K. unifolia*
- 16a. Corolla tube 2.9–4.5 cm long, reddish brown spot; corolla lobes reddish brown spot; bracts reddish brown spot *K. picheansoonthonii*
- 16b. Corolla tube 1.5–2 cm long, white; corolla lobes white; bracts green 17
- 17a. Leaves dark green, apex rounded; anther crest shallowly bilobed, each lobe apex acute *K. isanensis*
- 17b. Leaves dark green with light grey markings, apex acute; anther crest deeply bilobed, each lobe apex rounded *K. pseudoparviflora*
- 18a. Stamens light brown or white 19
- 18b. Stamens lilac, purple or violet 27
- 19a. Stamens light brown *K. saraburiensis*
- 19b. Stamens white 20
- 20a. Labellum purple *K. marginata*
- 20b. Labellum white 21
- 21a. Leaves green with dark blotches or spots 22
- 21b. Leaves green without dark blotches or spots 23
- 22a. Floral tube 7.5–8 cm long; labellum white with two purple blotches along midvein from sinus to base ... *K. pardi*
- 22b. Floral tube 3.4–3.5 cm long; labellum white without purple blotches as above *K. napavarniae*
- 23a. Labellum white with yellow spot at base 24
- 23b. Labellum white with purple, lilac, or red 25
- 24a. Leaves glabrous on both surfaces *K. roscoeana*
- 24b. Leave glabrous above and pubescent below *K. koratensis*
- 25a. Calyx and ovary hairy; labellum white, sometimes with a darker reddish patch at the inner base of each lobe with a longitudinal white line at the base of lobes *K. phuphanensis*
- 25b. Calyx and ovary glabrous; labellum white with purple blotch at the center or with purple marking at base 26
- 26a. Bracts hairy *K. laotica*
- 26b. Bracts glabrous *K. galanga*
- 27a. Calyx and ovary glabrous *K. minuta*
- 27b. Calyx and ovary hairy 28
- 28a. Stigma capitate, deep red-purple; anther crest reniform; leaves glaucous, green *K. glauca*
- 28b. Stigma 2-lipped, creamy white or white; anther crest triangular or linear; leaves dark olivaceous black with grey markings above or black or black with light grey markings 29
- 29a. Peduncles less than 1 cm long; stamens sessile; anther crest triangular and bend to the back; stamens broadly obovate, light purple with white spot at base, longer than labellum; labellum light purple with pure white spot at base; leaves sessile, black or black with light grey markings, sparsely hairy above *K. nigrifolia*
- 29b. Peduncles c. 7.6 cm long; stamens with very short filament; anther crest very long linear apex entire rounded, recurved; stamens obovate, mauve, as long as labellum; labellum lilac with the base pale yellowish-white spots; leaves petiolate, dark olivaceous black with grey markings above, glabrous above *K. pulchra*

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