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Three New Species of the Yellow-flowered *Caulokaempferia* (Zingiberaceae) from Northeastern Thailand

Chayan Picheansoonthon[1,2,3] and Supachai Koonterm[1]

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ABSTRACT: Three new species of the genus *Caulokaempferia* (Zingiberaceae) from northeastern Thailand, *C. phuwoaensis* Picheans. & Koonterm, *C. phulangkaensis* Picheans., and *C. phutokensis* Picheans., are described and illustrated. Relationship with other closely related taxa is also discussed.

KEYWORDS: Zingiberaceae, new *Caulokaempferia*, northeastern Thailand.

INTRODUCTION

The Zingiberaceae is one of the important families of medicinal plants in Thailand. Members of this family are aromatic, several species are economic plants, *Zingiber officinale* Rosc., *Amomum testaceum* Ridl., *Elletaria cardamomum* (L.) Maton, *Curcuma longa* L., to mention a few. A large number of taxa are either ethnobotanically or ethnopharmacologically importance.

In the Thai folk botanical classification, some members of this family, together with some members of other families (mainly of the Monocotyledonae), form an important plant group called "wan". In the Thai-Laos culture, the "wan" has either medicinal or magical power, or both. Several "wans" still play an important role in daily life of the Thai-Laos. These "wans" can often be seen in local markets nationwide. However, many "wans" of the family Zingiberaceae are still unknown or uncertain taxonomically.

We have been working to establish fundamental botanical knowledge on the Thai "wans" for decades for the purpose of future research and development, and worldwide legal protection of our Thai folk wisdom on the uses of the Thai "wans". Resulting from our intensive studies in the past few years, we have reported several new taxa from this family. Our focus on the genus *Caulokaempferia*, *Kaempferia*, *Hedychium*, and *Elettariopsis* led us to report several new taxa (Picheansoonthon and Mokkamul, 2004a; Picheansoonthon and Mokkamul, 2004b; Mokkamul and Picheansoonthon, 2004; Picheansoonthon and Mokkamul, 2005; Picheansoonthon and Mokkamul, 2006; Picheansoonthon et al., 2007).

In this paper, three new species, *C. phuwoaensis* Picheans. & Koonterm, *C. phulangkaensis* Picheans., and *C. phutokensis* Picheans. from Northeastern Thailand, are described and illustrated.

1. Pharmaceutical Botany and Pharmacognosy Research Unit, Faculty of Pharmaceutical Sciences, Khon Kaen University, Khon Kaen 40002, Thailand.
2. The Academy of Science, The Royal Institute of Thailand, Sanam Suea Pa, Khet Dusit, Bangkok 10300, Thailand.
3. Corresponding author. Email: chayan@kku.ac.th

TAXONOMIC TREATMENTS

1. *Caulokaempferia phuwoaensis* Picheans. & Koonterm, *sp. nov.* Figs. 1, 2 & 7

Type. *Picheansoonthon 723*, Phu Woa Wildlife Sanctuary, Amphoe Bung Khla, Changwat Nong Khai, N 18° 13.918', E 103° 57.393', elevation 225 m, 21 August 2004, (BKF holotype, including dried and spirit materials; BK and SING paratypes).

Caulokaempferiae jirawongsei similis, habitu terrestri, foliis 3-5 ovatis ad ovate lanceolatis sessilibus ad subsessilibus, ligula 2-5 mm longa, apice bilobato, bractea late ovata infima 6 vel 7(-10)-flora, staminodio laterali obovato differt.

Perennial herb, with short rhizome; root fibrous, some form longish storage tubers. Pseudostems 3.9-26.2 cm, lower half with 2-4 bladeless sheaths or reduced lamina. Leaves 3-5, subsessile to sessile, lower ones smaller, the two uppermost ones usually the largest; ligule membranous, 2-5 mm long, apex bilobe; leaf blades ovate to ovate-lanceolate, the uppermost two the largest, 5.7-9.0 by 1.7-2.8 cm, both sides glabrous, apex acuminate, margin entire to slightly undulate. Inflorescence terminal, 4.7-5.7 cm long, peduncle glabrous, enclosed in leaf sheaths of the two uppermost leaves, 1.3-1.6 cm long. Bract 1-3(-4),

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imbricate, unilateral with amplexicaul base, forming pouches for cincinnae, broadly ovate, glabrous, 2.5-4.1 by 1.5-2.2 cm, apex acuminate, margin free to the base, axis visible on one side, the lowest bract enclosing a cincinnus of 6-7(-10) yellow flowers, the upper one(s) subtend fewer flowers, some inflorescences terminated by a sterile bract. Bracteole ovate, 7-8 by 3-4 mm. Calyx tubular, hiden in the bract, 6-8 mm long, glabrous, split 1-2 mm down on one side, apex trilobe. Corolla tube 2.8-3.2 cm long, ca 2 mm wide, lobe 3, yellow; dorsal corolla lobe ovate, hooded with apex produced into a 0.5 mm thorn-like point, 8-9 by 3-4 mm; lateral corolla lobes ovate, place close together below the labellum, 0.4-1.2 by 0.3-0.5 cm, apex acute. Lateral stamenodes patent, auriculate, obovate, 1.0-1.4 by 0.7-1.1 cm, apex round to emarginate. Labellum broadly obovate, 1.7-2.1 by 1.7-2.0 cm, distal part 3-lobed with median lobe ligulate and emarginate to shallowly bilobe, extending 3-5 mm. Filament very short, ca. 1 mm; anther ca. 3 by 2 mm long; anther crest yellow, broadly ovate, ca. 5 by 3 cm, slightly reflexed. Stylodial glands 2, ca. 1 mm long; ovary ca. 2 by 3 mm, glabrous, unilocular. Fruit fleshy capsule, ovate-elliptic to ovate, 6-7 by 3-4 mm. Seed many, light brownish, oblong to oblanceolate, hairy, ca. 2 mm long. Flowering May-September, fruiting June-October.

Distribution: This new species can be found at Tham Noi (ถ้ำน้อย) and Jet Si Waterfall (น้ำตกเจ็ดสี) in Phu Woa Wildlife Sanctuary, Amphoe Bung Khla, Changwat Nong Khai in Northeastern Thailand.

Ecology: This new species grows on moist sandstone rocks near the waterfall under the shade of mixed deciduous forests, at the altitude of 203-325 m. It is one of the dominant species of the special type of seasonal wetland vegetation called “blanket marsh vegetation” only appearing in the rainy season.

Vernacular names: Wan Proa Ton (ว่านเปราะต้น), Proa Ton Phu Woa (เปราะต้นภูวัว)

Use: Medicinal.

Note: This new species is similar to *C. jirawongsei* Picheans. & Mokkamul, but can be easily distinguished by its shorter ligules (2-5 mm), fewer lanceolate-ovate to ovate leaves (3-5), broadly ovate bract(s), and 6-7(-10)-flowered lowest bract. Also, this new taxon is terrestrial and smaller in habit. Leaves of *C. phuwoaensis* Picheans. & Koonterm are thicker in texture, and generally arranged on the upper half of a pseudostem.

Material studied other than type: *Picheansoonthon 857* (BKF), Phu Woa Wildlife Sanctuary (Jed Si Waterfall), Changwat Nong Khai, N 18° 09.595’ E 103° 57.105’, elevation 203 m, 22 September 2005.

2. ***Caulokaempferia phulangkaensis*** Picheans., *sp. nov.* Figs. 3, 4 & 7

Type. *Picheansoonthon 729*, Tad Kham Waterfall, Phu Langka National Park, Amphoe Ban Paeng, Changwat Nakhon Panom, N 17° 57.084’, E 104° 09.436’, elevation 176 m, 21 August 2004, (BKF holotype including dried and spirit materials; BK and SING paratypes).

Caulokaempferia jirawongsei similis, foliis (4-)7-10(-12) lanceolatis subsessilibus vel breviter petiolatis, apice caudato, bracteis 1 vel 2 (vel 3) ovate ellipticis, infima 1-10-flora differt.

Lithophytic perennial herb, tuft, slender, with short rhizome; root fibrous, some form longish storage tubers. Pseudostems 10.0-32.7 cm, with 2-3 bladeless sheaths or reduced lamina. Leaves (4-)7-10(-12), subsessile to shortly petiolate; ligule deltoid, membranous, 2-5 mm long, apex acute; leaf blades lanceolate, the uppermost two the largest, 6.8-13.7 by 1.3-2.3 cm, both sides glabrous, apex caudate, margin entire to slightly undulate. Inflorescence terminal, 2.1-4.4 cm long, peduncle glabrous, enclosed in leaf sheaths of the two uppermost leaves, 1.0-1.7 cm long. Bract 1-2(-3), imbricate, unilateral with amplexicaul base, forming pouches for cincinnae, elliptic-ovate, glabrous, the lowest ones 2.2-3.7 by 1.1-1.5 cm, apex acuminate, margin free to the base, axis visible on one side, the lowest bract enclosing a cincinnus of 1-10 yellow flowers, the upper one(s) subtend fewer flowers, some inflorescences terminated by a sterile bract. Bracteole deltoid, 3-4 by 1-2 mm. Calyx tubular, hiden in the bract, 0.7-1 cm by 3-4 mm, glabrous, split 1-2 mm down on one side, apex acute, bilobe, trilobe. Corolla tube 3.0-3.2 cm by 1-2 mm, lobe 3, yellow; dorsal corolla lobe ovate, hooded with apex produced into a 0.1 mm thorn-like point, 7-11 by 4mm; lateral corolla lobes ovate, 0.8-1.0 by 0.3-0.4 cm, apex acute. Lateral stamenodes obovate, 1.4-1.5 by 0.8-0.9 cm, apex shallowly emarginate. Labellum broadly obovate, 2.2-2.5 by 1.8-2.1 cm, distal part 3-lobed with median lobe ligulate extending 5-8 mm, apex bilobe split 2-4 mm down, apex acute to obtuse. Filament very short, ca. 1 mm; anther ca. 3 by 2 mm long; anther crest yellow, suborbicurlar, ca. 5 by 4 mm, slightly reflexed. Stylodial glands 2, *c.* 1 mm long; ovary ca. 2 by ca.1 mm, glabrous, unilocular. Fruit fleshy capsule, ovate to ovate-oblong, greenish, outer surface rough, 0.9-1.1 cm by 4-5 mm. Seed many, light brownish, fusiform, hairy, ca. 2 mm long. Flowering July-September, fruiting August-October.

Distribution: This new species can be found in Tad Kham Waterfall (น้ำตกตาดขาม), Phu Langka National Park, Amphoe Ban Phaeng, Changwat Nakhon Panom in Northeastern Thailand.

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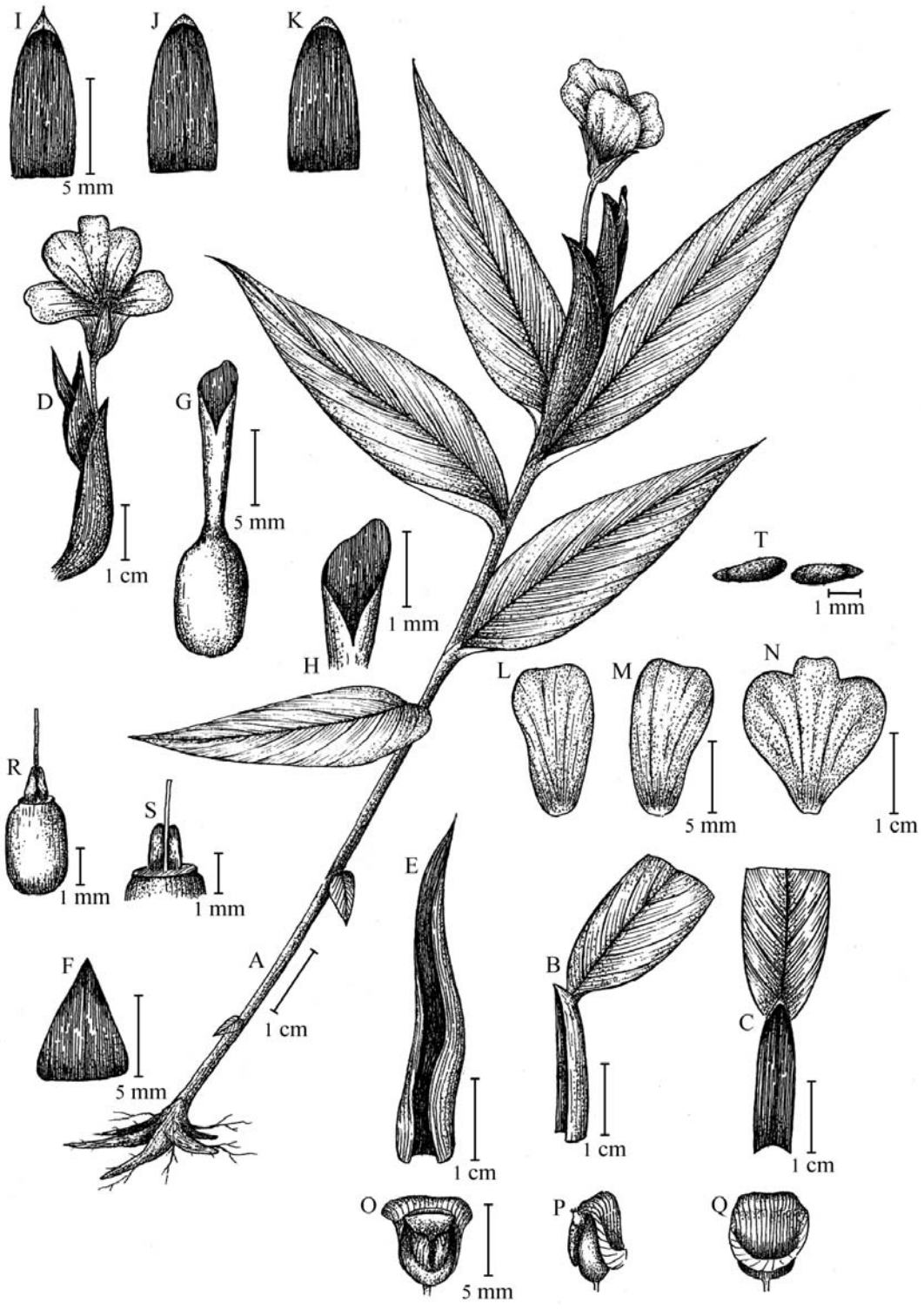


Fig. 1. *Caulokaempferia phuwoaensis* Picheans. & Koonterm. A: Habit, showing leaves and inflorescence. B, C: Different views of a ligule. D: Inflorescence. E: Bract; F: Bracteole. G: Calyx tube and ovary. H: Apex of calyx tube. I: Dorsal corolla lobe. J, K: Lateral corolla lobes. L, M: Staminodes. N: Labellum. O, P, Q: Different views of anther crest. R, S: Different views of stylodial glands. T: Seeds (line drawing by Chalermchoke Boonchit).

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Fig. 2. *Caulokaempferia phuwoaensis* Picheans. & Koonterm. A: Habit. B: Infructescence C: Close-up of flowers.



Fig. 3. *Caulokaempferia phulangkaensis* Picheans. A: Habit and habitat. B: Top view of a flower. C: Obligue view of an inflorescence. D: Infructescence.

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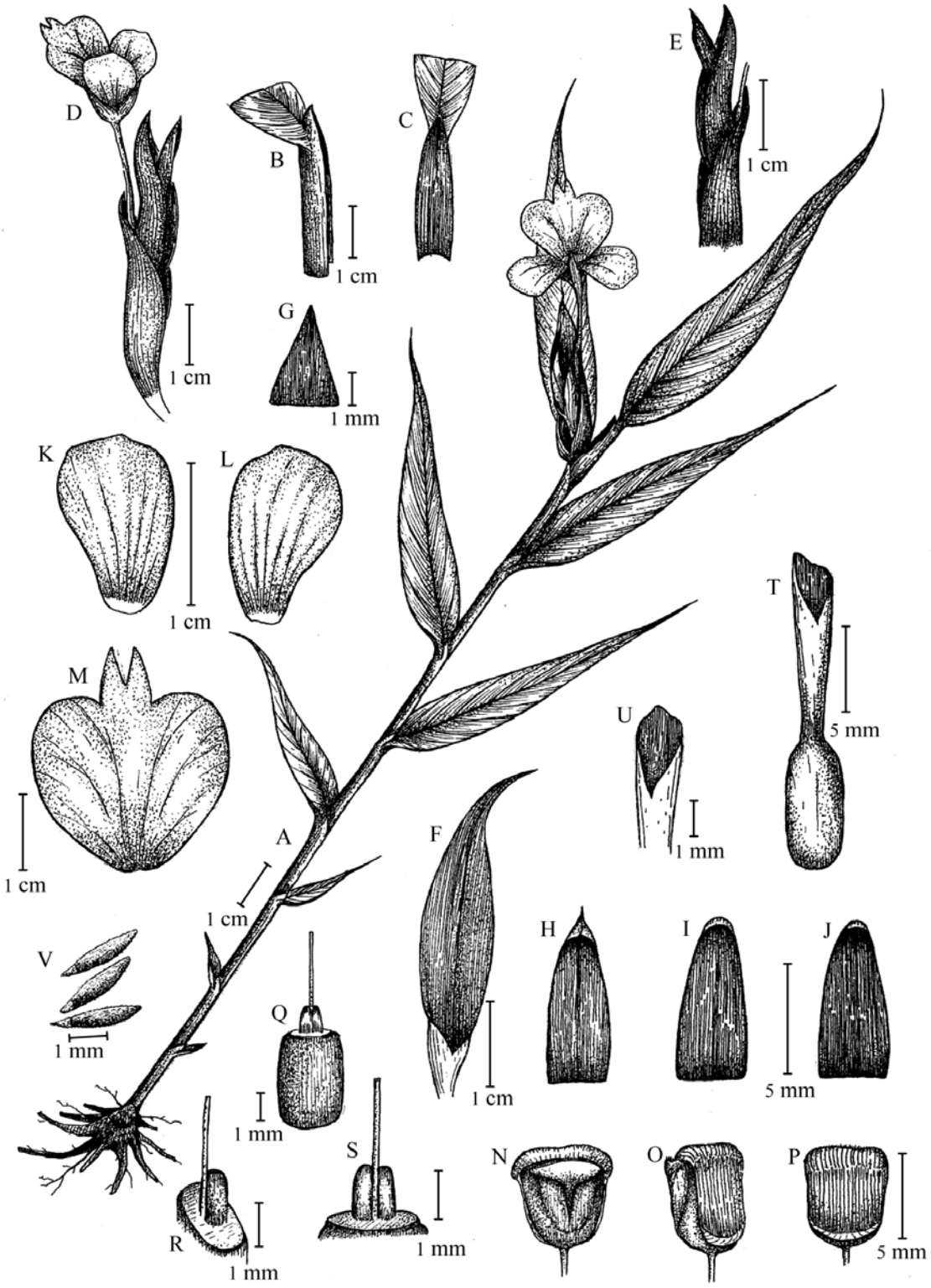


Fig. 4. *Caulokaempferia phulangkaensis* Picheans. A: Habit, showing leaves and inflorescence. B, C: Different views of a ligule. D, E: Different views of inflorescence. F: Bract; G: Bracteole. H: Dorsal corolla lobe. I, J: Lateral corolla lobes. K, L: Staminodes. M: Labellum. N, O, P: Different views of anther crest. Q, R, S: Different views of stylodial glands. T: Calyx tube and ovary. U: Apex of calyx tube. V: Seeds (line drawing by Chalermchoke Boonchit).

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Ecology: Moist red sandstone rocks along the waterfall, under the shade of mixed deciduous forests at the altitude of 176-195 m.

Vernacular names: Wan Proa Hin (ว่านเปราะหิน), Proa Hin Phu Langka (เปราะหินภูลังกา), Proa Ton Phu Langka (เปราะต้นภูลังกา)

Use: Medicinal.

Note: This new species is similar to *C. jirawongsei* Picheans. & Mokkamul, but can be easily distinguished by its shorter ligules (2-5 mm), more leaves (7-10), and fewer bracts (1-2, rarely 3). It can be differentiated from *C. phuwoaensis* Picheans. & Koonterm by its epilithic habit, more lanceolate leaves arranged along a pseudostem, and fewer elliptic-ovate bracts. The labellum of this new species is unique, comparing with other taxa mentioned in this paper, in the long ligulate median lobe with apex divided halfway down and apex of each lobe acute.

Materials studied other than type: *Picheansoonthon 892* (BKF), Tad Kham Waterfall, Phu Langka National Park, Changwat Nakhon Panom, N 17° 57.183' E 104° 09.427', elevation 165 m, 22 September 2005; *R. Pooma et al. 2628* (BKF), same location, N 17° 57' 00" E 104° 09' 44", elevation 150 m, 25 August 2001.

3. *Caulokaempferia phutokensis* Picheans., *sp. nov.* Figs. 5-7

Type. *Picheansoonthon 732*, Phu Tok Noi, Amphoe Si Wilai, Nong Khai province, N 18° 08.176', E 103° 52.731', elevation 278 m, 21 August 2004, (BKF holotype including dried and spirit materials; BK and SING paratypes).

Caulokaempferia jirawongsei similis, foliis ovatis ad ovate ellipticis, sessilibus ad subsessillibus, ligulae apice irregulariter obtuso emarginato bilobato, bractea ovata sub anthesi inflorescentiae axe arcte amplectenti, infima 3-6-flora differt.

Lithophytic perennial herb, with short rhizome; root fibrous, some form longish storage tubers. Pseudostems 13.2-18.5 cm, with 3-4 bladeless sheaths or reduced lamina. Leaves 4-6, subsessile to sessile, lower ones smaller, the two uppermost ones usually the largest; ligule deltoid, membranous, 0.3-1.0 cm long, apex acute, obtuse, truncate, emarginate, or bilobe; leaf blades ovate to ovate-elliptic, the uppermost two thelargest, 11.3-15.5 by 3.1-4.1 cm, both sides glabrous, apex acuminate, margin entire to slightly undulate. Inflorescence terminal, 3.2-5.6 cm long, peduncle glabrous, enclosed in leaf sheaths of the two uppermost leaves, 1.1-1.3 cm long. Bract 1-2(-3), tightly imbricate, ovate, glabrous, 2.9-3.5 by 2.1-2.4 cm, apex acuminate, margin free to the base, axis invisible in flowering stage but visible on one side in fruiting stage, the lowest bract enclosing a cincinnus of 3-6 yellow flowers, the upper one(s) smaller and subtend fewer flowers, some inflorescences terminated by a sterile bract. Bracteole ovate, 7-8 by ca. 4 mm. Calyx tubular, hiden in the bract, 1.2-1.4 cm by ca. 5 mm, glabrous, split 1-2 mm down on one side, apex obtuse. Corolla tube 3.1-3.3 cm by ca. 2 mm, lobe 3, yellow; dorsal corolla lobe ovate to lanceolate, hooded, ca. 1.2 cm by 5-6 mm; lateral corolla lobes ovate to lanceolate, hooded, place close together below the labellum, 1.1-1.2 by 4-5 mm. Lateral stamenodes patent, auriculate, obovate, 1.7-1.8 by ca. 1 cm, apex slightly emarginate. Labellum broadly obovate or deltoid with short clawed, c. 2.6 by 2.2-2.5 cm, distal part 3-lobed with median lobe ligulate and emarginate to shallowly bilobe, extending 4-8 mm. Filament sessile; anther ca. 3 by 2 mm long; anther crest yellow, broadly ovate, 4-6 by 2-5 cm, apex round, slightly reflexed. Stylodial glands 2, ca. 1 mm long; ovary ca. 3 by 2 mm, glabrous, unilocular. Fruit fleshy capsule, subspherical, ovate-oblong, ovate, 7-8 by 3-4 mm long. Seed many, brownish, fusiform, hairy, 2-3 by ca. 0.5 mm. Flowering May-September, fruiting June-October.

Distribution: This new species can be found in Phu Tok Noi (ภูทอกน้อย), Amphoe Si Wilai, Changwat Nong Khai in Northeastern Thailand.

Ecology: Moist red sandstone rocks under the shade of mixed deciduous forests, at the altitude of 270-350 m.

Vernacular names: Wan Proa Hin (ว่านเปราะหิน), Proa Hin Phu Tok (เปราะหินภูทอก)

Use: Medicinal

Note: This new species is morphologically similar to *C. jirawongsei* Picheans. & Mokkamul, but can be easily distinguished by its large ovate leaves and a characteristic bract arrangement. In flowering stage, the bracts of this new taxon wraped tightly around an inflorescence axis, until later fruiting stage. Also, the "flowers" of this new species is very delicate, and will be shrunk within 2-3 hours after bloom.

Materials studied other than type: *Picheansoonthon 898* (BKF), Phu Tok Noi, Amphoe Si Wilai, Changwat Nong Khai, N 18° 08.147', E 103° 52.976', elevation 398 m, elevation 278 m, 22 June 2006; and *Niyomdham 5060* (BKF), same locality, 21 June 1997.

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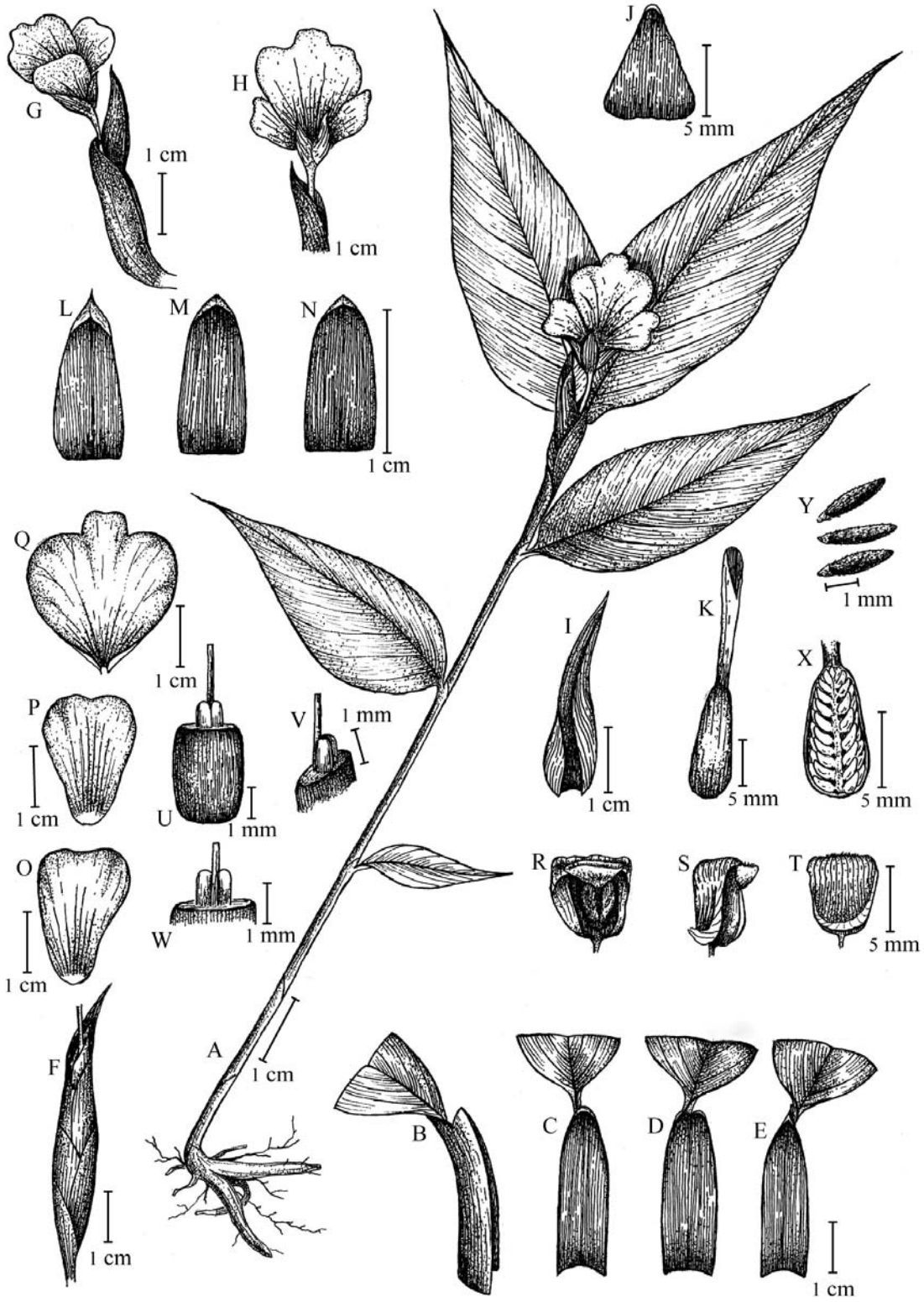


Fig. 5. *Caulokaempferia phutokensis* Picheans. A: Habit, showing leaves and inflorescence. B, C, D, E: Different views of a ligule. F: Inflorescence, showing bract imbricate. G: Showing side views of inflorescence. H: Showing under views of flower. I: Bract. J: Bracteole. K: Calyx tube and ovary. L: Dorsal corolla lobe. M, N: Lateral corolla lobes. O, P: Staminodes. Q: Labellum. R, S, T: Different views of anther crest. U, V, W: Different views of stylodial glands. X: Ovary. Y: Seeds (line drawing by Chalermchoke Boonchit).

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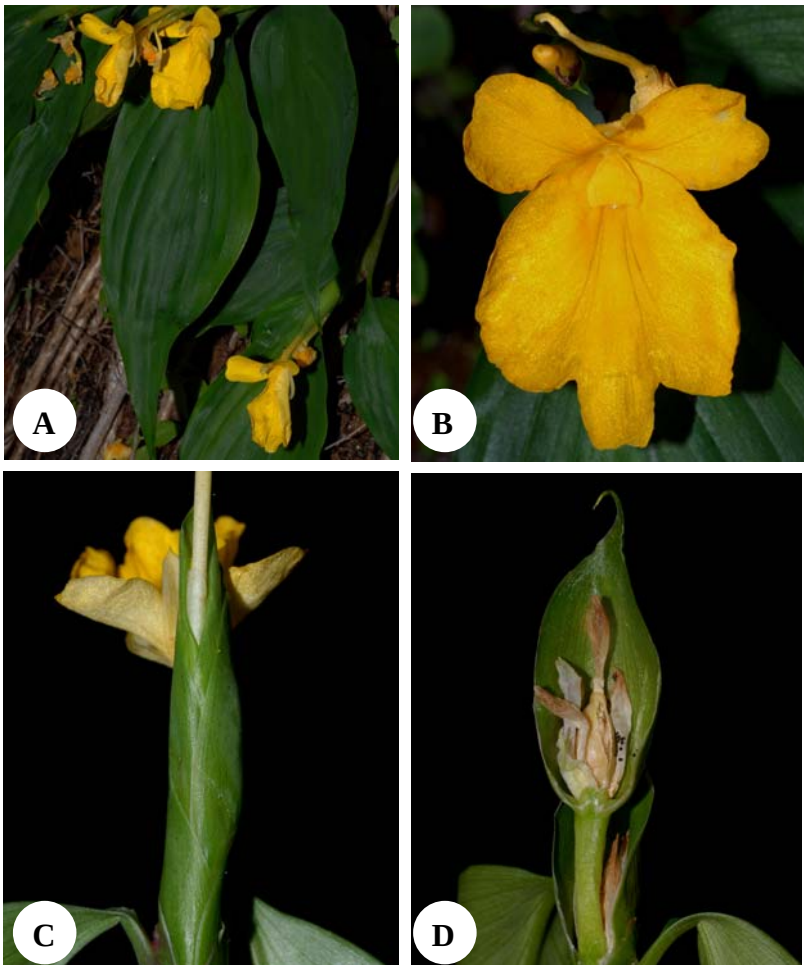


Fig. 6. *Caulokaempferia phutokensis* Picheans. A: Habit. B: Top view if a flower. C: Top view of an inflorescence. D: Infructescence.

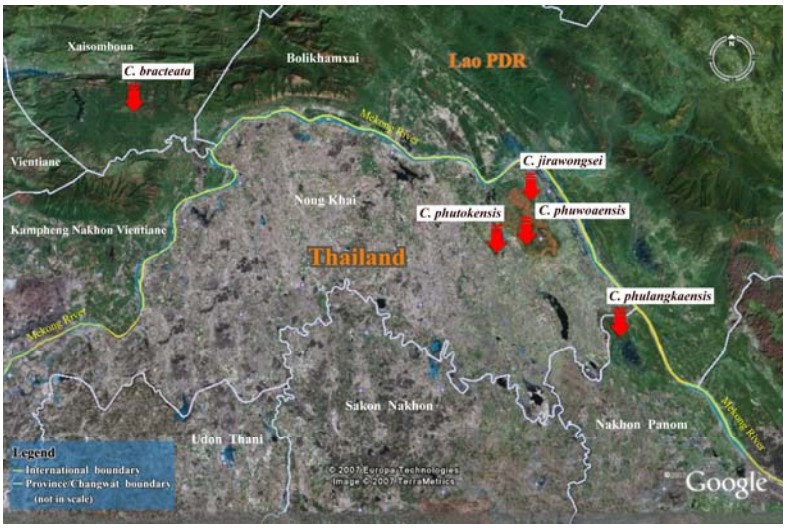


Fig. 7. Distribution topography of *C. bracteata* K. Larsen & S. S. Larsen, *C. jirawongsei* Picheans. & Mokkamul, *C. phuwoaensis* Picheans. & Koonterm, *C. phulangkaensis* Picheans., and *C. phutokensis* Picheans. along the Mekong River in Changwats Nong Khai and Nakhon Panom of Thailand, and Central Laos PDR (Phou Khao Khaouy National Park in Bolikhamxai, Xaisomboun, Vientiane Districts, and Kampheng Nakhon Vientiane) (adapted from www.googleearth.com)

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DISCUSSION

Including these three new species, there are currently 5 taxa of *Cualokaempferia* reported from Thai-Laos border around Changwat Nong Khai and Nakhon Panom of Northeastern Thailand and Bolikhamxai district of central Laos PDR: *C. bracteata* K. Larsen & S. S. Larsen, *C. jirawongsei* Picheans. & Mokkamul, *C. phuwoaensis* Picheans. & Koonterm, *C. phulangkaensis* Picheans., and *C. phutokensis* Picheans. The labella of all five species are unique in their 3-lobed distal parts with ligulated median lobes, the character not found in taxa found in other part of the country.

Key to the five taxa

1. Leaves elliptic-ovate to ovate ….....……..…… 2
1. Leaves lanceolate ….....……...…… 3
2. Plant lithophytic; bracts wraped tightly around an inflorescence axis (axis invisible) in flowering stage ……..... *C. phutokensis*
2. Plant terrestrial; bract imbricate, unilateral with amplexicaul base margin free to the base, axis partially visible on one side ..……..…… *C. phuwoaensis*
3. Leaf blades glabrous on both sides ...……..…… 4
3. Leaf blades finely pubescent on both sides ……..… *C. bracteata*
4. Ligule 6-10 mm long ……...…. *C. jirawongsei*
4. Ligule to 5 mm long ……...…..…….. *C. phulangkaensis*

From our field studies throughout the region, we conclude that *C. bracteata* K. Larsen & S. S. Larsen is not a Thai species and can only been found in central Laos (Phou Khao Khouay National Park) as shown in Figure 7 (Picheansoonthon et al., 2007). Other four taxa are the Thai species concentrated in limited areas in Phu Woa Wildlife Sanctuary (Changwat Nong Khai) and Phu Langka national Park (Changwat Nakhon Panom) (Fig. 7). These four species can be differentiated from each other by their lithophytic or terrestrial habits, ligule shapes and sizes, leaf shapes and sizes, number of bracts per an inflorescence, number of flowers per bract, and shapes of labella and staminodes.

Molecular study on the Thai and Laos taxa revealed that these five species are phylogenically closely related, but distinct (Chaiyoot, 2007). They form a separated clade from other taxa found around the country (Chaiyoot, 2007). Anatomical and chemical studies on leaves of these five species are planned.

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泰國東北部產薑科黃花 *Caulokaempferias* 屬三種新種植物

Chayan Picheansoonthon[1,2,3] and Supachai Koonterm[1]

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摘　　要

本文描述泰國東北部所產三種薑科 *Caulokaempferia* 屬植物，*C. phuwoaensis* Picheans. & Koonterm.，*C. phulangkaensis* Picheans. 和 *C. phutokensis* Picheans.，並提供手繪圖。分子證據亦支持三個分類群的建立，而此三種植物與 *C. bracteata* K. Larsen & S. S. Larsen 和 *C. jirawongsei* Picheans. & Mokkamul 近似。

關鍵詞：薑科、*Caulokaempferias* 新種、泰國東北部。

1. Pharmaceutical Botany and Pharmacognosy Research Unit, Faculty of Pharmaceutical Sciences, Khon Kaen University, Khon Kaen 40002, Thailand.
2. The Academy of Sciences, The Royal Institute of Thailand, Sanam Suea Pa, Khet Dusit, Bangkok 10300, Thailand.
3. 通信作者。Email: chayan@kku.ac.th

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