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RESEARCH ARTICLE

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Taxonomic revision of some taxa in *Kaempferia* subgenus *Protanthium* (*Zingiberaceae*) revealing a new species from Thailand and two new synonyms

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Key words

endemic species
Kaempferia albiflora
Kaempferia rotunda
Kaempferia subglobosa
Kaempferia takensis
northern Thailand
taxonomic revision
Zingiberaceae

Abstract *Kaempferia subglobosa* (*Zingiberaceae*) is described and illustrated as a new species of *Kaempferia* subg. *Protanthium* from Tak Province, northern Thailand. It can easily be distinguished from all other species of subg. *Protanthium* by having branched storage roots with numerous, tiny, lateral and terminal subglobose to ovoid tubers. The diagnostic characters of this taxon are discussed and compared with those of the morphologically most similar species *K. rotunda*. Detailed photographs of plants and dissected flowers, and information on phenology, distribution and ecology, are provided. Interestingly, a red dwarf honeybee, *Apis florea*, is likely a pollinator. The IUCN conservation status of Vulnerable is assigned for *K. subglobosa*. In addition, the names *K. uttaraditensis* and *K. kamthornii* are synonymized with *K. albiflora* and *K. takensis*, respectively. As a result of this taxonomic revision, the Flora of Thailand currently harbours 14 species of the subgenus of which 9 strictly endemic. Two alternative updated identification keys for *Kaempferia* subg. *Protanthium* are also presented.

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INTRODUCTION

Kaempferia L. (Linnaeus 1753) is a genus belonging to the family *Zingiberaceae*. It comprises approximately 50 taxa, distributed throughout monsoonal tropical Asia (Mabberley 2017, Insisiengmay et al. 2020). Thailand, which is situated in the Indo-Chinese biodiversity hotspot, is regarded as one of the centres of distribution of the genus and provides the richest species diversity (Sirirugsa 1989, 1992, Larsen & Larsen 2006). Since the past century, 25 new species from Thailand have been discovered and taxonomically described and it now hosts more than 40 native *Kaempferia* species (Phokham et al. 2013, Wongsuwan et al. 2015, Nopporncharoenkul & Jenjittikul 2017, 2018, Saensouk & Saensouk 2019a, b, 2021a, b, Boonma et al. 2020, 2021, 2022, Jenjittikul & Larsen 2020, Jenjittikul & Ruchisansakun 2020, Nopporncharoenkul et al. 2020, 2021, Wongsuwan et al. 2020, Meechonkit & Picheansoonthon 2021, Saensouk et al. 2022).

Most *Kaempferia* species are small, perennial, understory herbs with a dormancy period during the dry season from November to May. The underground part consists of short rhizomes and fascicled storage roots with terminal tubers. The pseudostem is composed of the enclosed leaf sheaths that are completely buried in the ground to upright and outstanding above the ground. The leafy shoot comprises one to few appressed to upright leaves. The flowers, which are generally white, light pink to purple, are attractive and fragile, consisting of a semi-translucent calyx tube, slender floral tube that terminally divides into 3 corolla lobes, 2 remarkable lateral petaloid staminodes, and the prominent bilobed labellum. The fertile stamen includes a negligible, flat filament and a well-developed connective with 2 anther thecae and the remarkable anther crest, and the pistil consists of a trilocular, inferior ovary, 2 subulate epigynous glands, a thread-like style, and a cup-shaped stigma. The floral plane can be easily classified into 2 main types, namely perpendicular or parallel to the ground. The perpendicular type is characterised by upright to slightly arcuate lateral staminodes and a labellum deflexed in the distal half. The latter type is characterised by a T-shape formed by the horizontal staminodes and labellum, which are arranged in the same plane and parallel to the ground (Nopporncharoenkul et al. 2021).

Kaempferia is subdivided into two subgenera based on the position of the inflorescence (Insisiengmay et al. 2018): subg. *Kaempferia* and subg. *Protanthium* (Horan.) Baker (Horaninow 1862, Baker 1890, Kam 1980). The species in subg. *Kaempferia* typically produce terminal inflorescences, between the innermost leaves or in the pseudostems. Most of them have a subsessile peduncle that is completely enclosed by the leaf sheaths, although some species display an obvious elongated peduncle, for example *K. elegans* (Wall.) Baker, *K. koontermii* Prasarn, Wongsuwan & Picheans., *K. parviflora* Wall. ex Baker, and *K. pulchra* Ridl. (Wongsuwan et al. 2015). In contrast, the species belonging to subg. *Protanthium* produce lateral inflorescences directly from the rhizome, usually separated from the pseudostem. The inflorescences are partly embedded in the soil and appear before the leafy shoot arises (Nopporncharoenkul & Jenjittikul 2018).

Currently, 16 species are recognised in *Kaempferia* subg. *Protanthium*. Apart from the widespread *K. rotunda* L. which is widely distributed from India, Sri Lanka, China to Indochina, the

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Table 1 List of the species belonging to *Kaempferia* subg. *Protanthium* (1753–2022).

Species	Distribution	References
K. albiflora Jenjitt. & Ruchis.	Endemic to Thailand	Jenjittikul & Ruchisansakun 2020
K. aurora Nopporn. & Jenjitt.	Thailand, expected in Myanmar	Nopporncharoenkul et al. 2020
K. caespitosa Nopporn. & Jenjitt.	Endemic to Thailand	Nopporncharoenkul et al. 2020
K. graminifolia Nopporn. & Jenjitt.	Endemic to Thailand	Nopporncharoenkul & Jenjittikul 2018
K. grandifolia Saensouk & Jenjitt.	Endemic to Thailand	Saensouk & Jenjittikul 2001
K. jenjittikuliae Nopporn.	Endemic to Thailand	Nopporncharoenkul et al. 2021
K. kamthornii Picheans. & Meechonkit	Endemic to Thailand	Meechonkit & Picheansoonthon 2021
K. lopburiensis Picheans.	Endemic to Thailand	Picheansoonthon 2010
K. noctiflora Nopporn. & Jenjitt.	Endemic to Thailand	Nopporncharoenkul & Jenjittikul 2017
K. rotunda L.	Sri Lanka, India, Myanmar, Thailand, China, Cambodia, Laos, Vietnam, Malaysia, and Indonesia	Linnaeus 1753
K. simaoensis Y.Y.Qian	China and Thailand, expected in Myanmar	Qian 1995, Nopporncharoenkul et al. 2016
K. sipraiana Boonma & Saensouk	Endemic to Thailand	Boonma et al. 2022
K. takensis Boonma & Saensouk	Thailand, expected in Myanmar	Boonma et al. 2020
K. udonensis Picheans. & Phokham	Thailand, expected in Myanmar and Laos	Phokham et al. 2013
K. uttaraditensis Picheans. & Meechonkit	Endemic to Thailand	Meechonkit & Picheansoonthon 2021
K. xiengkhouangensis Picheans. & Phokham	Endemic to Loas	Phokham et al. 2013

other taxa are distributed in the Indo-Chinese floristic region, especially in Thailand, Myanmar and Laos. Biogeographically, 10 taxa are strictly endemic to Thailand and one species, *K. xiengkhouangensis* Picheans. & Phokham, is endemic to Laos (Phokham et al. 2013, Insisiengmay et al. 2019, Meechonkit & Picheansoonthon 2021, Boonma et al. 2022, Jenjittikul et al. 2023). A list of the species, distributions and references is shown in Table 1.

During our ongoing revision of *Kaempferia* for the Flora of Thailand Project, we found an undescribed taxon, which is a strict endemic to Tak Province of northern Thailand. We have carried out a morphological study of living material from the type locality, in both flowering and vegetative phases, including comparison with protologues and herbarium specimens deposited at the main herbaria in Thailand. The diagnostic characters are discussed in relation to the morphologically closest taxon. As the characters of the undescribed taxon do not match with any existing species belonging to *Kaempferia* subg. *Protanthium*, we taxonomically characterise and confidently identify it as a species new to science, *K. subglobosa* Nopporn. & Jenjitt. In addition, we also revise the taxonomic status of *K. uttaraditensis* and *K. kamthornii* which are morphologically similar to *K. albiflora* and *K. takensis*, respectively. Furthermore, two updated alternative keys to the species of *Kaempferia* subg. *Protanthium* are provided.

MATERIALS AND METHODS

A taxonomic revision of *Kaempferia* subg. *Protanthium* for the Flora of Thailand Project has been carried out from 2016 until the present. Field studies were conducted throughout Thailand and living material of the new taxon was collected. The morphological and phenological characters were investigated, measured, photographed and described from living specimens in their natural habitat and in cultivation like especially the Ginger nursery at Queen Sirikit Botanic Garden (QSBG) in Chiang Mai, Thailand. Protologues and herbarium specimens of *Kaempferia* subg. *Protanthium* held at BK, BKF, QBG, SING, SLR herbaria (for herbarium abbreviations see Thiers continuously updated) and several online herbarium specimen databases, especially the Kew Herbarium Catalogue (https://data.kew.org/) and the Chinese Virtual Herbarium (CVH; https://www.cvh.ac.cn/) were also intensively examined. Morphological terminology used in the species description follows Beentje (2016); the only exception is the term petiole, a term consistently used in the Flora of Thailand (Jenjittikul et al. 2023), which is in fact a pseudopetiole between leaf sheath and blade. The diagnostic characters were discussed in relation to the morphologically closest taxa. The conservation status was assessed following the IUCN Red List Categories and Criteria, version 15.1 (IUCN Standards and Petitions Subcommittee 2022). Two alternative updated keys to the species of *Kaempferia* subg. *Protanthium* were constructed, the second starting with a question that can also be used with dried material. Type specimens with duplicates were prepared and deposited in the BK, BKF, QBG, and SLR herbaria.

NEW SPECIES

Kaempferia subglobosa Nopporn. & Jenjitt., *sp. nov.* (subg. *Protanthium*) — Fig. 1, 2, 3

Etymology. The specific epithet '*subglobosa*' refers to the unique characteristic of the species, the branched storage roots with numerous, tiny subglobose tubers absent in all known taxa belonging to *Kaempferia* subg. *Protanthium*.

Similar to *Kaempferia rotunda* L. in overall habit, inflorescences and flower colour, but differs in having the branched storage roots with numerous, tiny, lateral and terminal subglobose to ovoid tubers (vs storage roots not branched, consisting of a single, large, terminal fusiform, ellipsoid to ovoid tuber), ligules 7–14 mm long, opaque (vs ligules 1–3(–5) mm long, translucent), labellum narrowly obovate with an incision around 1/3 of its length (vs labellum obdeltoid to broadly obovate with an incision around 1/2 of its length), and the anther crest bifid apex with apices aristate, incision serrate to undulate, incision base angular (vs anther crest bilobed apex with apices acute, incision entire, usually with 2–3 small teeth between incision base). — Type: *Nattapon Nopporncharoenkul NNSB-749* (holo QBG! with sheet code 20192834 A3-H, and spirit collection code 20192834 A3-A; iso BK!, BKF!, SLR! including flowers preserved in spirit as part of a single specimen), Thailand, Tak Province, Ban Tak District, Thung Kracho, alt. 510 m, 11 Sept. 2019. Paratypes are mentioned below.

Rhizomatous perennial herb, 40–62.6 cm tall. *Rhizome* conical to ovoid, 2–2.5 by 1–1.5 cm, with fascicled storage roots, (6–)14–20 cm long, and numerous lateral and terminal tubers. *Root tubers* subglobose to ovoid, 0.5–1 by 0.5–0.8 cm. *Leafy shoot* with 5–7 leaves. *Pseudostem* upright, up to 27.5 cm long, composed of leaf sheaths, more obvious when young as the leaf sheaths disengage with age. *Bladeless sheaths* 2–3, 4.5–8.5 cm long, reddish to deep purplish red, with shortly mucronate (c. 1 mm long) to acute apex, sparsely villous. *Blade bearing sheaths* green, reddish to deep purplish red, sparsely villous; ligule bilobed, lobes narrowly deltoid with acute apex, 0.7–1.4 cm long, opaque, reddish to purplish red,

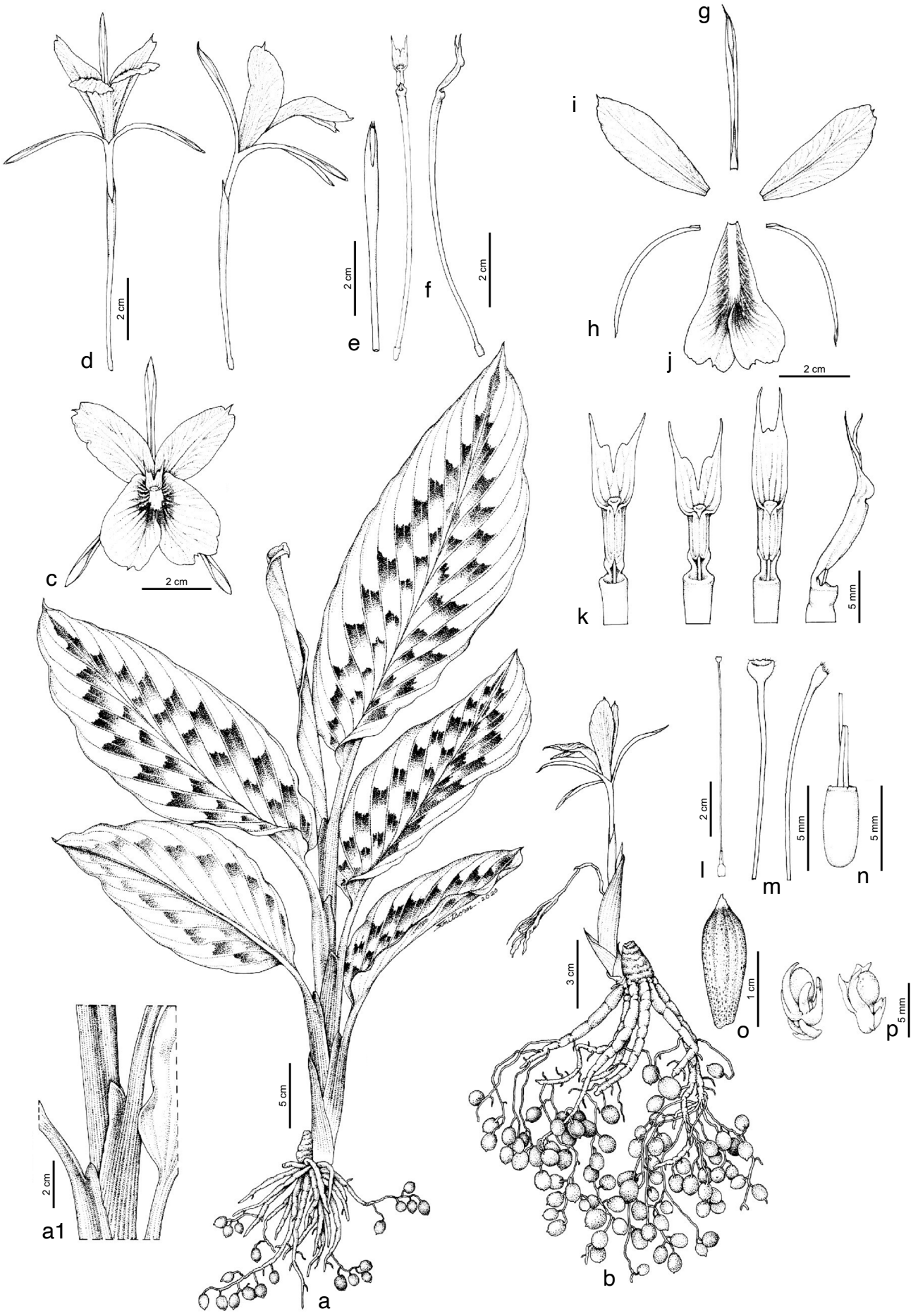

Fig. 1 *Kaempferia subglobosa* Nopporncharoenkul & Jenjitt. a. Habit of vegetative part (a1: detail of ligules); b. rhizome and inflorescence; c. flower in front view; d. flower in side views; e. calyx; f. floral tube with ovary and stamen in front and side view; g. dorsal corolla lobe; h. lateral corolla lobes; i. lateral staminodes; j. labellum; k. detail of stamens and anther crests in front and side view; l. pistil; m. detail of stigma with upper part of style in front and side view; n. ovary with epigynous glands and lower part of style; o. fruit; p. seeds (all: *Nattapon Nopporncharoenkul NNSB-749*, QBG). — Drawing by Sunitsorn Pimpasalee.

Fig. 2 *Kaempferia subglobosa* Nopporn. & Jenjitt. at the type locality. a. Habit of the plants in flowering period (19 May 2023); b. habit of the plants in rainy season (11 Sept. 2019); c. flowers; d. flower with suspected pollinator red dwarf honeybee (*Apis florea* Fabricius, 1787); e. infructescence with dehisced capsules (a, c–e: *Nattapon Nopporncharoenkul NNSB-916,* b: *Nattapon Nopporncharoenkul NNSB-749*; all QBG). — Photos by N. Nopporncharoenkul.

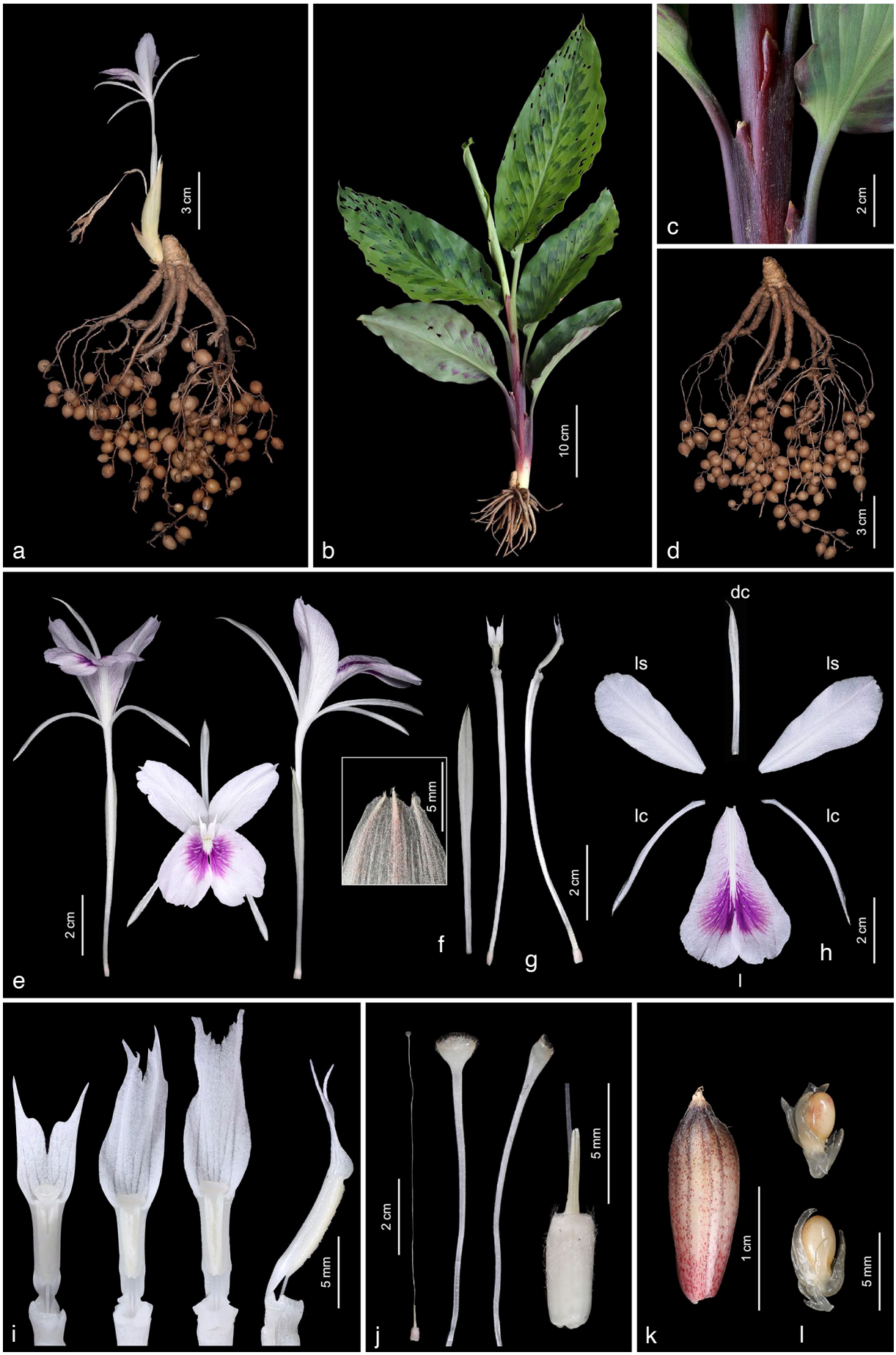

Fig. 3 *Kaempferia subglobosa* Nopporncharoenkul & Jenjitt. a. Inflorescence and rhizome; b. habit; c. detail of ligules; d. rhizome with fascicled storage roots and numerous subglobose tubers; e. flower in front and side view; f. calyx (inset: detail of calyx apex); g. floral tube with ovary and stamen in front and side view; h. flower dissection (dc. dorsal corolla lobe; l. labellum; lc. lateral corolla lobe; ls. lateral staminode); i. detail of stamens and anther crests in front and side view; j. detail of pistil (from left to right: pistil; stigma and style in front and side view; ovary with epigynous glands); k. fruit; l. seeds (all: *Nattapon Nopporncharoenkul NNSB-749*, QBG). — Photos by N. Nopporncharoenkul.

sparsely villous; petiole 5–10.5 cm by 3–5 mm, 4–6 mm thick, canaliculate, light green with deep purplish red basally, densely villous; lamina narrowly ovate to elliptic-oblong, 16–35.5 by 9–12.5 cm, adaxially light green, usually with 1–3 layers of deep green patches arranged parallel along the leaf edges, between the midrib and both sides of the edges, sometimes with silver tinged areas between deep green patches, glabrous, abaxially light green, usually purplish red tinged under the position of the adaxially deep green patches, densely villous, base slightly oblique, obtuse to rounded, margin entire to slightly undulate with purplish red band, apex acuminate to acute. *Inflorescence* lateral, emerging from the rhizome before the leafy shoot, partly embedded in the soil; peduncle obscured by bladeless sheaths, up to 1.2 cm long, puberulent; raceme fusiform-ovoid, 3.5–4.2 by 0.7–1.5 cm, composed of up to 15 bracts each supporting a single flower; bracts deltoid-ovate to narrowly ovate to ovate, 1.2–4.2 by 0.6–2 cm (outer bracts larger), apex slightly mucronate (c. 1 mm long), light green to cream-white with reddish to deep brownish red veins from apex, sparsely villous; bracteoles deltoid-ovate, c. 10 by 0.5 mm, hyaline, sparsely villous, apex deeply bifid, apices slightly mucronate and densely villous. *Flowers* 10–13 cm long, diurnal anthesis; floral plane perpendicular to soil, with lateral staminodes upright to slightly arcuate and deflexed distal half of the labellum. *Calyx* 4–5 by 0.4–0.5 cm, with unilateral incision 1–1.2 cm long from apex, apex trilobed-crenate with 3 cuspidate-teeth, semi-translucent white to cream-white, glabrous, sometimes sparsely villous at apex. *Floral tube* 5.2–7.5 cm by 1.5–3 mm, narrowly cylindrical at base above ovary, narrowly funnel-shaped distally, white, glabrous; dorsal corolla lobe narrowly ovate to oblong, 3–4(–4.7) by 0.4–0.6(–0.8) cm, apex hooded, mucronate, mucro 3–5 mm long, concave, white, glabrous; lateral corolla lobes narrowly ovate to oblong, 2.8–4(–4.6) by 0.3–0.5(–0.6) cm, apex mucronate, mucro 1–1.5 mm long, concave, white, glabrous; lateral staminodes narrowly obovate, elliptic to oblong, 2.8–4.5 by 1–1.7(–2) cm, apex obcordate, mucronate to acute, white; labellum narrowly obovate, 3.2–4(–5) by 1.6–2.5(–3.4) cm, shallowly bilobed with an incision around 1/3 of labellum length, base flat, lobes suborbicular to obovate, 1.3–1.8 by 1–2 cm, apex obcordate to slightly crenate, lobes partly overlapping, white to pale light purple with central white to pale yellow patch basally surrounded by two light purple stripes from base towards centre of lobes. *Stamen* 1.7–2(–2.4) cm long; filament 2–3 mm long, c. 1.5 mm broad, white, glabrous; *anther* 14–17(–22) mm long including straightened anther crest, connective tissue white, glabrous; anther thecae (5–)6–7 by 1–1.5 mm, white to cream white, dehiscing along their entire length; pollen white; anther crest oblong to narrowly ovate, 8–12(–17) by 4–4.5(–5) mm, apex bifid with apices aristate, incision 3–6(–12) mm deep, serrate to undulate, incision base angular (rarely with an interval). *Pistil* 6.5–8.6 cm long; ovary cylindrical, 3–5 by 1.5–2.5 mm, trilocular, white to pale yellowish cream, densely villous, ovules numerous, placentation axile; epigynous glands 2, subulate, 3.5–5 mm long, cream to cream white; style 6–8.2 cm long; stigma crateriform, 1.5–1.8 by 0.8–1 mm, ostiole ciliate. *Fruit* narrowly obovoid to ellipsoid, 1.5–1.7 cm by 6–6.5 mm, cream with several longitudinal stripes of brown spots from apex and reddish spots, densely villous at apex, with 9–12 seeds. *Seeds* ellipsoid to obovoid, 3.5–4.2 by 2–2.4 mm, yellowish cream to light brown with reddish spots, with basally attached a fleshy, semi-translucent white, laciniate aril.

Distribution — This species is strictly endemic to Ban Tak District, Tak Province, northern Thailand.

Habitat & Ecology — Growing in loamy soil with high amount of organic matter, mostly in a shaded mixed deciduous forest on hills, usually near a stream, at 480–700 m elevation. During field work, we observed a red dwarf honeybee (*Apis florea* Fabricius, 1787) visiting and entering the flower, and making contact with the anther. We, therefore, presume that this bee might be a pollinator of *K. subglobosa*.

Phenology — Flowering period starts in late-April and lasts until May. Fruit and seeds mature in May. Leafy shoots usually emerge in May. The plants enter dormancy in November.

Conservation status — The species is only known from Ban Tak District, Tak Province, northern Thailand. During our observations, populations in the type locality and adjacent area, which is less than 3 km from the type locality, consist of around a thousand mature individuals. However, the area with the existing population is not under any legal protection. Also, cultivation is in close proximity as land is used as cassava and corn plantations and as garbage dump area by local people. It is likely to be directly threatened by expansion of agriculture that will deteriorate the population. However, the Extent of Occurrence (EOO) and Area of Occupancy (AOO) remain at this point unknown. Due to the current information on population size and threatening factors, we propose to assess *K. subglobosa* as Vulnerable (VU C2a(i) and D1), in accordance with the IUCN Red List Categories and Criteria, version 15.1 (IUCN Standards and Petitions Subcommittee 2022).

Vernacular name — We propose the common name ดอกดิน ไข่ปลา (Dok Din Khai Pla) in Thai language. Dok Din is the flower which occurs on the ground and Khai Pla means fish eggs. The name refers to the number and shape of tubers, which resemble fish eggs.

Other specimens examined (paratypes). Thailand, Tak Province, Ban Tak District, Thung Kracho, alt. 700 m, 10 June 2020, *Nattapon Nopporncharoenkul NNSB-781* (SLR!); ibid., alt. 480 m, 19 May 2023, *Nattapon Nopporncharoenkul NNSB-916* (QBG-living specimen!, SLR!).

Note — Morphologically, *K. subglobosa* can be confused with the most similar looking species, *K. rotunda*, because they share

Table 2 Diagnostic morphological characters differing between *Kaempferia subglobosa* and *K. rotunda*; the description of the latter based on the Flora of Thailand treatment (Jenjittikul et al. 2023).

Character	*K. subglobosa*	*K. rotunda*
Tuber position	Lateral and terminal	Terminal
Number of tubers per storage roots	Numerous	Single
Tuber shape	Subglobose to ovoid, 0.5–1 cm long, 0.5–0.8 cm diam	Fusiform, ellipsoid, ovoid to subglobose, 1.5–3.5 cm long, 1.2–2 cm diam
Ligule	7–14 mm long, opaque, reddish to purplish red	1–3(–5) mm long, translucent, greenish white, reddish to purplish red
Labellum shape	Narrowly obovate, 3.2–4(–5) by 1.6–2.5(–3.4) cm	Obdeltoid to broadly obovate, (2.5–)3.3–5.3 by (2–)3–4.2 cm
Labellum incision	Around 1/3 of labellum length	Around 1/2 of labellum length
Anther crest	Bifid apex with apices aristate, incision serrate to undulate, incision base angular (rarely with an interval between incision base)	Bilobed apex with aristate acute, incision entire, usually with 2–3 small teeth between incision base

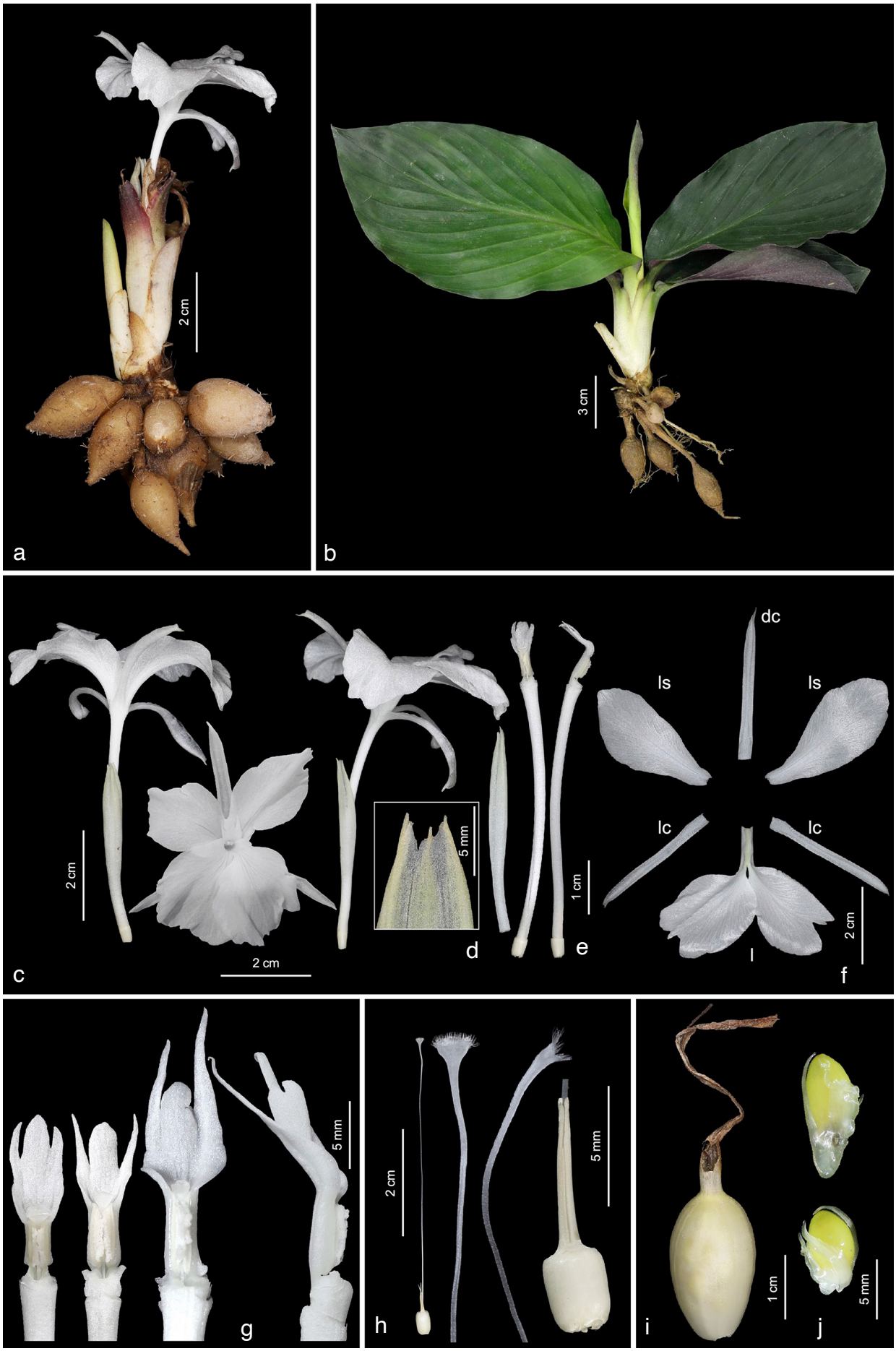

Fig. 4 *Kaempferia albiflora* Jenjitt. & Ruchis. a. Inflorescence and rhizome; b. habit; c. flower from above and side view; d. calyx (inset: detail of calyx apex); e. floral tube with ovary and stamen in front and side view; f. flower dissection (dc. dorsal corolla lobe; l. labellum; lc. lateral corolla lobe; ls. lateral staminode); g. detail of stamen and anther crest in front and side view; h. detail of pistil (from left to right: pistil; stigma and style in front and side view; ovary with epigynous glands); i. fruit; j. seeds (all: *Nattapon Nopporncharoenkul NNSB-634*, QBG). — Photos by N. Nopporncharoenkul.

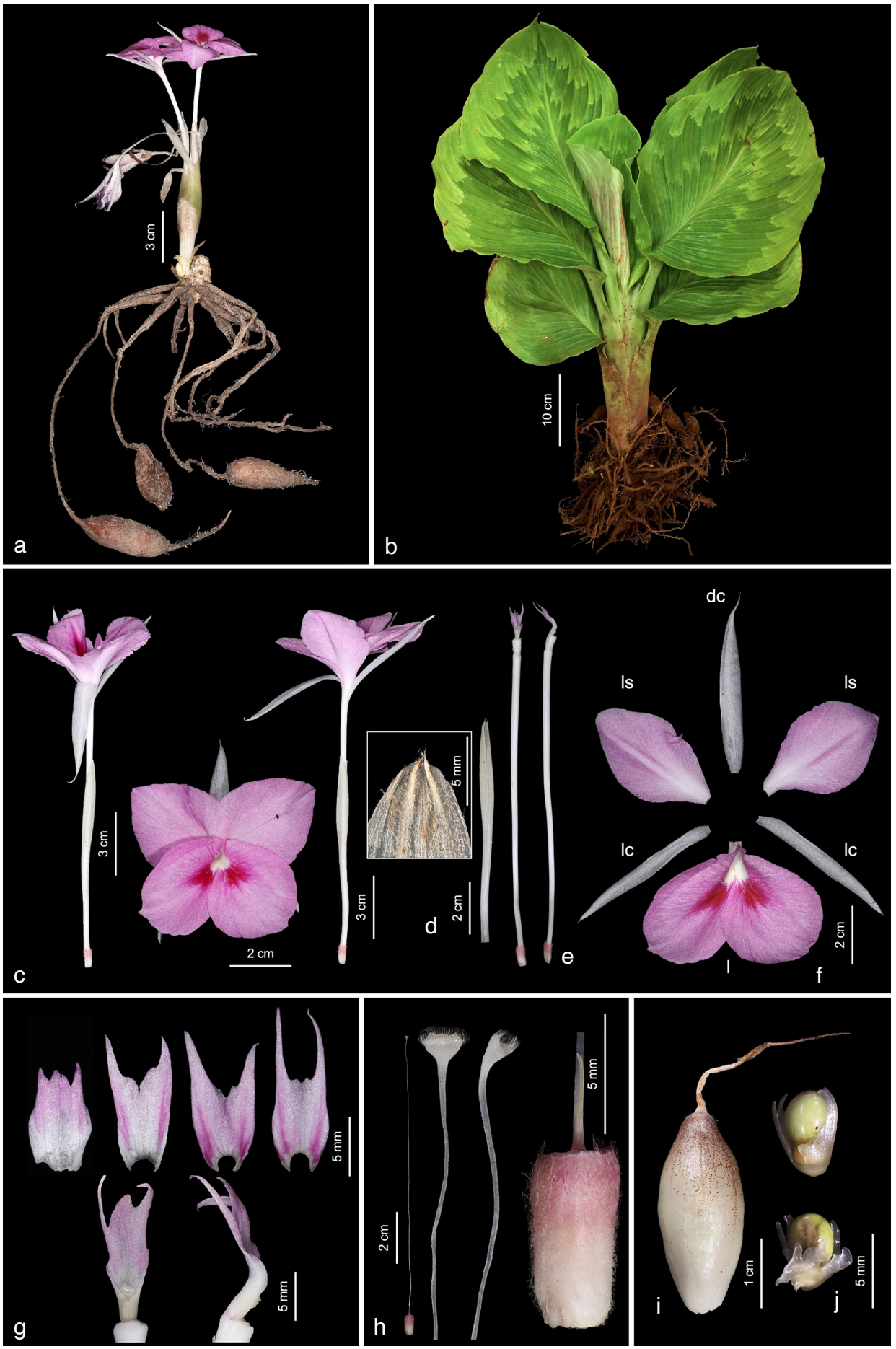

Fig. 5 *Kaempferia takensis* Boonma & Seansouk. a. Inflorescence and rhizome; b. habit; c. flower from above and side view; d. calyx (inset: detail of calyx apex); e. floral tube with ovary and stamen in front and side view; f. flower dissection (dc. dorsal corolla lobe; l. labellum; lc. lateral corolla lobe; ls. lateral staminode); g. detail of stamen and anther crests in front and side view; h. detail of pistil (from left to right: pistil; stigma and style in front and side view; ovary with epigynous glands); i. fruit; j. seeds (all: *Nattapon Nopporncharoenkul NNSB-595*, QBG). — Photos by N. Nopporncharoenkul.

the same overall habit, variegated leaves, inflorescences and flower colour. *Kaempferia subglobosa* can easily be distinguished from all other known species in subg. *Protanthium* by having the branched storage roots with numerous, tiny, lateral and terminal subglobose to ovoid tubers (vs storage roots not branched consisting of a single, large, terminal fusiform, ellipsoid to ovoid tuber). *Kaempferia subglobosa* differs also from *K. rotunda* in having 7–14 mm long opaque ligules (vs 1–3(–5) mm long translucent ligules), a narrowly obovate labellum with an incision around 1/3 of its length (vs an obdeltoid to broadly obovate labellum with an incision around 1/2 of its length), and an anther crest with a bifid apex with apices aristate, incision serrate to undulate, incision base angular (vs anther crest with a bilobed apex with apices acute, incision entire, usually with 2–3 small teeth between incision base), as shown in Table 2. During our observations at and around the type locality, we found good fruit set with numerous viable seeds at the end of the flowering season. This evidence indicates that *K. subglobosa* has high fertility and sexual productivity in its natural habitat.

NEW SYNONYMY

Kaempferia albiflora Jenjitt. & Ruchis. — Fig. 4

Kaempferia albiflora Jenjitt. & Ruchis. (2020) 1. — Type: *Thaya Jenjittikul - Tiptabiankarn 7911* (holo BKF!), Thailand, Tak Province, Mueang Tak District, Wang Prachop, 22 Apr. 2002.

Kaempferia uttaraditensis Picheans. & Meechonkit in Meechonkit & Picheansoonthon (2021) 2223; syn. nov. — Type: *Chayan Picheansoonthon & Penjun Meechonkit 140616-1* (holo BK!), Thailand, Uttaradit Province, Phichai District, Na Yang, alt. 125 m, 14 June 2016.

Notes — *Kaempferia albiflora* was taxonomically recognised in 2020 (Jenjittikul & Ruchisansakun 2020). However, material of the species was already used in molecular research as accession *TT15793* (mentioned as *Kaempferia* sp. nov. 2 'Proh Mang Mum') for chloroplast DNA sequences of *Kaempferia* (Techaprasan et al. 2010) and as '*Kaempferia* sp. 2 Proh Mang Mum' (accessions *NNSB270*, *NNSB379,* and *NNSB317* collected from Tak, Sukhothai, and Kamphaeng Phet provinces) for nuclear ITS2 sequences (Nopporncharoenkul et al. 2016).

In 2021, *K. uttaraditensis* was recognised as a new taxon based on material from Uttaradit Province, northern Thailand (Meechonkit & Picheansoonthon 2021). In the protologue of *K. uttaraditensis* no morphological comparison was made with *K. albiflora*. According to our morphological study of the living plants (as shown in Fig. 4), there is no distinct morphological difference between both species to warrant their recognition as separate species. Therefore, we conclude that *K. albiflora* and *K. uttaraditensis* are the same species, and the younger name *K. uttaraditensis* is a synonym to *K. albiflora*.

During the numerous field observations it became apparent that the distribution range of *K. albiflora* in northern Thailand is larger than first thought and includes Tak, Kamphaeng Phet, Sukhothai, Phitsanulok, and Uttaradit Provinces.

Kaempferia takensis Boonma & Seansouk — Fig. 5

Kaempferia takensis Boonma & Seansouk in Boonma et al. (2020) 371. — Type: *Thawatphong Boonma 012* (holo KKU!), Thailand, Tak Province, Mae Sot District, 18 Mar. 2019.

Kaempferia kamthornii Picheans. & Meechonkit in Meechonkit & Picheansoonthon (2021) 2221; syn. nov. — Type: *Chayan Picheansoonthon & Penjun Meechonkit 060416-1* (holo BK!), Thailand, Tak Province, Mae Sot District, roadside along highway 12 between km 63–64, 6 Apr. 2015.

Notes — During the taxonomic revision of *Kaempferia* for the Flora of Thailand Project, *K. takensis* and *K. kamthornii* were described and recognised as new species (Boonma et al. 2020, Meechonkit & Picheansoonthon 2021, respectively). However, in the protologue of *K. kamthornii* no comparison was made with *K. takensis*. The plant specimens of both species were not only collected from the same area, Mae Sot District of Tak Province in Thailand, but they also displayed the same morphological characters (Fig. 5). Based on morphological evidence and a similar distribution, we synonymise the younger name *K. kamthornii* with *K. takensis*.

Kaempferia takensis collected from Mae Sot District of Tak Province was used as accession *NNSB373* (called '*Kaempferia* sp. 3 Phaya Nokkhum') in the analysis of nuclear ITS2 sequences of *Kaempferia* subg. *Protanthium* (Nopporncharoenkul et al. 2016).

We also observed that the distribution of *K. takensis* is larger than originally described, it is found in various provinces of Thailand: Tak, Mae Hong Son, Chiang Mai, Chiang Rai, Phayao, Lamphun, Lampang, Phrae, Kamphaeng Phet, Nakhon Sawan, and Uthai Thani.

DISCUSSION AND CONCLUSION

In the Flora of Thailand volume of *Zingiberaceae* (Jenjittikul et al. 2023), 12 species of *Kaempferia* subg. *Protanthium* are recognised, including the ambiguous taxon, *K. kamolwaniae* Picheans., Meechonkit & Wongsuwan (Wongsuwan et al. 2020), which was considered to be a synonym of *K. rotunda*. Although three new taxa, *K. kamthornii*, *K. sipraiana* and *K. uttaraditensis*, were not included in the Flora of Thailand as they were taxonomically described after the final draft of the Flora of Thailand was submitted, it resulted in a total of 15 accepted names in Thailand (Meechonkit & Picheansoonthon 2021, Boonma et al. 2022). The present study intensively revised the taxonomic circumscription of the species belonging to the subgenus and revealed *K. subglobosa* as a new species, and two new synonyms, *K. kamthornii* and *K. uttaraditensis*. As a result of this revision, the subgenus comprises 15 species in total, which are mainly distributed in the Indo-chinese floristic region with 14 species in Thailand (see Table 1 for distributions). Of these, 9 species are strictly endemic, and the other six are also found or expected to be distributed in China, Myanmar, and Laos (see Table 1). However, there is no updated taxonomic revision of *Kaempferia* subg. *Protanthium* from Myanmar. Further study and collecting is needed in order to cover most of the distribution of the subgenus and to study the variation between the species within their complete distribution.

KEY 1 TO THE SPECIES OF KAEMPFERIA SUBG. PROTANTHIUM

(Use when timing of flowering is observed)

1. Nocturnal anthesis 2
1. Diurnal anthesis 4
2. Leaves obovate to suborbicular; ligule bilobed, c. 1 cm long . . . . . *K. grandifolia*
2. Leaves ovate, elliptic to narrowly ovate; ligule bilobed-truncate, 1–3 mm long 3
3. Leaves green. Labellum with an incision up to 2/3 of its length; labellum base involute, enclosing the anther . . . . . *K. albiflora*
3. Leaves green to deep purple, usually with a deep purplish red patch towards the midvein. Labellum with an incision around 1/2 of its length; labellum base flat . . *K. noctiflora*
4. Floral plane perpendicular to the ground. Staminodes upright to slightly arcuate; labellum deflexed in distal half with an incision around 1/2 of its length 5
4. Floral plane parallel to the ground. Lateral staminodes and labellum horizontal, arranged in the same plane; labellum with an incision more than 2/3 of its length 11

5. Pseudostem mostly buried in the ground; leafy shoot adpressed to the ground. Leaves broadly ovate to suborbicular . . . . . *K. jenjittikuliae*
5. Pseudostem upright and outstanding above the ground; leafy shoot upright. Leaves linear, narrowly narrowly ovate to oblong, elliptic to ovate 6
6. Leaves linear grass-like to narrowly ovate to oblong, less than 5 cm wide . . . . . *K. graminifolia*
6. Leaves narrowly ovate to oblong, elliptic to ovate, more than 5 cm wide 7
7. Labellum with two conspicuous yellow bands from base towards sinus; anther crest obtuse to trilobed-undulate, the middle lobe more elongated than side lobes *K. simaoensis*
7. Labellum with central white to pale yellow patch basally towards sinus surrounded by purple stripes; anther crest bifid, bilobed to tridentate 8
8. Anther crest tridentate to undulate-truncate 9
8. Anther crest bifid to bilobed, usually with 1–3 small teeth or lobes between the main lobes. 10
9. Bracts and bracteole sparsely villous; epigynous gland 8–12 mm long . . . . . *K. aurora*
9 . Bracts and bracteole glabrous; epigynous gland 6–7 mm long . . . . . *K. sipraiana*
10. Storage roots unbranched with a single, terminal fusiform, ellipsoid to ovoid tuber; tuber 1.5–3.5 by 1.2–2 cm . . . . . *K. rotunda*
10. Storage roots branched with numerous, lateral and terminal subglobose to ovoid tubers; tubers 0.5–1 by 0.5–0.8 cm . . . . . *K. subglobosa*
11. Pseudostem upright and outstanding above the ground; leafy shoot upright; leaves oblong, elliptic to ovate . . . 12
11. Pseudostem mostly buried in the ground; leafy shoot adpressed to the ground; leaves broadly ovate, suborbicular to orbicular. 14
12. Lateral staminodes pure white; labellum white with central pale yellow patch basally towards sinus . . *K. caespitosa*
12. Lateral staminodes light pink to purple; labellum light pink to purple with two large darker pink to deep purple spots at sinus 13
13. Leaves with petiole, green usually with 1–3 layers of white to pale light green patches arranged parallel along the leaf edges, between the midrib and both sides of the edges . . . . . *K. takensis*
13. Leaf blade sessile, green . . . . . *K. xiengkhouangensis*
14. Labellum with central white patch basally towards sinus . . . . . *K. lopburiensis*
14. Labellum without central white patch basally towards sinus . . . . . *K. udonensis*

KEY 2 TO THE SPECIES OF KAEMPFERIA SUBG. PROTANTHIUM

(Use when timing of flowering is not observed)

1. Floral plane perpendicular to the ground; lateral staminodes upright to slightly arcuate; labellum deflexed in distal half with an incision around 1/2 of its length 2
1. Floral plane flat to the ground; lateral staminodes and labellum horizontal, arranged in the same plane; labellum with an incision more than 2/3 of its length 9
2. Leaves adpressed to the ground, suborbicular to ovate; ligule 1.5–3 cm long . . . . . *K. jenjittikuliae*
2. Leaves semi-adpressed to upright, ovate, elliptic, to narrowly ovate to oblong; ligule less than 1 cm long 3
3. Leaves linear grass-like to narrowly ovate to oblong, less than 5 cm wide . . . . . *K. graminifolia*
3. Leaves narrowly ovate to oblong, elliptic to ovate; more than 5 cm wide 4
4. Lateral staminodes pure white; labellum white with pale yellow patch basally towards centre . . . . . *K. noctiflora*
4. Lateral staminodes white, light pink to pale purple; labellum white, light pink to pale purple with two deep pink to purple spots at centre 5
5. Labellum with two conspicuous yellow bands from base towards centre; anther crest with obtuse to trilobed-undulate apex, middle lobe more elongated than side lobes . . . . . *K. simaoensis*
5. Labellum with white to pale yellow band from base towards centre, surrounded by purple stripes; anther crest with bifid, bilobed to tridentate apex 6
6. Storage roots branched with numerous, lateral and terminal subglobose to ovoid tubers; tubers 0.5–1 by 0.5–0.8 cm . . . . . *K. subglobosa*
6. Storage roots unbranched with a single, terminal fusiform, ellipsoid to ovoid tuber; tuber 1.2–3.5 by 1–2 cm. 7
7. Anther crest with bilobed apex, usually with 1–3 small teeth between the main lobes; epigynous glands 2–6 mm long . . . . . *K. rotunda*
7. Anther crest with tridentate to undulate-truncate apex; epigynous glands 6–12 mm long 8
8. Bracts and bracteole sparsely villous; epigynous gland 8–12 mm long . . . . . *K. aurora*
8. Bracts and bracteole glabrous; epigynous gland 6–7 mm long . . . . . *K. sipraiana*
9. Pseudostem buried in the ground; leaves adpressed to the ground, orbicular, suborbicular to ovate 10
9. Pseudostem upright and outstanding above the ground; leaves narrowly ovate to oblong, elliptic to broadly ovate 12
10. Lateral staminodes pure white; labellum white with pale yellow patch basally towards centre . . . . . *K. grandifolia*
10. Lateral staminodes light pink to deep pink; labellum light pink to purple with two deep reddish to deep purple spots at centre 11
11. Labellum with white to cream white patch basally towards centre . . . . . *K. lopburiensis*
11. Labellum with deep pink to deep purple patch basally towards centre . . . . . *K. udonensis*
12. Lateral staminodes pure white; labellum white with pale yellow patch basally towards centre 13
12. Lateral staminodes light pink to deep pink; labellum light pink to purple with two deep reddish to deep purple spots at centre 14
13. Petiole subsessile to 2.5 cm long . . . . . *K. albiflora*
13. Petiole more than 10 cm long . . . . . *K. caespitosa*
14. Leaves with petiole, green usually with 1–3 layers of white to pale light green patches arranged parallel along the leaf edges, between the midrib and both sides of the edges . . . . . *K. takensis*
14. Leaf blade sessile, green . . . . . *K. xiengkhouangensis*

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