



Research article

A taxonomic revision of *Globba* subsect. *Nudae* (Zingiberaceae)

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Abstract. *Globba* subsect. *Nudae* K.Larsen is revised. Seven species are recognised and three names are lectotypified. A key to the species and descriptions are provided. Three new species are described and illustrated: *G. aranyaniae* Sangvir. & M.F.Newman sp. nov., *G. lithophila* Sangvir. & M.F.Newman sp. nov., and *G. macrochila* Sangvir. & M.F.Newman sp. nov. Four names based on types from Bangladesh, India and Myanmar remain doubtful. The morphological expression of andromonoecy in this group is described in detail. Provisional IUCN conservation assessments of all species are supplied.

Keywords. Andromonoecy, *Globba*, *Nudae*, taxonomic revision, Zingiberaceae.

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Introduction

Globba L. belongs to the tribe Globbeae Meisn. of the subfamily Zingiberoideae Haask., family Zingiberaceae Martinov. This is a family of monocotyledonous plants which includes ginger, *Zingiber officinale* Roscoe, turmeric, *Curcuma longa* L. and cardamom, *Elettaria cardamomum* (L.) Maton. The order Zingiberales Griseb., to which the Zingiberaceae belong, also includes the banana family, Musaceae Juss., the arrowroot or prayer-plant family, Marantaceae R.Br. and the canna lily family, Cannaceae Juss.

Of the three genera of the tribe Globbeae, *Globba* is the largest (comprising about 100 species), including *Mantisia* Sims, which was placed in synonymy under *Globba* by Williams *et al.* (2004). The other two genera of the Globbeae are *Gagnepainia* K.Schum. and *Hemiorchis* Baill., which each have three species (Kress *et al.* 2002; Williams *et al.* 2004).

Globba occurs in Sri Lanka, India, and throughout southeast Asia as far as Australia (Leong-Škorničková & Newman 2015), though the number of native species east of Wallace's Line is very low, perhaps only one (*G. marantina* L.). Most species are medium-sized herbs growing in semi-shaded areas as terrestrial

plants or lithophytes. The most conspicuous character which can be used to recognise a species of *Globba* is the long filament which arches over the labellum of the flower.

Various authors have tried to classify the many species into infrageneric taxa according to different concepts (Horaninow 1862; Schumann 1904; Larsen 1972; Williams *et al.* 2004). The number of anther appendages has always been an important character for classification at sectional rank. Morphologically, the genus was classified into three sections (Horaninow 1862; Baker 1894; Schumann 1904), as follows: (1) *G.* sect. *Globba* (formerly *G.* sect. *Marantella* (Horan.) Benth. & Hook.f. nom. illegit.) with four anther appendages; (2) *G.* sect. *Haplanthera* Horan. without anther appendages; (3) *G.* sect. *Ceratanthera* (Horan.) Petersen (*G.* subg. *Ceratanthera* (Horan.) K.J.Williams) with two anther appendages. *Globba* sect. *Ceratanthera*, which bears two anther appendages, was classified into three series according to the position of appendage attachment, namely *G.* series *Basicalcaratae* K.Schum., *G.* series *Mediocalcaratae* K.Schum. and *G.* series *Apicalcaratae* K.Schum. This classification remained in use for over a hundred years (Horaninow 1862; Schumann 1904).

In 1972, a small change was made when *G.* sect. *Nudae* K.Larsen, comprising *G. nuda* K.Larsen alone, was added to the others (Larsen 1972). *Globba nuda* bears four anther appendages so it would formerly have been put in *G.* sect. *Globba*, but Larsen (1972) erected *G.* sect. *Nudae* on account of its unique inflorescence position, small caducous bracts, and chromosome number.

Williams *et al.* (2004) published the results of a molecular phylogenetic study of *Globba* and the *Globbeae* performed using internal transcribed spacer (ITS) and *trnK-matK* nucleotide sequence data. The results suggested that *Globba* should be divided into three subgenera and seven sections. Three strongly supported, monophyletic groups were newly described, namely *G.* sect. *Mantisia* (Sims) K.J.Williams, *G.* sect. *Substrigosa* K.J.Williams, and *G.* sect. *Sempervirens* K.J.Williams. In addition, *G.* (sect. *Ceratanthera*) series *Mediocalcaratae* K.Schum. was transferred to *G.* (sect. *Nudae*) subsect. *Mediocalcaratae* (K.Schum.) K.J.Williams (Table 1). This now leaves *G.* sect. *Nudae* comprising 26 species with two subsections, *G.* subsect. *Nudae* (7 species) and *G.* subsect. *Mediocalcaratae* (19 species), in which the numbers of anther appendages are four and two, respectively.

In this paper, we revise the species of *G.* subsect. *Nudae* after revisiting the type localities of most names and carefully studying living and herbarium specimens. Although the species look very much alike at first glance, we have found that many characters which have been ignored or overlooked in the past are important for species-level diagnosis. One of these is the andromonoecy occurring in *G.* sect. *Nudae* which affects species circumscription and reveals intriguing facts that allow a reinterpretation of the pollination system in these species (Sangvirojjanapat *et al.* 2017a, 2017b). In addition, we have plotted the distribution and made IUCN conservation assessments for each species of this subsection.

Material and methods

Protologues and types of the eleven names in *G.* subsect. *Nudae* were examined (IPNI 2018). Herbarium specimens at A, AAU, BK, BKF, BM, C, E, GH, HCU, IBSC, K, K-W, L, MO, P, QBG, SING, SMAO, UC, and US (herbarium codes in accordance with Thiers 2019) were studied, about 250 sheets in total. Field collections were made throughout Thailand and neighbouring countries, especially at three type localities in northern Thailand. Living specimens were studied in their natural habitat, at the Zingiberaceae nursery of Queen Sirikit Botanic Garden in Chiang Mai province, and in the living collection of the Royal Botanic Garden Edinburgh. Floral dissections and tests of morphological stability of some characters in two growing seasons were carried out at the Zingiberaceae nursery of Queen Sirikit Botanic Garden and a private nursery in Bangkok. Assessments of conservation status were carried out following IUCN guidelines (IUCN 2012). Specimen data were stored in Padme (Miller *et al.* 2015) and, for each species, an Excel file was generated listing the following fields for each specimen:

Table 1. Comparison of classifications using morphological characters only (Schumann 1904; Larsen 1972) and molecular and morphological characters combined (Williams *et al.* 2004); anther appendage numbers are in parentheses.

Schumann (1904), Larsen (1972)	Williams <i>et al.</i> (2004)	
Section	Subgenus	Section
<i>G. sect. Haplanthera</i> Horan. (0)	<i>G. subg. Mantisia</i> (Sims) K.J.Williams	<i>G. sect. Haplanthera</i> (0) <i>G. sect. Substrigosa</i> K.J.Williams (0) <i>G. sect. Mantisia</i> (Sims) K.J.Williams (2)
<i>G. sect. Ceratanthera</i> (Horan.) Petersen <i>G. series Basicalcaratae</i> K.Schum. (2) <i>G. series Mediocalcaratae</i> K.Schum. (2) <i>G. series Apicalcaratae</i> K.Schum. (2)	<i>G. subg. Ceratanthera</i> (Horan.) K.J.Williams	<i>G. sect. Ceratanthera</i> (2)
<i>G. sect. Globba</i> (4) <i>G. sect. Nudae</i> K.Larsen (4)	<i>G. subg. Globba</i>	<i>G. sect. Globba</i> (4) <i>G. sect. Nudae</i> <i>G. subsect. Nudae</i> K.Larsen (4) <i>G. subsect. Mediocalcaratae</i> (K.Schum.) K.J.Williams (2) <i>G. sect. Sempervirens</i> K.J.Williams (4)

species name, collector, collection number, collection date, herbarium code, locality, latitude, longitude, altitude. These data were imported into QGIS v. 2.18.20. (QGIS Development Team 2018) and used to produce the distribution maps. Larger symbols on the maps indicate type specimens.

Results

Globba subsect. *Nudae*

Class Magnoliopsida Brongn.
Order Zingiberales Griseb.
Family Zingiberaceae Martinov
Genus *Globba* L.
Section *Nudae* K.Larsen
Subsection *Nudae* K.Larsen

General morphology

The main distinguishing characteristics of *G. subsect. Nudae* are the lax conical inflorescence and flowers with four anther appendages. These differentiate this subsection clearly from *G. sect. Globba* and *G. sect. Sempervirens*, which also have four anther appendages, but have dense inflorescences with colourful, persistent bracts.

Description

Clump-forming herbs (10–)40–80 cm tall, rarely to 1.5 m, leaning, with inflorescence turned upright. Bladeless leaf sheaths 3–5; ligule truncate to bilobed, glabrous or ciliate, light green with white margin; blades 5–11, oblong, elliptic or ovate, base obliquely obtuse, cuneate, apex acuminate to caudate, glabrous or strigose, sometimes with a grey patch or silver striate above, pubescent below. Inflorescence erect, lax, conical; peduncle 1–5(–15) cm long; rachis green, glabrous or pubescent; bracts and bracteoles

caducous or persistent, oblong, elliptic, deltoid, 5–12 mm long, glabrous or pubescent, apex acute, green; cincinni numerous, lax or crowded; pedicel 0–5 mm long. Flowers 2.8–3.8 cm long; ovary 3–4 mm long, ellipsoid, green (♀), ridged; calyx 3–5 mm long, infundibuliform, with lobes acute to acuminate, ciliate, green or yellow-green; floral tube 9–16 mm long, yellow-orange, pubescent, dorsal and lateral corolla lobes 6–7.5 mm long, elliptic, hooded, yellow, orange, orange-green; lateral staminodes 11–20 × 3–11 mm, obliquely obovate, oblong, bright yellow, yellow-orange or orange, apex rounded; labellum 6–8 × 5–7 mm, triangular, bilobed, yellow-orange, self-coloured, rarely (*G. aranyaniae* Sangvir. & M.F.Newman sp. nov.) with red or brown spot at centre, base truncate, apex round, acute or obtuse; nectar tube 3–6 mm long; filament 23–30 mm long, yellow or yellow-orange; anther 1–2 mm long with 4 appendages, connective tissue, crest, and appendages orange, semi-translucent, crest ca 1 mm long (shorter in ♂), truncate; ♀ appendages ca 3 mm long, acuminate, bifid, upper pair bigger, decurrent to connective tissue and crest, lower pair smaller; ♂ appendages 3–4 mm long, acuminate, bifid to halfway, upper pair only slightly bigger than lower. Fruits 2.5–27 × 1–10 mm, ellipsoid or almost globose, longitudinally or shallow ridged, topped with persistent calyx. Bulbils produced at base of peduncle or tip of cincinni or protruding from leaf sheaths, spindle-shaped or obovate, tissue corky, producing one shoot.

Habitat

The substrate and ecological surroundings are found to relate to plant size. Plants in *G.* subsect. *Nudae* are mostly middle-sized, about 50–100 cm tall. Occasionally *G. expansa* Wall. ex Horan., found in mixed evergreen montane forest, can grow to 1.5 m tall while *G. lithophila* Sangvir. & M.F.Newman sp. nov., which grows on limestone, is a miniature plant, only 10 cm tall. The most variable species is *G. insectifera* Ridl., which is large or small depending on the conditions of the dry or the rainy season which determine the production of inflorescence shoots or leafy shoots.

Rhizome

Small, globose, about 3–5 cm in diameter. In one growing season, 5–8 rhizomes can be produced in a moniliform arrangement. The root tubers are spindle-shaped or elongate and function in food storage during the dormant period.

Leafy shoots

Pseudostem consisting of enfolded leaf sheaths. At the base there are 3–5 bladeless sheaths which are usually darker. The ligule is membranaceous, truncate to bilobed, light green with paler or white margin. Normally, ligules of this subsection do not vary greatly but, in the case of *G. lancangensis* Y.Y.Qian, the ligule appears node-like by embracing the axis of the leafy stem. This is a diagnostic difference between *G. lancangensis* Y.Y.Qian and *G. insectifera* Ridl. All leaf blades are arranged distichously, the lowest one smallest then becoming larger towards the apex. A few species have silver striations along the midrib, for instance *G. expansa* Wall ex Horan. and *G. lithophila* sp. nov. There is almost always an indumentum on both sides of the leaf blade which may be dense on the midrib and veins above but more evenly spread below. It should be noted that *G. expansa* Wall. ex Horan. is the sole species having a glabrous blade above. *Globba flagellaris* K.Larsen is unique as horizontal shoots protrude from the rhizome at an early stage, looking like flagella. This characteristic is reflected in its specific epithet (Larsen 1977).

Inflorescence

Terminally produced (on a leafless shoot in *G. insectifera*), erect, and lax. The overall shape is conical consisting of many cincinni arranged spirally. The main rachis and cincinni elongate greatly during flowering. The lowest cincinnus is the longest one becoming shorter toward top of inflorescence. The rachis is rather short when it is young then may elongate with age. Bulbils may be produced on the

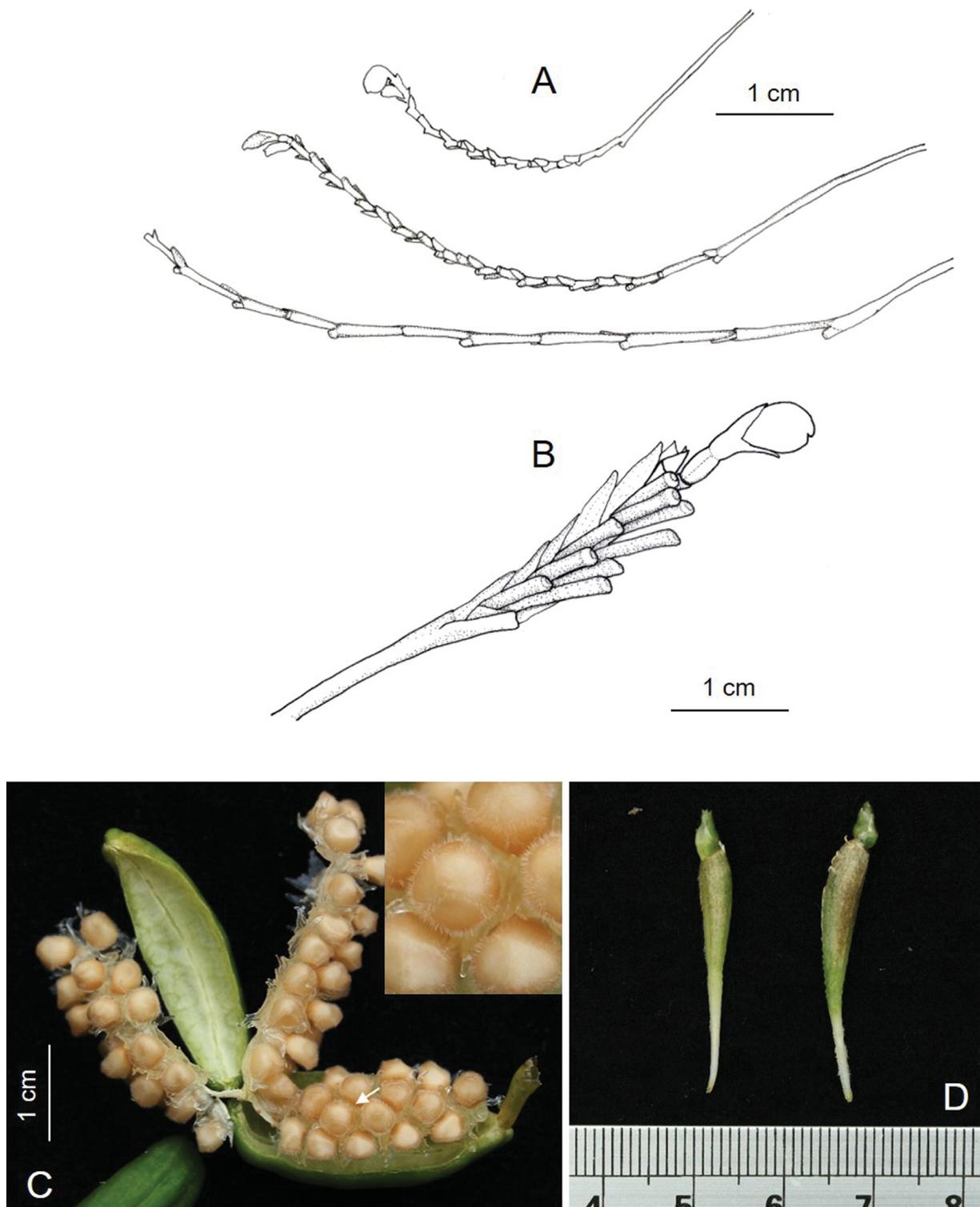


Fig. 1. Cincinnus morphology in *G.* subsect. *Nudae* K.Larsen. **A.** Lax cincinnati (M.F. Newman 2561 leg.). **B.** Crowded cincinnus (S. Sangvirotjanapat 642 leg.). **C.** Seeds (M.F. Newman 2561 leg.); the area in the inset is indicated by a white arrow. **D.** Bulbils (M.F. Newman 2561 leg.). Drawings and photographs: S. Sangvirotjanapat.

rachis at the end of the period of growth. The cincinni are held at nearly 90° to the rachis and are subtended by green, glabrous or pubescent bracts which are very small and caducous, rarely seen on herbarium specimens. The flowers are produced in two rows at the apex of the cincinni, each flower subtended by a bracteole which is usually the same shape as the bract. We recognise two morphological types of cincinnus, lax and crowded, which can be distinguished by the bracteole and flower scars on the cincinni. Lax cincinni may be elongate with a very short pedicel (e.g., *G. expansa*, Fig. 1A) while crowded cincinni may have long pedicels closely packed (e.g., *G. flagellaris* and *G. lithophila* sp. nov., Fig. 1B).

Species in this subsection are often misidentified because they show considerable similarity of habit and inflorescence structures. The flowers, bracts and bracteoles also easily fall so most herbarium specimens look alike. In this study, the most taxonomically informative character in the key to species is the crowded or lax cincinni. This character is effective and consistent when examining herbarium specimens without flowers but with good details on their labels. There is only one species, *G. aranyaniae* sp. nov. that shows both cincinnus types but their distribution areas do not overlap.

Flower

For reliable identification to species, the flower must be seen. Flower colour seems to be a variable character while, on the other hand, the yellow and orange tone of flowers in this subsection is clearly different and useful for classification in many cases. A red or brown spot on the labellum is quite common in other groups of *Globba* but, in *G.* subsect. *Nudae*, *G. aranyaniae* sp. nov. is unique in having a spot (Fig. 2A).

Andromonoecy

Monoecy is rare in the Zingiberaceae, having been reported in only a few species. *Siphonochilus aethiopicus* (Schweinf.) B.L.Burt, an African ginger, shows gynomoecy in which hermaphrodite and female flowers are produced on the same plant (Gordon-Gray *et al.* 1989), while *Alpinia* sect. *Monopleura* K.Schum. and *Alpinia* sect. *Myriocrater* K.Schum. are considered andromonoecious with hermaphrodite and male flowers on the same plant (Burt & Smith 1972). Our investigations of the reproductive biology of *G.* section *Nudae* (Sangvirotjanapat *et al.* 2017b) show that andromonoecy occurs as a synapomorphic character of both subsections. The hermaphrodite (♂) and functionally male (♂) flowers are in the same inflorescence but on separate cincinni, ♂ flowers arising only on the two to four proximal cincinni. The fact that two floral types occur together has great taxonomic relevance because it has led earlier authors to recognise the flower types as different species. The differences of morphology between the floral types are highlighted below with an asterisk (*) and shown in Fig. 3.

Floral size*

The ♂ flower is smaller than the ♀ flower and has a shorter floral tube.

Ovary and ovules*

These are strikingly dissimilar between the floral types. The ovary of the ♀ flower is well developed, ellipsoid and longitudinally ridged with fully developed ovules inside. By contrast, the ♂ flower has a greatly reduced ovary about 1 mm long with aborted ovules inside.

Calyx

Infundibuliform, trilobed, two of the lobes smaller than the other, with acute or acuminate lobes.

Epigynous nectaries or stylodes

All species of *Globba* have two linear epigynous nectaries above the ovary. Nectar is secreted into the floral tube towards the nectar tube.

Floral tube*

A narrow tube, about 1 mm in diameter. The outer surface is pubescent. Within an inflorescence, the ♀ flower has a longer and more sharply curved floral tube than the ♂ flower.

Dorsal and lateral corolla lobes

Hooded, elliptic, oblong or obovate, the dorsal one slightly bigger than the laterals. At anthesis, the lateral corolla lobes are usually concealed by the lateral staminodes or labellum but, in *G. lithophila*

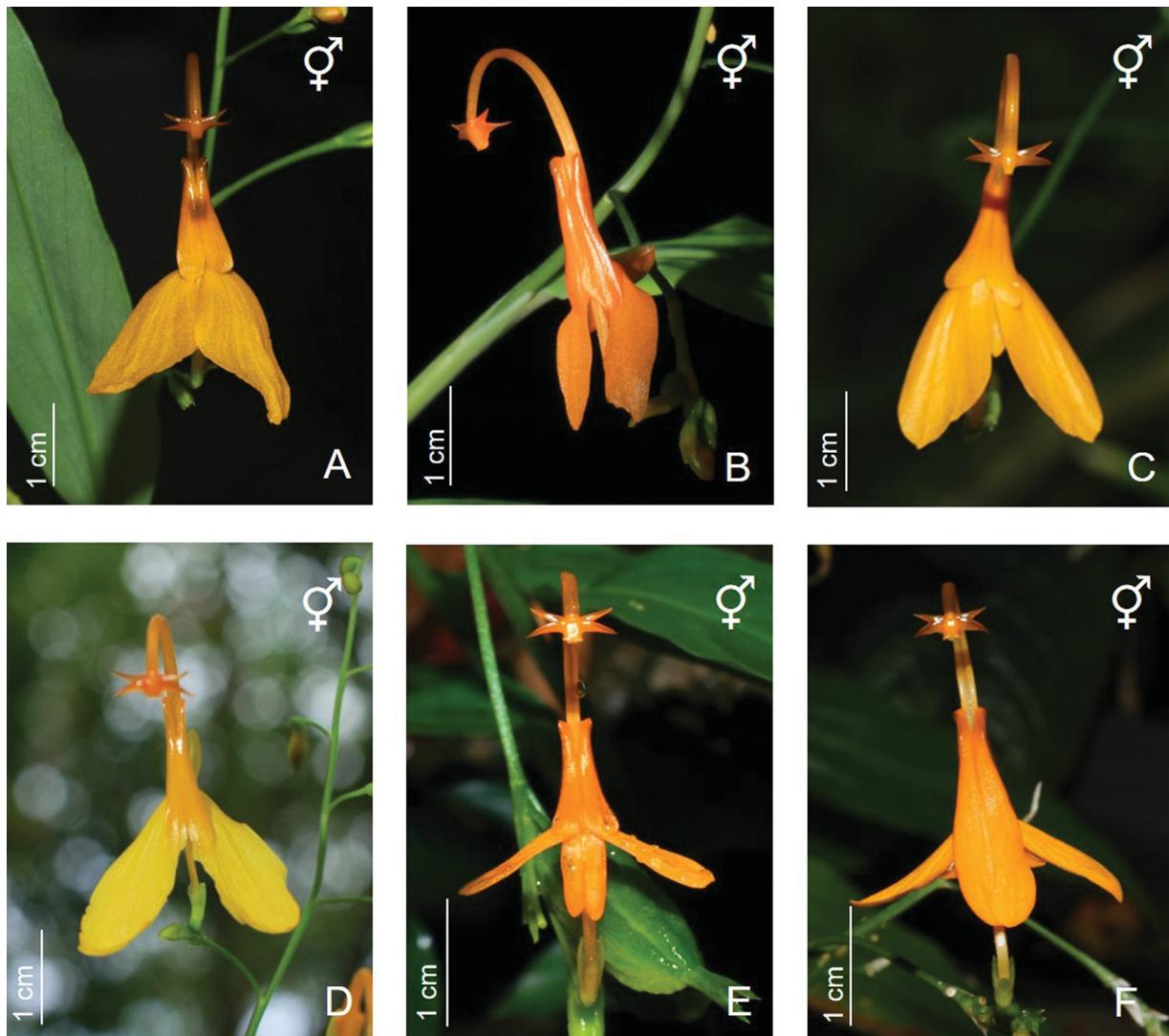


Fig. 2. *Globba* subsect. *Nudae* K.Larsen. **A.** *G. aranyaniae* Sangvir. & M.F.Newman sp. nov. (S. Sangvirotnjanapat 785 leg.). **B.** *G. expansa* Wall. ex Horan. (M.F. Newman 2561 leg.). **C.** *G. flagellaris* K.Larsen (M.F. Newman and *JLS* 2048 leg.). **D.** *G. insectifera* Ridl. (S. Sangvirotnjanapat s.n. leg.). **E.** *G. lithophila* Sangvir. & M.F.Newman sp. nov. (M.F. Newman 2576 leg.). **F.** *G. macrochila* Sangvir. & M.F.Newman sp. nov. (S. Sangvirotnjanapat 795 leg.). Photographs: S. Sangvirotnjanapat.

sp. nov., the lateral staminodes are rather narrow so the lateral corolla lobes can be seen clearly. The outer surface of the lobes is slightly pubescent and the colour is the same as the other parts but green tinted.

Lateral staminodes

All gingers possess staminodes derived from stamens. The tribe Globbeae is characterised by its free lateral staminodes and labellum. As for *Globba*, the lateral staminodes are attached above the lateral corolla lobes and are conspicuous, flat and patent. The shape can be oblong or obovate. All these differ from other sections in which the lateral staminodes are not as prominent.

Nectar tube and labellum

We consider the labellum of *Globba* to be made up of two parts. The nectar tube is connected to the floral tube but the cavity inside it is larger. Along one side, it is fused to the filament. This tube holds the nectar and is the channel for the style to reach the tip of the flower. The apex of the nectar tube expands and reflexes to form the labellum which is always triangular, bilobed. The labellum is slightly thicker and

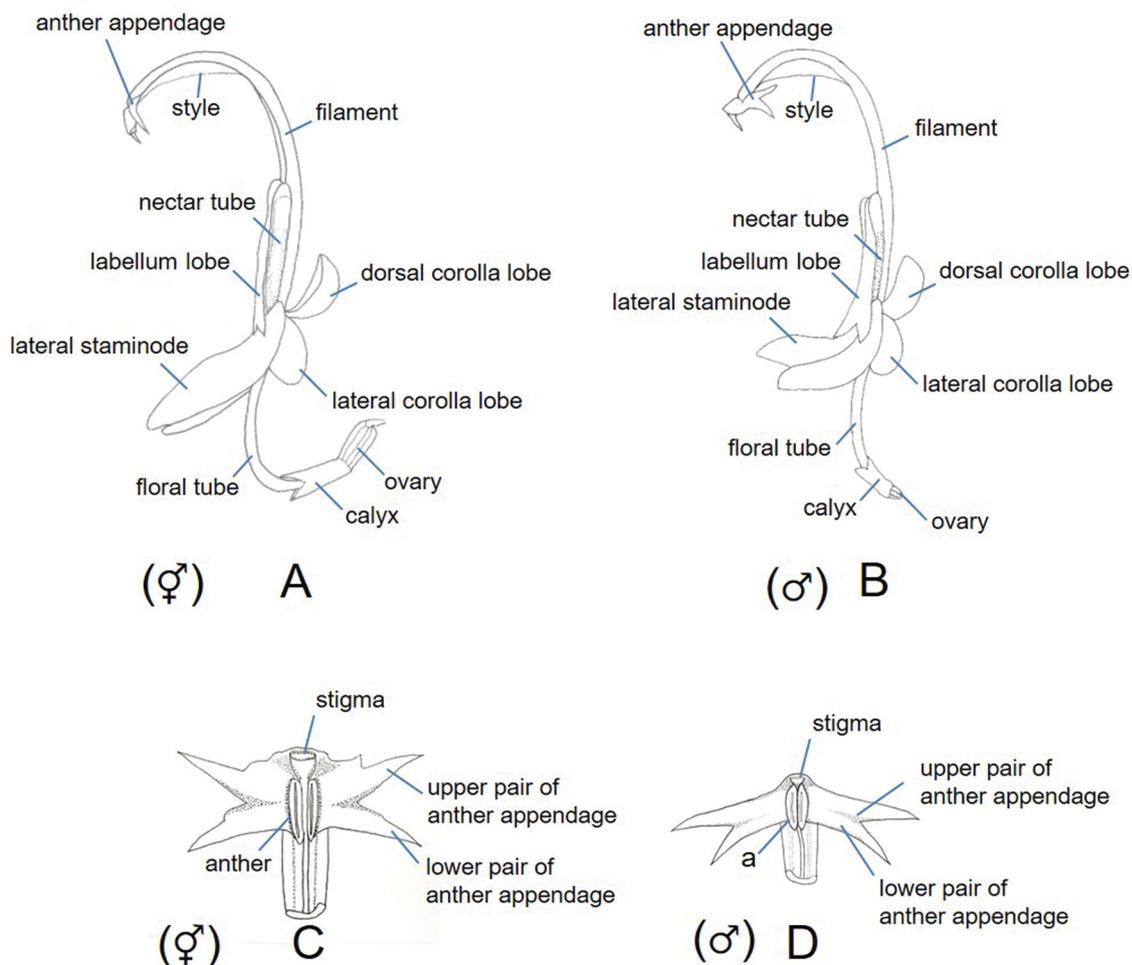


Fig. 3. Parts of the hermaphrodite and functionally male flowers. **A.** ♀ flower. **B.** ♂ flower. **C.** Anther appendages of ♀ flower. **D.** Anther appendages of ♂ flower. Drawing: S. Sangvirotjanapat from M.F. Newman 2561 leg. (*G. expansa* Wall. ex Horan.).

darker than the other floral organs. In pollination, it serves as a landing platform and the spot may be a nectar guide indicating the position of the nectar tube where the pollinator reward is found.

Filament

Long and arching with a groove for the style in the lower part. In this paper, the measurement of the filament is calculated from the point of fusion with the nectar tube to the anther sac. This makes the length seem longer than is noted in the literature. Traditionally, only the part of the filament which extends from the labellum is measured. An approximate conversion can be made by adding or subtracting the length of the nectar tube.

Anther

Consisting of two thecae, each with loculicidal dehiscence along its entire length.

Anther appendages*

Both floral types have four-appendaged flowers. The appendages of this subsection consist of an upper and a lower pair of triangular appendages. They are fused at the base while the tips are completely free from each other. Consequently, the number of appendages when looking at the base is two while, at the tip, it is four. The ♀ flower has larger appendages which occupy the whole length of the anther. The appendages are deeply bifid, and the upper pair is decurrent to the crest (Fig. 3C). The appendages of the ♂ flower are split half-way with their bases fused together like a swallow's tail. The anther crest is much less prominent in the ♂ flower than in the ♀ flower (Fig. 3D). This difference in size was first mentioned by Smith (1988) but she noted that the smaller crest may have been an effect of dehydration.

Style

Filiform, as long as the flower, the tip near the stigma held in position by the anther thecae.

Stigma*

In the ♀ flower, bigger and completely full of stigmatic fluid to promote germination of pollen tubes.

Fruit

Ellipsoid and ridged in *G.* subsect. *Nudae*, except in *G. lancangensis* which has nearly globose and shallowly ridged fruits. The apex of the fruit in *Globba* always bears a persistent calyx.

Seed

Brown, globose to ovate, about 2–3 mm in diameter with a praemorse aril attached at the hilum. The surface is hairy (Fig. 1C and Fig. 7G). There are no seed characters which allow the species of this subsection to be differentiated.

Bulbil

A vegetative propagule, produced late in the growing season, before the plant goes dormant in the dry season (Fig. 1D). Generally, it is a corky tissue with one shoot but *G. flagellaris*, which grows in moist areas, has a prolonged shoot and the corky part is scarcely visible (Fig. 7K).

Key to the species

1. Flowers lax; bracteoles caducous2
- Flowers crowded at tip of cincinni; bracteoles usually persistent on cincinni, packed with pedicels5

2. Flower yellow-orange; labellum with red or brown spot at centre; limestone bedrock near streams ..
.....*G. aranyaniae* Sangvir. & M.F.Newman sp. nov.
– Flower pure orange, bright yellow or primrose; labellum without spot; evergreen forest or open
areas in dipterocarp forest3
3. Lateral staminodes oblong to narrowly obovate, 11–13 × 3–5 mm, yellowish orange; leafy
stem to 150 cm; leaf glabrous above*G. expansa* Wall. ex Horan.
– Lateral staminodes obovate, ca 20 × 11 mm, bright yellow or primrose; leafy stem to 80 cm; leaf
strigulose above4
4. Flower lemon or bright yellow; bracts deltoid, 0.5–4 × 1–2 mm; fruit ellipsoid, longitudinally
ridged; leaf sheaths smooth along the leafy stem; inflorescences produced on separate shoots and
at tip of leafy shoots*G. insectifera* Ridl.
– Flower primrose or pale yellow; bracts lanceolate, 1.5–7 × 1–2 mm; fruit almost globose,
shallowly ridged; leaf sheaths node-like along the leafy stem; inflorescences only produced at
tip of leafy shoots*G. lancangensis* Y.Y.Qian
5. Flower yellow-orange; labellum with red or brown spot at centre; lateral staminodes obliquely
obovate*G. aranyaniae* Sangvir. & M.F.Newman sp. nov.
– Flower pure orange; labellum without spot; lateral staminodes oblong or obliquely obovate ...6
6. Lateral corolla lobes easily seen; lateral staminodes oblong, to 5 mm wide; lithophyte in small pockets
of soil over limestone*G. lithophila* Sangvir. & M.F.Newman sp. nov.
– Lateral corolla lobes covered by labellum or lateral staminodes; lateral staminodes broad, obovate,
5–9 mm wide; terrestrial7
7. Labellum as long as lateral staminodes, 10–12 mm long; inflorescence 10–30 × 7–18 cm;
growing in wet areas; flagella produced*G. flagellaris* K.Larsen
– Labellum longer than lateral staminodes, 19–20 mm long; inflorescence 5–11 × 5–12 cm; growing
in somewhat dry areas or bamboo forest; without flagella
.....*G. macrochila* Sangvir. & M.F.Newman sp. nov.

Globba aranyaniae Sangvir. & M.F.Newman sp. nov.

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Figs 2A, 4–6

Diagnosis

The main distinguishing character within *G.* subsect. *Nudae* is the red or brown spot on the labellum. Laotian and northern Thai populations resemble *G. flagellaris* and *G. macrochila* sp. nov. by their condensed cincinni, and orange-toned flowers with rather broad lateral staminodes (> 5 mm). Central and eastern Thai populations resemble *G. expansa* by their lax cincinni, orange-toned flowers, and ellipsoid fruits.

Etymology

The epithet ‘aranyaniae’ derives from ‘Aranyani’ who is a princess in the myth relating to the name of the type locality, Pha Nang Khoy (‘Cave of the Lady who Waits’).

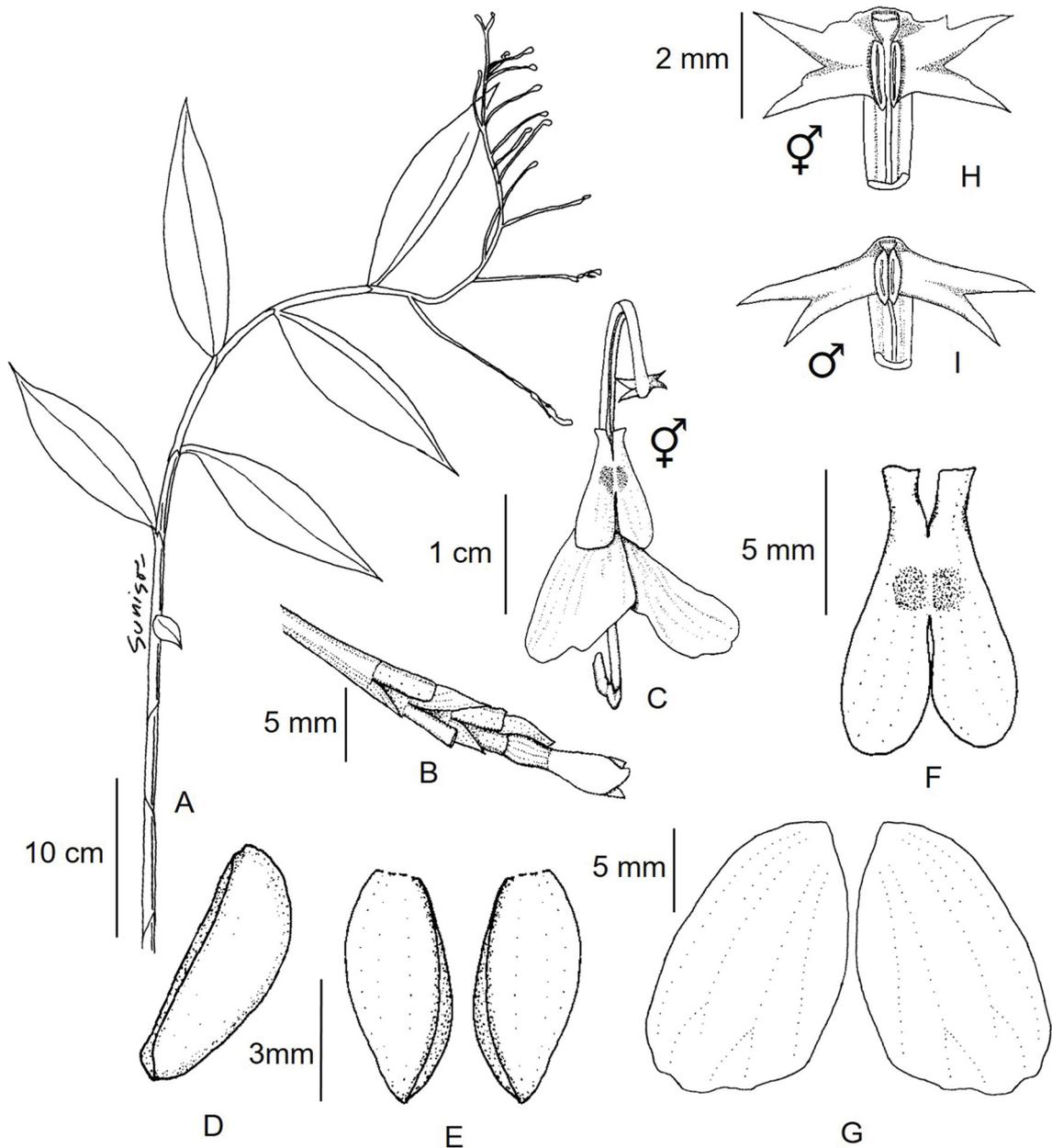


Fig. 4. *Globba aranyaniae* Sangvir. & M.F.Newman sp. nov. **A.** Habit. **B.** Tip of cincinnus. **C.** ♀ flower. **D.** Dorsal corolla lobe. **E.** Lateral corolla lobes (same scale as D). **F.** Labellum. **G.** Lateral staminodes. **H.** ♀ appendages. **I.** ♂ appendages (same scale as H). Drawing: S. Sangvirotjanapat from S. Sangvirotjanapat 785 leg.

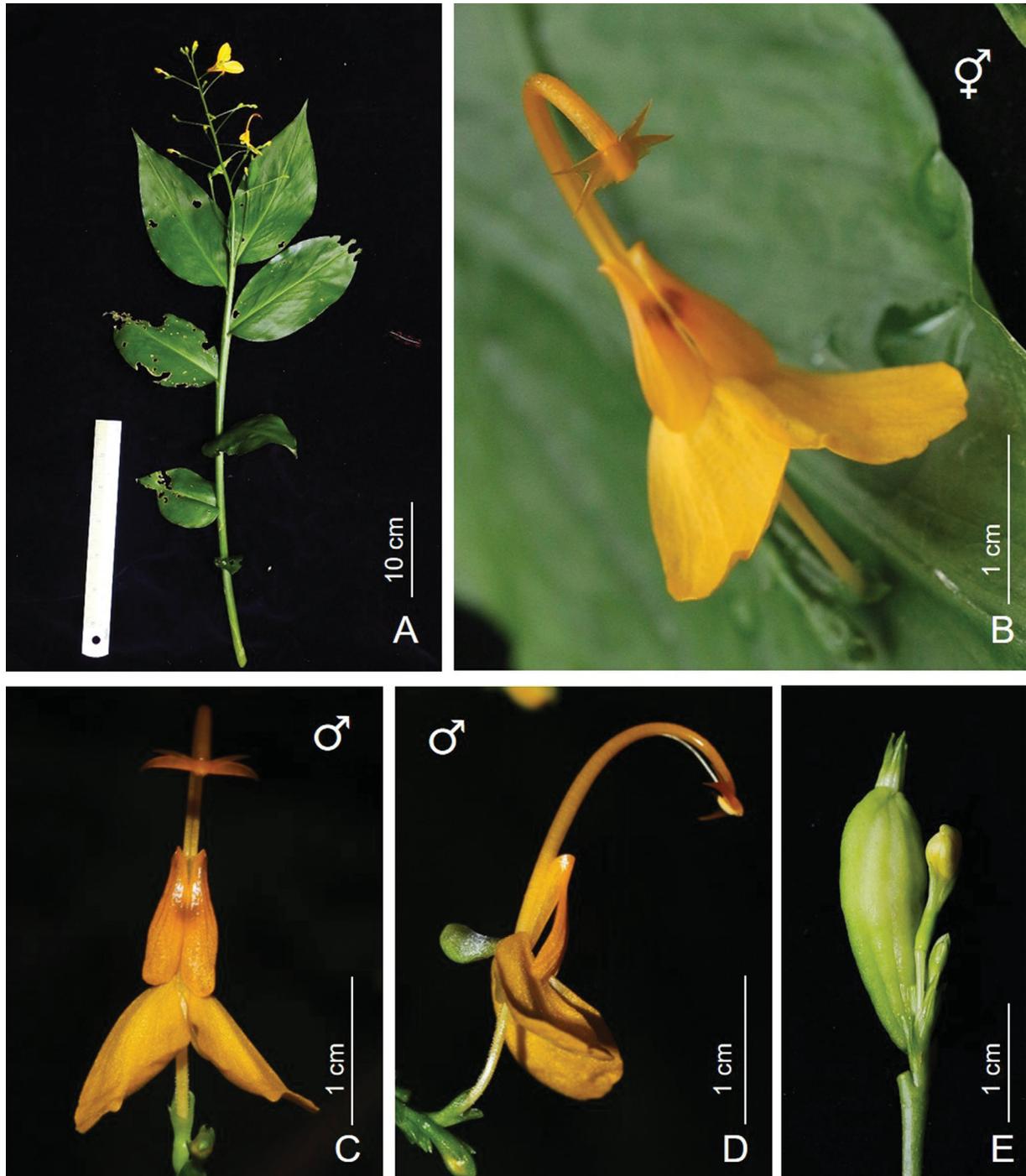


Fig. 5. *Globba aranyaniae* Sangvir. & M.F.Newman sp. nov. **A.** Habit. **B.** ♀ flower. **C.** ♂ flower (front view). **D.** ♂ flower (side view). **E.** Fruit. Photographs: A, E, J.L. Škorničková from J.L. Škorničková 1688 leg.; B–D, S. Sangvirotjanapat from S. Sangvirotjanapat 785 leg.

Type material

Holotype

THAILAND • Phrae, Rong Kwang, Tham Pha Nang Khoi; 18°22'9" N, 100°21'16" E; 350 m a.s.l.; 15 Sep. 1999; P. Srisanga and C. Puff 1075 leg.; QBG.

Isotype

THAILAND • Same data as for the holotype; E00726636; E.

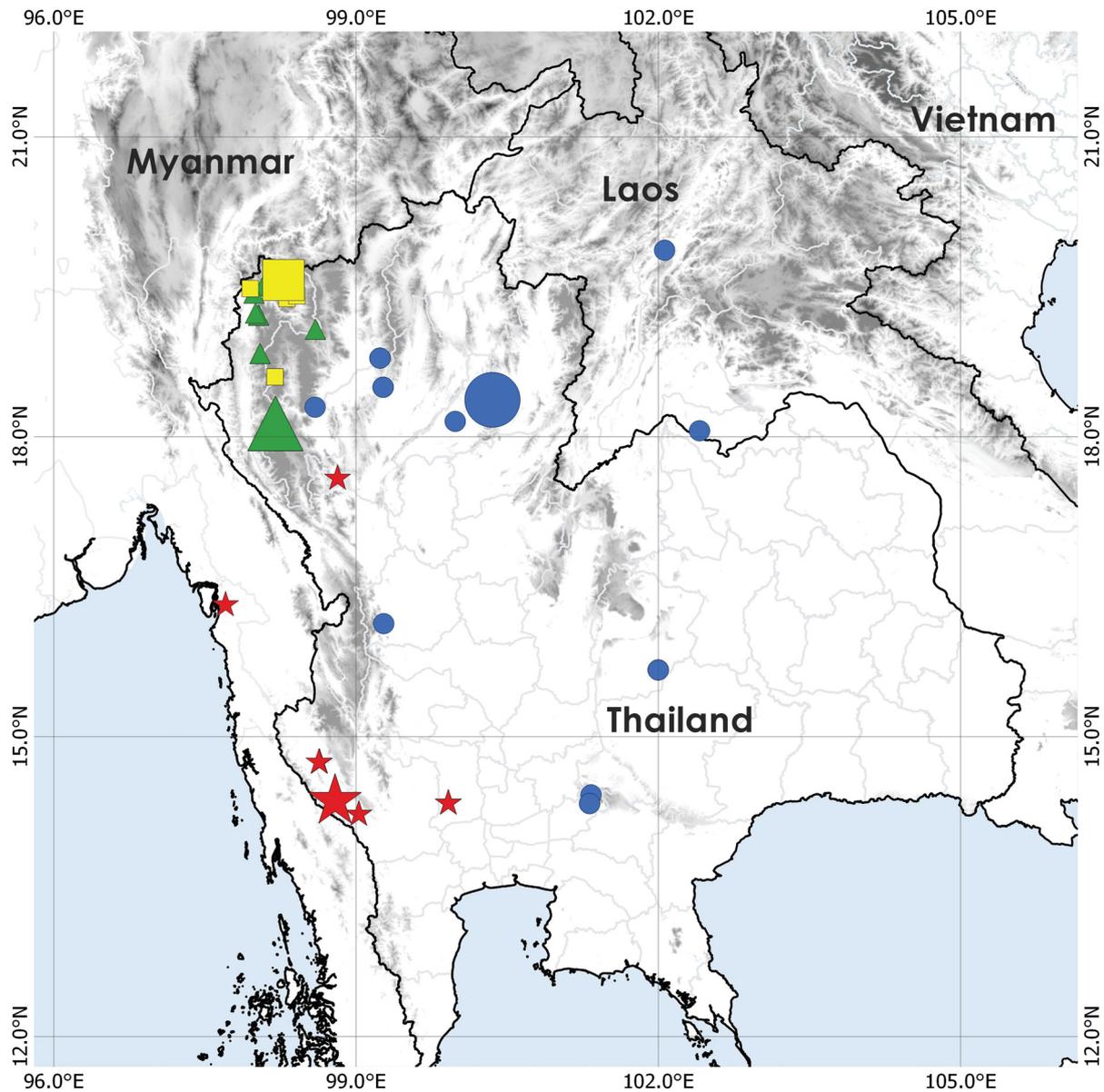


Fig. 6. Distribution range of *G. aranyaniae* Sangvir. & M.F.Newman sp. nov. (circles), *G. flagellaris* K.Larsen (squares), *G. lithophila* Sangvir. & M.F.Newman sp. nov. (triangles), *G. macrochila* Sangvir. & M.F.Newman sp. nov. (stars). The type locality of each species is indicated by a bigger symbol.

Other material examined

LAOS – **Louangphabang** • Along Mekong River; 12 Jun. 2012; J. Leong-Škorničková, H.Đ. Trần, O. Šída, K. Phouthavong and S. Oudomsack 1688 leg.; E. – **Vientiane Capital** • Ban Dong Mak Kay; 27 Jun. 2012; J. Leong-Škorničková, H.Đ. Trần, S. Bouamanivong, P. Phothisath and S. Lonphongs 1827 leg.; E.

THAILAND – **Chaiyaphum** • Ban Nam Phrom; 25 May 1974; R. Geesink, T.A. Hattink and C. Phengkhai 6974 leg.; AAU, BKF, C, K, P. – **Chiang Mai** • Sankamphaeng, Doi Muang On, west side, Muang On subdistrict; 4 Sep. 1995; P. Palee 315 leg.; L • Sankamphaeng, Muang On Cave; 29 Jul. 1989; J.F. Maxwell 89–956 leg.; A, L • Chom Thong, Mae Soi valley; 9 Sep. 1990; J.F. Maxwell 90–974 leg.; L. – **Kamphaeng Phet** • Khlong Lan, Khlong Lan waterfall; 20 Sep. 2015; W. Tanming 883 leg.; QBG. – **Lamphun** • Doi Khun Taan National Park, Tah Goo station area; 29 Aug. 1994; J.F. Maxwell 94–926 leg.; A, BKF, L. – **Nakhon Nayok** • Nang Rong Waterfall; 4 Aug. 1992; K. Larsen, S.S. Larsen, C. Niyomdham, P. Sirirugsa, D.D. Tirvengadum and C.T. Nørgaard 43775 leg.; AAU • Nang Rong Waterfall; 13 Aug. 1968; K. Larsen, T. Santisuk and E. Warncke 3359 leg.; AAU, BKF • Phrae, Huai Rong [Doi Sawan] waterfall, NE of Phrae; 9 Sep. 1995; K. Larsen, S.S. Larsen, C. Tange and D. Sookchaloem 46260 leg.; AAU. – **Non wild collected material** • Phrae, Long, Doi Phaklong National Park; 27 Jun. 2014; Queen Sirikit Botanic Garden acc. no. 20146414A, vouchered as, S. Sangvirotjanapat 785; QBG.

Description

Clump-forming herb, 40–80 cm tall, stems leaning with inflorescence turned upright. Leaf sheaths ca 3, bladeless; ligule 2–5 mm long, light green with white margin, bilobed, ciliate; blades 6–9, 7.5–16 × 2.5–4.5 cm, elliptic, plicate, base obliquely obtuse, apex acuminate, strigose along veins above, otherwise glabrous. Inflorescence 7–15 × 5.5–13 cm, lax, conical; peduncle 2–5 cm long; rachis green, glabrous; bracts caducous; bracteoles 2–10 mm long, persistent, elliptic, glabrous but for a few strigillose hairs at apex, light green; cincinni 1–10 cm long, flowers condensed at tip or lax; pedicel to 5 mm. Flowers 3–3.8 cm long; ovary ellipsoid, ca 4 mm long, green (♂), ridged; calyx ca 4 mm long, infundibuliform, lobes acuminate, ciliate, green; floral tube ca 13 mm long, yellow-orange, dorsal and lateral corolla lobes 5–7 × 3 mm, elliptic, hooded, orange-green; lateral staminodes 14–16 × 6–8 mm, obliquely obovate, yellow-orange, apex round; labellum 6–8 × 5–7 mm, triangular, bilobed, yellow-orange with red or brown spot at centre (flowers of pure colour, without a spot occur rarely in natural populations), base truncate, apex round, nectar tube ca 5 mm long; filament 26–28 mm long, yellow-orange; anther ca 1.5 mm long, connective tissue, crest, and appendages orange, semi-translucent, crest truncate, ca 1 mm long (shorter in ♂); ♀ appendages ca 3 mm long, acuminate, bifid, upper pair bigger, decurrent to connective tissue and crest, lower pair smaller; ♂ appendages ca 3 mm long, acuminate, bifid to halfway, upper pair only slightly bigger than lower. Fruit 17–18 × 4–6 mm, ellipsoid, longitudinally ridged. Bulbils produced at base of peduncle or tip of cincinni or protruding from leaf sheaths, obovate, tissue corky, producing one shoot.

Distribution and habitat

Laos and Thailand, at 100–700 m a.s.l., on limestone in mixed evergreen forest or near streams.

Conservation status

Least Concern. This species occurs in protected areas and suitable habitats across its range. In recent years, no major threat to this species has been reported so it is of Least Concern.

Notes

This species grows on limestone bedrock from the Louangphabang range to the Sankamphaeng range. It is the only species in *G.* subsect. *Nudae* with a spot on the labellum, which varies from red to brown. The

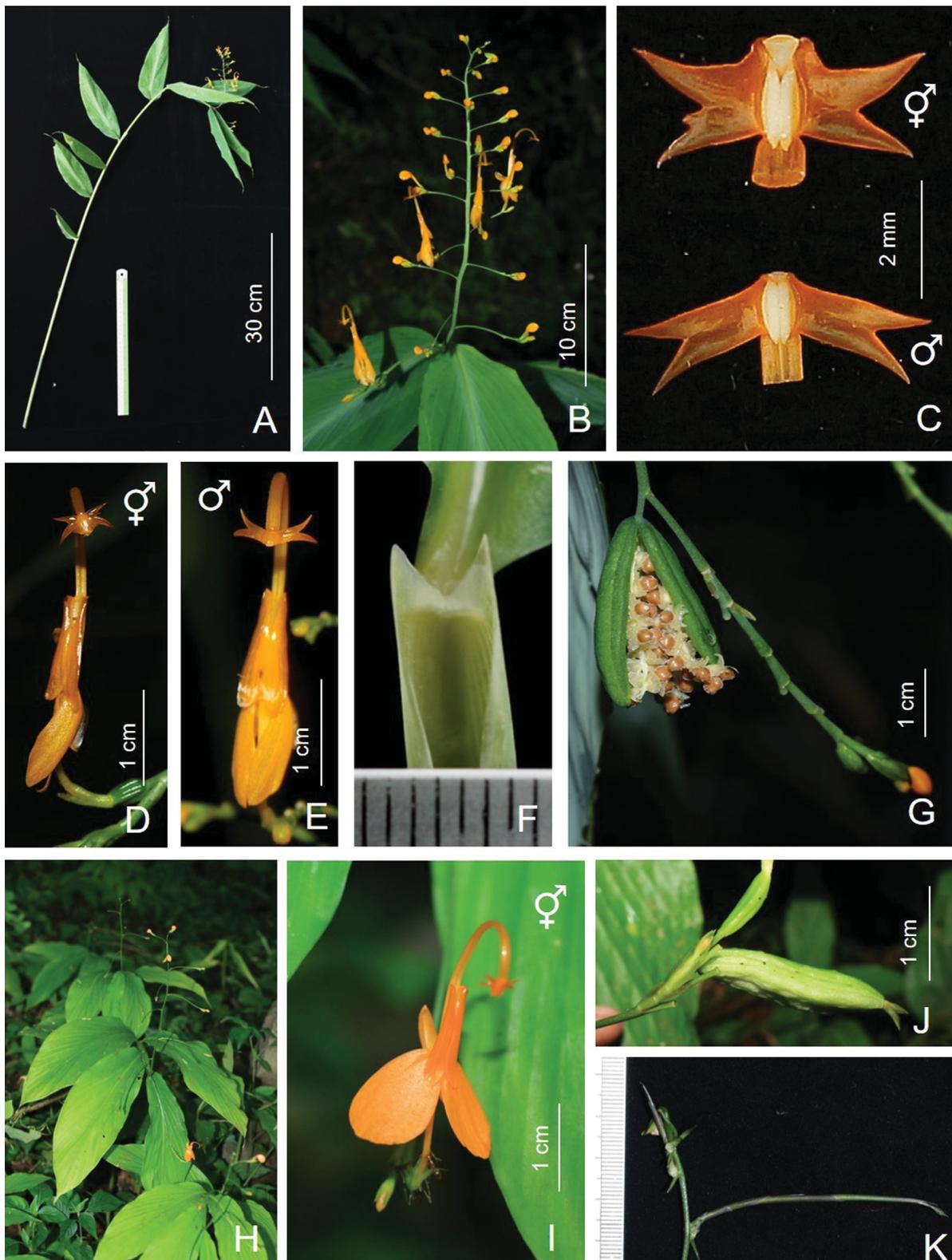


Fig. 7. A–G. *G. expansa* Wall. ex Horan. A. Habit. B. Inflorescence. C. ♀ (above) and ♂ (below) appendages. D. ♀ flower. E. ♂ flower. F. Ligule. G. Mature fruit with seed (M.F. Newman 2561 leg.). H–K. *G. flagellaris* K.Larsen. H. Habit. I. ♀ flower. J. Fruit. K. Bulbils (M.F. Newman 2581 leg.). Photographs: S. Sangvirotjanapat.

vegetative parts of this species vary between the two main distribution areas. In Laotian and northern Thai populations, the inflorescences consist of condensed cincinni packed with bracteoles and pedicels at the tip of each cincinnus, and bulbils produced at the base of the peduncle, while, in central and eastern Thai populations, the cincinni are more elongate, and the bulbils are usually produced at the tip of the cincinni or protrude from the leaf sheaths. In eastern Thailand, the plants are found in more humid places so there may be an ecological difference between the populations but the floral morphology is very uniform, especially the diagnostic characters, namely the spot on the labellum and broad lateral staminodes.

Globba expansa Wall. ex Horan.
Figs 2B, 7A–G, 8

Prodromus Monographiae Scitaminearum Additis Nonnullis de Phytographia, de Monocotyleis et Orchideis: 19 (Horaninow 1862).

Synonyms

G. yeatsiana Craib, *Bulletin of Miscellaneous Information, Royal Botanic Gardens, Kew* 1912: 400 (Craib 1912). – Type: THAILAND • Northern, Chiang Mai, Doi Suthep-Pui National Park; 960 m a.s.l.; 12 Jun. 1910; A.F.G. Kerr 1214 leg.; K (lectotype, designated here), E E00097516 (isolectotype).

G. platystachya sensu Gagnepain, *Flore Générale de l'Indo-Chine* 6 (1): 33 (Gagnepain 1908), non Baker, *The Flora of British India* 6 (17): 206 (Baker 1890).

Type material

Lectotype (designated here)

MYANMAR • Mon State, Attaran, banks of Attaran River; 5 Sep. 1826; N. Wallich 6536C leg.; K-W.

Other material examined

MYANMAR • Ava, Irrawaddy River; 5 Sep. 1826; N. Wallich 6536A leg.; K, K-W.

LAOS – **Xaignabouly** • Paklay, Bane Na Khagnang, Nam Gnam; 2 Sep. 1999; J.F. Maxwell 99–295 leg.; A • Bane Muangham; 7 Sep. 2015; C. Maknoi, W. Pongamornkul and P. Yadee L4256 leg.; QBG.

THAILAND – **Chiang Mai** • Bo Luang, along a stream near Bo Luang; 12 Jun. 1973; R. Geesink, D. Phanichapol and T. Santisuk 5886 leg.; AAU, C, E, K, P • Doi Chiang Dao; 20 Jul. 1998; W.J. Kress, M.W. Bordelon and M. Collins 986256 leg.; US • Chiang Dao; 10 Jun. 2016; N. Sutjaritjai ZB204 leg.; QBG • Doi Saket, Ban Thep Sadet; 29 Sep. 2001; P. Suksathan 3134 leg.; QBG • Doi Suthep-Pui National Park; 12 Jun. 1910; A.F.G. Kerr 1214 leg.; E, K • Doi Suthep-Pui National Park; 3 Jul. 1958; K. Larsen, B. Hansen and T.J. Sørensen 3864 leg.; C • W. Micholitz; K • Doi Suthep-Pui National Park; 21 Jun. 1958; K. Larsen, B. Hansen and T.J. Sørensen 3654 leg.; C • Doi Suthep-Pui National Park; 25 Jul. 1958; K. Larsen, B. Hansen and T.J. Sørensen 4396 leg.; C • Fang, 10 km W of Fang; 24 Jul. 1968; K. Larsen, T. Santisuk and E. Warncke 2650 leg.; AAU, C, E, K, P • Between Mae Klang and Sop Aep; 1 Oct. 1971; G. Murata, K. Iwatsuki, C. Phengkklai and C. Charamphol T 15516 leg.; AAU • Ang-ka-noi; 26 Jun. 1978; C. Phengkklai, M. Tamura, C. Niyomdham and B. Sangkhachand 4121 leg.; A, C • Doi Suthep-Pui National Park, N side, Mae Sa botanical garden; 20 Jul. 1989; J.F. Maxwell 89–912 leg.; A, L • Doi Suthep-Pui National Park, S side, Mae Hia Nai village; 8 Aug. 1990; J.F. Maxwell 90–847 leg.; A, L • Doi Suthep-Pui National Park, N side, Mae Sa Botanical Garden, along Huay Mae Sa Noi; 3 Jul. 1992; J.F. Maxwell 92–358 leg.; E, GH, L, P • Doi Inthanond; 15 Sep. 1995; K. Larsen, S.S. Larsen, C. Tange and D. Sookchaloem 46485 leg.; AAU, L • Doi Inthanond, Wachirathan waterfall, Chom Tong district; 19 Sep. 2008; D.J. Middleton, P. Karaket, P. Triboun, U. Kawatkul and R. Meeboonya 4513 leg.;

E, QBG[2] • Mae Chaem, near Huay Bo Ka Long, Doi Chan Pa Di, near Bo Ka Long (Karen) village; 26 May 1995; J.F. Maxwell 95–473 leg.; A • Mae Rim, Ban Mae Sa Mai; 11 Aug. 1998; W. Nanakorn 11719 leg.; QBG • Mae Rim, Ban Mae Sa Mai; 28 Jun. 2008; J.F. Maxwell 08134 leg.; QBG • Mae Rim, Pong Yaeng, Road to Nong Hoi Royal Project; 26 Jul. 2013; M.F. Newman, S. Sangvirotjanapat, P. Suksathan, E. Závěská and M. Pospíšilová 2561 leg.; QBG • Mae Rim, Pong Yaeng, Ban Maesa Mai; 27 Jul. 2013; M.F. Newman, S. Sangvirotjanapat, P. Suksathan, E. Závěská and M. Pospíšilová 2562 leg.; QBG • Chiang Rai, Wiang Pa Pao, Mae Chedi, Mae Lao; 1 May 1933; H.B.G. Garrett 749 leg.; K • San Klang, Amphoe Phan, ca 3 km W of Thung Ma Fang village, along stream flowing into Huay Mae Bon reservoir; 18 Jun. 1997; J.F. Maxwell 97–664 leg.; A, L. – **Kanchanaburi** • Ban Wang Kalang, Neeckey; 9 May 1946; G.d. Hoed 246a leg.; K, P • Thong Pha Phum, Hin Dat; 1 Jul. 1926; Put 64 leg.; K • Thung Yai Naresuan, along Ro Kee stream; 17 Jun. 1993; J.F. Maxwell 93–644 leg.; A, L. – **Lampang**

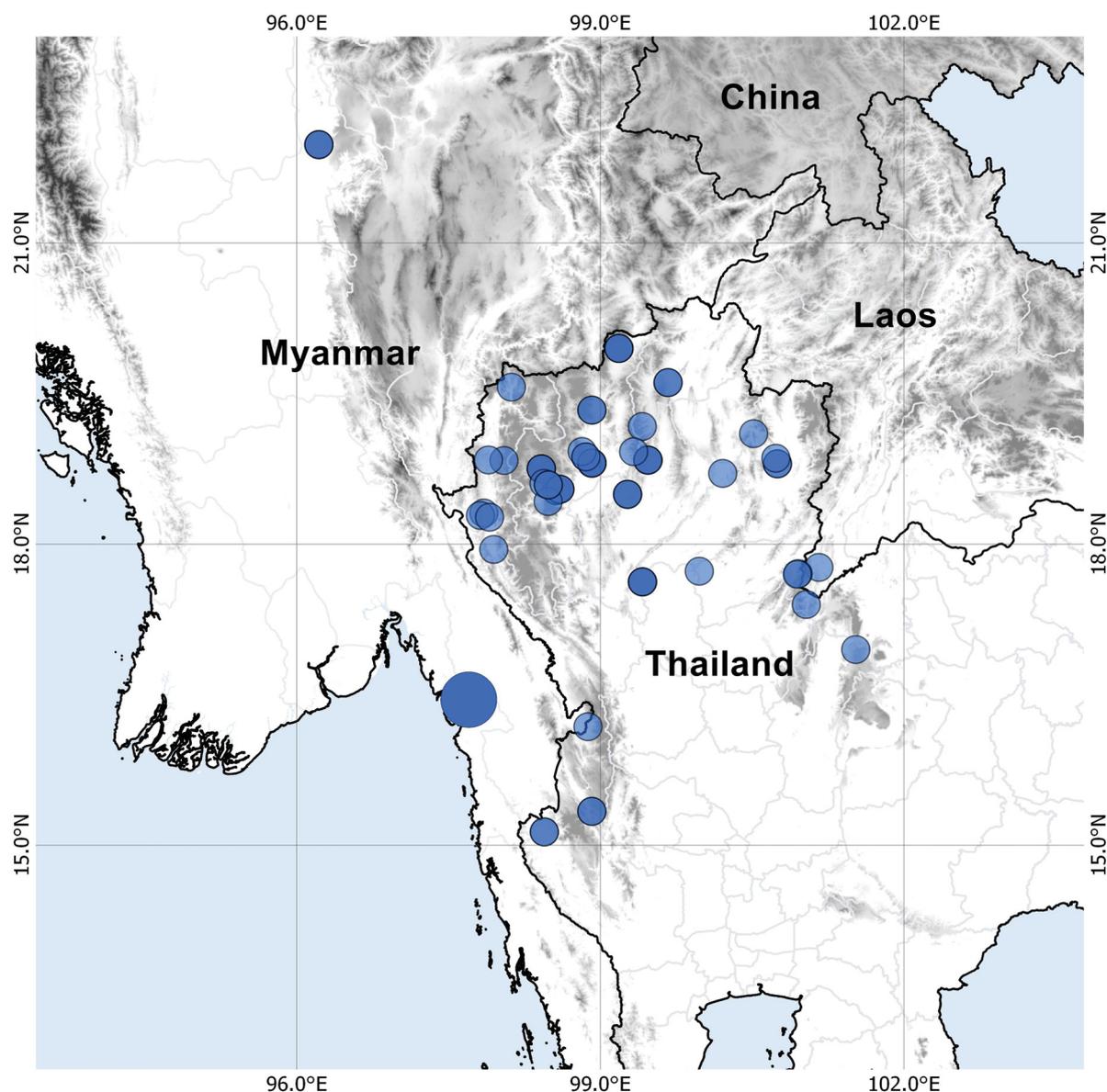


Fig. 8. Distribution range of *G. expansa* Wall. ex Horan. The type locality is indicated by a bigger symbol.

• Chae Son National Park, park HQ area; 23 Sep. 1995; J.F. Maxwell 95–734 leg.; BKF, L • Chae Son National Park, Mae Sook subdistrict, Mae Awe station; 30 May 1996; J.F. Maxwell 96–753 leg.; A, L • Doi Khun Taan National Park; 17 May 1933; H.M. Smith 545 leg.; US • Doi Khun Taan National Park, W side of mountain, near Yaw 3; 5 Jun. 1993; J.F. Maxwell 93–573 leg.; A, L. **Loei** • Na Haeo; 27 Apr. 1995; W. Nanakorn 3237 leg.; QBG. – **Mae Hong Son** • Khun Yuam; 15 Aug. 1998; C. Trisonthi KY487 leg.; QBG • Khun Yuam, Mae Yum Luang waterfall; 7 Aug. 2000; K.J. Williams 00–353 leg.; E • Salawin National Park, Mae Sariang District; 2 Aug. 2013; M.F. Newman, S. Sangvirotjanapat, P. Suksathan, E. Závěská and M. Pospíšilová 2589 leg.; QBG • San Pan Daen Wildlife Sanctuary, Pang Mapha District; 5 Aug. 1999; J.F. Maxwell 99–83 leg.; A • Mae Sariang, Mae Top Karen village; 2 Aug. 2013; M.F. Newman, S. Sangvirotjanapat, P. Suksathan, E. Závěská and M. Pospíšilová 2592 leg.; QBG • Mae Sariang, Ban Kat, Doi Khun Mae Tob; 20 Jul. 2015; P. Phaosrichai 238 leg.; QBG • Sob Moei; 11 Jun. 2016; N. Sutjaritjai ZB206 leg.; QBG. – **Nan** • Tham Pha Tup Forest Park; 25 Jul. 1992; K. Larsen, S.S. Larsen, C. Niyomdham, P. Siriruga, D.D. Tirvengadum and C.T. Nørgaard 43582 leg.; AAU • Tham Pha Tup Forest Park; 13 Sep. 1995; K. Larsen, S.S. Larsen, C. Tange and D. Sookchaloem 46430 leg.; AAU • Tham Pha Tup Forest Park, trail to Tham Phra; 16 Aug. 2012; D.J. Middleton, P. Karaket, S. Suddee and P. Triboun 5614 leg.; E. – **Phayao** • Pong, Doi Pha Chang Wildlife Sanctuary, E side of Doi Pha Lom, Khun Khuan subdistrict; 1 Aug. 1998; J.F. Maxwell 98–761 leg.; A. – **Phetchabun** • Nam Nao National Park, Tham Yai; 2 Sep. 2014; C. Maknoi 7097 leg.; QBG. – **Phetchaburi** • Phetchaburi River; J.B.L. Pierre 48 leg.; P. – **Phitsanulok** • Phu Soi Dao, Chat Trakan District; 14 Aug. 2000; P. Suksathan 2675 leg.; QBG. **Phrae** • Song; 10 Jun. 2006; J.F. Maxwell 06371 leg.; QBG. – **Sukhothai** • Si Satchanalai, Phakha; 12 Jun. 2012; S. Klongngern 22 leg.; QBG • Si Satchanalai National Park, Route to Tham Tharawasan; 21 Jul. 2015; C. Maknoi 7985 leg.; QBG • Si Satchanalai National Park, Tham Khangkhao; 22 Jul. 2015; C. Maknoi 8070 leg.; QBG • Si Satchanalai National Park, Route to Tham Khangkhao; 26 Aug. 2015; C. Maknoi 8192 leg.; QBG. – **Tak** • Mae Sot, Phawo, Mu Kee Haw (Karen) village; 18 Aug. 1994; J.F. Maxwell 94–886 leg.; A • Mae Sot; 14 Jul. 1999; M.F. Newman 909 leg.; E. **Uttaradit** • Laplae, Mae Phun; 28 Jun. 2012; M. Norsaengsri and N. Tathana 9648 leg.; QBG • Nam Pat, Phu Soi Dao, Path by waterfall towards pine forest; 7 Aug. 2013; M.F. Newman, S. Sangvirotjanapat, P. Suksathan, E. Závěská and M. Pospíšilová 2624 leg.; QBG.

Description

Herb (25–)45–150 cm tall, clump-forming, leaning with inflorescence turning upright. Leaf sheaths ca 3, bladeless; ligule 1–6 mm long, truncate to bilobed, glabrous to pubescent, light green with white margin; blades 6–9, 10–29 × 1.7–9 cm, elliptic, usually glaucous, sometimes with grey patch along midrib above, base cuneate or obliquely rounded, apex acuminate to caudate, adpressed pubescent below, otherwise glabrous. Inflorescence 10–27 × 6.5–17 cm, lax, conical; peduncle to 3 cm long; rachis green, glabrous; bracts and bracteoles to 10 mm long, caducous, elliptic, glabrous to minutely pubescent, green; cincinni 1–12 cm, elongate, flowers lax on cincinnus; pedicel 1–2 mm. Flowers 3.4–3.6 cm long; ovary ca 4 mm long (♀), ellipsoid, ridged, glabrous, green; calyx ca 4 mm long, infundibuliform, green, lobes acuminate, margins sparsely pubescent; floral tube 9–14 mm long, minutely pubescent, yellowish orange, dorsal and lateral corolla lobes 6–7.5 × 3–4 mm, hooded, the dorsal one slightly larger, orange-green; lateral staminodes 11–13 × 3–5 mm, oblong to narrowly obovate, yellowish orange, apex round; labellum 11–12 × 4–5 mm, triangular, bilobed, yellowish orange, spot absent, base truncate, apex round, nectar tube 3–5 mm long; filament 26–28 mm, minutely pubescent, orange; anther 1–2 mm long, connective tissue, crest and appendages orange, semi-translucent, crest ca 1 mm long, truncate (shorter in ♂); ♀ appendages ca 3 mm long, acuminate, bifid, upper pair bigger, decurrent to connective tissue and crest, lower pair smaller; ♂ appendages ca 3 mm long, acuminate, bifid to halfway, upper pair only slightly bigger than lower. Fruit to 2.7 × 1 cm, ellipsoid, longitudinally ridged, green. Bulbils occasional, subtended by sterile bracts below lowest cincinnus, spindle-shaped, tissue corky.

Distribution and habitat

Myanmar, Laos, Thailand, 174–1350 m a.s.l., growing in mixed evergreen forest along the trail under semi shade. Usually found as dense clump.

Conservation status

Least Concern. The species occurs in a number of protected areas across its range. The species is grown in *ex situ* collections at two botanic Gardens (BGCI 2018).

Notes

Globba expansa is the most common species in this subsection, growing widely in northern Myanmar, Thailand, and Laos. Usually found in evergreen forest or deciduous forest, it is easily noticed by its large inflorescence with bright orange flowers on elongate cincinni. As its distribution is wide, this species has been described twice from Myanmar and Thailand. Type specimens and living specimens at the type locality of *G. yeatsiana* were compared. In the case of *G. expansa* from Myanmar, Wallich's specimens no. 6536 are in good condition, especially no. 6536C which has a male flower attached to the sheet. As for *G. yeatsiana* from Thailand, type specimens were studied alongside living plants found predominantly at 800–1000 m a.s.l. in evergreen forest of Doi Suthep-Pui. Both specimens shared the same morphological characteristics, such as oblong to narrowly obovate lateral staminodes, labellum shape, anther appendage shape, and floral part ratio. As a result, *G. yeatsiana* is placed in synonymy under the earlier name, *G. expansa*.

Globba flagellaris K.Larsen
Figs 2C, 6, 7H–K

Nordic Journal of Botany 17: 119 (Larsen 1997).

Type material**Holotype**

THAILAND • Mae Hong Son, Doi Pui; 19°13'0" N, 98°2'0" E; 800 m a.s.l.; 23 Sep. 1995; K. Larsen, S.S. Larsen, C. Tange and D. Sookchaloem 46843 leg.; AAU.

Isotypes

THAILAND • Same data as for the holotype; MO, L, K.

Other material examined

THAILAND – **Chiang Mai** • Bo Luang, 20 km W of Bo Luang towards Mae Sariang; 4 Jul. 1968; K. Larsen, T. Santisuk and E. Warncke 2100 leg.; AAU, C, E, K, P • Doi Pui, Huai Mae Sa Kut to Huai Thond road; 6 Aug. 2000; K.J. Williams 00–347 leg.; E. – **Mae Hong Son** • Ban Nam Kat, edge of forest near stream; 5 Aug. 2000; K.J. Williams 00–343 leg. E • Khun Yuam, Mae Yum Luang waterfall; 6 Aug. 2000; K.J. Williams 00–354 leg.; E • Khun Yuam; 5 Sep. 1974; K. Larsen and S.S. Larsen 34168 leg.; AAU). – **Nan** • Amphoe Ban Wang Luang, near Tham Lod; 5 Aug. 2000; K.J. Williams 00–338 leg.; E. – **Non wild collected material** • 1 Dec. 1970; S.N. Chong s.n. leg.; Royal Botanic Garden Edinburgh acc. no. 19991624, vouchered as 'M.F. Newman and J. Škorničková 2048'; E.

Description

Herb (20–)50–100 cm tall with erect, flattened, leafy stems and prostrate, leafless stems running ca 75 cm along the ground to produce bulbils which take root. Leaf sheaths 3–5 bladeless; ligule 5–6 mm long, truncate to bilobed, glabrous to minutely ciliate; blades 6–8, 15–20 × (3.5–) 6–8 cm, usually broadly elliptic, sometimes narrowly so, base cuneate to decurrent, apex caudate, glabrous, petiole

2–5 mm long. Inflorescence 10–30 × 7–18 cm, lax, conical, elongating greatly at anthesis; peduncle to 15 cm long; rachis glabrous; bracts 3–12 mm long, caducous, bracteoles persistent, triangular, glabrous to minutely pubescent; cincinni 3.5–15 cm long; pedicel to 6 mm long. Flowers 3.3–3.6 cm long, ovary and calyx green, the rest pure orange; ovary ca 3 mm long (♀), ellipsoid, ridged; calyx 3–5 mm long, infundibuliform, lobes acuminate, margins sparsely pubescent; floral tube ca 15 mm long, minutely pubescent, dorsal and lateral corolla lobes 6–7.5 × 3–4 mm, hooded, the dorsal one slightly larger, the lateral lobes usually concealed by the lateral staminodes; lateral staminodes 12–15 × 5–9 mm, obovate, usually very large, apex round; labellum triangular, 10–12 mm long, bilobed for 1/3–1/2 its length, spot absent, base truncate, apex obtuse, nectar tube ca 4.5 mm long; filament ca 27 mm long, minutely pubescent; anther 1–2 mm long, connective tissue, crest and appendages orange, semi-translucent, crest ca 1 mm long (shorter in ♂), truncate; ♀ appendages ca 3 mm long, acuminate, bifid, upper pair bigger, decurrent to connective tissue and crest, lower pair smaller; ♂ appendages ca 3 mm long, acuminate, bifid to halfway, upper pair only slightly bigger than lower. Fruit 20–27 × 8–10 mm, ellipsoid, triangular in cross section, longitudinally ridged, green. Bulbils occasional, subtended by sterile bracts below lowest cincinnus, spindle-shaped with prolonged shoot, tissue corky; also on flagellate stems.

Distribution and habitat

Chiang Mai, Mae Hong Son, and Nan provinces, Thailand, 450–1100 m a.s.l. It grows in dense populations in rather moist areas, often near streams.

Conservation status

Least Concern. *Globba flagellaris* has a small area AOO of 32 km² and EOO of 5619 km², suggesting a status of Vulnerable. As it grows in protected areas, however, as well as *ex situ* in Queen Sirikit Botanic Garden, it is therefore of Least Concern.

Globba insectifera Ridl.

Figs 2D, 9A–D, 10

Journal of the Straits Branch of the Royal Asiatic Society 49: 42 (Ridley 1908).

Synonyms

G. kerrii Craib, *Bulletin of Miscellaneous Information, Royal Botanic Gardens, Kew* 1912: 398 (Craib 1912). – Type: THAILAND • Chiang Mai, Doi Suthep-Pui National Park; 1200 m a.s.l.; 24 Jul. 1910; A.F.G. Kerr 1278 leg.; E (lectotype, designated here), BM (isolectotype), E E00097477 (isolectotype), K (isolectotype, 2 sheets).

G. nuda K.Larsen, *Notes from the Royal Botanic Garden Edinburgh* 31: 235 (Larsen 1972). – Type: THAILAND • Chiang Mai, Doi Suthep-Pui National Park; 850 m a.s.l.; 13 Apr. 1958; K. Larsen, B. Hansen and T.J. Sørensen 2678 leg.; AAU (holotype), C (isotype), BKF (isotype).

Type material

Lectotype (designated by Turner 2000)

MYANMAR • Shan State, Shan Hills; W. Micholitz 783 leg.; SING.

Other material examined

THAILAND – **Chiang Mai** • 15 May 1977; T. Santisuk 991 leg.; A, BKF, US • 20 km W of Chiang Mai; 5 Jun. 1963; R.M. Bird, R.A. Darrow and R.M. King 5465 leg.; AAU, GH, K, UC • Kanlayaniwatthana, Chaem Luang, slopes above Mae Chaem, Huai Ya Tai (Karen) village; 11 Jun. 1998; J.F. Maxwell 98–644 leg.; A, BKF • Sankamphaeng, Doi Muang On (cave); 25 Jun. 1992; J.F. Maxwell 92–317 leg.; L •



Fig. 9. A–C. *G. insectifera* Ridl. **A.** Isotype of *G. kerrii* Craib (E00097476). **B.** Inflorescence in dry season. **C.** Inflorescence in rainy season (S. Sangvirotjanapat 743 leg.). **D–E.** *G. lancangensis* Y.Y.Qian. **D.** Flowers (P. Suksathan s.n. leg.). **E.** Specimens from China, S.S. Zhou 2993 leg. (QBG). Photographs: A–C, E, S. Sangvirotjanapat; D, P. Suksathan.

Doi Chiang Dao, watershed station; 6 Jun. 1973; R. Geesink, D. Phanichapol and T. Santisuk 5733 leg.; BKF, C • Chiang Dao, Lan Son; 4 May 2001; M. Norsaengsri, P. Suksathan and R. Pongsattayapipat 1478 leg.; QBG • Doi Chiang Dao, Animal Sanctuary, Ban Yang Toong Bong Forest Station area; 16 Jun. 1990; J.F. Maxwell 90–642 leg.; L • Doi Chiang Dao; 24 Apr. 1956; P. Suwannakoset 1177 leg.; BKF • Doi Inthanond, road between Chom Thong and Mae Chaem; 16 Jul. 1998; W.J. Kress, M.W. Bordelon and M. Collins 986189 leg.; US • Doi Saket, Huay Hong Khrai Royal Development Project; 27 May 1993; S. Suwannaratana 1 leg.; A, L • Doi Suthep-Pui National Park; 24 Jul. 1910; A.F.G. Kerr 1278 leg.; BM, E[2], K[2] • Doi Suthep-Pui National Park; 13 Apr. 1958; K. Larsen, B. Hansen and T.J. Sørensen 2678 leg.; AAU, BKF, C • Doi Suthep-Pui National Park; 18 Apr. 1958; K. Larsen, B. Hansen and T.J. Sørensen 2875 leg.; AAU, C • Doi Suthep-Pui National Park, E side, trail to Pah Laht temple; 20 Apr. 1988; J.F. Maxwell 88–484 leg.; BKF • Doi Suthep-Pui National Park; 9 Apr. 1966;

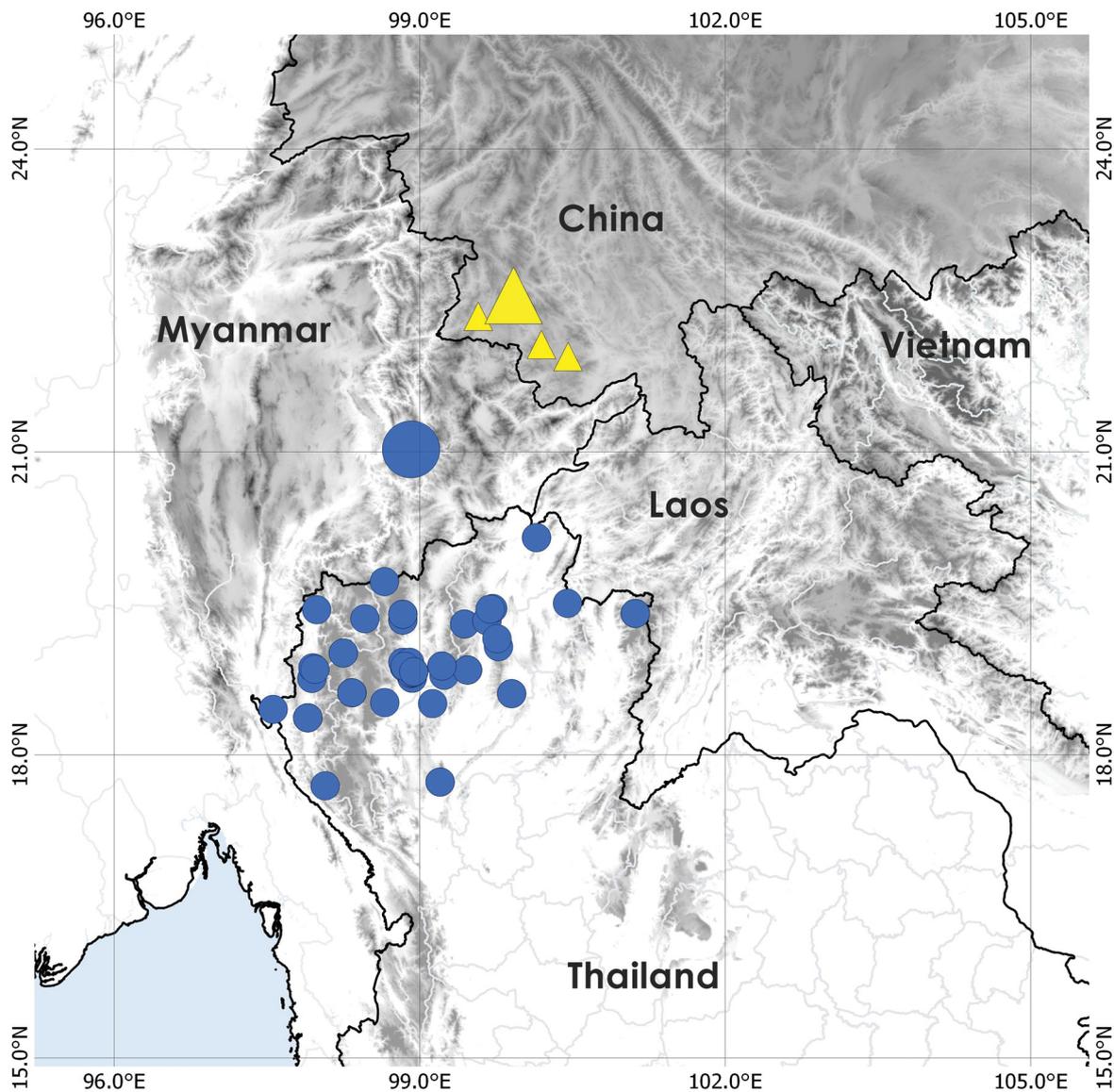


Fig. 10. Distribution range of *G. insectifera* Ridl. (circles) and *G. lancangensis* Q.Q.Yian (triangles). The type locality of each species is indicated by a bigger symbol.

B. Sukkri 80 leg.; BKF • Doi Suthep-Pui National Park, E side, Chiang Mai Uni. observatory; 31 Mar. 1989; J.F. Maxwell 89–401 leg.; BKF • Doi Suthep-Pui National Park, east side, near Palat Temple; 3 Jul. 1993; A. Phuakam 34 leg.; L • Doi Suthep-Pui National Park; 26 Jun. 1958; K. Larsen, B. Hansen and T.J. Sørensen 3740 leg.; AAU, C • Doi Suthep-Pui National Park; 9 Jul. 1999; M.F. Newman 892 leg.; BKF, E • Mae Chaem, E side of Doi Chan Pah Dih; 25 May 1995; J.F. Maxwell 95–455 leg.; BKF, L • Mae Chaem, near Huay Bo Gah Long, Doi Chan Fah Dih, near Bo Gah Long village; 26 May 1995; J.F. Maxwell 95–475 leg.; BKF • Ob Luang National Park, along Mae Chaem river, ca 14 km W of Hot; 4 Aug. 1990; J.F. Maxwell 90–842 leg.; L • Mae On, Huai Kaeo, Doi Suthep-Pui NP; 26 Jul. 2013; M.F. Newman, S. Sangvirotjanapat, P. Suksathan, E. Závěská and M. Pospíšilová 2560 leg.; QBG • Mae Rim, 15 km N of Chiang Mai; 17 Jul. 1968; K. Larsen, T. Santisuk and E. Warncke 2590 leg.; AAU • Queen Sirikit Botanic Garden; 7 Jun. 2016; Y. Seepacha and J. Ongkhakat YJ5 leg.; QBG • Queen Sirikit Botanic Garden, Forest trail near cultivated section of garden; 31 Jul. 2000; K.J. Williams 00–289 leg.; E • Queen Sirikit Botanic Garden, above small stream in forest near back of cultivated side of garden; 2 Aug. 2000; K.J. Williams 00–297 leg.; E • Queen Sirikit Botanic Garden, in forest along road near summit, accommodation side of garden; 3 Aug. 2000; K.J. Williams 00–323 leg.; E • Queen Sirikit Botanic Garden, Huay Mae Sa Noi; 23 Apr. 1997; anonymous 9025 leg.; QBG • Chai Prakan, Ban Pak Sam; 6 Jun. 2001; M. Norsasengri and W. Boonchai 1547 leg.; QBG • Queen Sirikit Botanic Garden; 14 May 2005; C. Glamwaewwong 1072 leg.; QBG • Queen Sirikit Botanic Garden, Beside herbarium building; 4 Sep. 2005; C. Glamwaewwong 58 leg.; QBG • Queen Sirikit Botanic Garden; 16 Jun. 2015; S. Sangvirotjanapat 743 leg.; QBG • Wiang Haeng, Piang Luang, Ban Na Yao; 14 May 2001; M. Norsasengri 1535 leg.; QBG. – **Chiang Rai** • Doi Luang National Park – Chiang Rai, Phu Kaeng falls; 27 Aug. 2015; M. Norsasengri 12501 leg.; QBG • Doi Luang National Park-Chiang Rai, Wiang Papao Dist., summit ridge of Doi Mok; 25 May 1998; J.F. Maxwell 98–578 leg.; A, BKF • Wiang Pa Pao; 14 May 1933; H.B.G. Garrett 768 leg.; K, P. – **Lampang** • Chae Son National Park, along Mae Mon stream above Chae Son waterfall; 22 Jun. 1996; M. Panatkool 39 leg.; A, L • Doi Luang National Park-Lampang, SW side, Wang Kaeo waterfall; 20 Apr. 1997; J.F. Maxwell 97–351 leg.; A, L • Chae Son National Park, along Mae Mon stream at Chae Son waterfall; 23 Apr. 1996; M. Panatkool 8 leg.; L • Chae Son National Park, along Mae Mon stream, near falls; 23 Apr. 1996; J.F. Maxwell 96–570 leg.; A, BKF, L • Nam Mae Huat; 4 Jul. 1954; Amnat 14 leg.; BKF, C • Mae Kang; 30 Apr. 1925; Winit 1407 leg.; BK, BKF, K. – **Lamphun** • Doi Khun Taan National Park, near the accommodation centre; 3 Jun. 1993; J.F. Maxwell 93–540 leg.; L • Doi Khun Taan National Park; 15 Feb. 1933; Din Nakkhan 168 leg.; BKF • Muang Lamphun, Sibuan; 6 Jun. 2016; N. Sutjaritjai ZB202 leg.; QBG • Loei, Na Hao; 27 Apr. 1995; anonymous 3237 leg.; QBG [as aff.]. – **Mae Hong Son** • Ban Mae La Noi, 25 km N of Mae Sariang; 9 Jul. 1968; K. Larsen, T. Santisuk and E. Warncke 2296 leg.; AAU, BKF, C, E, K, P • Khun Yuam, Ban Pa Fang; 15 Jun. 2012; K. Chanta 36 leg.; QBG • Khun Yuam, Ban Namon; 1 Aug. 2013; M.F. Newman, S. Sangvirotjanapat, P. Suksathan, E. Závěská and M. Pospíšilová 2585 leg.; QBG • Road to Mae Sariang; 6 Aug. 2000; K.J. Williams 00–351 leg.; E [as aff.] • Mae Sariang, 87 km N of Mae Sariang on the road to Mae Hong Son; 18 Jul. 1998; W.J. Kress, M.W. Bordelon and M. Collins 986233 leg.; US • Mae Sariang, 19–24 km E of Mae Sariang towards River Salween; 17 Jul. 1998; W.J. Kress, M.W. Bordelon and M. Collins 986211 leg.; US • Mae Sariang, 87 km N of Mae Sariang on the road to Mae Hong Son; 18 Jul. 1998; W.J. Kress, M.W. Bordelon and M. Collins 98–6233 leg.; US • Mueang Mae Hong Son, Na Pla Chad, Tham Pla-Namtok Pha Suea N.P.; 20 Aug. 2013; M. Norsasengri 10489 leg.; QBG • Pai; 29 Jun. 1995; W. Nanakorn 3926 leg.; QBG • Sob Moei, Ban Um Da Tai; 10 Jul. 2013; W. Pongamornkul 3461 leg.; QBG • Nan, Doi Phu Kha, Baan Huay Pud; 5 Jul. 1999; P. Srisanga, S. Watthana and W. La-onsri 892 leg.; E, QBG • Tham Pha Tup Forest Park; 13 Sep. 1995; anonymous 4235 leg.; QBG. – **Phayao** • Chiang Kham, Doi Huai Sa, Rom Yen subdistrict; 18 Jun. 2013; W. La-onsri, M. Norsasengri, P. Panyachan, P. Tatiya and S. Satatha 2913 leg.; QBG • Doi Luang National Park-Phayao, Sra Pa Ko, trail to summit of Doi Luang; 6 May 2015; M. Norsasengri 12264 leg.; QBG • Doi Luang National Park-Phayao, Pha Kled Nak WF; 8 May 2015; M. Norsasengri 12433 leg.; QBG • Doi Luang National Park-Phayao; 31 May 2016; N. Muangyen 1004 leg.; QBG.

Description

Herb 25–120 cm tall, leafy shoot leaning, with inflorescence turned upright. Leaf sheaths ca 3, bladeless; ligule 2–4 mm long, truncate or shallowly bilobed, sparsely pubescent, light green; blade 5–11, 5.5–18 × 0.6–3.5 cm, sessile, oblong to elliptic, base obliquely cuneate, apex acuminate, puberulous below, strigose above. Inflorescences, 5.5–15 × 4–12 cm, produced on separate, leafless shoots in April to early May, then on leafy shoots in July and August, lax, conical, sometimes secund; peduncle ca 3 cm long; rachis light green, pubescent; bracts and bracteoles 0.5–2 mm long, caducous, deltoid to lanceolate, glabrous to pubescent, apex acute, light green; cincinni 4–12, 1.5–5.5 cm long; pedicel ca 1 mm long. Flowers 3.4–3.8 cm long, lemon or bright yellow; ovary c. 3 mm long (♀), ellipsoid; calyx 4 mm long, infundibuliform, lobed acute, yellow-green; floral tube ca 10 mm long, dorsal and lateral corolla lobes 6–7 mm long, hooded, elliptic, yellow; lateral staminodes 18–20 × 9–11 mm, obovate, usually very large, apex acute to obtuse, bright yellow; labellum 12–14 × 4–5 mm, triangular, bilobed, spot absent, base truncate, apex round, nectar tube ca 8 mm long, yellow-orange; filament 26–28 mm long; anther ca 2 mm long, connective tissue, crest and appendages bright yellow-orange, semi-translucent, crest c. 1 mm long (shorter in ♂), truncate; ♀ appendages ca 3 mm long, acuminate, bifid, upper pair bigger, decurrent to connective tissue and crest, lower pair smaller; ♂ appendages ca 4 mm long, acuminate, bifid to halfway, upper pair only slightly bigger than lower. Fruit to 2.5 × 1 cm, ellipsoid, longitudinally ridged, green. Bulbils occasional, subtended by sterile bracts below lowest cincinnus, spindle-shaped, tissue corky.

Distribution and habitat

Myanmar and Thailand, 240–1500 m a.s.l. Common in dipterocarp or grass forest in open areas. The plants grow over large areas but not covering the ground densely.

Conservation status

Least Concern. *Globba insectifera* is fairly widespread in Thailand and Myanmar with an extent of occurrence of 77052 km². Threats to the species are mostly localized and are not of major concern. In addition, many populations grow in national parks so the species is assessed as Least Concern.

Notes

The growth pattern of *G. insectifera* from the dry to the rainy season was monitored at Doi Suthep-Pui, Chiang Mai province, Thailand, and the results showed that this species produces inflorescences twice a year. The first inflorescences appear in the middle of summer (April to early May) with only very small leaflets at the base. Later, inflorescences are produced terminally on the leafy shoots during the rainy season following the normal pattern of this genus. This information is useful for taxonomic treatment of this species.

Specimens collected in the dry season have been described twice as *G. insectifera* and *G. nuda*. Ridley's specimen grew spontaneously from plants collected in the Shan state, Myanmar, labelled as "*Paphiopedilum bellatulum*" and cultivated in Singapore Botanic Gardens. Ridley mentioned that this species had an inflorescence shoot and that its flower looked like a butterfly because of its large lateral staminodes. This species was lectotypified by Turner (2000) on a colour illustration deposited at Singapore Botanic Garden which we have seen. The other name, *G. nuda*, was described from Doi Suthep-Pui, Chiang Mai province, Thailand. Larsen diagnosed this species by its inflorescence shoot which had no leaves, giving it the specific epithet '*nuda*', meaning without leaves. Larsen did not mention *G. insectifera*. We have seen the holotype of *G. nuda* at AAU and other specimens from Thailand. Furthermore, we have visited Doi Suthep-Pui which is the type locality of *G. nuda*.

As for specimens growing in the rainy season, Craib (1912) described *G. kerrii* from Doi Suthep-Pui which he diagnosed by its wide lateral staminodes. One of the isotype sheets at E (E00097476 and E00097477), which we have seen, has an inflorescence shoot remaining at the base of the plant. This was not mentioned in the protologue but it gives strong support for the placement of *G. kerrii* and *G. nuda* in synonymy under *G. insectifera* (Fig. 9A–D).

***Globba lancangensis* Y.Y.Qian**

Figs 9E, 10

Acta Botanica Austro Sinica 9: 51 (Qian 1994).

Type material

Holotype

CHINA • Yunnan, Lancang Lahuzu Zizhixian, Lancang; 1200 m a.s.l.; 16 Oct. 1984; Y.Y. Qian 2255 leg.; SMAO.

Isotype

CHINA • Same data as for the holotype; IBSC.

Other material examined

CHINA – **Lancang Lahuzu Zizhixian** • Lancang; 13 Jul. 2000; K.J. Williams, Q-J. Li and Y.Y. Qian 00–241 leg.; E • Menghai, Xishuangbanna pref., Mung-Ze, near Mung-Hai city; 14 Jul. 2000; K.J. Williams and Q-J. Li 00–253 leg.; E • Liming Farm, Mengzhe; 14 Oct. 2005; S.S. Zhou 2962 leg.; QBG • Menglian, Langle village; 15 Oct. 2005; S.S. Zhou 2993 leg.; QBG.

Description

Herb 60–80 cm tall. Leaf sheaths ca 4, bladeless, leaf sheaths appearing node-like along the leafy stem; ligule ca 2 mm long, truncate or shallowly bilobed, sparsely pubescent, light green; blades 6–10, 6.5–13 × 2.5–3 cm, sessile, oblong to narrowly elliptic, base obliquely cuneate, apex acuminate, puberulent above and below. Inflorescence, 10–20 × 5–7 cm, lax, conical sometimes secund; peduncle 1.5–3 cm long; rachis light green, minutely pubescent; bracts and bracteoles 1.5–7 × 1–2 mm, caducous, narrowly elliptic, apex acute, pubescent, light green; cincinni 5–9(–14), 1.5–6.5 cm long; pedicel ca 1 mm long. Flowers ca 3 cm long, primrose or pale yellow; ovary ca 3 mm long (♀), ellipsoid; calyx ca 4 mm long, infundibuliform, lobes acute; floral tube 12–16 mm long, dorsal and lateral corolla lobes to 6 mm long, hooded, elliptic; lateral staminodes 11–13 × 5–7 mm, obovate, apex round, pale yellow; labellum 10–13 × 4–5 mm, triangular, bilobed, spot absent, base truncate, apex round, nectar tube ca 4 mm long; filament ca 23 mm long; anther ca 2 mm long, connective tissue, crest and appendages yellow-orange, semi-translucent, crest ca 1 mm long (shorter in ♂), truncate; ♀ appendages ca 3 mm long, acuminate, bifid, upper pair bigger, decurrent to connective tissue and crest, lower pair smaller; ♂ appendages ca 3 mm long, acuminate, bifid, upper pair only slightly bigger than lower. Fruit 7–10 × 5–7 mm, almost globose, shallowly ridged, green. Bulbils not seen.

Distribution and habitat

China (Yunnan), 1080–1350 m a.s.l.

Conservation status

Least Concern. Although *G. lancangensis* has a small AOO of 20 km² and EOO of 1897 km², this species occurs in the Xishuangbanna Biosphere Reserve. It may also occur in the adjoining Nam Ha

reserve in Lao PDR. Surveys should be carried out to see if the species occurs in this area. The species is also in *ex situ* cultivation at one botanical garden (BGCI 2018).

Notes

Globba lancangensis is endemic in China. It is similar to *G. insectifera* in its habit, broad lateral staminodes, and labellum shape but differs by its fruit shape, the form of the leafy stem and the colour of the lateral staminodes.

Globba lithophila Sangvir. & M.F.Newman sp. nov.

[urn:lsid:ipni.org:names:77195004-1](https://nomenclature.ipni.org/urn:lsid:ipni.org:names:77195004-1)

Figs 2E, 6, 11–12

Diagnosis

Similar to *G. flagellaris* and *G. macrochila* sp. nov. in its condensed cincinni and bright orange flowers, but differing from them by its clearly visible lateral corolla lobes, oblong and patent lateral staminodes, smaller size and ecological requirements, being found only in pockets of soil in cracks in limestone.

Etymology

From the Greek ‘*lithos*’ (stone) and ‘*phila*’ (loving), reflecting its limestone habitat.

Type material

Holotype

THAILAND • Mae Hong Son, Pang Mapha, Tham Lot; 675 m a.s.l.; 7 Aug. 1999; J.F. Maxwell 99–109 leg.; BKF.

Isotype

THAILAND • Same data as for the holotype; A.

Other material examined

THAILAND – **Chiang Mai** • Doi Chiang Dao, near cave at base of mountain; 14 Aug. 1963; T. Smitinand and H.O. Sleumer 1000 leg.; AAU. – **Mae Hong Son** • Mae Lan; 23 May 1921; A.F.G. Kerr 5487 leg.; BK, C, K • Mae Sa-nga, near Phasua waterfall; 6 Aug. 2000; K.J. Williams 00–345 leg.; E • Pang Mapha, Tham Lot, Ban Wana Luang; 5 Aug. 2000; K.J. Williams 00–336 leg.; E • Pang Mapha, Tham Lot; 5 Sep. 1999; P. Suksathan 1739–1 leg.; QBG • Pang Mapha, Tham Pha Mon, near Pha Mon cave; 5 Aug. 2000; K.J. Williams 00–334 leg.; E • Pang Mapha, Ban Bo Khai; 12 Sep. 1999; P. Srisanga and C. Puff 1060 leg.; QBG. – **Non wild collected material** • Mae Hong Son, Pai, Lum Nam Pai Wildlife Sanctuary, 30 km from Amphoe Pang Mapha; 14 Jun. 2014; Queen Sirikit Botanic Garden acc. no. 20130622B, vouchered as ‘S. Sangvirotjanapat 642’; QBG.

Description

Herb 10–60 cm tall, growing in small pockets of rock or on soil near cliffs. Leaf sheaths ca 3, bladeless; ligule 2–5 mm long, bilobed, glabrous to minutely pubescent, light green with white margin; blades 5–6(–10), 8.7–18 × 5.5–6 cm, sessile, elliptic to narrowly ovate, base obliquely cuneate, apex acuminate, pubescent along midrib above, dark green sometimes with silver striations along midrib above, pubescent to sericeous below. Inflorescence 7–13 × 3–9 cm, lax, conical; peduncle ca 1 cm long; rachis light green with sparse hairs; bracts 2–5 × 1–1.5 mm, caducous, oblong, glabrous or pubescent, light green; cincinni 5–16, 0.5–4.7 cm long, flowers condensed at tip of cincinnus and arranged in two rows; pedicel 1–3 cm long, pubescent; bracteoles 1–4 × 0.5–2 mm, persistent, triangular, apex acute, mucronate, sparsely pubescent, green with paler margin. Flowers 2.8–3.2 cm long, ovary and calyx green, the rest

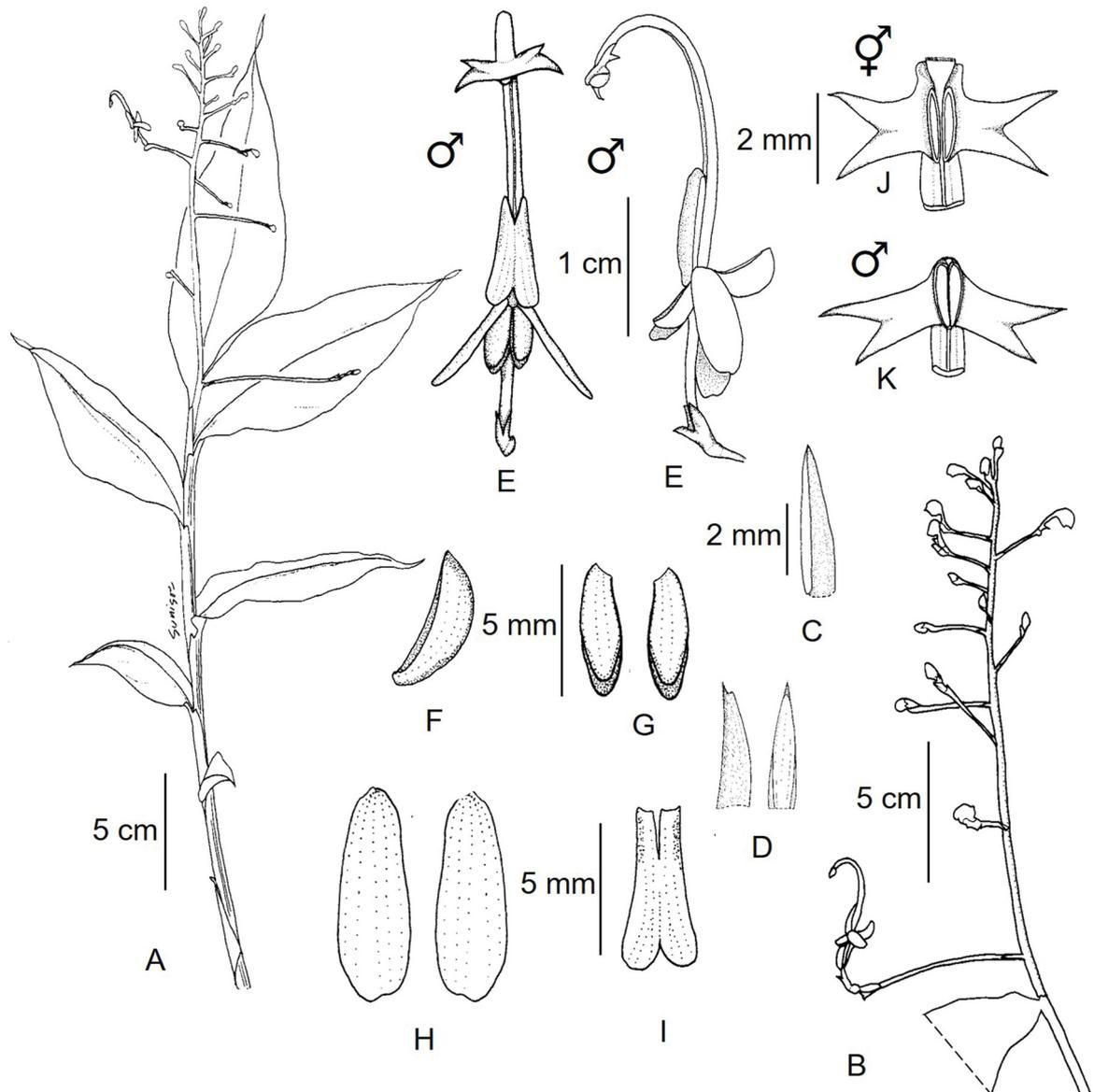


Fig. 11. *Globba lithophila* Sangvir. & M.F.Newman sp. nov. **A.** Habit. **B.** Inflorescence. **C.** Bract. **D.** Bracteole, side and front views (same scale as C). **E.** Flower, front and side views. **F.** Dorsal corolla lobe. **G.** Lateral corolla lobes (same scale as F). **H.** Lateral staminodes. **I.** Labellum (same scale as H). **J.** ♀ appendages. **K.** ♂ appendages (same scale as J). Drawing: S. Sangvirotnjanapat from S. Sangvirotnjanapat 642 leg.

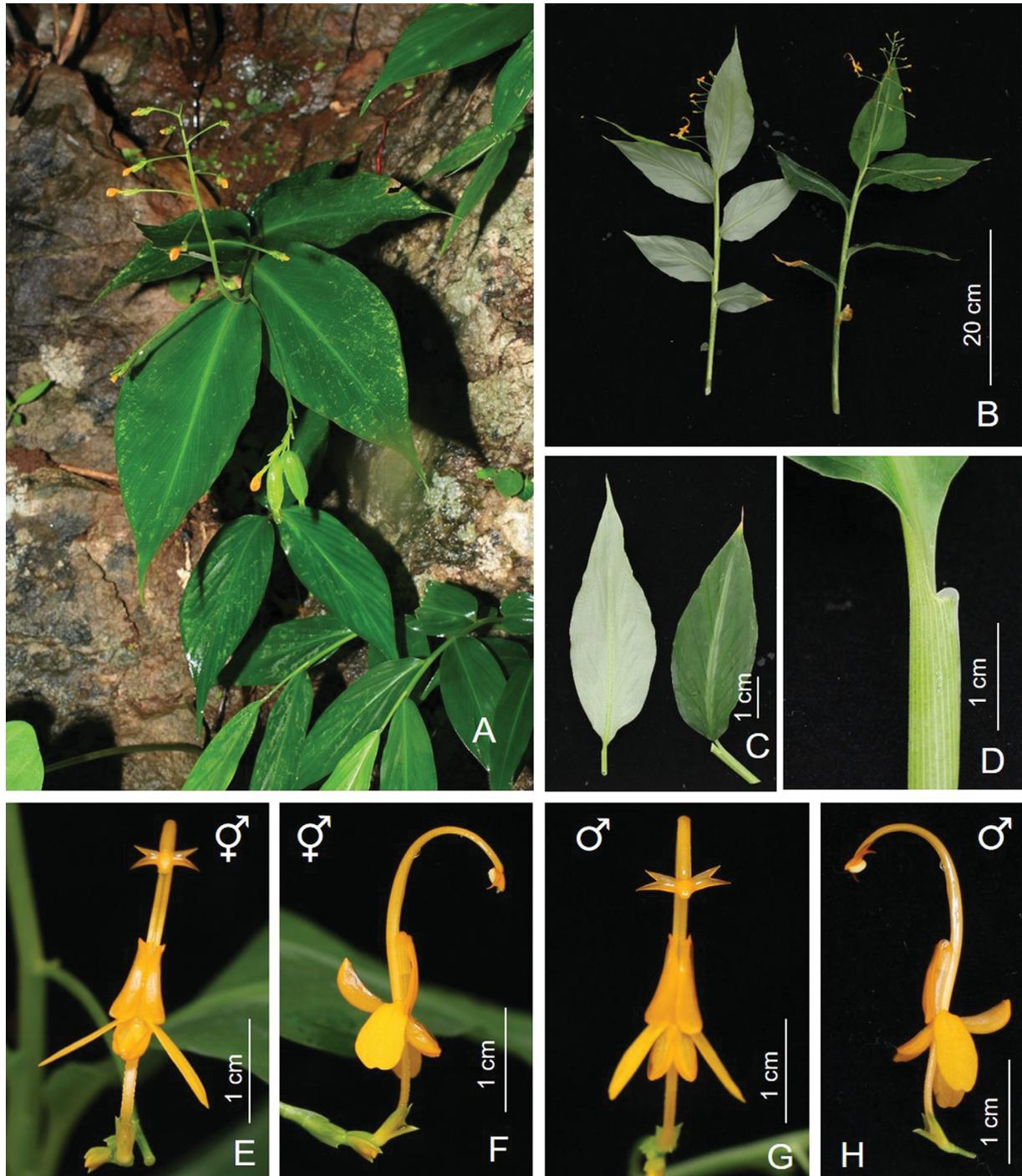


Fig. 12. *Globba lithophila* Sangvir. & M.F.Newman sp. nov. **A.** Plant in its habitat. **B.** Habit. **C.** Leaves. **D.** Ligule. **E.** ♀ flower (front view). **F.** ♀ flower (side view). **G.** ♂ flower (front view). **H.** ♂ flower (side view). Photographs: S. Sangvirotjanapat from S. Sangvirotjanapat 642 leg.

pure orange; ovary 1–4 mm long (♀), ellipsoid, ridged; calyx 4 mm long, infundibuliform, lobes acute; floral tube 12–14 mm long, minutely pubescent, dorsal and lateral corolla lobes 6–7 × 2–3 mm, hooded, elliptic, the lateral lobes easily seen; lateral staminodes ca 11 × 4.5 mm, patent, oblong, apex round or shallowly bilobed; labellum 7–8 × 4–5 mm, triangular, bilobed, spot absent, apex round to truncate, nectar tube ca 4.5 mm long; filament 23–26 mm long; anther 1–2 mm long, connective tissue, crest and appendages orange, semi-translucent, crest ca 1 mm long (shorter in ♂), truncate; ♀ appendages ca 2 mm long, acuminate, bifid, upper pair bigger, decurrent to connective tissue and crest, lower pair smaller; ♂ appendages ca 2 mm long, acuminate, bifid to halfway, upper pair only slightly bigger than lower. Fruit 10–15 × 5–6 mm, triangular, longitudinally ridged. Bulbils not seen.

Distribution and habitat

Thailand, 450–800 m a.s.l., only found in small pockets of soil in or very near limestone.

Conservation status

Least Concern. *Globba lithophila* sp. nov. has a small AOO of 28 km² and EOO of 2600 km², suggesting a status of Endangered but it grows in Lum Nam Pai Wildlife Sanctuary as well as *ex situ* in Queen Sirikit Botanic Garden so it is of Least Concern. It is a lithophyte which makes it sensitive to environmental factors so good management of protected areas is important to keep it in its natural habitat.

Notes

Globba lithophila sp. nov. has been compared closely to *G. flagellaris*, with which it is sympatric in north Thailand. Both species were cultivated in the same place at the Zingiberaceae nursery of Queen Sirikit Botanic Garden under controlled conditions. After two years of growth, the vegetative parts of the plants were larger than those of wild plants, while the floral parts and ratios of sizes remained the same. We conclude that these are two separate species and that *G. lithophila* sp. nov. is not merely a part of the variation of *G. flagellaris*.

Globba macrochila Sangvir. & M.F.Newman sp. nov.

[urn:lsid:ipni.org:names:77195005-1](https://nomenclature.ipni.org/names/77195005-1)

Figs 2F, 6, 13–14

Diagnosis

Similar to *G. flagellaris* in its bright orange flowers, but differing by its much longer labellum, 19–20 mm long (vs short labellum, 10–12 mm long) and growing in dry areas (vs moist areas).

Etymology

Greek, ‘*macros*’ (large) and ‘*-chila*’ (-lipped), referring to its long labellum.

Type material

Holotype

THAILAND • Kanchanaburi, Sai Yok; 30 Jul. 1928; Put 1779 leg.; BK.

Isotypes

THAILAND • Same data as for the holotype; C, K, P.

Other material examined

MAYNMAR – **Mawlamyine** • Kyauk Ta Lon Pagoda, 13½ miles from Moulmein on Ye road; 21 Jul. 1958; H.S. McKee 6319 leg.; K.

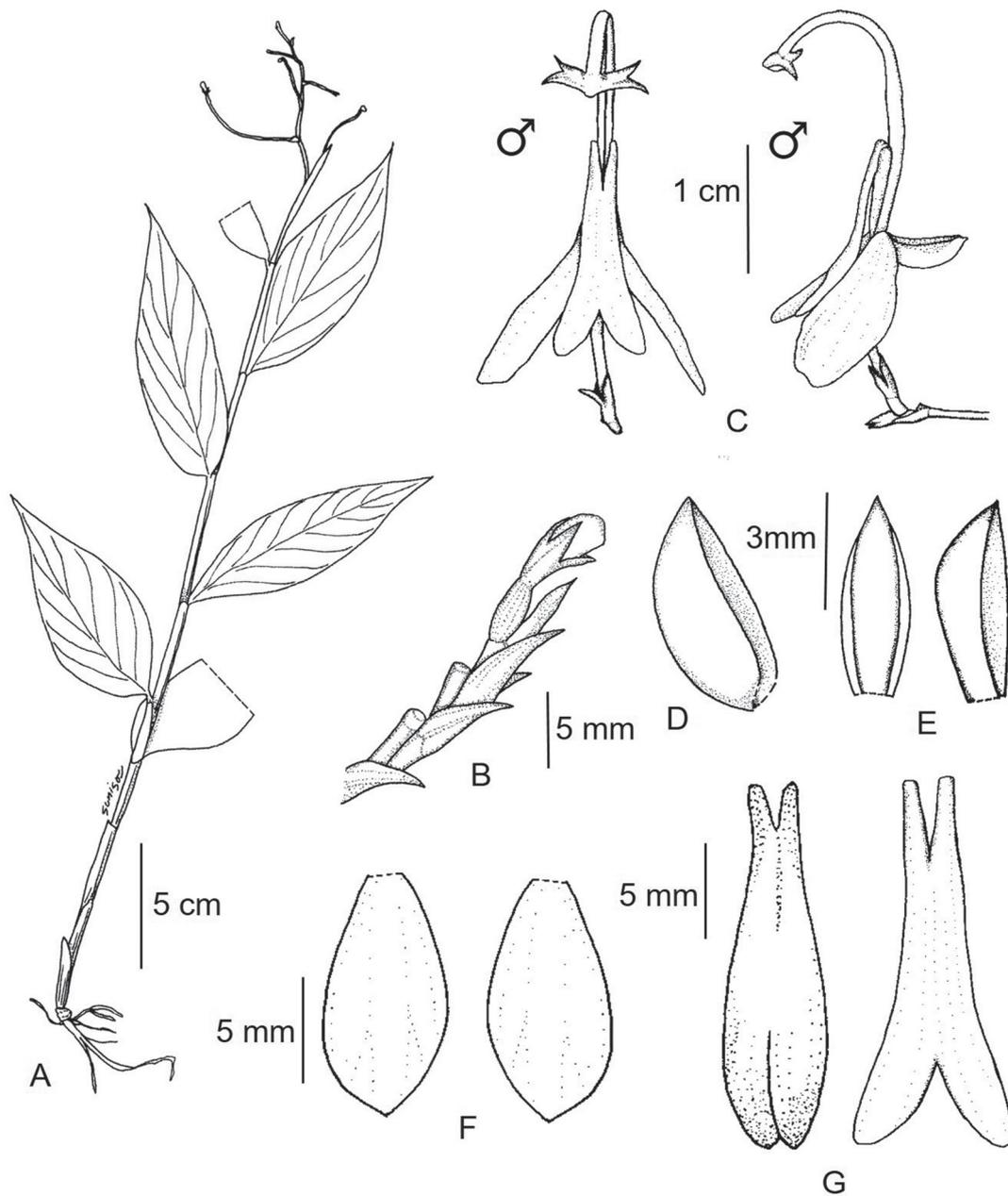


Fig. 13. *Globba macrochila* Sangvir. & M.F.Newman sp. nov. **A.** Habit. **B.** Crowded cincinnus. **C.** Flower, front and side views. **D.** Dorsal corolla lobe. **E.** Lateral corolla lobes, front and side views (same scale with D). **F.** Lateral staminodes. **G.** Variation of labellum shape. Drawing: S. Sangvirotjanapat from S. Sangvirotjanapat 795 leg.

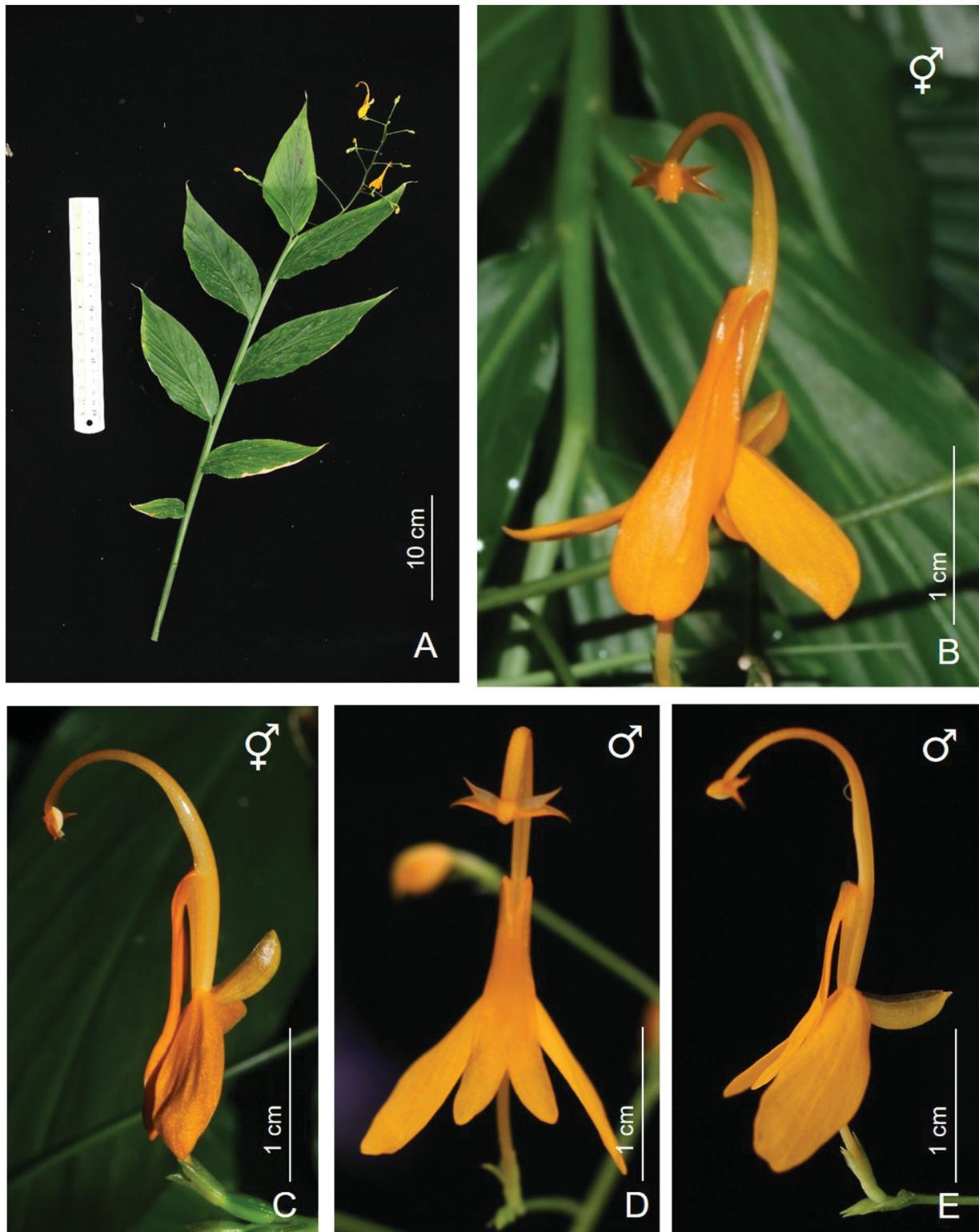


Fig. 14. *Globba macrochila* Sangvir. & M.F.Newman sp. nov. A. Habit. B. ♀ Flower (front view). C. ♀ flower (side view). D. ♂ flower (front view). E. ♂ flower (side view). Photographs: S. Sangvirotjanapat from S. Sangvirotjanapat 795 leg.

THAILAND – **Kanchanaburi** • Erawan National Park; 1 Jul. 1974; K. Larsen and S.S. Larsen 33956 leg.; AAU, BKF, K, P; Erawan National Park; 11 Jul. 1978; C. Phengkklai, M. Tamura, C. Niyomdham and B. Sangkhachand 4286 leg.; BKF • Kin Sayok [Sai Yok?], ca 120 km NW of Kanchanaburi; 10 Jul. 1946; A.J.G.H. Kostermans 1050 leg.; A, P, US • Khao Tha Takua, “Ta Taklua”; 25 Jun. 1925; Put 20 leg.; BK, C, K • Sai Yok; 30 Jul. 1928; A. Marcan 2341 leg.; K • Sai Yok; 1 Jul. 1963; K. Larsen 10410 leg.; AAU, BKF • Sai Yok, Thung Kang Yang; 5 Jul. 1963; K. Larsen 10525 leg.; AAU • Thong Pha Phum, Ban Prang Kasi; 19 Jun. 1946; G.D. Hoed and A.J.G.H. Kostermans 665 leg.; A, K, P • Thong Pha Phum; 4 Jul. 1973; J.F. Maxwell 73–108 leg.; AAU. – **Lamphun** • Li, Mae Ping National Park, Ko Luang Waterfall; 9 Sep. 2009; D.J. Middleton and P. Triboun 4818 leg.; E, QBG. – **Non wild collected material** • Kanchanaburi, Sai Yok; 24 Jun. 2014; Queen Sirikit Botanic Garden acc. no. 20161700A, vouchered as ‘S. Sangvirotjanapat 795’; QBG.

Description

Herb, 25–60 cm tall, clump-forming, growing in rather dry areas, leaning, with upright inflorescence. Leaf sheaths 3–5, bladeless; ligule 2–5 mm long, bilobed or truncate, pubescent or glabrous, light green with white margin; blades 5–10, 5–15.5 × 1.3–2.5 cm, elliptic to ovate, base obliquely obtuse, apex acuminate, strigose along veins above, otherwise glabrous; petiole, if present, to 1 cm. Inflorescence 5–11 × 5–12 cm, lax, conical; peduncle 1–2 cm long; rachis glabrous; bracts caducous, bracteoles 2–10 mm long, persistent, elliptic, apex and margin pubescent; cincinni 1–7 cm long; pedicel to 6 mm. Flowers 3.0–3.6 cm long, ovary and calyx green, the rest pure orange; ovary ca 4 mm long (♀), ellipsoid, ridged; calyx 3–5 mm long, infundibuliform, lobes acuminate; floral tube 9–11 mm long, dorsal and lateral corolla lobes ca 6 × 3 mm, hooded, elliptic; lateral staminodes 12–14 × 7–8 mm, obovate, apex acute; labellum 19–20 × 4–7 mm, triangular, bilobed, spot absent, base truncate, apex obtuse, nectar tube ca 6 mm long; filament ca 30 mm; anther ca 1.5 mm long, connective tissue, crest and appendages orange, semi-translucent, crest ca 1 mm long (shorter in ♂), truncate; ♀ appendages ca 3 mm long, acuminate, bifid, upper pair bigger, decurrent to connective tissue and crest, lower pair smaller; ♂ appendages ca 3 mm long, acuminate, bifid to halfway, upper pair only slightly bigger than lower. Fruit ellipsoid, longitudinally ridged, green. Bulbils produced at peduncle and cincinni, ellipsoid, tissue corky.

Distribution and habitat

Myanmar and Thailand, 100–350 m a.s.l., in rather dry forest.

Conservation status

Least Concern. Although this species has a small AOO of 32 km², the populations in Kanchanaburi province, where this species is commonest, are found in several protected areas. It is also grown in Queen Sirikit Botanic Garden.

Notes

Usually found in somewhat dry areas, such as bamboo forest. The labellum is remarkable, being longer than the lateral staminodes. It always covers the lateral corolla lobes. Plants were cultivated under more humid test conditions in Bangkok to find out the stability of the morphological characters. After growing for one season, the environmental factors affected only vegetative structures, i.e., leafy stem size, inflorescence size but did not influence the ratios of the floral parts.

Doubtful species of Globba subsect. Nudae

***Globba pauciflora* King ex Baker**

Flora of British India 6: 205 (Baker 1890).

Type material

Syntype

INDIA • Andaman Island; 1884; King's collector 376 leg.; K.

Distribution and habitat

Only known from the type locality.

Notes

This species is close to *G. expansa* in its habit and flower, but differs by its ovate leaves and rather small inflorescence.

***Globba rahmanii* Yusuf**

Journal of Economic and Taxonomic Botany 28: 88 (Yusuf 2004).

Type material

Holotype

BANGLADESH • Chittagong, Khagrachari, Dighinala, Dighinala-Marissha road, Teentila; 30 Aug. 1997; M.A. Rahman 1878 leg.; HCU.

Isotype

THAILAND • Same data as for the holotype; K.

Distribution and habitat

Only known from the type locality.

Notes

The information given in the protologue does not allow the status of this species to be decided. No type specimen deposited at Kew was found. In overall appearance, it resembles *G. flagellaris* by its habit and broad lateral staminodes.

***Globba subscaposa* Collett & Hemsl.**

Journal of the Linnean Society. Botany 28: 135 (Collett & Hemsley 1890).

Holotype

MYANMAR • Shan State; 1210–1520 m a.s.l.; 1888; H. Collett s.n. leg.; K.

Distribution and habitat

Only known from the type locality, collected in 1888 in Myanmar, Shan State, 1210–1520 m a.s.l., said to be common above 1200 m a.s.l. throughout the southern Shan Hills.

Notes

Collett & Hemsley placed *G. subscaposa* in *G. sect. Ceratanthera* (Horan.) Petersen because it has two anther appendages but the description in the protologue and the appearance of the type convince us that it belongs in *G. subsect. Nudae*. Dissection of a flower on the type shows that it is morphologically similar to *G. insectifera* by the shape of the anther appendages of a functionally male flower and its broad lateral staminodes but it differs by its rather clump-forming habit (not tending to grow as solitary shoots), and densely villous indumentum on the leafy stem and inflorescence (vs glabrous to minutely pubescent).

Discussion

Of the fourteen validly published species names in *G. subsect. Nudae*, seven are accepted while three are placed in synonymy. The characteristics, distribution ranges and habitats of these species have been clarified and a key to their determination has been provided. Four doubtful species cannot be further defined until exploration at their type localities can be carried out.

This research confirms that andromonoecy is a synapomorphy uniting *G. subsect. Nudae* and *G. subsect. Mediocalcaratae* and supports the most recent infrageneric classification of *Globba* (Williams *et al.* 2004). Importantly, our morphological study has also clarified a point which has been greatly misunderstood in relation to *G. subsect. Nudae* in earlier taxonomic accounts. This is the fact that all the flowers on a few lowermost cincinni of the inflorescences are hermaphrodite while all the later flowers have an undeveloped ovary and are functionally male. Earlier taxonomists have mistaken the hermaphrodite and male flowers for flowers of different taxa. For instance, in the *Flora of British India* (Baker 1890), *G. subscaposa* was classified in *G. sect. Ceratanthera* which has two anther appendages. After study of the type specimen at Kew, we suppose that Baker saw only functionally male flowers in which the anther appendages are bilobed only to about half their length (Fig. 3D) and, in this way, he thought there were two of them rather than four. Similarly, in *Das Pflanzenreich* (Schumann 1904), two species of *G. subsect. Nudae*, *G. subscaposa*, and *G. platystachys* Baker, were classified into *G. sect. Ceratanthera*.

Recent research on the development of anther appendages in *Globba* has shown that six appendages occur in *G. subg. Globba* (Cao *et al.* 2018). In *G. sect. Nudae* and *G. sect. Sempervirens*, *G. siamensis* (Hemsl.) Hemsl., *G. propingua* Ridl., and *G. atosanguinea* Teijsm. & Binn. were found to have a pair smaller appendages inserted between the large ones, as a result of fragmentation in development. *Globba sect. Nudae* was the only section in *G. subg. Globba* in which six appendages were not found. Our results above confirm this finding.

The centre of diversity of this subsection is in the monsoon area of mainland Southeast Asia, especially in mountain ranges. The Isthmus of Kra, which runs between Nakhon Nayok province in Thailand and the Nicobar islands in the Andaman sea and is an important phytogeographic barrier in this area (Parnell 2013), forms the southernmost extent of distribution of *G. subsect. Nudae*. The western border may extend to the Western Ghats in India if *G. platystachya* is confirmed to belong in the subsection. This is of particular interest in the cases of *G. platystachya* and *G. pauciflora*, which are separated from the main distribution area of the subsection, in Karnataka State and the Andaman Islands, respectively. *Globba subsect. Nudae* and the other sections of *G. subg. Globba* occur either north or south of the Isthmus of Kra but *G. subsect. Mediocalcaratae* is the exception to this rule. Members of *G. subsect. Mediocalcaratae* occur both north and south of the Isthmus of Kra (Williams *et al.* 2004). To gain an understanding of the factors governing distribution and to complete our knowledge of species distributions in *G. sect. Nudae*, *G. subsect. Mediocalcaratae* needs to be revised.

All species are assessed as of least concern using IUCN conservation status criteria, although some species have a small area of area of occupancy (AOO) and extent of occurrence (EOO) suggesting a higher degree of threat. These grow in protected areas and botanical gardens so the threats to them are thought not to be serious in the immediate future.

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References

- Baker J.G. 1890. *Globba*. In: Hooker J.D. (ed.) *Flora of British India* 6: 201–207. Available from <https://biodiversitylibrary.org/page/355773> [accessed Aug. 2018].
- BGCI 2018. [PlantSearch/ThreatSearch/GlobalTreeSearch] Online database. Botanic Gardens Conservation International. Richmond, U.K. Available from www.bgci.org [accessed Jul. 2018].
- Burt B.L. & Smith R.M. 1972. Monoecism in *Alpinia* (Zingiberaceae), with descriptions of six new species. *Notes from the Royal Botanic Garden Edinburgh* 32: 29–43.
- Cao L., Newman M.F., Kirchoff B.K. & Ronse de Craene L.P. 2018. Developmental evidence helps resolve the evolutionary origins of anther appendages in *Globba* (Zingiberaceae). *Botanical Journal of the Linnean Society* 189: 63–82. <https://doi.org/10.1093/botlinnean/boy071>
- Craib W.G. 1912. Contributions to the Flora of Siam. *Bulletin of Miscellaneous Information, Kew* 1912: 398–400. <https://doi.org/10.5962/bhl.title.21865>
- Gagnepain F. 1908. In: Lecomte M.H., Humbert H. & Gagnepain F. (eds) *Flore Générale de l'Indo-Chine* 6 (1): 1–128. Masson et Cie., Paris. Available from <https://www.biodiversitylibrary.org/bibliography/44886#/summary> [accessed 22 Feb. 2019].
- Gordon-Gray K.D., Cunningham A.B. & Nichols G.R. 1989. *Siphonochilus aethiopicus* (Zingiberaceae): observations on floral and reproductive biology. *South African Journal of Botany* 55: 281–287. [https://doi.org/10.1016/S0254-6299\(16\)31177-2](https://doi.org/10.1016/S0254-6299(16)31177-2)
- Horaninow P.F. 1862. *Prodromus Monographie Scitaminearum*. Academiae Caesareae Scientiarum, Saint Petersburg. Available from <http://www.botanicus.org/title/b12065481> [accessed Jul. 2018].
- IUCN 2012. IUCN Red List Categories and Criteria: Version 3.1. Second Edition. IUCN, Gland, Switzerland and Cambridge, U.K.
- Kress W.J., Prince L.M. & Williams K.J. 2002. The phylogeny and a new classification of the gingers (Zingiberaceae): evidence from molecular data. *American Journal of Botany* 89: 1682–1696. <https://doi.org/10.3732/ajb.89.10.1682>
- Larsen K. 1972. Studies in the genus *Globba* in Thailand. *Notes from the Royal Botanic Garden Edinburgh* 31: 229–241.

- Larsen K. 1977. *Globba flagellaris* sp. nov. (Zingiberaceae) from Thailand. *Nordic Journal of Botany* 17:119–121. <https://doi.org/10.1111/j.1756-1051.1997.tb00296.x>
- Leong-Škorničková J. & Newman M.F. 2015. *Gingers of Cambodia, Laos and Vietnam*. Singapore Botanic Garden National Parks Board, Pha Tad Ke Botanical Garden.
- Miller A.G., Hall M., Watson M.F., Knees S.G., Pendry C.A. & Pullan M.R. 2015. Floras yesterday, today and tomorrow. In: Watson M.F., Lyal C.H.C & Pendry C.A. (eds) *Descriptive taxonomy: The foundation of biodiversity research. The Systematics Association*. Special Volume 84. Cambridge University Press, Cambridge. <https://doi.org/10.1017/CBO9781139028004.003>
- Parnell J. 2013. The biogeography of the Isthmus of Kra region: A review. *Nordic Journal of Botany* 31: 1–15. <https://doi.org/10.1111/j.1756-1051.2012.00121.x>
- QGIS Development Team 2018. QGIS Geographic Information System. Open Source Geospatial Foundation Project. Available from <http://qgis.osgeo.org> [accessed 15 Jun. 2018].
- Qian Y.Y. 1994. Three new species of Zingiberaceae from Yunnan. *Acta Botanica Austro Sinica* 9: 47–53.
- Ridley H.N. 1908. New or rare Malayan plants. *Journal of the Straits Branch of the Royal Asiatic Society* 49: 42. Available from <https://biodiversitylibrary.org/page/41737116> [accessed Aug. 2018].
- Sangvirotjanapat S., Denduangboripant J., Triboun P. & Newman M.F. 2017a. Morphological revision of *Globba* section *Nudae*: andromonoecy and discussion of a misleading point. Abstract book 1: 9–10. The 11th Botanical Conference of Thailand: BCT11, Bangkok.
- Sangvirotjanapat S., Warrit N., Triboun P. & Newman M.F. 2017b. Revealing the pollination system of *Globba* section *Nudae* (Zingiberaceae): How does *Globba expansa* achieve cross pollination? Abstract Book 1: 62–63. 17th Flora of Thailand conference Krabi, Thailand.
- Schumann K.M. 1904. Zingiberaceae. In: Engler A. (ed.) *Das Pflanzenreich* IV 46 (Heft 20). Wilhelm Engelmann, Leipzig. Available from <https://biodiversitylibrary.org/page/16815170> [accessed Aug. 2018].
- Smith R.M. 1988. A review of Bornean Zingiberaceae: IV (Globbeae). *Notes from the Royal Botanic Garden Edinburgh* 45: 1–19.
- IPNI 2018. The International Plant Names Index. Available from <http://www.ipni.org> [accessed Jan. 2018].
- Thiers B. 2019. Index Herbariorum: A global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium, New York. Available from <http://sweetgum.nybg.org/science/ih/> [accessed 15 Jun. 2018].
- Turner I.M. 2000. The plant taxa of H. N. Ridley, 3. the Zingiberales. *The Southeast Asian Journal of Tropical Biology* 4: 1–47.
- Williams K.J., Kress W.J. & Manos P.S. 2004. The phylogeny, evolution, and classification of the genus *Globba* and tribe Globbeae (Zingiberaceae): appendages do matter. *American Journal of Botany* 91: 100–114. <https://doi.org/10.3732/ajb.91.1.100>
- Wu D. & Larsen K. 2000. Zingiberaceae. In: Wu Z.-Y. & Raven P.H. (eds) *Flora of China* 24: 322–377. Missouri Botanical Garden Press, Beijing, Science Press and Saint Louis.
- Yusuf M. 2004. A new species from Bangladesh. *Journal of Economic and Taxonomic Botany* 28: 87–90.

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