STUDIES IN THE GENUS GLOBBA IN THAILAND

KAI LARSEN*

ABSTRACT. Four new species of *Globba* from Thailand are described, viz. *G. aphanantha* *G. obscura*, *G. laeta*, and *G. nuda*; the last species is referred to a new section on cytological and morphological criteria, sectio *Nudae*. 13 species are studied cytologically with the following result: *G. clarkei* Bak., 2n = 24; *G. aphanantha* K. Larsen, 2n = 28; *G. pendula* Roxb., 2n = 32; *G. schomburgkii* Hook. fil., 2n = 48 and ca. 64; *G. winitii* C. H. Wright, n = 16; *G. garrettii* Kerr, 2n = 32 and 48; *G. kerrii* Craib, 2n = 32; *G. nisbethiana* Craib, 2n = ca. 32; *G. obscura* K. Larsen, 2n = 32; *G. purpurascens* Craib, 2n = 32; *G. reflexa* Craib, 2n = 32; *G. laeta* K. Larsen, 2n = 32; *G. nuda* K. Larsen, n = 17. The cytological pattern of the genus is described.
As an appendix, a new name *Geostachys kerrii* K. Larsen is proposed for the species originally described as *G. densiflora* K. Larsen.

INTRODUCTION

The genus *Globba* is one of the largest and most natural in the Zingiberaceae. About one hundred species are recognized; most of these have their distribution within the northern monsoon area, that is from the eastern Himalayas through Burma and Thailand to Laos, Cambodia and Vietnam. For several years the author has collected material within this group partly as dried specimens with flowers preserved in alcohol, partly as transplants. Furthermore, a number of fixations for chromosome studies have been undertaken.

The present paper does not deal with all the species found in Thailand; but concentrates on selected taxa new to science or those in which cytological observations have been made. There are certainly several undescribed taxa in Thailand particularly belonging to the *Marantella*-group, but more material is needed to be able to evaluate the variation. However we are already able to confirm Schumann (1904) when he emphasizes that most of the species have a very restricted distribution area; the author would even add that it is a genus which in an extraordinary way has been able to create local endemics.

The author is indebted to Mr Tyge Christensen, M.Sc., for translating the diagnoses into Latin.

SOME NEW TAXA

The following new taxa are described from the material studied: four new species and one new section.

Globba aphanantha K. Larsen, **sp. nov.** sectionis *Haplantherae*, *G. substrigosae* affinis, floribus valde rudimentariis, seminibus verisimiliter formatione apomictica initiatis, fructu stratum exterius spongiosum exhibente ab ea diversa. Fig. 1.

Herba perennis, 20–25 cm alta. *Folii* lamina utrinque sparse pilosa, area pallidiore ovata $\frac{1}{3}$–$\frac{2}{3}$ laminae occupante in medio ornata, ad 15 cm longa, 8 cm lata; petiolus manifestus, ad 2 cm longus; ligula brevissima, valde pilosa; vagina ad 8 cm longa, pilis longis vestita, vaginis inferioribus laminis

* Botanical Institute, Aarhus University, Denmark..

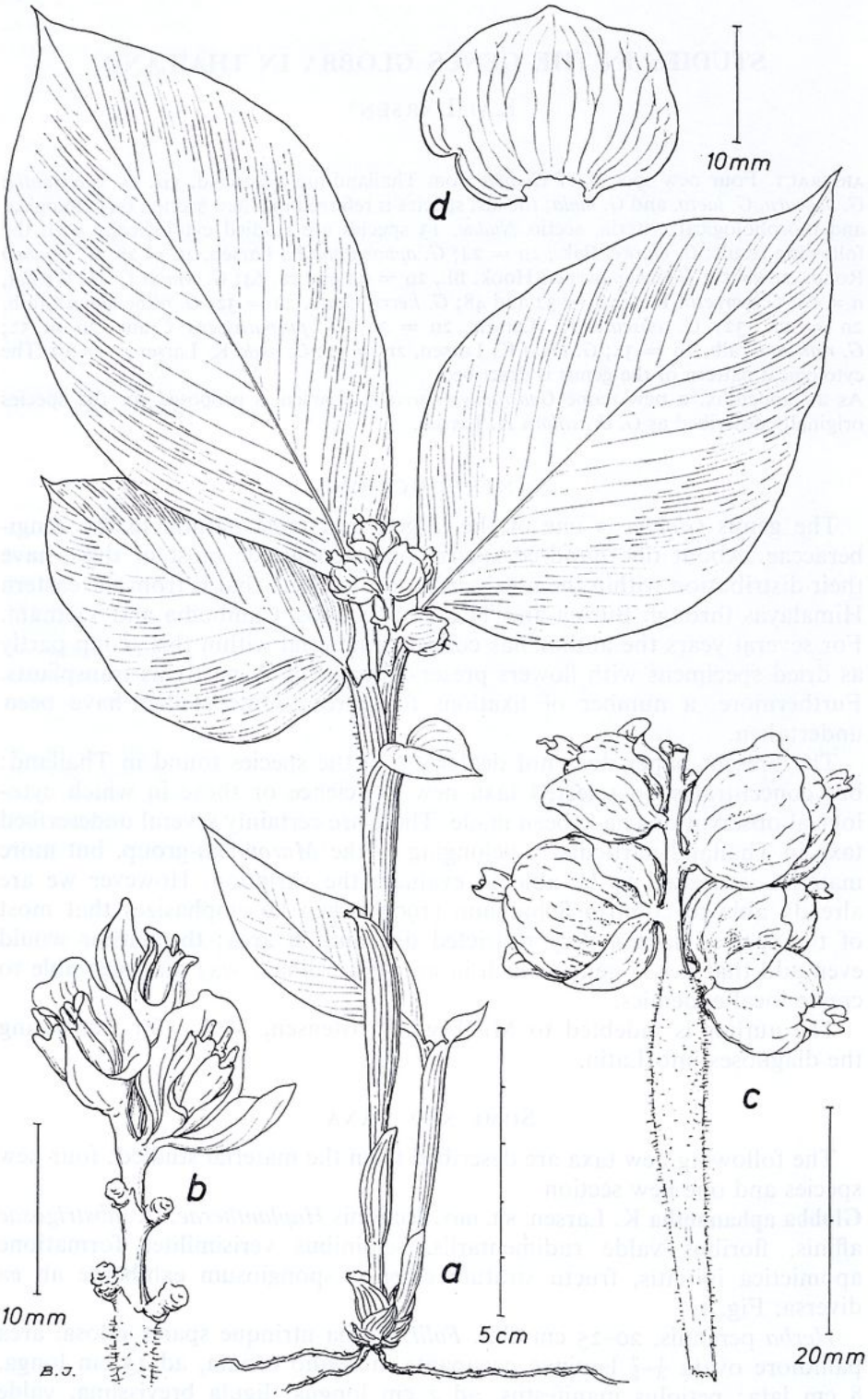

FIG. 1. *Globba aphanantha* K. Larsen: a, habit; b, inflorescence; c, infructescence; d, bract. *Larsen* 10355.

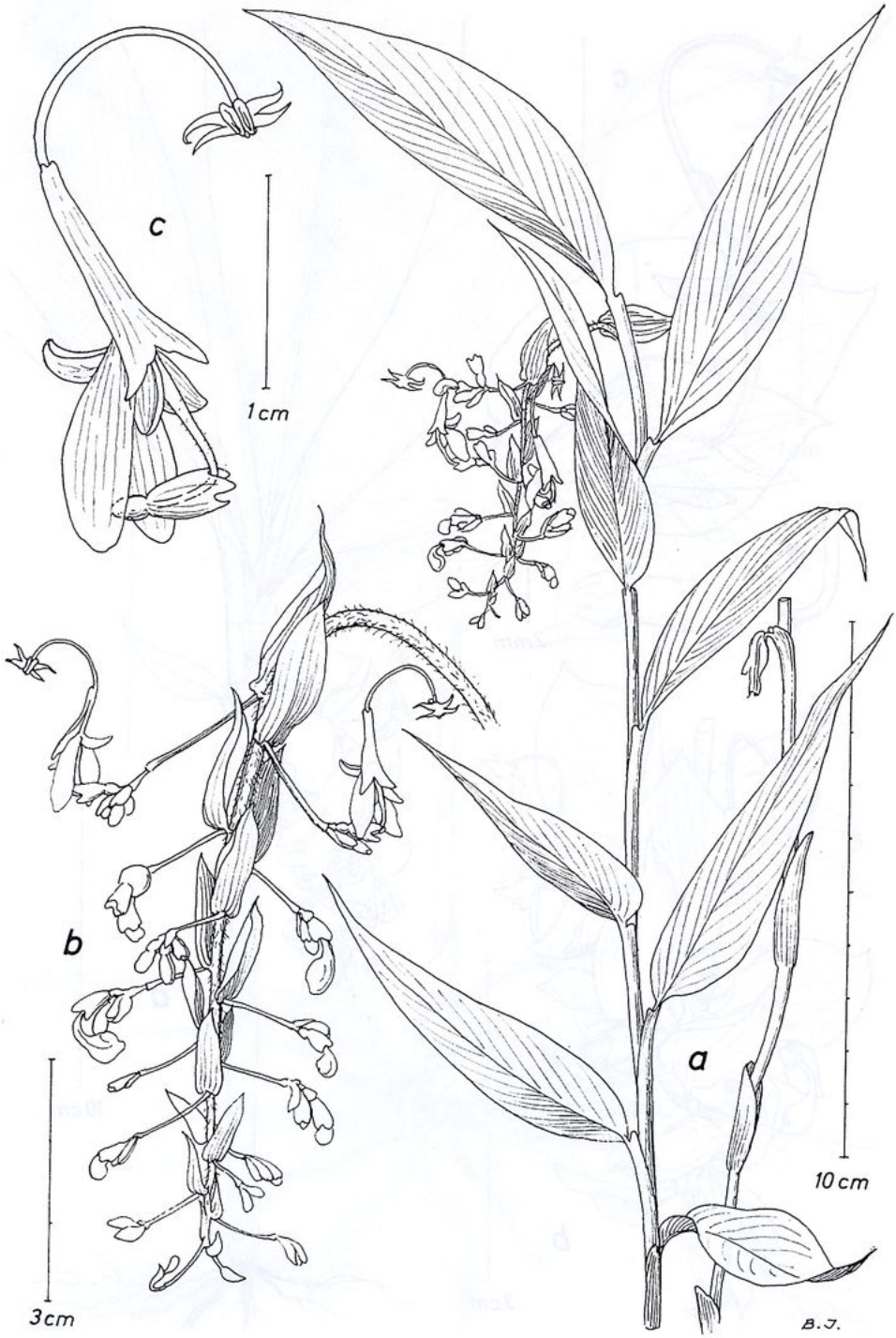

FIG. 2. *Globba obscura* K. Larsen: a, habit; b, inflorescence; c, flower. *Larsen* 10161.

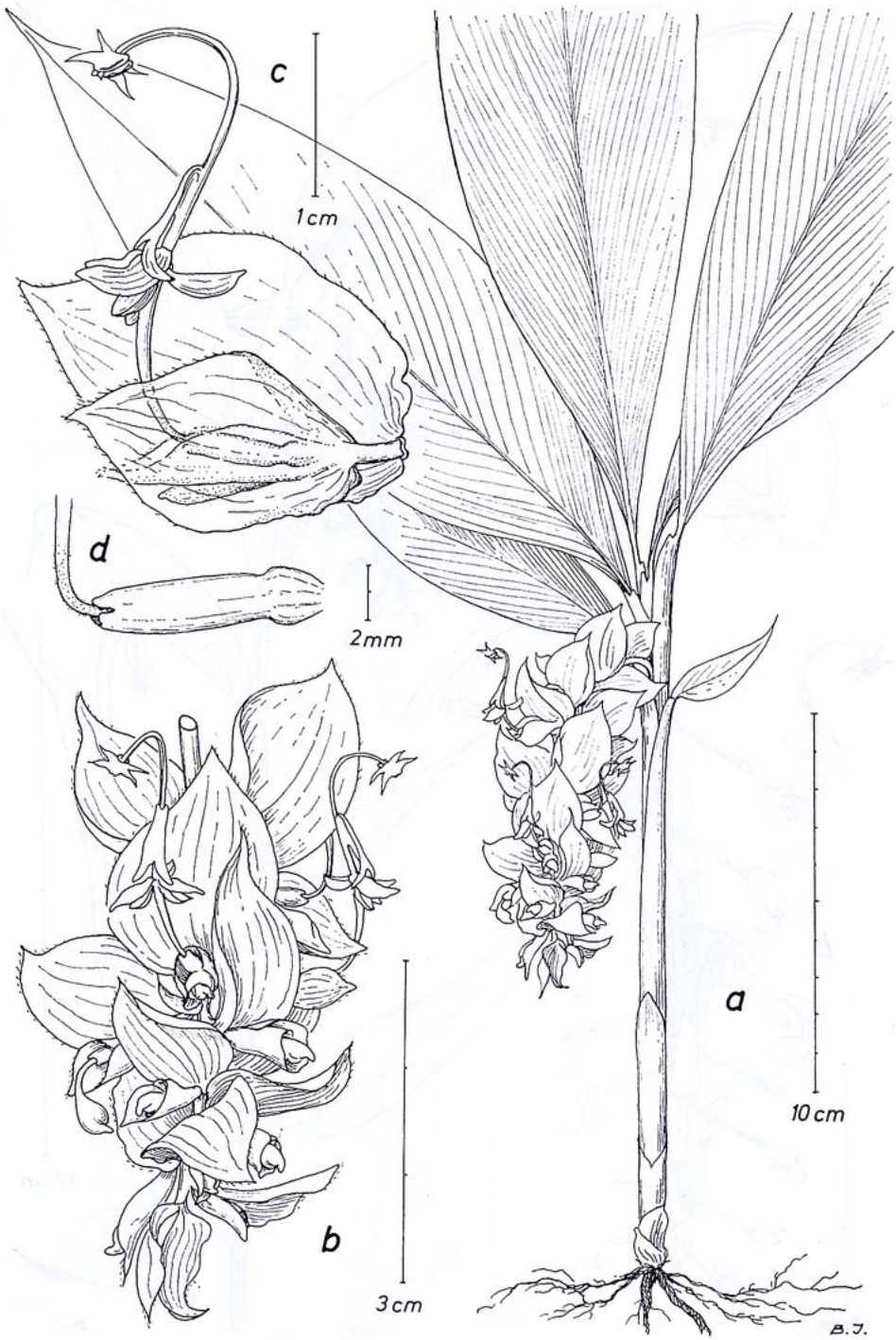

FIG. 3. *Globba laeta* K. Larsen: a, habit; b, inflorescence; c, flower; d, calyx. *Larsen* 2243.

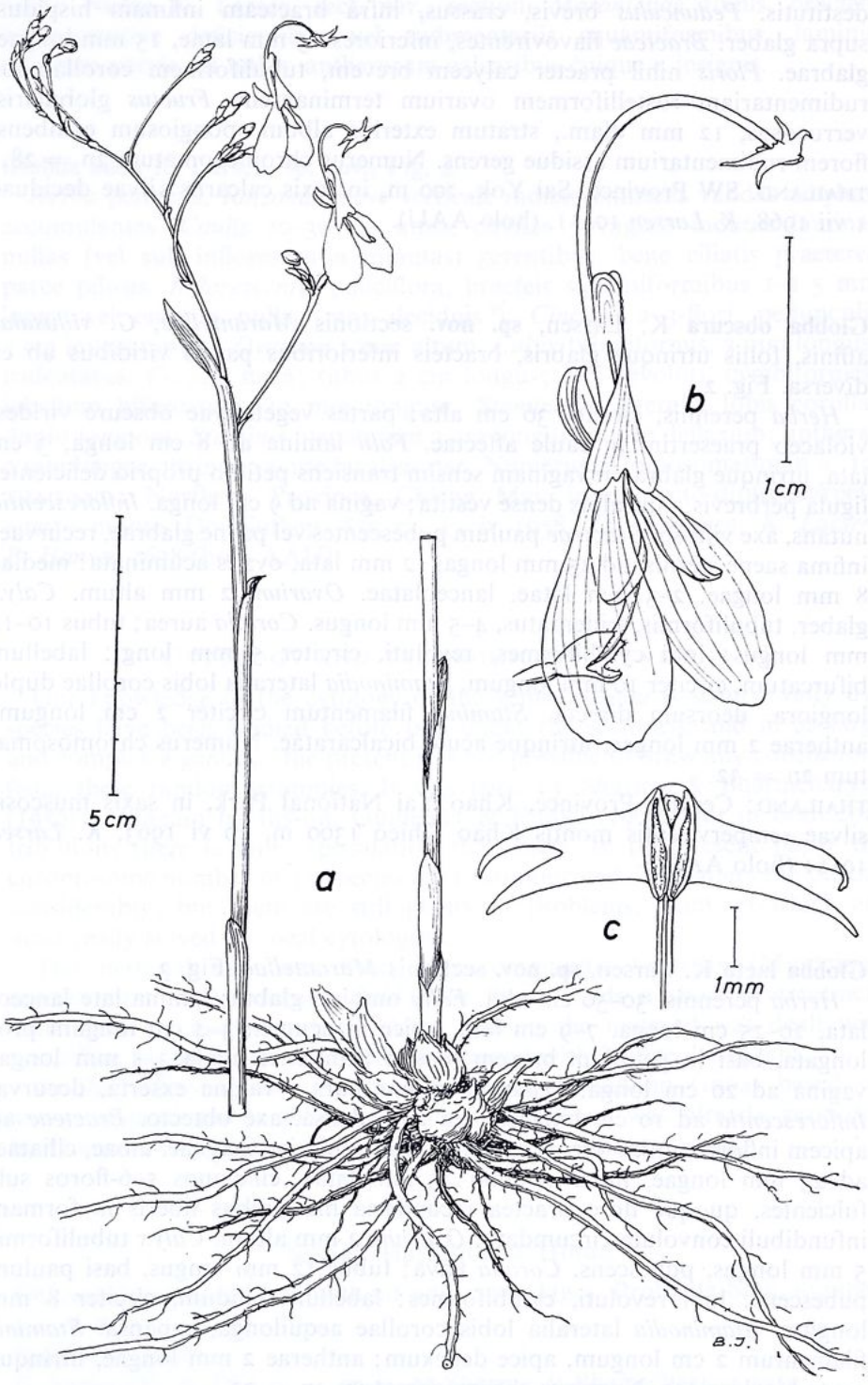

FIG. 4. *Globba nuda* K. Larsen: a, habit; b, flower; c, anther. *Larsen* 2678.

destitutis. *Pedunculus* brevis, crassus, infra bracteam infimam hispidus, supra glaber. *Bracteae* flavovirentes, inferiores 25 mm latae, 15 mm longae, glabrae. *Floris* nihil praeter calycem brevem, tubuliformem corollamque rudimentariam rostelliformem ovarium terminantem. *Fructus* globularis, verrucosus, 12 mm diam., stratum exterius album spongiosum exhibens, florem rudimentarium assidue gerens. Numerus chromosomatum 2n = 28.
THAILAND. SW Province, Sai Yok, 200 m, in saxis calcariis silvae deciduae 1 vii 1968, *K. Larsen* 10411, (holo AAU).

Globba obscura K. Larsen, **sp. nov.** sectionis *Marantellae*, *G. villosulae* affinis, foliis utrinque glabris, bracteis inferioribus parvis viridibus ab ea diversa. Fig. 2.

Herba perennis, circiter 30 cm alta; partes vegetativae obscure virides, violaceo praesertim in caule affectae. *Folii* lamina ad 8 cm longa, 3 cm lata, utrinque glabra, in vaginam sensim transiens petiolo proprio deficiente; ligula perbrevis, pilis albis dense vestita; vagina ad 9 cm longa. *Inflorescentia* nutans, axe villoso. *Bracteae* paulum pubescentes vel paene glabrae, recurvae; infima saepe sterilis, ad 25 mm longa, 12 mm lata, ovalis acuminata; mediae 8 mm longae, 2–3 mm latae, lanceolatae. *Ovarium* 2 mm altum. *Calyx* glaber, tubuliformis, tridentatus, 4–5 mm longus. *Corolla* aurea; tubus 10–14 mm longus; lobi cymbiformes, revoluti, circiter 5 mm longi; labellum bifurcatum, circiter 10 mm longum. *Staminodia* lateralia lobis corollae duplo longiora, deorsum directa. *Staminis* filamentum circiter 2 cm longum; antherae 2 mm longae, utrinque acute bicalcaratae. Numerus chromosomatum 2n = 32.
THAILAND: Central Province, Khao Yai National Park, in saxis muscosis silvae sempervirentis montis Khao Khieo 1300 m, 20 vi 1963, *K. Larsen* 10161 (holo AAU).

Globba laeta K. Larsen, **sp. nov.** sectionis *Marantellae*. Fig. 3.

Herba perennis, 30–50 cm alta. *Folia* omnino glabra; lamina late lanceolata, 20–25 cm longa, 7–9 cm lata, apice in acumen 3–4 cm longum prolongata, basi in petiolum brevem sensim transiens; ligula 3–5 mm longa; vagina ad 20 cm longa. *Pedunculi* minor pars e vagina exserta, decurva. *Inflorescentia* ad 10 cm longa, 4 cm lata, densa, axe obtecto. *Bracteae* ad apicem inflorescentiae versus decrescentes, primariae magnae, albae, ciliatae, ad 25 mm longae, infra medium 25 mm latae, cincinnos 5–6-floros suffulcientes, quoque flore bractea secundaria marginibus liberis in formam infundibuli convoluta circumdato. *Ovarium* 2 mm altum. *Calyx* tubuliformis 5 mm longus, pubescens. *Corolla* flava; tubus 12 mm longus, basi paulum pubescens; lobi revoluti, cymbiformes; labellum bifidum, circiter 8 mm longum. *Staminodia* lateralia lobis corollae aequilonga, expansa. *Staminis* filamentum 2 cm longum, apice deflexum; antherae 2 mm longae, utrinque acute bicalcaratae. Numerus chromosomatum 2n = 32.
THAILAND: Northern Province, in valle humida silvae deciduae prope vicum Mae Sariang, 350 m, 8 vii 1968, *K. Larsen, T. Santisuk, E. Warncke* 2243 (holo AAU).

Sectio **Nudae** K. Larsen, **sect. nov.,** sectioni *Marantellae* affinis, bracteis inflorescentiae deficientibus vel rudimentariis squamiformibus, laminis foliorum parvis vel nullis, antherarum calcaribus cuique 4 insignis.

Globba nuda K. Larsen, **sp. nov.,** Fig. 4.

Herba perennis. *Rhizoma* breve verticale radices emittens validas amylum accumulantes. *Caulis* 20–30 cm altus, circiter 5 vaginis indutus laminas nullas (vel sub inflorescentia minutas) gerentibus, bene ciliatis praeterea parce pilosis. *Inflorescentia* pauciflora, bracteis squamiformibus 1–1·5 mm longis vel omnino nullis (mox deciduis?). *Cincinni* 2–3-flori, pedunculis 3 cm longis portati. *Ovarium* 1 mm altum. *Calyx* tubuliformis, 3 mm longus, tridentatus. *Corolla* flava; tubus 2 cm longus; lobi revoluti, cymbiformes; labellum bifurcatum, 12 mm longum. *Staminodia* lateralia lobis corollae duplo longiora. *Staminis* filamentum 3 cm longum, apice deflexum; antherae 2 mm longae, utrinque acute bicalcaratae. Numerus chromosomatum n = 17. THAILAND: Northern Province, Chieng Mai, in querceto-dipterocarpeto aperto montis Doi Suthep, 850 m, 13 iv 1958, *Th. Sorensen, K. Larsen, B. Hansen* 2678 (holo AAU).

Cytology and taxonomic annotations

Our knowledge of the cytology of the genus *Globba* is scanty: only five species have been studied before (see under the sections), and in as large and complex a genus as the present it is not possible to draw any conclusions from these random examples. It was tried by Sharma & Bhattacharyya (1959) and again by Bisson, Guillemet & Hamel (1968), but in both contributions there is more speculation than facts. In the present paper the chromosome number of 13 species are communicated. This alters the picture considerably; but there are still plenty of problems, many of which are most easily solved by local cytologists.

The material has been fixed in chrome-acetic formalin (Muntzing's modification of Nawashin's fluid); for flower buds a short pretreatment with Carnoy's fluid was used. After fixation the material was dealt with according to the paraffin method and stained with Feulgen's reagent.

In the following account the division of Schumann (1904) based on anther appendages is followed. This arrangement was already proposed by Horaninow (1862) and later on followed by Holttum (1950).

Section Haplanthera Horan.

Characterized by anthers without any appendages. Probable basic numbers x = 6 & 7.

Species counted:

G. hookeri C. B. Cl.	2n = 22	Sharma & Bhattacharyya 1959
G. racemosa Smith	2n = 24	Sharma & Bhattacharyya 1959
G. clarkei Bak.	2n = 24	author
G. aphanantha K. Larsen	2n = 28	author

G. clarkei Bak.

Material studied: *Sorensen, Larsen, & Hansen* 4664, Doi Suthep evergreen forest, common, 110 m, 2 ix 1958. *Sorensen, Larsen, & Hansen* 4684, *ibidem.*

Root tips of three plants from a large population were fixed as Nos 4664 a, b, c. They all showed 2n = 24 as seen from Fig. 5 a–c. In some of the metaphase plates one or two small satellites could be distinguished. Fig. 5 d shows a regular I metaphase with 12 bivalents from a PMC of No. 4684.

The species, which is known only from N Thailand, shows little variation, but the Siamese populations differ in some characters from the more westerly populations in Khasya and Sikkim.

G. aphanantha K. Larsen

Material studied: *Larsen* 10411, Sai Yok, limestone area, 200 m. 1 vii 1963.

This species is with hesitation referred to the section Haplanthera. As perianth and androecium are so greatly reduced it may be called hazardous; but as the vegetative parts and the bracts show great resemblances to the rather unique *G. substrigosa* King from nearby Burma, they are probably derivatives of a common ancestor. *G. substrigosa* is said to have a blackish capsule of the size of a pea. In this character *G. sterilis* is clearly deviating as the fruits are considerably larger, roundish and with a verrucose fleshy surface white of colour. Therefore the species cannot be regarded as merely an abnormal form of *G. substrigosa.*

The species occurs frequently on lateritic soil in the limestone area along the Menam Kwae Noi valley; two other collections are represented in herb AAU: *Larsen* 10355, Sai Yok, on clayey lateritic soil, 170 m, 30 vi 1963, and *Larsen* 10466, Sai Yok, deciduous forest with limestone outcrops, 200 m, 3 vii 1963.

The chromosome number has been counted as 2n = 28 (Fig. 5 e) and in some plates 3 SAT-chromosomes were observed, probably, if 2n = 28 represents tetraploidy of x = 7, 4 are present. Unfortunately seed development has not been studied.

Section Ceratanthera Horan.

Characterized by 2 anther appendages. Schumann (1904) distinguishes 3 groups according to the placing of the appendages basally, on the middle of the anther or apically. The species treated below has its appendages placed at the base of the anthers; no other species have been studied previously. Probable basic number x = 8.

G. pendula Roxb.

Material studied: Botanic Garden, Copenhagen, origin unknown.

The chromosome number 2n = 32 was counted in several good metaphases in root tips (Fig. 5 f, g); in none of them more than 2 SAT-chromosomes were observed. Still we regard the species as a tetraploid of an 8-series. It has its widest distribution on the Malay Peninsula but has also been reported from the peninsular part of Thailand.

Section Marantella Horan.

Characterized by 4 anther appendages and well developed bracts. Probable basic number x = 8.

Species counted.

G. bulbifera Roxb.	2n = 48	Raghavan & Venkatasubban 1943
	2n = 44	Sharma & Bhattacharyya 1959
G. schomburgkii Hook. fil.	2n = 48	Bisson & al. 1968
	2n = 48 & 64	author
G. winitii C. H. Wright	2n = 48	Bisson & al. 1968
	n = 16	author
G. garrettii Kerr	2n = 32, 48	—
G. kerrii Craib	2n = 32	—
G. nisbethiana Craib	2n = ca. 32	—
G. obscura K. Larsen	2n = 32	—
G. purpurascens Craib	2n = 32	—
G. reflexa Craib	2n = 32	—
G. laeta K. Larsen	2n = 32	—

G. schomburgkii Hook. fil.

Material studied: *Sorensen, Larsen, & Hansen* 4003, Wang Tao, dry deciduous forest, 500 m, 11 vii 1958; B. G. 1452 & 1453, Botanic Garden Copenhagen, material of unknown origin.

The species was described on material from the neighbourhood of Bangkok; it is a common and characteristic species found all over Thailand, where it propogates vigorously by means of bulbils. Bisson *et al.* (1968) counted 2n = 48 which is in correspondence with the material from the Botanic Garden, Copenhagen, while the specimen from North Thailand was found to be octoploid with 2n = ca. 64 (Fig. 5h).

G. winitii C. H. Wright

Material studied: Botanic Garden, Copenhagen, origin unknown.

We have studied meiosis as well as mitosis. In the PMC's all divisions were regular with 16 bivalents (Fig. 5j) and in the root-tip mitoses correspondingly 2n = 32 (Fig. 5i) were observed, normally 1–2 satellites could be distinguished. As seen from the above list, Bisson *et al.* (1968) found 2n = 48. The species is a local endemic of Northern Thailand (the Lamphoon-area) from where rhizomes were sent to Kew and Aberdeen by Winit. It is probably from Kew that this beautiful and unique species has been distributed to other botanic gardens and cytological polymorphism should therefore not have been expected; a parallel picture, however, is found in *G. garrettii* (see below).

G. garrettii Kerr

Material studied: *Sorensen, Larsen, & Hansen* 4218, Doi Chieng Dao, on limestone rocks, 1300 m, 17 vii 1958; *Sorensen, Larsen, & Hansen* 4247, Doi Chieng Dao in evergreen forest, 500 m, 17 vii 1958.

Kerr mentions that this species, endemic to the isolated limestone mountain Doi Chieng Dao, is related to *G. reflexa*, but this species seems always to be found on igneous rocks. Two populations were studied cytologically,

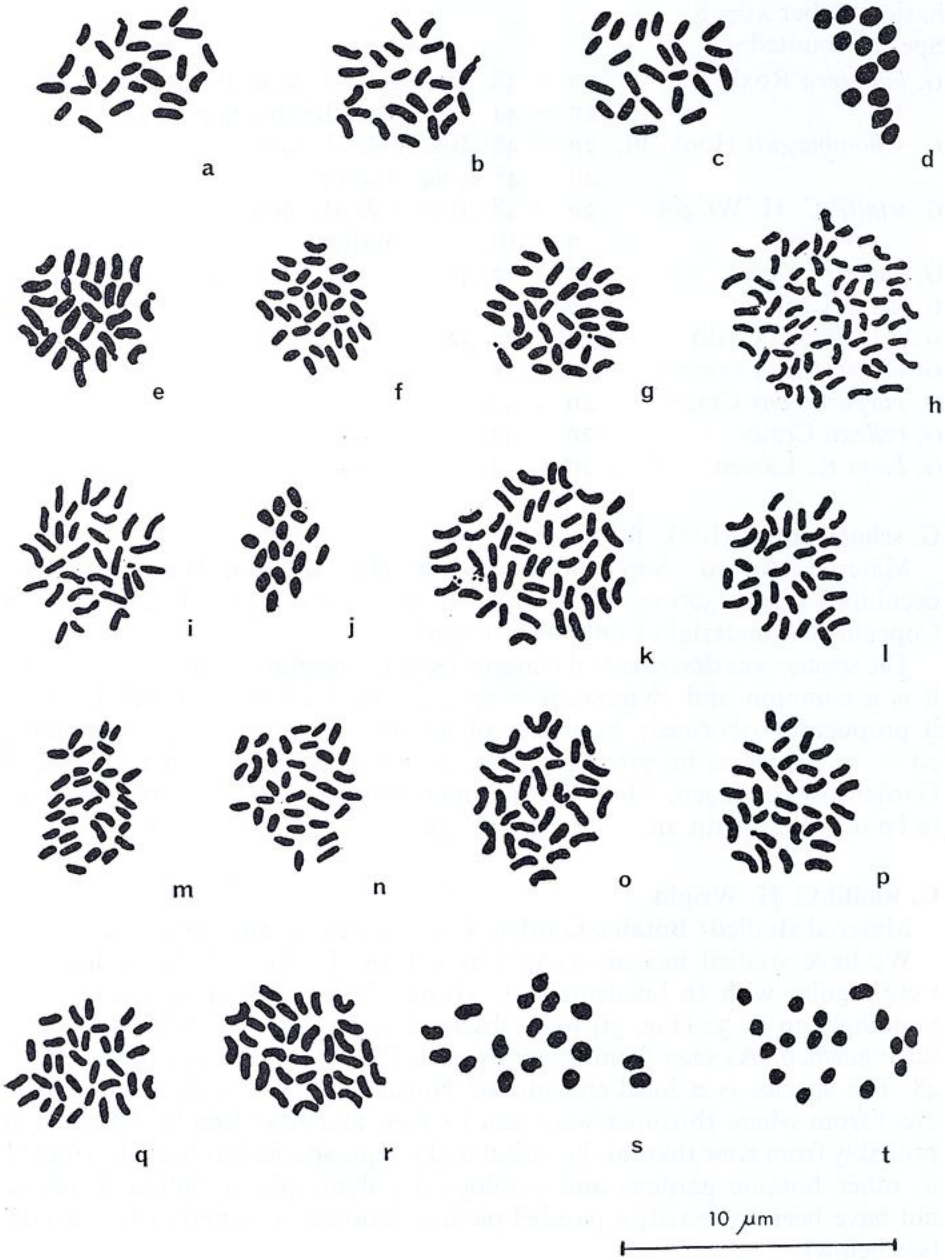

FIG. 5. a-c: *G. clarkei* 4664, 2n = 24; d: *G. clarkei* 4686, n = 12; e: *G. aphanantha* 10411, 2n = 28; f, g: *G. pendula* 1450, 2n = 32; h: *G. schomburgkii* 4003, 2n = 64; i: *G. winitii* 2n = 32; j: *G. winitii*, n = 16; k: *G. garrettii* 4218, 2n = 48; l: *G. garrettii* 4247, 2n = 32; m, n: *G. kerrii* 4396 & 3654, 2n = 32; o: *G. obscura* 10161, 2n = 32; p: *G. purpurascens* 3738, 2n = 32; q: *G. reflexa* 2901, 2n = 32; r: *G. laeta* 2243, 2n = 32. s, t: *G. nuda* 2678, n = 17. The collectors' numbers are referred to more fully in the text.

4218 was found to be hexaploid with 2n = 48 (Fig. 5k) while 4247 is tetraploid (Fig. 5l). Significant morphological differences between the two ploidy levels cannot be demonstrated.

G. kerrii Craib

Material studied: *Sorensen, Larsen, & Hansen* 3654, Doi Suthep, in *Pinus khasya* plantation, 1100 m, 21 vi 1958; *Sorensen, Larsen, & Hansen* 4396, Doi Suthep, open grassy pine forest (natural), 1100 m, 25 vii 1958.

Craib described 5 species of *Globba* from the mountain massif Doi Suthep north of Chiengmai. He often used a narrow species concept, but as far as *Globba* is concerned, we fully agree with his opinion. During nine months stay in the area all his species were refound; four of them have now been studied cytologically and all showed the tetraploid number 2n = 32. Fig. 5m, n shows clear root-tip metaphases of *G. kerrii*.

G. nisbethiana Craib

Material studied: *Sorensen, Larsen & Hansen* 4525, Doi Suthep, hillside evergreen forest with dark humus soil, 1100 m, 29 vii 1958.

A small species probably closely related to *G. pauciflora* King ex Baker. The description of *G. pauciflora*, found on the Andaman islands, is however, incomplete and material of this species has not been seen. The root-tip fixation of the present plant was not very good and the plates difficult to count, but the approximate number 32 could be established.

G. obscura K. Larsen

Material studied: *Larsen* 10161, Khao Yai National Park, Khao Khieo, evergreen forest, 1300 m, 20 iv 1963.

This species is an endemic of the hillside evergreen forest of the Khao Yai massif Central Thailand. It often grows in moss cover and was here found together with another endemic *Caulokaempferia saxicola* (see Larsen 1964). The metaphase plates from root tips were clear and showed 2n = 32 but no satellites could be seen (Fig. 5, o).

G. purpurascens Craib

Material studied: *Sorensen, Larsen, & Hansen* 3738, Doi Suthep, clearing in evergreen forest, 1100 m, 26 vi 1958.

The species was extremely common around our station, situated at an elevation of 1000 m, and in other clearings in the hillside forest. Fig. 5p shows a metaphase plate from root-tip material with 32 chromosomes. 1–2 SAT-chromosomes were generally found.

G. reflexa Craib

Material studied *Sorensen, Larsen, & Hansen* 2901, Doi Suthep, open grassy mixed oak forest, 1300 m, 18 iv 1958.

This seems to be the widest distributed of the "Craib-species" from Doi Suthep as it also occurs in mountain groups in Central Thailand. It is a rather polymorphous species and should be studied cytologically from a wider range. Our material was tetraploid, 2n = 32 (Fig. 5q).

G. laeta K. Larsen

Material studied: *Larsen, Santisuk, & Warncke* 2243, South of Mae Sarieng in moist creek in deciduous forest, 350 m, 8 vii 1968.

A very characteristic species easily distinguished by the thick dense inflorescense unlike that of any other *Globba* species. It may be regarded as an endemic of the Salween valley around Mae Sarieng. To the author it is known only from the type locality. Morphologically it seems not to be closely related to any other known species; but its basic number is the same as found in the other species of this section, and it is tetraploid, 2n = 32, like the majority of them (Fig. 5r).

Section Nudae K. Larsen

Characterized by 4 anther appendages, and missing bracts. Basic number $x_2 = 17$.

G. nuda K. Larsen

Material studied: *Sorensen, Larsen, & Hansen* 2678, Doi Suthep, dry dipterocarp forest, 700 m, 13 iv 1958.

This species, endemic to the dry dipterocarp forests at low elevation in the upper Meping valley, is unique in its morphology (see Fig. 4) as in its cytology. Besides the type it is also represented by a collection (*Garrett* 749) from Wieng Papau. We have chosen our own collection as type instead of the older one, on account of the cytological evidence which it is possible to add to the description. Fig. 5s, t show two very clear PMC-metaphases with 17 bivalents.

Discussion

The genus *Globba* is in this study shown to be a polyploid complex in the sense of Stebbins (1950). So far it has not been possible to demonstrate the postulated diploid level, but this may be due to the fact that the species investigated are all advanced monsoon taxa. Ancestral diploids should be searched for in the wet tropical forests of Malaya and New Guinea.

The cytological level which seems to have had the greatest success is the tetraploid. On this level a very rapid speciation has evidently taken place in the mountainous region of Northern Thailand, and the taxa could be characterized as neoendemics.

Sharma & Bhattacharyya (1959) propose one of two basic numbers, x = 11 or x = 12, and this is followed by Bisson & al. (1968). The cytology of *Globba* is better explained, in the writers view, by calculating from a lower basic number, such as is known elsewhere in the family (e.g. x = 9 in *Boesenbergia* spp.; Larsen unpublished). The number x = 8 would fit well for sections *Ceratanthera* and *Marantella*, with 2n = 32, 48, 64. *G. clarkei* (2n = 24) and *G. aphanantha* (2n = 28), both in section *Haplanthera*, may be tetraploids of x = 6 and x = 7: numbers that could be related to n = 8 in a dysploid series. Finally the curious *G. nuda* (2n = 34) seems to have a secondary basic number $x_2 = 17$; this species may have arisen through

amphiploidy. An objection could be raised, as most often only two SAT-chromosomes are seen in the metaphase plates of the species studied here. Now the paraffin method is not ideal for fine structures like that and, furthermore, these species are well established entities with normal meioses in which one pair of satellites may have been lost due to evolutionary diploidization.

While thus the basic numbers give us the first hint towards the evolutionary pattern of the group; chromosome morphology is not of much use, as all species show a high degree of similarity in their karyotypes with little obvious differentiation of the individual chromosome pairs.

With the present study of 13 species, new light has been thrown on the evolution of the complex genus. A great amount of work remains still to be done particularly in the Indochinese monsoon area, but also in the eastern evolution centre on the Philippines and New Guinea; so far we have no cytological information at all from this part of the range of the genus *Globba*.

Appendix

In a previous paper the genus *Geostachys* in Thailand has been treated and a new species described as *Geostachys densiflora* K. Larsen. This name, however, is already occupied by a species described by Ridley. Therefore, the collection of A. F. G. Kerr, No. 15495, has to be given another name. To honour the great pioneer I have chosen to rename the species:

Geostachys kerrii K. Larsen, **nom. nov.**

Syn.: *G. densiflora* K. Larsen 1962 in Bot. Tidsskr. 58: 45; non Ridley 1920, Journ. Str. Br. Roy. As. Soc. 82: 201.

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