

# Distribution patterns and diversity centres of Zingiberaceae in SE Asia

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A revised classification, based on molecular and morphological data, has recently been proposed. The new classification divides the family into four subfamilies. 1: The Tamijioideae including the recently discovered monotypic genus *Tamijia* from N Borneo. 2: The Siphonochiloideae including the genus *Siphonochilus* (15) restricted to tropical Africa. The remaining c. 50 genera, with c. 1300 species are classified in two subfamilies: 3: The Alpinioideae, the most widespread, is represented by *Renealmia* (100) in the Neotropics and Africa, *Aframomum* (50) and *Aulotandra* (5) in Africa while the remaining c. 20 genera with some 700 species are all from the Asian tropics. 4: The Zingiberoideae, a far more diverse group with c. 30 genera comprising c. 600 species. They are only represented in Asia. The main centre of distribution for the two large subfamilies is SE Asia. The biogeography of all genera from this region is presented and it is shown that the Alpinioideae have their main centre of diversity in the Malesian region while the Zingiberoideae are centred in the northern monsoon region with Indochina having the highest diversity. In the light of the many recent discoveries of new genera and species it is also stressed that, besides continued studies on the molecular based phylogeny, basic field-work is still highly needed.

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## Introduction

In 1904 Schumann published his monograph on the Zingiberaceae. The system presented here was, with some refinements, mainly by Loesener (1930), Holttum (1950), and Burt and Smith (1972), accepted throughout a century. A revised classification, based on molecular and morphological data, was proposed by Kress *et al.* (2002) (Fig. 1).

The new classification divides the family into four subfamilies.

- Subfamily Tamijioideae. This subfamily comprises only one genus, the recently discovered, monotypic *Tamijia* restricted to N Borneo (Sakai & Nagamasu 2000).

- Subfamily Siphonochiloideae. Schuman treated the genus *Siphonochilus* (15), restricted to tropical Africa, as *Kaempferia*. Surprisingly, molecular studies have revealed it as a very distinct and basic group.
- Subfamily Alpinioideae (Fig. 2A,B). About 20 genera with c. 700 species are the most widespread, represented by *Renealmia* (100) in the neotropics and Africa, *Aframomum* (50) and *Aulotandra* (5) in Africa while the remaining genera are all restricted to Asia.
- Subfamily Zingiberoideae (Fig. 2C-F). The most diverse group with c. 30 genera comprising c. 600 species, are only represented in Asia.

The author has studied the family in SE Asia for over 30 years and is organizer of and contributor to the treatment of the family for the Flora of Thailand and the Flora Malesiana. Several years ago, I established a team of a dozen botanists, Thai and foreign, to treat the family in Thailand. Among these are six Ph D students from Thailand who have now for 2-4 years collected throughout the country. This has increased our knowledge of the diversity of the family in this large country immensely. In the last published checklist of Thai Zingiberaceae (Larsen 1996), 200 species were included; today close to 300 species have been documented. Three new genera have been discovered and described as well as numerous new species, and we are aware of several undescribed taxa.

### Subfamily Alpinioideae

The Alpinioideae consists of c. 20 genera after *Nanochilus*, *Rhynchanthus* and *Pommereschea*, three small genera from the northern monsoon area, have been transferred to the Zingiberoideae based on molecular studies. This makes the subfamily more uniform morphologically, consisting of large herbs with a main distribution in the lowland forests of the Malesian region. The distichy of the leaves are transverse to the rhizome and the lateral staminodes are reduced to small teeth at the base of the labellum. To illustrate the distribution patterns in the Alpinioideae, the genera are presented here in groups corresponding to the results of the molecular analysis in which two tribes, the Alpinieae and the Riedelieae, are recognized. The first one is by far the largest.

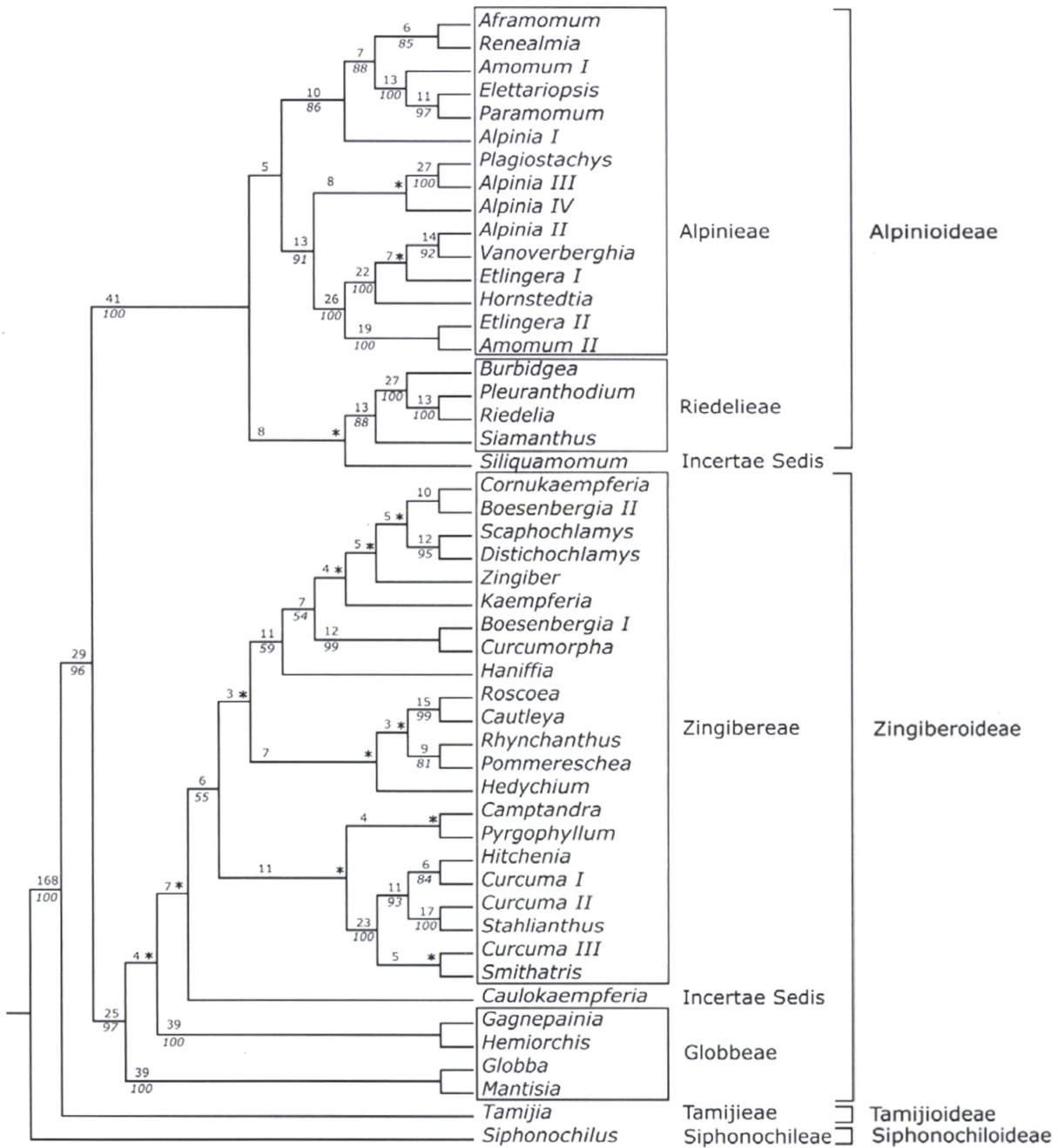
### Tribe Alpinieae

*Alpinia* – This is the largest genus in the Zingiberaceae with over 200 species (Fig. 2A). The plants are tall herbs up to 8 (-12) m with a

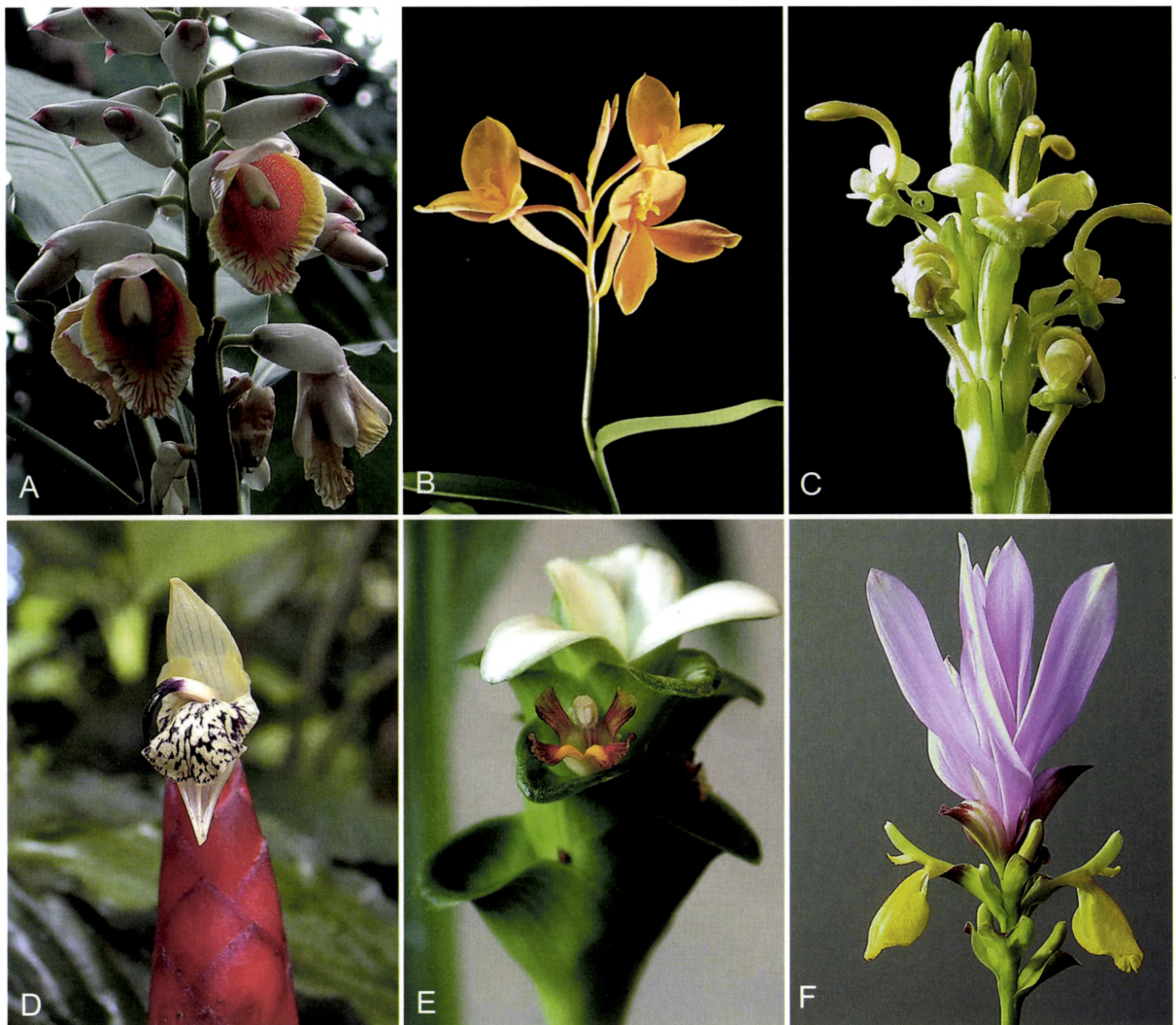
robust rhizome and a terminal inflorescence. Several attempts have been made to split the genus into smaller genera, the latest by Hottum (1950), but none of these have been satisfactory. Smith (1990) joined the segregate genera and gave a framework for an infrageneric classification. The molecular analysis, however, has shown that *Alpinia* is polyphyletic consisting of at least four groups not really corresponding with those of Smith. There is no recent revision of the genus, but the overall distributional pattern is representative for the subfamily. The largest number of species occurs in Malesia with about 60 species in China (Wu & Larsen 2000) and the Indochinese region. Thus clearly two diversity centres exist: one in central Malesia and one in the northern monsoon region where the species are mostly found in montane evergreen forests. Several undescribed species are expected.

*Amomum* – The situation in *Amomum*, with some 150 species, is similar to some extent to *Alpinia*. This genus also seems to be polyphyletic even if only few species have been sampled in the analysis. Again no recent revision exists, and much field-work is needed as many new species have been described in recent years mainly from northern Borneo. It is remarkable that there are far fewer collections of *Amomum* than of *Alpinia* in the large herbaria. This may be due to the less eye-catching, basal inflorescences and shorter flowering period. There are two diversity centres: one, with the majority of species, in Borneo and one in China-Indochina with about one third of the species.

*Etilingera* – This, the third largest genus with about 80 species of large forest herbs was, in its present circumscription, established by Burt & Smith (1986) who joined *Achasma*, *Geanthus* and *Nicolaia*. This genus may also be polyphyletic. Again we find the same overall pattern with a distribution from the southern



**Fig. 1.** Cladogram showing the system of the Zingiberaceae as proposed by Kress *et al.* (2002). Reproduced with permission from *Amer. J. Bot.* **89**, 2002.



**Fig. 2.** Representative species of SE Asian Zingiberaceae. The species represent the two subfamilies Alpinioideae (A-B) and Zingiberoideae (C-F) and the tribes Alpinieae (A: *Alpinia malaccensis*), Riedelieae (B: *Burbidgea nitida*), Globbeae (C: *Gagnepainia godefroyi*) and Zingibereae (D: *Zingiber puberulum*, E: *Curcuma* sp. nov., F: *Laosanthus graminifolius*).

Himalayas throughout SE Asia to N Queensland with the main diversity centre in Malesia, particularly Borneo. There are only few species in Indochina and two species in China, one endemic, *E. yunnanensis*, and one, *E. littoralis*, a very widespread species. Also in this genus much field-work is needed.

***Hornstedtia*** – This genus follows the same

pattern as described for the preceding genera with c. 50 species in Malesia and NE Australia. There are a few Malaysian species, some of which also occur in S Thailand. Further north, one species is endemic to N Vietnam, and two to China (Hainan and Tibet).

***Plagiostachys*** – About 25 species of this taxonomically poorly studied genus are mainly

found in the Malesian region. One species has recently been collected in S. Thailand, one undescribed species is found in central Thailand while one, *P. austrosinensis*, is endemic to S China. A problem with the genus is that in most species the inflorescence dissolves after anthesis in a mucilaginous substance, causing most old herbarium material to be of little use. Kress *et al.* (2002) included only two species in their molecular analysis. The genus follow the same pattern of distribution as the genera above with the majority of the species in Malesia and a narrow "tail" of endemic species in the continental monsoon region.

***Geostachys*** – This genus was not included in the molecular analysis by Kress *et al.* (2002). It seems to be related to *Amomum* but is recognizable by the leaves in a radical tuft on the rhizome raised above the ground by stilt-roots and a basal inflorescence with sterile bracts at base and tubular bracteoles enclosing the cincinni. Holttum (1950) was the first to study *Geostachys* from Peninsular Malaysia, where he found that it had its centre of diversity in contrast to the other genera in the Alpinioideae. It is also characteristic that all species are found as endemics occurring in montane forests at altitudes above 800 m. I have for several years studied the genus and described new species from Thailand, all mountain endemics (Larsen 1962, 2001). Schumann (1904) enumerated 5 species, Holttum (1950) recognized 14 species, today at least 24 species are known, including 10 endemic to Thailand, Cambodia, Vietnam, Sumatra, Borneo.

***Small genera*** – Besides the larger genera treated above, some smaller genera with one or few species belong to this tribe. Not all of these have been available for the molecular analysis. These taxa include *Cyphostigma* (1), in Sri Lanka, *Elettaria* (7), in Malesia, *Elettariopsis* (10), in Malesia, *Geocharis* (7), in eastern Malesia, *Leptosolena* (1), in the Philippines, and *Vanoverbergia* (2), from China (Taiwan) to the

Philippines. The place of the monotypic genus *Paramomum*, endemic to China, treated by Larsen *et al.* (1998) as *Amomum*, was found by Kress *et al.* (2002) to be close to *Elettariopsis*, a genus with uncertain circumscription.

## Tribe Riedelieae

The tribe Riedelieae consists of 4 or 5 genera with long capsules opening longitudinally and extrafloral nectaries on the leaves.

***Burbidgea*, *Riedelia*, *Pleuranthodium* and *Siamanthus*** – *Burbidgea* (8; Fig. 2B) is endemic to Borneo whereas *Riedelia* (60) and *Pleuranthodium* (25) are both distributed in Eastern Malesia to N. Australia. Finally *Siamanthus* (1) as described by Larsen and Mood (1998), is one of the strangest endemisms from S Thailand possessing a bilabiate floral structure quite different from what is known elsewhere in the Zingiberaceae. The tribe Riedelieae again appears to have the same distribution pattern as the Alpinioideae, but here it is even more pronounced, with some 100 species distributed throughout the East Malesian area and only one, *Siamanthus*, in Thailand.

***Siliquamomum*** – Finally, *Siliquamomum* is a monotypic genus from N Vietnam and adjacent S China. It seems difficult to place at present and Kress *et al.* (2002) included it as *incerta sedis*. It may be related to *Siamanthus* even if the floral morphology is very different.

## Subfamily Zingiberoideae

The Zingiberoideae consists of c 30 genera. Only *Zingiber* matches in size the largest genera in the Alpinioideae. The species are generally smaller herbs mostly with a pronounced seasonal dormancy period adapted to the monsoon climate. In many genera we find species that produce inflorescences at the end of the dry season and leafy shoots in the rainy season. The distichy of the leaves are parallel to the rhi-

zome. The lateral staminodes are well developed, either free from the labellum or attached to it as in *Zingiber*. The Zingiberoideae includes the three tribes Zingibereae, Hedychieae, and Globbeae in Schumann's (1904) classification. Kress *et al.* (2002) recognize two tribes, the Zingibereae and the Globbeae. Finally the genus *Caulokaempferia*, established by Larsen (1964), is placed as *incerta sedis*. The largest tribe is the Zingibereae with some 25 genera.

### Tribe Zingibereae

**Zingiber** – The *Zingiber*-clade comprises *Zingiber*, *Kaempferia*, *Scaphochlamys*, *Haniffia*, *Distichochlamys*, *Boesenbergia*, *Haplochorema* and *Cornukaempferia*. *Zingiber* deviates in many ways from the other genera. It is a large genus with between 100-150 species (Fig. 2D), widespread from subtropical Japan through Malesia to Indochina, China, and India. Most species are evergreen, medium-sized herbs belonging to the lowland forests. The flowers are characteristic in possessing a long produced connective. The uncertain number of species is due to our lack of knowledge of the diversity in the main centres, Borneo and Indochina. This situation is best illustrated by Thailand. A few years ago Larsen (1996) estimated the number of species native to Thailand to 25. Then Theilade (1999) subsequently described 8 new species and 2 new records. Most recently, collecting all over the country has increased the number of species to about 50, with 5 new species and several new records (Triboun in prep.). We are also aware of several new species from Vietnam. A similar situation could be reported from other parts of SE Asia (see also Theilade & Mood 1997 and Mood & Theilade 2002). In spite of these drastic changes it is clear that there are two diversity centres: an eastern centre in Borneo and a western one in the Indochinese region.

**Kaempferia** – The genus *Kaempferia* consists of small herbs with a pronounced dormancy period. Intensive collecting activities in Thailand and neighbouring countries have revealed an extraordinary diversity in limestone regions. At present about 10 new species from Thailand and Laos are being prepared for publication (Jenjittikul, pers. comm.). This genus is widespread in tropical Asia, but with most of the species in the Indochinese region. *Kaempferia* is a well-defined genus according to Kress *et al.* (2002), still I suggest that *K. scaposa* from India should be excluded due to its deviating morphology. The small genus **Haplochorema**, endemic to Borneo, is very similar to *Kaempferia*. It has not been included in the molecular studies.

**Scaphochlamys** – The genus *Scaphochlamys* was studied in depth by Holtum (1950) in connection with his treatment of the Peninsular Malaysian Zingiberaceae. It is a group of small herbs with tufted leaves, spirally arranged bracts, glandular floral parts and patent staminodes; nearly all species are restricted to the lowland forest of the Malay Peninsula.

**Haniffia** – The genus *Haniffia* was described by Holtum (1950) and is morphologically close to *Scaphochlamys* in its floral characters with *e.g.* the glandular hairs and patent staminodes; vegetatively, however, it looks like a small *Zingiber* on account of the elongated pseudostem. Besides the type species, *H. cyanescens*, a second species was recently described in S Thailand, *H. albiflora* (Larsen & Mood 2000). The genus is restricted to the lowland evergreen forests of the Malay Peninsula.

**Distichochlamys** – Newman (1995) described the genus *Distichochlamys* from a limestone region in central Vietnam. In floral characters it matches *Scaphochlamys* and *Haniffia*, but the bracts are distichous. Geographically, as well as ecologically, it is distinctly separated from *Scaphochlamys*. A second species was described by Larsen and Newman (2002), and a third

species by Rhese and Kress (2003). All three species are from the same limestone region in central Vietnam.

***Boesenbergia*** – This is a genus that I have studied for several years. The molecular analysis suggests that it is polyphyletic. The genus, as generally recognized today, is widely distributed, but with two very distinct centres: N Borneo and monsoon Asia. Almost every expedition to Brunei, Sarawak and Sabah has brought back undescribed species of *Boesenbergia* and we strongly suspect that there are still more to be discovered. Also from Thailand, Myanmar and adjacent regions of India intensive collecting activities in recent years have revealed several new species. Morphologically 3 or 4 rather distinct groups can be identified: 1. The group including the generic type, *B. pulcherrima*, with apical flowering. 2. the *Curcumorpha* group, based on *B. longiflora*, which flowers from the base. 3. An intermediate group (e.g., *B. tenuispicata*), which has not been studied in the molecular analysis. In all three groups the bracts are distichous, not spirally arranged as described by Rao and Verma (1971) for *Curcumorpha* (see Larsen 1997). 4. Finally the very polymorphic species *B. curtisii*, with a morphologically distinct floral structure may not belong here. It has not yet been included in the molecular analysis. Thus, there is still a long way to go before the phylogeny of the genus (or generic complex) has been elucidated and understood.

***Cornukaempferia*** – This, the last genus in the *Zingiber*-clade, has an interesting history. The genus has been known for more than two decades and sold through American nurseries under various fancy names until Mood and Larsen (1997) described it. The characteristic flower has a superficial resemblance with *Zingiber* while the vegetative parts are similar to *Kaempferia*. It was described as a monotypic genus from central northern Thailand with the species *C. aurantiflora*. Soon, however, a second

species, *C. longipetiolata*, was collected close to the border of Laos (Mood & Larsen 1999).

***Curcuma*** – The *Curcuma*-clade consists of the large genus *Curcuma* (Fig. 2E) centred in monsoon Asia and with a tail of small closely related genera in the northern part of the region. *Curcuma* is, as several of the other genera in the Zingiberoideae, subject to intense collecting through the major part of its distribution area, and important new knowledge of the diversity is accumulating. Almost all species have a distinct dormancy period and several develop the inflorescence before the leafy shoot. From Thailand new species have recently been described by Mood and Larsen (2001). In Larsen *et al.* (1998) the number of species in the genus was estimated to 50. With our present knowledge it will probably be closer to 80.

***Hitchenia* and *Stahlianthus*** – Two small genera, *Hitchenia* (3) distributed from western India to Myanmar and *Stahlianthus* (4) from Myanmar to Thailand are closely related to *Curcuma*.

***Smithatris*** – The genus *Smithatris* has a similar exciting history as *Cornukaempferia*. A plant was in 1998 presented at a horticultural exhibition in Singapore and here observed by Kress. At the same time I had seen other collections in Thailand. The Maranthaceae-like leaves and small flowers with a long corolla tube, which recoils after anthesis, are very characteristic. Kress and Larsen (2001) described the material as a *species et genus nova* with the species *S. supraneaanae*. Even if it was new to science, the species has been known by the local people just outside Bangkok for years and used to embellish the temples during the Buddhist lent. Recently Kress and Htun (2002) described a second species from Myanmar.

***Laosanthus*** – This genus was described by Larsen and Jenjittikul (2001) as a monotypic genus from Laos, has a strongly reduced version of the *Curcuma* flower, without lateral staminodes and anther appendages combined

with free inflorescence bracts and long, narrow grass-like leaves (Fig. 2F). It has not yet been included in the molecular analysis.

***Roscoea*, *Cautleya*, *Pommereschea* and *Rhyncanthus*** – One group, consisting of the genera *Roscoea* (20), *Cautleya* (2), *Pommereschea* (2) and *Rhyncanthus* (6), belongs to the Himalayan element in the SE Asian floras and have the most northwestern distribution of the Asian Zingiberaceae. The two latter genera formerly were treated as members of the Alpinioideae but following the molecular analysis were transferred to the Zingiberoideae. It should be mentioned also that earlier authors (*e.g.*, Burtt & Smith 1972) had suggested that they might be better placed here.

***Pyrgophyllum* and *Camptandra*** – The genus *Pyrgophyllum* is a monotypic genus endemic to S China. Schumann (1904) treated it as part of *Camptandra*. Gagnepain (1908) referred it to *Kaempferia* (where it clearly does not belong). Larsen and Smith (1972) included it in *Caulokaempferia*. Schumann's placement comes closest to the results of the molecular analysis. *Camptandra* (3) shares the one large spatheaceous bract with *Pyrgophyllum*. Biogeographically *Camptandra* belongs to the lowland Malesian element found in the evergreen forests in the Malay Peninsula and Borneo.

***Hedychium*** – This is a very natural monophyletic genus. It possesses a number of unique characters, the dense inflorescences with imbricate bracts, the long exerted stamen, the development of several flowers at the same time, and the seeds embedded in the more or less merged arils. The main distribution centre for the c 80 species is clearly monsoon Asia to S China and the Himalayan region; a few species do occur in the Malesian region, particular in Borneo. About half of the species occur in the Indochinese region (Sirirugsa & Larsen 1995). A recently finished monograph is anticipated (T. Wood in prep.). Ongoing studies on the genus in Thailand by P. Sirirugsa and the

author have revealed four new species (unpublished).

***Caulokaempferia*** – The genus *Caulokaempferia* may or may not belong in the Zingibereae. Kress *et al.* (2002) keeps it as *incerta sedis*. This genus deserves attention. Larsen (1964) separated it from *Kaempferia* where it clearly did not belong. At that time seven species were known ranging from N India, Yunnan, N Vietnam to Thailand, *i.e.* the Himalayan element in continental SE Asia. All the species are from high altitudes, with yellow flowers, unilocular capsule opening by one large window and minute, exarillate seeds. In 1972, Larsen and Smith described, *C. alba* with white flowers and a trilocular, fleshy capsule dehiscing by three valves releasing a few, large seeds with a well developed aril. Some related species with violet flowers were later described from other plateau mountains (Larsen 2003). The type of the genus has yellow flowers and unilocular capsule and may be related to *Globba*. The group with white-violet flowers has not yet been included in molecular studies, but I strongly suspect that it is not related to *Caulokaempferia* and should be treated as a separate genus, Larsen (2003). The author is working on a monograph on this group.

***Nanochilus*, *Paracautleya*, *Parakaempferia* and *Stadiochilus*** – Four monotypic genera of very restricted occurrence are poorly known and have not been treated in the phylogenetic analysis: *Nanochilus* (1) from Sumatra, *Paracautleya* (1) India, Kanara, *Parakaempferia* (1) India, Assam and *Stadiochilus* (1) Myanmar.

### Tribe Globbeae

***Globba*, *Mantisia*, *Gagnepainia* and *Hemiorchis*** – All previous systematists have recognized this tribe as a distinct group consisting of 4 genera, *Globba* (90), *Mantisia* (2), *Gagnepainia* (3; Fig. 2C) and *Hemiorchis* (3), of which at least the first three are closely related. The largest genus



*Globba* has its diversity centre in the Indochinese monsoon region, but with offshoots to the Malay Peninsula, Sumatra and Borneo. M. Newman is now revising the genus for Thailand, and a monograph by K. Williams is in the pipeline. *Mantisia* belongs to the Himalayan element and may be included in *Globba*. *Gagnepainia* (3) is restricted to Thailand and adjacent regions of Laos and Cambodia. From the molecular analysis it appears, surprisingly, closer to *Hemiorchis* (3), distributed from India to western Thailand. I have always found that this genus was not belonging naturally to the Globbeae.

## Conclusion

The intense study of the Zingiberaceae during the last decade has not been equalled since the days of Gagnepain (1908), Ridley (1899) and Schumann (1904) published their valuable contribution to the knowledge of the family a century ago. We are now exploring the last undercollected regions of SE Asia and have found a hitherto unknown richness of diversity and gained a much more precise picture of the diversity centres. Through the very recent molecular studies, we have got a new phylogenetic system. This will undoubtedly be adjusted and refined in the future as more taxa are included.

The overall picture of the two large subfamilies is, however, clear. The Alpinioideae is widespread throughout the tropics but, as for the family, is mainly found in the Asian tropics. It is most diverse in the Malesian region and here again Borneo is clearly the main centre on the Sunda shelf, while a second less explored centre is placed further East. A third centre, with about one third of the species, is in continental monsoon Asia. Some of the genera seem to be so closely related morphologically that some species may change their position in the future or genera may be combined.

The other large subfamily, the Zingiberoideae, is far more complex. There are some well-defined clades with one large genus, for example *Curcuma* and a tail of smaller, closely related genera found in special environments such as isolated limestone areas, sandstone table mountains and evergreen forests of the Malay Peninsula. The overall picture is that of a subfamily centred in continental SE Asia and particularly in the northern monsoon region. Two of the largest genera, *Zingiber* and *Boesenbergia*, however, have a distribution pattern like the majority of the Alpinioideae, with two main centres, one in continental monsoon Asia, the other on Borneo.

Some areas of SE Asia are rather well collected, e.g. Peninsular Malaysia, Thailand and N Borneo. With so many new taxa of Zingiberaceae found in the last few years in Thailand and Sabah, due to intense collecting activities, there is no doubt that the far less well-known regions, such as Myanmar, Vietnam, and particularly Laos and Kalimantan, will in the future, bring many new discoveries.

In the coming years, molecular studies, clearly, should have high priority as certain genera cannot yet be placed at present, and many have been found to be polyphyletic. As yet we cannot with any certainty answer the question: "How many species of Zingiberaceae are there?" Therefore we must also support basic field-work in the last remaining wilderness in SE Asia.

## Literature cited

- Burtt, B.L. & Smith, R.M. 1972. Key species in the taxonomic history of Zingiberaceae. *Notes Roy. Bot. Gard. Edinburgh* **31**: 177-227.
- Burtt, B.L. & Smith, R.M. 1986. Etlingera: the inclusive name for *Achasma*, *Geanthus* and *Nicolaia*. *Notes Roy. Bot. Gard. Edinburgh* **43**: 235-241.
- Gagnepain, F. 1908. Zingiberaceae. In: Gagnepain, F. (ed.), *Flore Générale de l'Indochine*. Vol. 6. Masson et Cie, Paris. Pp. 25-121.

- Holtum, R.E. 1950. The Zingiberaceae of the Malay Peninsula. *Gard. Bull. Singapore* **13**: 1-249 & Fig. 11-32.
- Kress, W.J. & Htun, T. 2002. A second species of *Smithatris* (Zingiberaceae) from Myanmar. *Novon* **13**: 68-71.
- Kress, W.J. & Larsen, K. 2001. *Smithatris*, a new genus of Zingiberaceae from Southeast Asia. *Syst. Bot.* **26**: 226-230.
- Kress, W.J., Price, L.M. & Williams, K.J. 2002. The phylogeny and a new classification of the gingers (Zingiberaceae): Evidence from molecular data. *Amer. J. Bot.* **89**: 1682-1696.
- Larsen, K. 1962. Studies in Zingiberaceae. I. The genus *Geostachys* in Thailand. *Bot. Tidsskr.* **58**: 43-49.
- Larsen, K. 1964. Studies in Zingiberaceae. IV. *Caulokaempferia*, a new genus. *Bot. Tidsskr.* **60**: 165-179.
- Larsen, K. 1996. A preliminary checklist of the Zingiberaceae of Thailand. *Thai Forest Bull., Bot.* **24**: 35-49.
- Larsen, K. 1997. Further studies in the genus *Boesenbergia* (Zingiberaceae). *Nord. J. Bot.* **17**: 361-366.
- Larsen, K. 2001. *Geostachys smitinandii* K. Larsen (Zingiberaceae), a new species from Thailand. *Thai Forest Bull., Bot.* **29**: 17-22.
- Larsen, K. 2003. Three new species of *Caulokaempferia* (Zingiberaceae) from Thailand with a discussion of the generic diversity. *Nord. J. Bot.* **22**: 409-417.
- Larsen, K. & Jenjittikul, T. 2001. *Laosanthus*, a new genus of Zingiberaceae from Laos. *Nord. J. Bot.* **21**: 135-138.
- Larsen, K., Lock, J.M., Maas, H. & Maas, P.J.M. 1998. Zingiberaceae. In: Kubitzky, K. (ed.), *Families and genera of vascular plants. Vol. 4*. Springer Verlag, Berlin. Pp. 474-495.
- Larsen, K. & Mood, J.D. 1998. *Siamanthus* a new genus of Zingiberaceae from Thailand. *Nord. J. Bot.* **18**: 393-397.
- Larsen, K. & Mood, J.D. 2000. Revision of the genus *Haniffia*. *Nord. J. Bot.* **20**: 285-289.
- Larsen, K. & Newman, M. 2001. A new species of *Distichochlamys* from Vietnam and some observations on generic limits in *Hedychieae* (Zingiberaceae). *Nat. Hist. Bull. Siam Soc.* **49**: 77-80.
- Larsen, K. & Smith, R.M. 1972. Notes on *Caulokaempferia*. *Notes Roy. Bot. Gard. Edinburgh* **32**: 287-295.
- Loesener, T. 1930. Zingiberaceae. In: Engler, A. & Prantl, K. (eds.), *Die Natürliche Pflanzenfamilien, 2. Auf. Vol. 15a*. Engelmann, Leipzig. Pp. 541-640.
- Mood, J.D. & Larsen, K. 1997. *Cornukaempferia*, a new genus of Zingiberaceae from Thailand. *Nat. Hist. Bull. Siam Soc.* **45**: 217-221.
- Mood, J.D. & Larsen, K. 1999. New to cultivation: The genus *Cornukaempferia* in Thailand with description of a new species. *New Plantsman* **6**: 196-205.
- Mood, J.D. & Larsen, K. 2001. New *Curcumas* from Southeast Asia. *New Plantsman* **8**: 207-217.
- Mood, J.D. & Theilade, I. 2002. New gingers from SE Asia. *Plantsman New Ser.* **1**: 14-22.
- Newman, M. 1995. *Distichochlamys*, a new genus from Vietnam. *Edinburgh J. Bot.* **52**: 65-69.
- Rao, A.S. & Verma, D.M. 1971. *Curcumorpha* – a new genus of Zingiberaceae. *Bull. Bot. Surv. India* **13**: 339-341.
- Rhese, T. & Kress, W.J. 2003. *Distichochlamys rubrostriata* (Zingiberaceae), as new species from northern Vietnam. *Brittonia* **55**: 205-208.
- Ridley, H.N. 1899. The Scitamineae of the Malay Peninsula. *J. Straits Branch Roy. Asiat. Soc.* **32**: 85-184.
- Sakai, S. & Nagamasu, H. 2000. Systematic studies of Bornean Zingiberaceae: III. *Tamijia*, a new genus. *Edinburgh J. Bot.* **57**: 245-255.
- Schumann, K. 1904. Zingiberaceae. In: Engler, A. (ed.), *Das Pflanzenreich. Vol. 4/46*. Engelmann, Leipzig. Pp. 1-458.
- Sirirugsa, P. & Larsen, K. 1995. The genus *Hedychium* (Zingiberaceae) in Thailand. *Nord. J. Bot.* **15**: 301-304.
- Smith, R.M. 1990. *Alpinia* (Zingiberaceae) a proposed new infrageneric classification. *Edinburgh J. Bot.* **47**: 1-75.
- Theilade, I. 1999. A synopsis of the genus *Zingiber* (Zingiberaceae) in Thailand. *Nord. J. Bot.* **19**: 389-410.
- Theilade, I. & Mood, J.D. 1997. Two new species of *Zingiber* (Zingiberaceae) from Sabah, Borneo. *Sandakania* **9**: 21-26.
- Wu, D. & Larsen, K. 2000. Zingiberaceae. In: Wu, Z.Y. & Raven, P.H. (eds.), *Flora of China. Vol. 24*. Science Press, Beijing & Missouri Bot. Gard. Press, St. Louis. Pp. 322-377.