ความหลากหลายของพืชวงศ์ขิงในเขตอุทยานแห่งชาติเขานัน และอุทยานแห่งชาติเขาหลวง

Zingiberaceae Diversity in Khao Nan and Khao Luang National Parks

นภัทร กิตติพนังกุล

Napat Kittiparangkul

วิทยานิพนธ์วิทยาศาสตรมหาบัณฑิต สาขาวิชาวิทยาศาสตร์ศึกษา (ชีววิทยา)

มหาวิทยาลัยวลัยลักษณ์

Master of Science Thesis in Science Studies (Biology)

Walailak University

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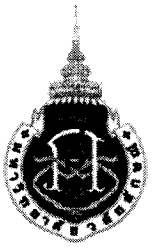

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ณภัทร กิตติพนังกุล

Napat Kittipanangkul

วิทยานิพนธ์วิทยาศาสตรมหาบัณฑิต สาขาวิชาวิทยาศาสตร์ศึกษา (ชีววิทยา)
มหาวิทยาลัยวลัยลักษณ์

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Thesis Title	Zingiberaceae diversity in Khao Nan and Khao Luang National Parks
Author	Napat Kittipanangkul
Program	Master of Science Program in Science Studies (Biology)

Thesis Advisory Committee

.....Chairman
(Asst. Prof. Dr. Chatchai Ngamriabsakul)

.....Committee
(Asst. Prof. Dr. Maruay Mekanawakul)

Examining Committee

.....Chairman
(Professor Puangpen Sirirugsa)

.....Committee
(Asst. Prof. Dr. Chatchai Ngamriabsakul)

.....Committee
(Asst. Prof. Dr. Maruay Mekanawakul)

The committee of Master of Science Studies (Biology) Program, Walailak University, has approved this thesis as partial fulfillment of Master of Science Degree in Science Studies (Biology).

.....
(Assoc. Prof. Dr. Amara Changsub)
Chairman, Master of Science Studies (Biology) Program

ชื่อวิทยานิพนธ์ ความหลากหลายของพืชวงศ์ขิงในเขตอุทยานแห่งชาติเขานัน และอุทยานแห่งชาติเขาหลวง
ผู้เขียน ณภัทร กิตติพนังกุล
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บทคัดย่อ

การศึกษาความหลากหลายของพืชวงศ์ขิงในเขตอุทยานแห่งชาติเขานันและอุทยานแห่งชาติเขาหลวง ในช่วงเดือนกันยายน 2549 ถึงเดือนเมษายน 2550 พบพืชวงศ์ขิงจำนวน 29 ชนิด ใน 11 สกุล 3 เผ่า จากพื้นที่ศึกษาจำนวน 9 สถานี ซึ่งมีจำนวนน้อยกว่า 30 เปอร์เซ็นต์ของพืชวงศ์ขิงที่มีการรายงานในภาคใต้ของประเทศไทย เผ่า Alpinieae มีจำนวนชนิดมากที่สุด จำนวน 5 สกุล 15 ชนิด เผ่า Zingibereae มี 5 สกุล 12 ชนิด ส่วน เผ่า Globbeae มี 2 ชนิด พืชวงศ์ขิงทุกชนิดที่พบ ได้เขียนคำบรรยายลักษณะ บันทึกภาพถ่าย สร้างรูปวิธานแยกสกุลและชนิด

พืชวงศ์ขิงที่ศึกษาส่วนใหญ่เติบโตในป่าดิบชื้น มี 4 ชนิดคือ กระวานเขานัน (*Amomum* sp.) หงส์เหินขาว (*Globba leucantha*) กระชายเขาหลวง (*Boesenbergia basispicata*) และกระชายถิ่นใต้ (*B. plicata*) พบได้ที่ป่าดิบเขาต่ำ ลักษณะดินที่พบในบริเวณที่มีพืชวงศ์ขิงเติบโตอยู่เกือบทั้งหมดเป็นดินที่มีส่วนผสมของทราย มีเพียงชนิดเดียวคือเร่วช้าง (*Amomum aculeatum*) ที่เจริญอยู่ในดินร่วนอย่างเดียว

การกระจายตัว และจำนวนชนิดของพืชวงศ์ขิงลดน้อยลงมากในส่วนที่อยู่ลึกเข้าไปด้านในของป่า ความหลากหลายของพืชวงศ์ขิงจะมีมากที่สุดที่ระดับความสูง 90 ถึง 300 เมตร และจะลดลงเมื่อความสูงเพิ่มขึ้น นอกจากนี้จะพบว่ามีพืชวงศ์ขิงประมาณ 6 ชนิดจากเขตอุทยานแห่งชาติเขานันที่สามารถพบได้ทางด้านเหนือของอุทยานแห่งชาติเขาหลวง เช่น ขิงเขาหลวง (*Zingiber newmanii*) ที่กระจายตัวอยู่รอบต้นลำน้ำคลองกลาย

จากการศึกษานี้ มีพืชวงศ์ขิงจำนวน 8 ชนิดที่สามารถพัฒนาเป็นไม้ดอกไม้ประดับ คือ *Alpinia mutica*, *A. zerumbet*, *Etlingera elatior*, *E. fulgens*, *Curcuma aurantiaca*, *C. rubescens*, *Kaempferia pulchra* และ *Z. newmanii* พืชวงศ์ขิงจำนวน 7 ชนิดที่เป็นอาหาร คือ *Amomum biflorum*, *E. elatior*, *E. fulgens*, *E. littoralis*, *C. longa*, *Z. officinale* และ *Z. zerumbet* เมล็ดของพืชวงศ์ขิง 3 ชนิด คือ ขิงเขาหลวง (*Z. newmanii*) ดาหลาปากนกแก้ว (*E. fulgens*) และ ดาหลา (*E. elatior*) อาจสามารถนำมาสกัดสารสำคัญทางยาจากส่วนของเมล็ดเพื่อใช้ในการรักษาโรคได้

Thesis Title	Zingiberaceae diversity in Khao Nan and Khao Luang National Parks
Author	Napat Kittipanangkul
Program	Science Studies (Biology)
Academic Year	2007

Abstract

Zingiberaceae diversity in Khao Nan and Khao Luang National Parks was conducted from September 2006 to April 2007. Twenty-nine species in 11 genera in 3 tribes of the family were collected from nine stations, less than 30% of the Zingiberaceae recorded for southern Thailand. Tribe Alpinieae, the highest diversity, comprises 5 genera and 15 species. Tribe Zingibereae, the second high diversity, includes 5 genera and 12 species. The least diversity, tribe Globbeae consists of only 2 species in the genus *Globba*. The checklist, descriptions, illustrations and distributions of 29 species found are given along with the keys to genera and species.

Most species of Zingiberaceae in this study grow in Tropical Evergreen Rain Forest. Four species, *Amomum* sp., *Globba leucantha, Boesenbergia basispicata* and *B. plicata* grow in Lower Montane Rain Forest. Soils at the stations that most species are found, are partly composed of sand. Only one species, *Amomum aculeatum* is found at loam soil type.

There are few species found in the interior part of the forest and they are less abundant and sparsely distributed. The diversity of species is mostly distributed in altitude 90-300 m and the number of species decrease when altitude increases. It is observed that at least 6 species of Zingiberaceae of Khao Nan National Park are also found in the northern part of Khao Luang National Park, such as *Zingiber newmanii* distributed around the Klong Klai Basin.

At least 8 species could be developed to be ornamental plants, i.e. *Alpinia mutica*, *A. zerumbet*, *Etlingera elatior*, *E. fulgens*, *Curcuma aurantiaca*, *C. rubescens*, *Kaempferia pulchra* and *Z. newmanii*. Seven species are edible, i.e. *Amomum biflorum, E. elatior, E. fulgens, E. littoralis, C. longa, Z. officinale* and *Z. zerumbet*. The seed of 3 species, *Z. newmanii*, *E. fulgens* and *E. elatior* may prove to be important resources for medicinal essential oils.

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Finally, I wish to express my special gratitude to my family for their support and encouragement during my study.

Napat Kittipanangkul

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CHAPTER I

INTRODUCTION

Zingiberaceae species have been well known as spices and condiments. The family includes many medicinally important species, in particular members of genera *Alpinia, Curcuma* and *Zingiber*. In addition, several species are used as ornamental plants, for example, *Alpinia purpurata* (Vieill) Schum., *Curcuma alismatifolia* Gagnep. and *Etlingera elatior* (Jack) R. M. Smith.

Thailand is one of the richest countries of Zingiberaceae in the world. At least 300 species in 26 genera of Zingiberaceae are found throughout Thailand, however, the number of species will most certainly rise (Larsen and Larsen, 2006). Many genera have been revised, e.g. *Boesenbergia* (Sirirugsa, 1992a, Larsen, 1997), *Kaempferia* (Sirirugsa, 1992b), *Haniffia* (Larsen and Mood, 2000). Many genera are still under revision, e.g. *Zingiber* (Theilade, 1998, Triboun, 2005), *Alpinia* (Saensouk *et al.*, 2003) *Hedychium* (Sirirugsa and Larsen, 1995), and *Amomum* (Kaewsri, pers. comm.).

This thesis is a part of the Area-Based Research Project 'the Khao Nan Cloud Forest' supported by Biodiversity Research and Training Program (BRT) (Baimai and Tantalakha, 2005). The area is the unexplored part of Khao Luang Mountain Range, Southern Thailand. Zingiberaceae is one of the significant components of the

herbaceous ground flora of Thai tropical forests. They mostly grow in damp and humid shady places. They are also found from the lowlands, secondary forests, to the highest elevations in primary forests. Some species can fully expose to the sun. Many species are rare and highly vulnerable to endangered. Many wild species, especially species from Khao Nan National Park and the upper part of Khao Luang National Park are thought to be undocumented and to a larger extent undescribed.

FAMILY DESCRIPTIONS AND CLASSIFICATION

The ginger family or Zingiberaceae belongs to order Zingiberales (previously called Scitamineae). It is a very natural order, which today is divided into eight families falling into two groups, the banana group and the ginger group, the latter being the more advanced (Larsen and Larsen, 2006).

Key to the families (Larsen and Larsen, 2006)

1. Stamens 5 or 6 (Banana group)	2
Stamen 1 (Ginger group)	5
2. Flowers unisexual, plant monoecious, with latex	**Musaceae**
Flowers bisexual, without latex	3
3. Stem woody, 2 lateral petals joined, enclosing the anthers	**Strelitziaceae**
Stem not woody, 2 lateral petals not joined	4

4. Median petal free, forming a labellum; leaves finely reticulately veined **Lowiaceae**

   Median petal not forming a labellum **Heliconiaceae**

5. Flowers symmetrical along the median axis, sepals joined at base 6

   Flowers asymmetrical, sepals free 7

6. Leaves distichous, sheaths open **Zingiberaceae**

   Leaves spirally arranged, sheaths closed **Costaceae**

7. Leaves with a pulvinus below the leaf blade **Marantaceae**

   Leaves without pulvinus **Cannaceae**

All gingers are herbaceous perennial plants with a rhizome, and usually underground. Roots are produced from the base of stem or rhizome. The terminal part of the rhizome turns upwards and becomes the leafy shoot. In some species, the rhizome is raised above the ground on stilt roots.

A real stem is present in most species but usually it is short and higher up replaced by a pseudostem ("false stem") formed by the leaf sheaths. The leaves are distichous (arranged in two rows) in all species. The leaves consist of an opened leaf sheath, lamina usually reduced in lower part of shoot. The leaf sheath is terminated by the ligule, a membranous structure on the inner side of the sheath. Above the sheath follows the petiole, a short or long stalk-like part after which follows the leaf blade. The lamina varies from few cm to more than 1 m in some *Alpinia* species. The bases of the lamina vary from cordate to rounded or tapering towards the petiole, the tip from rounded to acute or acuminate. The vegetation parts may be glabrous or hairy in various degrees.

The inflorescence is either terminal on the leaf shoot or produce on a separate shoot from the rhizome near to the leafy shoot or in some distance from it. The inflorescences are of the cymose type and called cincinnae, compact or loose, usually surrounded by bracts called involucral bracts. The terminal bracts in many *Curcuma* species are sterile and have more color than the floriferous bracts, this structure is called a coma.

Flower is always bisexual, having both stamen and pistil. Stamens, petals and sepals attached to the top of the ovary, epigynous flowers. The ginger flowers consist of 5 whorls, two perianth, each with 3 lobes, two stamens also with 3 each, and finally the ovary composed of 3 carpels. The outer whorl of the perianth is formed as a calyx tube, usually 3-lobed or 3-dentate sometime split down along one side. The inner whorl of the perianth consists of the corolla tube ending in the 3 corolla lobes. The androecial whorl, only one stamen is functioning as a reproductive organ; two stamens are transformed to lateral staminodes. Of the remaining 3 stamens, one is reduced while 2 form the labellum or lip. The anther maybe terminally fixed on the filament or it maybe attached near the middle rather that at one end. It consists of two pollen sacs connected by connective tissue.

The gynoecial whorl, the pistil formed of 3 carpels, ovary either 3-locular with axile placentation or 1-locular with pareital or basal placentation. The style is thin and placed in the furrow of the filament, leaving only the stigma, usually funnelshaped. Fruit is dry or fleshy capsule, dehiscing in various ways or indehiscent. Seed is provided with an aril, a succulent tissue originating from the base of the seed.

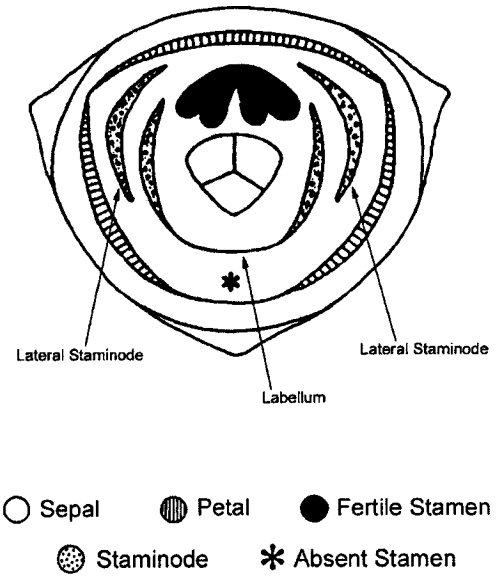


Fig. 1 Floral diagram of the Zingiberaceae with perianth whorls, fertile stamen, lateral staminodes and labellum indicated. (Not drawn to scale, based on Kress *et al.*, 2002)

A very recent phylogenetic analysis, based on molecular studies by Kress *et al.* (2002), suggests several changes to old system. It is here proposed to divide the family into 4 subfamilies of which only first two are native to Thailand.

1. Zingiberoideae

    Tribe Zingibereae

    Globbeae

2. Alpinioideae

    Tribe Alpinieae

    Riedelieae

3. Tamijioideae

4. Siphnochiloideae

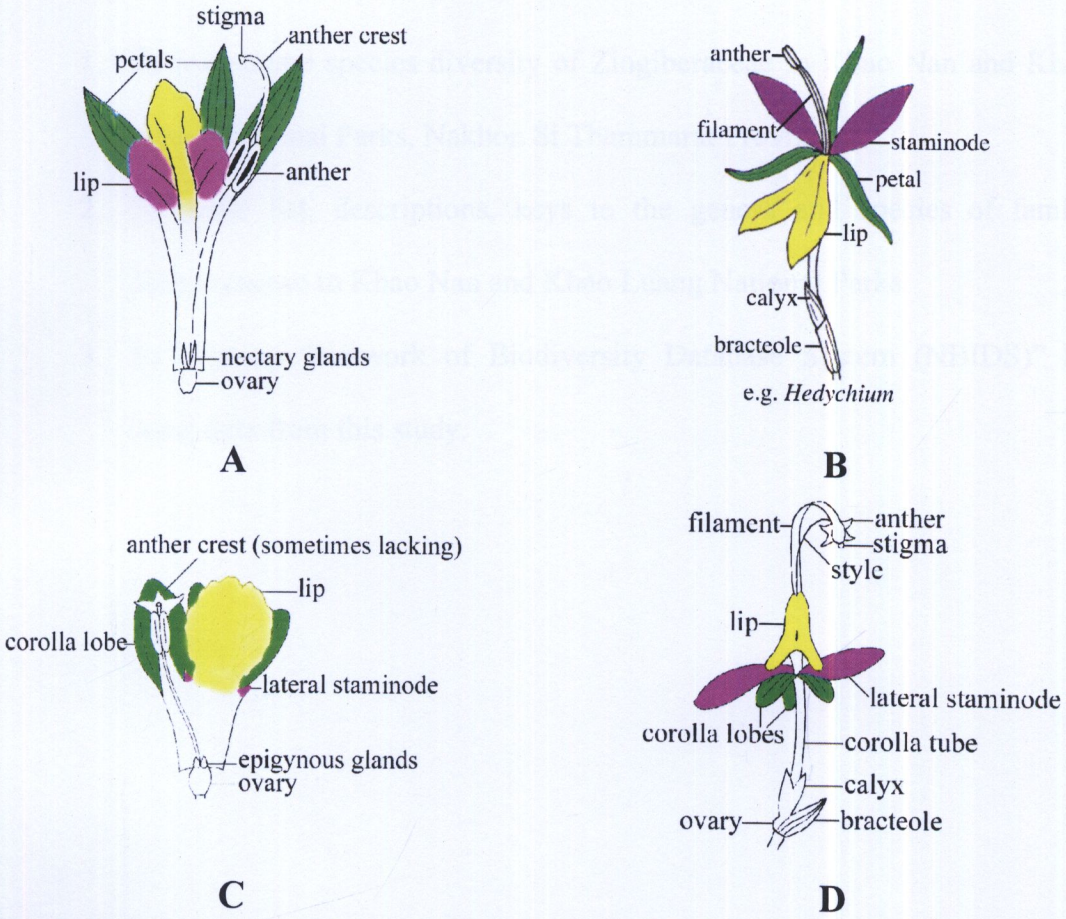


Fig. 2 Floral structure of three tribes that are found in this study; (A,B) Tribe Zingibereae (C) Tribe Alpinieae (D) Tribe Globbeae. (Not drawn to scale, Adapted from Larsen *et al.*, 1999)

OBJECTIVES

1. To investigate species diversity of Zingiberaceae in Khao Nan and Khao Luang National Parks, Nakhon Si Thammarat Province.
2. To make list, descriptions, keys to the genera and species of family Zingiberaceae in Khao Nan and Khao Luang National Parks.
3. To develop "Network of Biodiversity Database System (NBIDS)" by using data from this study.

CHAPTER II

LITERATURE REVIEW

Zingiberaceae Diversity Study

Larsen (1980) first published annotated key to the genera of Zingiberaceae of Thailand in Natural History Bulletin of Siam Society.

Sirirugsa (1987) described 3 new species and one combination of *Boesenbergia* in Thailand, i.e. *B. acuminata* Sirirugsa, *B. basispicata* K. Larsen ex Sirirugsa, *B. petiolata* Sirirugsa and *B. siamensis* (Gagnep.) Sirirugsa.

Sirirugsa (1992a) revised genus *Boesenbergia* in Thailand. Thirteen species were recognized. As followings, *Boesenbergia basispicata, B. prainiana, B. curtisii, B. petiolata, B. xiphostachya, B. thorelii, B. longipes, B. siamensis, B. rotunda, B. plicata, B. acuminata, B. parvula* and *B. pulcherrima.*

Sirirugsa (1992b) revised genus *Kaempferia* in Thailand. Fifteen species were recognized, including 3 new species of *Kaempferia*, i.e. *Kaempferia larsenii* Sirirugsa, *K. siamensis* Sirirugsa and *K. spoliata* Sirirugsa.

Larsen (1996) reported about 200 species in 21 genera in "A Preliminary Checklist of Zingiberaceae of Thailand". They are *Alpinia*(12), *Amomum*(15), *Boesenbergia*(15), *Caulokaempferia*(5), *Cautleya*(1), *Curcuma*(34), *Curcumorpha*(1), *Elettaria*(1), *Elettariopsis*(3), *Etlingera*(5), *Gagnepainia*(2), *Geostachys*(3), *Globba*(34), *Haniffia*(3), *Hedychium*(25), *Hornstedtia*(1), *Kaempferia*(15), *Pommereschea*(1), *Scaphoclamys*(3), *Stahlianthus*(3) and *Zingiber*(25). The numbers in parentheses are the number of species in each genus.

Theilade (1999) published the synopsis of the genus *Zingiber* of Thailand, with 26 species recognized. Six species are endemic to the Malay Peninsula, i.e. *Zingiber petiolatum*, *Z. puberulum* var. *ovoideum*, *Z. spectabile*, *Z. wrayii*, *Z. peninsulare* and *Z. newmanii*. Four species are cultivated throughout Thailand, i.e. *Zingiber officinale*, *Z. montanum*, *Z. ottensii* and *Z. zerumbet*.

Maknoi and Sirirugsa (2001) surveyed Zingiberaceae along Thai-Malaysian border in Yala and Narathiwat provinces. Thirty-nine species in 12 genera were found. Ten species were new records to Thailand.

Sirirugsa (2001) reported tribe Alpinieae, genus *Geostachys, Pommereschea* (now Zingibereae) and *Siamanthus*, and tribe Zingibereae, genus *Boesenbergia, Caulokaempferia, Cornukaempferia, Kaempferia* and *Scaphochlamys* in Thailand. Forty-six species were recognized in both tribes.

Maknoi and Sirirugsa (2003) reported eleven species that were new records from Southern Thailand in Natural History Bulletin of Siam Society, i.e. *Boesenbergia flava* (Ridl.) Holtt., *Camptandra parvula* (King ex Bak.) Ridl.,

Etlingera metriocheilos (Griff.) R. M. Smith, *E. pauciflora* (Ridl.) R. M. Smith, *E. subterranea* (Holtt.) R. M. Smith, *E. triorgyalis* (Bak.) R. M. Smith, *Hornstedtia conica* Ridl., *H. leonurus* (König) Retz., *H. ophiuchus* (Ridl.) Ridl., *Plagiostachys* aff. *albiflora* Ridl. and *Scaphochlamys perakensis* Holtt.. Two genera, *Camptandra* and *Plagiostachys*, are also newly recorded.

Kharukanant and Tohdam (2003) published a new species, *Boesenbergia regalis* B. Kharuk. & S. Tohdam from the Halabala Forest Reserve in Southern Thailand.

Larsen (2003) reported about 290 species in 25 genera of Zingiberaceae in Thailand.

Saensouk *et al.* (2003) published notes on the genus *Alpinia* in Thailand. Two new records from Thailand, *Alpinia scabra* (Blume) Baker and *A. blepharocalyx* K. Schum. with two varieties were reported. Twenty-one species were recognized including 3 introduced species. A new species, *Alpinia peninsularis*, was described from southern Thailand.

Sirirugsa and Maknoi (2003) reported 80 species in 18 genera of Zingiberaceae in southern Thailand. Several of them are endemic to southern Thailand, for example *Boesenbergia basispicata* K. Larsen *ex* Sirirugsa, *Caulokaempferia saksuwaniae* K. Larsen, *Geostachys angustifolia* K. Larsen, *Hedychium samuiensis* Sirirugsa and *Scaphochlamys obcordata* Sirirugsa & K. Larsen.

In 2004, Picheansoonthon and Mokkamul found a new species, *Caulokaempferia khaomaenensis* Picheansoonthon & Mokkamul, from Khao Maen, Khao Luang National Parks at the altitude of 1,093-1,237 m.

Picheansoonthon and Mokkamul (2005) reported two new species, *Hedychium thaianum* Mokkamul &Picheansoonthon and *H. khaomaenense* Picheansoonthon & Mokkamul, from Chiang Mai and Nakhon Si Thammarat province respectively.

Triboun *et al.* (2005) studied biogeography and biodiversity of the genus *Zingiber* in Thailand. Fifty species were recognized. Eleven species were new records to Thailand. Eighteen species are endemic.

Larsen and Larsen (2006) reported about 300 species in 26 genera of Zingiberaceae of Thailand.

CHAPTER III

MATERIALS AND MATHODS

STUDY SITES

Plant collection and observations were made in Khao Nan and Khao Luang National Parks, Nakhon Si Thammarat Province, Thailand. These areas are tropical moist evergreen forest. Khao Nan and Khao Luang National Parks are located on the north-west of Nakhon Si Thammarat Province and lie between latitudes 8° 41′ – 8° 56′ North and longitudes 99° 31′ – 99° 48′ East (Fig. 3). Nine stations in different altitudes and locations are shown in table 1.

Table 1 Name, location and altitude of nine stations of study site in Khao Nan and Khao Luang National Parks (NP = National Park)

No	Code	Name of station	Location	Altitude
1	KN1	Klong Klai (คลองกลาย)	Khao Nan NP, 8°48′ N 99°34′ E	212 m
2	KN2	Huay Kaew (ห้วยแก้ว)	Khao Nan NP, 8°55′ N 99°39′ E	162 m
3	KN3	Klong Kan (คลองกัน)	Khao Nan NP, 8°47′ N 99°44′ E	277 m
4	KN4	Klong Tha Thon (คลองท่าทน)	Khao Nan NP, 8°52′ N 99°45′ E	100 m
5	KN5	Huay Lake (ห้วยเลข)	Khao Nan NP, 8°51′ N 99°37′ E	236 m
6	KN6	Klong Lum Pan (คลองลำแพน)	Khao Nan NP, 8°44′ N 99°38′ E	119 m
7	KN7	Klong Yod Num (คลองยอดน้ำ)	Khao Nan NP, 8°54′ N 99°44′ E	419 m
8	KN8	Sunanta Waterfall (น้ำตกสุนันทา)	Khao Nan NP, 8°46′ N 99°48′ E	96 m
9	KL1	Krung Ching Waterfall (น้ำตกกรุงชิง)	Khao Luang NP, 8°43′ N 99°41′ E	197 m

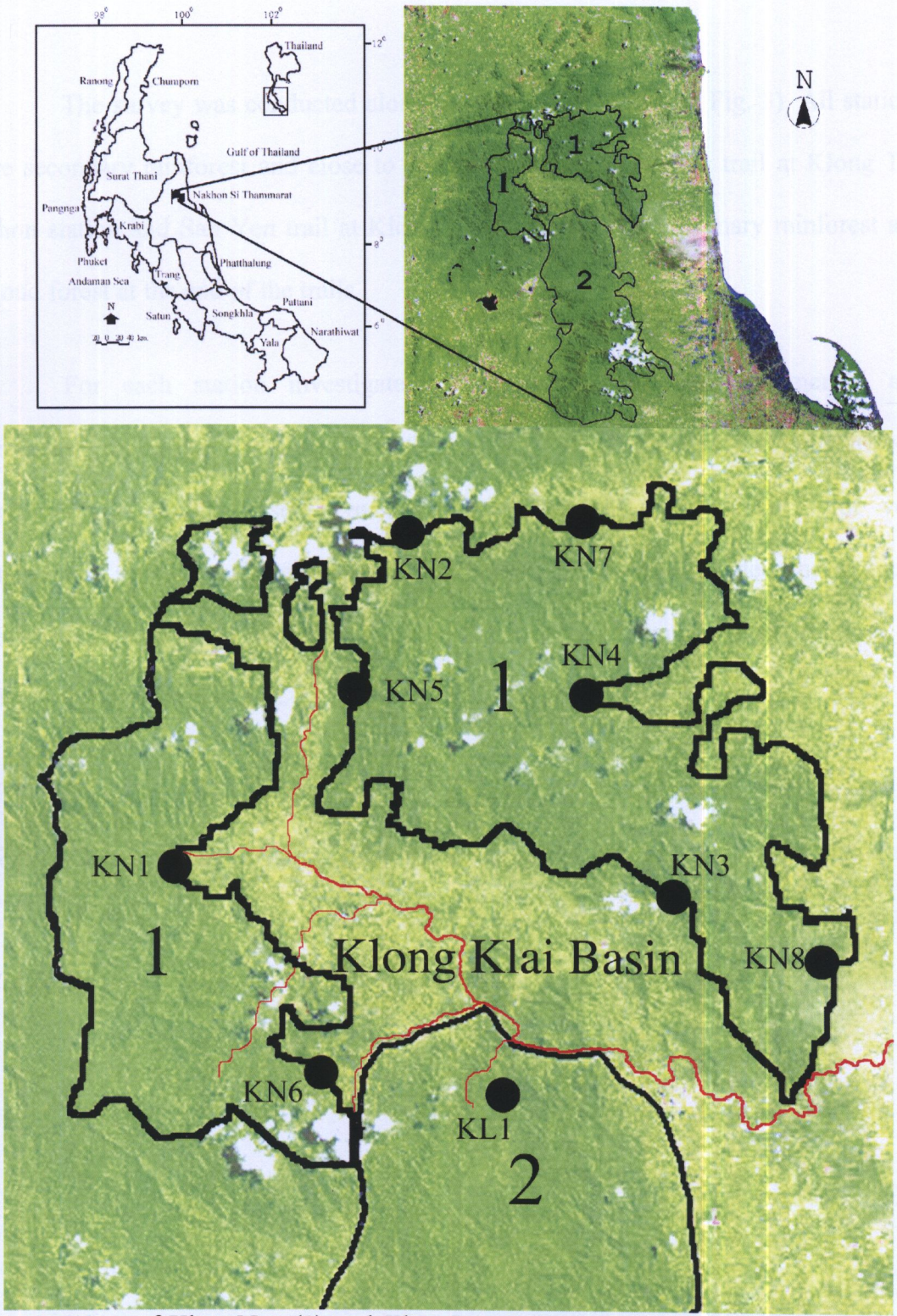


Fig. 3 Maps of Khao Nan (1) and Khao Luang (2) National Parks, and all stations (representing by dots). Red line shows the canal in Klong Klai Basin. Adapted from Google Earth 2006.

PLANT COLLECTION AND OBSERVATIONS

The survey was conducted along nine main station trails (Fig. 3). All stations are secondary rainforest and close to stream, except Yod Pansee trail at Klong Tha Thon station and San Yen trail at Klong Klai station that are primary rainforest and cloud forest at the end of the trails.

For each station investigated, plants were collected, documented and processed for herbarium specimens (Chayamarit, 2002). Flowers and/or fruit were preserved in liquid preservative (70% Ethyl alcohol). Occasionally, for very uncommon species or for conservation purposes plants were collected and recorded for their presence in a particular locality. Fresh, viable rhizomes were collected for planting whenever possible.

The identification of genera and species followed Sirirugsa (1992a, b), Lim (2001), Larsen and Larsen (2006), Kaewsri (pers. comm.) for genus *Amomum*, Saensouk (pers. comm.) for genus *Alpinia* and Triboun (pers. comm.) for genus *Zingiber*.

CHAPTER IV

RESULTS

DIVERSITY OF ZINGIBERACEAE

Twenty-nine species in 11 genera and 3 tribes of the Zingiberaceae were collected from nine stations (table 2). Tribe Alpinieae, the highest diversity, comprises 5 genera and 15 species. Tribe Zingibereae, the second high diversity, consists of 5 genera and 12 species. The least diversity, tribe Globbeae includes only 2 species in the genus *Globba*.

Keys to genera and species with descriptions and illustrations of 29 species are provided. Ecological data, i.e. altitude, soil types (GLOBE® Program), forest types (Santisuk, 2006) and uses are provided in table 3.

Table 2 List and distributions of species found in the study sites

No	Collection No.	Herbarium No.	Tribe	Scientific name	Stations
1	N. Kittipanangkul 174	WU 1436	Alpinieae	*Alpinia mutica* Roxb.	KN3, 4, 7, 8
2	N. Kittipanangkul 170	WU 1435		*Alpinia javanica* Blume	KN5
3	N. Kittipanangkul 125	WU 1423		*Alpinia zerumbet* (Pers.) Burtt & R. M. Smith	KN2
4	N. Kittipanangkul 106	WU 1418		*Amomum aculeatum* Roxb.	KN5
5	N. Kittipanangkul 112	WU 1420		*Amomum biflorum* Jack	KN1-8, KL1
6	N. Kittipanangkul 156	WU 1431		*Amomum hastilabium* Ridl.	KN1, 8, KL1
7	N. Kittipanangkul 161	WU 1433		*Amomum uliginosum* König	KN1, 2, 3, 4, 7, 8
8	N. Kittipanangkul 215	WU 1441		*Amomum* sp.	KN1
9	N. Kittipanangkul 101	WU 1417		*Elettariopsis curtisii* Bak.	KN1-8, KL1
10	N. Kittipanangkul 179	WU 1437		*Etlingera elatior* (Jack) R. M. Smith	KN3
11	N. Kittipanangkul 121	WU 1422		*Etlingera fulgens* (Ridl.) C. K. Lim	KN3, 5
12	N. Kittipanangkul 132	WU 1425		*Etlingera littoralis* (König) Giseke	KN1-8, KL1

Table 2 (Continued) List and distributions of species found in the study sites

No	Collection No.	Herbarium No.	Tribe	Scientific name	Stations
13	N. Kittipanangkul 195	WU 1442	Alpinieae	*Etlingera pauciflora* (Ridl.) R. M. Smith	KN5
14	N. Kittipanangkul 151	WU 1430		*Etlingera subterranea* (Holtt.) R. M. Smith	KN3
15	N. Kittipanangkul 144	WU 1428		*Hornstedtia leonurus* (König) Retz.	KN8, KL1
16	N. Kittipanangkul 140	WU 1427	Globbeae	*Globba pendula* Roxb.	KN8
17	N. Kittipanangkul 109	WU 1419		*Globba leucantha* Miq.	KN1
18	N. Kittipanangkul 166	WU 1434	Zingibereae	*Boesenbergia basispicata* K. Larsen ex Sirirugsa	KN1, 5, KL1
19	N. Kittipanangkul 189	WU 1440		*Boesenbergia plicata* (Ridl.) Holtt.	KN1, 5
20	N. Kittipanangkul 183	WU 1438		*Curcuma aurantiaca* van Zijp.	KN1
21	N. Kittipanangkul 192	WU 1441		*Curcuma longa* L.	KN8
22	N. Kittipanangkul 158	WU 1432		*Curcuma rubescens* Roxb.	KN1, 3, 5, 8
23	N. Kittipanangkul 217	WU 1449		*Curcuma zedoaria* Rosc.	KN8

Table 2 (Continued) List and distributions of species found in the study sites

No	Collection No.	Herbarium No.	Tribe	Scientific name	Stations
24	N. Kittipanangkul 216	WU 1448	Zingibereae	*Hedychium khaomaenense* Picheansoonthon & Mokkamul	KN1
25	N. Kittipanangkul 128	WU 1424		*Kaempferia pulchra* Ridl.	KN2
26	N. Kittipanangkul 117	WU 1421		*Zingiber newmanii* I. Theilade & J. Mood	KN1, 3, 6, KL1
27	N. Kittipanangkul 186	WU 1439		*Zingiber officinale* Rosc.	KN8
28	N. Kittipanangkul 147	WU 1429		*Zingiber ottensii* Val.	KN1, 3, 4, 5, 7, 8
29	N. Kittipanangkul 137	WU 1426		*Zingiber zerumbet* (L.) Smith	KN1, 2, 5

Keys to genera of Zingiberaceae

1. Filament long exerted 2

   Filament not long exerted 3

2. Rhizome long, bracts well developed, green, enclosing the cincinnus **9.*Hedychium***

   Rhizome poorly developed, bracts never enclosing the cincinnus **6.*Globba***

3. Anther-crest long, enclosing the style forming a horn-like structure **11.*Zingiber***

   Anther-crest variously shaped or absent, but not enclosing the style forming a horn-like structure 4

4. Lateral staminodes petaloid, usually free from labellum; distichy of leaves parallel to the rhizome 5

   Lateral staminodes absent or reduced to small teeth or linear appendages at base of labellum; distichy of leaves transverse to the rhizome 7

5. Bracts laterally connate to each other forming pouches **8.*Curcuma***

   Bracts not laterally connate 6

6. Ligule 2-lobed, labellum obovate or broadly oblong, larger than corolla lobes and lateral staminodes, filament erect **7.*Boesenbergia***

   Ligule usually small or absent, labellum flat, 2-lobed, usually white or lilac, filament very short or absent **10.*Kaempferia***

7. Inflorescence on a separate shoot at base of the leafy shoot 8

   Inflorescence terminal on the leafy shoot or apparently lateral **1.*Alpinia***

8. Labellum and filament connate into a distinct tube above the insertion of the petals; anther crest absent, mostly leafy shoot more than 2-4 m **4.*Etlingera***

   Labellum and filament not connate; anther usually crested 9

9. Leaves 1-5, tufted or leafy shoot rarely up to 1 m **3.*Elettariopsis***

   Leaves many on tall leafy shoots, mostly more than 1 m 10

10. Inflorescence spindle-shaped, enclosed by involucre of rigid, sterile bracts; flowers red, corolla tube more than twice as long as labellum **5.*Hornstedtia***

    Inflorescence not spindle-shaped, enclosed by sterile bracts; flowers varying in colour but not red; corolla tube about as long as labellum or shorter **2.*Amomum***

TRIBE ALPINIEAE

1. *Alpinia* Roxburgh

Three species were found in this study.

Key to the species

1. Bracts persistent, flowers compact in the cincinnus	**2. *A. javanica***
Bracts soon falling, flowers lax in the cincinnus	2
2. Bracteoles very soon falling, white	**1. *A. mutica***
Bracteoles persistent, white with bright pink-tinged	**3. *A. zerumbet***

1. *Alpinia mutica* Roxb., As. Res. xi. 354. 1810. (Fig. 4)

Terrestrial, perennial herb. **Leafy stem** 2-3 m tall. **Leaves** petiolate; *petiole* 4.5-5.5 cm long; *blade* oblong, 30-60 by 8-12 cm, upper and lower surface glabrous, apex acuminate, base cuneate; *ligule* 2-lobed, 1.5 cm long, hairy, ciliate; *leaf sheaths* green, hairy, ciliate. **Inflorescence** panicle, terminal, erect, 30-50 cm long; *bracts* oblong, 6 by 8 cm; *bracteoles* ovate, white, 2.0 by 0.7 cm, soon falling. **Flowers** cincinni of 2-3 flowers at each node; *pedicel* 1 cm long, hairy; *calyx* tubular, white, hairy at base, 1.8-2.2 by 0.4-0.6 cm; *corolla* tubular, white, 1.5-2.2 cm, glabrous, dorsal lobe hooded; *staminodes* 4 mm long, apex rounded; *labellum* apex 3-lobed, 3.5 by 4 cm, wrinkled, red and brown variegations with yellow edge; *stamen*: *filament* flat, cream, glandular hairy; *anther* yellow, glandular hairy at base, connective yellow. **Fruits** globose, green to red when old, ciliate, ca. 2.5 cm.

Specimen examined.- N. Kittipanangkul 174, 19 June 2006, Nakhon Si Thammarat (WU 1436).

Flowering : May – June

A B

Fig. 4. *Alpinia mutica* Roxb. A) flower, B) infructescence.

2. *Alpinia javanica* Blume, Enum. Pl. Jav. 59. (Fig. 5)

Terrestrial, perennial herb. **Leafy stem** 2-3 m tall. **Leaves** petiolate; petiole 5-15 cm long, short hairy; *blade* oblong-ovate, 40-80 by 10-14 cm, upper surface short hairy, lower surface glabrous, apex acuminate, base unequally cuneate, ciliate; *ligule* 2-lobed, 2 cm long, hairy, ciliate; *leaf sheaths* purplish, hairy near ligule. **Inflorescence** panicle, terminal, drooping; *bracts* concave, 8-10 by 2-3 cm, short hairy, apex caudate; *bracteoles* campanulate, 1.5 by 1.5 cm, pale pink and turn brown, hairy at base. **Flowers** cincinni of 2-3 flowers at each node; *pedicel* 5 mm long, hairy; *calyx* funnel form, pink, 1.5 cm long, pink, hairy at base; *corolla* tubular yellow, 1.5 cm long, short hairy, lobes pink with white tip, basal yellow, glabrous, dorsal lobe hooded, apex thick, lateral lobes concave, apex rounded; *staminodes* 2 mm long, apex 2-lobed, inner surface glandular hairy, red with darker tip; *labellum* concave, apex 3-lobed, 3.5 by 4 cm, glabrous, bright yellow with red stripes from base towards middle lobe, edge white, wrinkled; *stamen*: *filament* flat, cream, 1.2 by 0.4 cm, glandular hairy, *anther* yellow, 1.0 by 0.5 cm, glandular hairy at base, connective yellow, glandular hairy; *ovary* yellowish green, 5 mm long, hairy, *epigynous glands* cylindrical, 3 mm long, glabrous; style white, hairy; *stigma* cup-shaped, white, ciliate. **Fruits** globose, capsule, 2.5 cm, brown when old.

Specimen examined.- N. Kittipanangkul 170, 14 June 2006, Nakhon Si Thammarat (WU 1435).

Flowering : May - June

Fig. 5. *Alpinia javanica* Blume A) inflorescence, B) infructescence, C) habit.

3. *Alpinia zerumbet* (Pers.) Burtt & R. M. Smith, Notes Roy. Bot. Gard. Edinb. 31(2): 204. 1972. (Fig. 6)

Terrestrial, perennial herb. **Leafy stem** 2-3 m tall. **Leaves** petiolate; *petiole* hairy, 2.5-4.0 cm long, hairy; *blade* narrowly ovate, 50-90 by 10-15 cm, upper surface glabrous, lower surface short hairy or pubescent, apex acute, base cuneate; *ligule* 2-lobes, apex acute; *leaf sheaths* ciliate. **Inflorescence** raceme, terminal, erect, up to 40 cm long; *bracts* covered whole inflorescence when young, 20-25 by 15-20 cm, outer surface pubescent, inner surface glabrous, apex mucronate; *bracteoles* persistent, pinkish or pink-tinged, enfold the buds, ca. 2.5 by 3.5 cm, membranaceous. **Flowers** *pedicel* 1 cm long, hairy, waxy; *calyx* tubular, white, hairy at base, 2.5 cm long; *corolla* white to pinkish, 3-lobes, 2 cm long, apex obtuse, hooded; *staminodes* 5 mm long, narrowly lanceolate; *labellum* apex 3-lobed, 4.0-4.5 by 5.0-5.5 cm, wrinkled, red and brown variegations with yellow edge; *stamen*: *filament* flat, cream, glandular hairy, *anther* cream. **Fruits** globose, capsule, hairy, green to red-orange when old.

Specimen examined.- N. Kittipanangkul 125, 3 May 2006, Nakhon Si Thammarat (WU 1423).

Flowering : May - June

Fig. 6. *Alpinia zerumbet* (Pers.) Burtt & R. M. Smith A) flower, B) inflorescence, C) infructescence, D) habit.

2. *Amomum* Roxburgh

Five species were found in this study.

Key to the species

1. Leaves more than 20, leafy stem 2-5 m tall — 2
   Leaves less than 10, leafy stem 1.0-1.5 m tall — **5. *A. biflorum***
2. Fruit smooth — **6. *A. hastilabium***
   Fruit spiny — 3
3. Labellum inflexed, rarely margin reflexed — **7. *A. uliginosum***
   Labellum involute, margin reflexed — 4
4. Labellum white with middle lobe yellow, crest white with pinkish dots — **4. *A. aculeatum***
   Labellum bright yellow, crest yellow — **8. *Amomum* sp.**

4. *Amomum aculeatum* Roxb., Asist. Res. 2. t.6: 344. 1810. (Fig. 7)

Terrestrial, perennial herb. **Leafy stem** stout, growing in clump, 4-5 m tall. **Leaves** 32-46; petiolate; *petiole* 5 mm. long; *blade* narrowly oblong or lanceolate-oblong, 15.0-38.0 by 4.5-7.5 cm, apex acuminate, base round, upper surface glabrous, lower surface glabrous; *ligule* round, membranous, 7.0 mm long, pale green, glabrous, apex 2-lobed; *leaf sheaths* glabrous, green. **Inflorescence** lateral, arising from rhizomes near base of leafy stem, peduncle globose or cylindric, 4.0-9.0 by 4.0-14.0 cm, pinkish brown, mucilaginous; *peduncle* decumbent, stout, 20.0-38.0 cm long, peduncular bract ovate to deltoid, brown when dry, leathery, pubescent scatter, apex mucronate, ca. 4.0 by 3.5 cm; *bracts* oblong, 3.8-5.5 by 2.0-2.4 cm, brown, both surfaces hairy especially at base, apex apiculate, mucilaginous, soon disintegrating;

bracteoles tubular, 1.5-4.0 cm long including ovary, apex obscurely 2-lobed, shallowly split on 1 side, pinkish cream, outer surface with scattered brown pubescent. **Flowers** white; *calyx* 1.7-3.5 cm long, apex 2-fid, shallowly split on 1 side, membranous, scatter pubescent at base, cream with pinkish red spots; *corolla* tubular creamy white, tube hairy, 1.0-3.5 cm, dorsal lobe oblong, hooded, ca. 2.8-3.0 by 1.8-2.0 cm, apex blunt, hooded or mucronate, lateral lobes narrow; *staminodes* linear, ca. 3 mm, hairy; *labellum* obdeltoid, white with pinkish dotted lines radiating from base upward, slightly 3-lobed, 2 side lobes overlapping, 2.8-4.5 by 2.5-4.3 cm, base cuneate, middle lobe slightly reflexed, yellow, apex 2-fid or rounded, side lobes broad, round; *filament* 7.0-12.0 mm long, flat, creamy white, sparsely pubescent; *anther* 13.0-15.0 by 5.0 mm, sparsely strigose, dehiscing lengthwise; *anther crest* reniform, 3-lobed, round, ca. 10.0-11.0 by 3.5-4.0 mm, white with pinkish dots, central lobe ca. 3.0 by 1.0-4.0 mm, lateral ones ca. 4.0 by 4.0 mm; ovary cylindric, 5.0-6.0 by 3.0-4.0 mm; glabrous; *stigma* cup-shaped, aperture edge hairy; *style* with scattered hairs near tip, *epigynous glands* blunt, ca. 5 mm long. **Fruits** globose or elliptic, covered with rigid spines, 1.5-3.5 cm dia. including spines, green when young turning brown at maturity, spines ca. 3-4 mm long; *fruit stalk* ca. 0.5-2.0 cm long, stout, tomentose; *seeds* angular, ca. 5-6 by 2-3 mm.

Specimen examined.- N. Kittipanangkul 106, 16 April 2006, Nakhon Si Thammarat (WU 1418).

Flowering : April – June

Fig. 7. *Amomum aculeatum* Roxb. A) flowers, B) infructescence, C) habit.

5. *Amomum biflorum* Jack, Mal. Misc. 1:2. 1820; Holttum, Gard. Bull. Sing. 13:199. 1950. (Fig. 8)

Terrestrial, perennial herb. **Leafy stem** slender, 1.0-1.5 m tall, base swollen ca. 1.0-1.5 cm dia. **Leaves** ca. 8; petiolate; *petiole* 0.5-3.0 cm long; *leaf sheath* with brown pubescent; *ligule* entire and dried papery, villous, 1.0-2.0 mm long; *blade* oblong, ovate-oblong or elliptic, 8.5-35.0 by 5.0-8.5 cm, upper surface glabrous, lower surface densely pubescent, base attenuate, apex acuminate, tip caudate, 2.5-4.0 mm. **Inflorescence** ovate to conical, ca. 3.0-4.0 by 1.0-2.0 cm, 2-3 flowers; *peduncle* ca. 1.0 cm long; *peduncular bracts* oblong, ca. 5-8 by 3-5 mm, pinkish brown, glabrous, papery, apex round and hooded; *bracts* broadly oblong, 1.5-2.2 by 1.0-1.2 cm, glabrous, apex round and mucronate, pale brown with scattered brown dots; *bracteoles* tubular, ca. 1.5-1.6 cm long including ovary, apex unequally 2-fid, membranous, pinkish cream, outer surface glabrous, pubescent at base. **Flowers** white; *calyx* 3.0-3.5 cm long including ovary, apex 2-fid and shallowly split on 1 side, outer surface glabrous, white pubescent at base, pinkish cream; *corolla* creamy white, tube glabrous, 3.5-4.5 cm long including ovary, dorsal lobe broadly oblong, apex hooded, 1.8-2.3 by 0.9 cm, lateral lobes narrower; *staminodes* absent; *labellum* flabellate, spreading, ca. 3.0 by 2.5-3.1 cm, base attenuate, apex shallowly split and revolute, white with yellow band along center, lateral red veins along the band and paler upward, white pubescent base; *filament* 8.0-10.0 mm long, glabrous; *anther* ca. 4.0-5.0 mm long, dehiscing lengthwise, pale yellow, with slightly pubescent; *anther crest* 3-lobed, 4.0-5.0 by 3.0 mm, creamy white, middle lobe ca. 3.0 by 3.0 mm, round, erect, lateral ones ca. 2.0 by 1.5 mm, apex round, spreading; *ovary* cylindric, ca. 5.0 by 3.0 mm, villous; stigma cup-shaped, ca. 2.0 by 1.5 mm, aperture narrowly

transverse, edge hairy; *epigynous glands* blunt, slender, 6.0-7.0 mm long. **Fruits** not seen.

Specimen examined.- N. Kittipanangkul 112, 29 April 2006, Nakhon Si Thammarat (WU 1420).

Flowering : April - June

A B

Fig. 8. *Amomum biflorum* Jack A) flower, B) habit.

6. *Amomum hastilabium* Ridl., J. Str. Br. Roy. Asiat. Soc. 32:137. 1899. (Fig. 9)

Terrestrial, perennial herb. **Leafy stem** stout, growing in clump, ca. 3.0 m tall. **Leaves** petiolate to sessile; *petiole* 2.0 cm long; *ligule* entired, apex round, 4.0-7.0 mm long, glabrous; *blade* oblong to oblanceolate-oblong, 30.0-55.0 by 3.0-7.0 cm, glabrous, base attenuate, apex acuminate; *leaf sheath* glabrous. **Inflorescence** ellipsoid, ca. 9.0 by 3.5 cm; *peduncle* ca. 10.0 cm; *peduncular bract*s broadly ovate, 1.0-2.0 by 1.0-1.5 cm, stramineous, glabrous; *bract*s lanceolate, ca. 3.5 by 1.0 cm, apex acuminate, persistent; *bracteoles* tubular, 4.0-7.0 mm long, apex truncate and oblique, crustaceous, slightly split on 1 side, creamy white, glabrous. **Flowers** white; *calyx* 2.0-2.8 cm long including ovary, apex obliquely truncate, entire or slightly split on 1 side, creamy white, outer surface, pubescent base; *corolla* creamy white, outer surface sparsely pubescent, tube, 3.5-5.0 cm long including ovary, slender; dorsal lobe oblong, ca. 2.5 by 1.1 cm, apex hooded, lateral lobes oblong-spathulate, apex blunt, hooded, ca. 2.7 by 0.6 cm; *staminodes* narrow subulate, ca. 4.0 mm; *labellum* broad-ovate, ca. 4.0 by 2.5 cm, narrowly at base, margin crispate, recurved, white with yellow band along center, with purplish red short streaks on each side of band, sparsely pubescent at base; *stamen*: *filament* ca. 7.0 by 2.0 mm long, glabrous, *anther* 7.0-9.0 by 3.0 mm, glabrous, pale yellow, dehiscing lengthwise, *anther crest* slightly 3-lobed, creamy white, middle lobe ca. 3.0 by 3.0 mm, round, apex slightly recurved to back of anthers, lateral ones erect, ca. 2.5 by 1.5 mm; *ovary* cylindric, ca. 8.0 mm long, sericeus pale brown; stigma cup-shaped, aperture narrowly transverse, edge hairy; *epigynous glands* blunt, ca. 7.0 mm long. **Fruits** globose, smooth with longitudinal lines, 0.7-1.7 cm dia., brownish cream, glabrous or sparsely pale brown

hirtellous; *fruit stalk* sessile to 5 mm long; *seeds* angular, fragrant, ca 3.0 by 2.0 mm black, aril white.

Specimen examined.- N. Kittipanangkul 155, 13 June 2006, Nakhon Si Thammarat (WU 1431).

Flowering : May- June

A B

Fig. 9. *Amomum hastilabium* Ridl. A) flower, B) inflorescence.

7. *Amomum uliginosum* König, Obs. 3:56. 1783. (Fig. 10)

Terrestrial, perennial herb. **Leafy stem** stout, 2.4-4.0 m tall. **Leaves** petiolate; *petiole* ca. 3 mm long; 35-43; *ligule* 2-lobed, apex round and emarginate, leathery, 4.0-7.0 mm long, with 2 transversal ridges at axil, sparsely brown hairs; *blade* oblong, 23.0-64.0 by 3.0-12.0 cm, base attenuate or obtuse, apex acuminate or obtuse, tip caudate, 1.5-6.0 cm. **Inflorescence** obovoid, ca. 4.5 cm dia., ca. 25 flowers; *peduncle* 13.0-15.0 cm long, procumbent; *peduncular bracts* obovate-oblong, ca. 2.0 by 0.8 cm, pale brown, outer surface pubescent, apex hooded, apiculate; *bracts* hooded, oblanceolate, ca. 2.8 by 0.8 cm, soon decaying, submembranous, pale brown, outer surface pubescent, apex acuminate; *bracteoles* tubular, ca. 2.0 cm long including ovary, apex 2-fid, shallowly split on 1 side, creamy white with pinkish red at base, membranous, outer surface glabrous, whitish pubescent base. **Flowers** white; *calyx* 2.0-2.8 cm long including ovary, apex 3-fid with shallowly split on 1 side, pinkish white, outer surface glabrous; corolla creamy white, glabrous, tube ca. 2.5 cm long including ovary, with pinkish red at base, dorsal lobe oblong, apex blunt, hooded, ca. 1.5 by 0.4 cm, lateral lobes narrower; *staminodes* linear, ca. 3.0 mm long, base red, apex white; *labellum* suborbicular, inflexed, ca. 1.2-2.3 cm dia., base clawed, apex 2-fid and reflex, white with yellow band along center and broader at apex, crimson veins on each side of band, 2-3 crimson stripes on each side at base; *stamen*: *filament* 5.0-6.0 mm long, linear, glabrous, *anther* 6.0-7.0 mm long, dehiscing lengthwise, glabrous, *anther crest* 3-lobed, 5.0-7.0 by 2.0 mm, white, middle lobe round and emarginate, reflex, lateral ones auriculate, horn-like; *ovary* cylindric, 4.0 by 2.0-3.0 mm, surface with densely brownish pubescent; *stigma* small bulbous, edge glabrous; *epigynous gland* blunt, ca. 2.0 by 1.0 mm, glabrous. **Fruits** 7-8 per infructescence,

globose, ca. 1.7-2.0 cm dia., densely covered with rigid spines, greenish red to dark brown.

Specimen examined.- N. Kittipanangkul 161, 13 June 2006, Nakhon Si Thammarat (WU 1433).

Flowering : May – June

A B

Fig. 10. *Amomum uliginosum* König A) flowers within inflorescence, B) infructescence.

8. *Amomum* sp. (Fig. 11)

Terrestrial, perennial herb. **Leafy stem** stout, growing in clump, 4-5 m tall. **Leaves** 32-46; petiolate; *petiole* 5 mm. long; *blade* narrowly oblong or lanceolate-oblong, 15.0-38.0 by 4.5-7.5 cm, apex acuminate, base rounded, upper surface glabrous, lower surface glabrous; *ligule* rounded, membranous, 7.0 mm long, pale green, glabrous, apex 2-lobed; *leaf sheaths* glabrous, green. **Inflorescence** lateral arising from rhizomes near base of leafy stem, globose or cylindric, 2.5-3.0 by 6.0-6.5 cm, peduncle decumbent, stout, 25.0-35.0 cm long; *peduncular bracts* ovate to deltoid, dark green, leathery, glabrous, apex mucronate, ca. 3.0 by 2.5 cm; *bracts* oblong, 5.0-6.0 by 2.0-4.0 cm, deep green, glabrous, apex mucronate; *bracteoles* tubular, 2.5-3.0 cm long including ovary, apex obscurely 3-lobed, split on 1 side, deep red to brown. **Flowers** yellow; *calyx* 2.4-3.2 cm long, apex 3-fid, shallowly split on 1 side, membranous, glabrous, deep red to brown; *corolla* tubular pale yellow, glabrous, 1.2-1.5 by 2.5-2.8 cm, dorsal lobe oblong, hooded, ca. 1.6-1.8 by 1.8-2.4 cm, apex hooded, lateral lobes oblong or lanceolate; *staminodes* linear, ca. 3 mm; *labellum* slightly 3-lobed, elliptic or obdeltoid, crenate, 3.4-4.2 by 1.8-3.5 cm, base cuneate, middle lobe apex 2-fid or rounded, side lobes broad, rounded, yellow with reddish dotted lines radiating from base upward; *stamen*: *filament* 1.2-1.5 cm long, flat, creamy white, glabrous, *anther* 10.0-12.0 by 4.0 mm, dehiscing longitudinally, *anther crest* reniform, 3-lobed, rounded, ca. 12.0-15.0 by 5.0-8.0 mm, yellow, middle lobe ca. 4.0 by 4.0 mm, lateral ones ca. 7.0 by 8.0 mm; *ovary* cylindric, 4.0-6.0 by 4.0-5.0 mm, glabrous to granular; *stigma* cup-shaped, aperture edge hairy. **Fruits** globose or elliptic, covered with rigid spines, 1.5-2.5 cm dia. including spines, deep red to brown, spines ca. 3-4 mm long; *fruit stalk* ca. 8.0-10.0 mm long, stout, tomentose.

Specimen examined.- N. Kittipanangkul 106, 16 April 2006, Nakhon Si Thammarat (WU 1441).

Flowering : April - May

A B

Fig. 11. *Amomum* sp. A) flowers within inflorescence, B) infructescence.

3. *Elettariopsis* Baker

Only one species was found in this study.

9. *Elettariopsis curtisii* Bak., Fl. Brit. Ind. 6: 252. 1892. (Fig. 12)

Terrestrial, perennial herb. **Leafy stem** 0.5-1.5 m tall. **Leaves** erect, petiolate; *petiole* 5-15 cm long; *blade* elliptic, 20-25 by 8.0-10.0 cm, apex acuminate, base decurrent, glabrous; *ligule* short, 5-7 mm long, shallowly 2-lobed; *leaf sheaths* 2-3, glabrous, green. **Inflorescence** lateral, horizontal, just below ground surface, ca. 15 cm long, often producing lateral branches near base; *bracts* ca. 1.5 cm long, open, ovate, glabrous, pinkish, bearing in its axil a flower on pedicel; *bracteoles* glabrous, ca. 1.2 cm long. **Flowers** white; *calyx* tubular, 2.5-3.0 cm long, apex 3-lobed or 3 short blunt teeth, split down one side, white; *corolla* tubular, 1-2 cm long, longer than calyx, slender, lobes 1.0-1.2 cm long, transparent or white, concave at distal part and cucullate, ca. 5-6 mm wide, lateral lobes narrower; *staminodes* small, ca. 3 mm long, fleshy; *labellum* 2.5-3.0 by 1.8-2.2 cm, base narrow and widening abruptly, apex reflexed and crinkled at edges, median band thickened and yellow, bordered by a lateral red stripe on either side, side white; *stamen*: *filament* ca. 3 mm long, *anther thecae* 5 mm long, *anther crest* thin, ca. 4.0-4.5 mm long, concave and obliquely reflexed, lateral margins incurved slightly to face each other, apex broadly acute; *ovary* glabrous, trilocular; *stigma* raised well above anther thecae but not overtopping the crest, obconic, ca. 2 mm wide, triangular mouth fringed with short hairs. **Fruits** globose, ca. 1.2-1.5 cm diameter.

Specimen examined.- N. Kittipanangkul 101, 15 April 2006, Nakhon Si Thammarat (WU 1417).

Flowering : April - May

A

B

Fig. 12. *Elettariopsis curtisii* Bak. A) flower, B) habit.

4. *Etlingera* Giseke

Five species were found in this study.

Key to the species

1. Peduncle erect, more than 30 cm tall — 2
   Peduncle prostrate or underground — 3
2. Inflorescence cup shape, involucral bracts erect, involute — **11. *E. fulgens***
   Inflorescence torch shape, lower involucral bracts not erect, entire — **10. *E. elatior***
3. Inflorescence bearing 2-3 flowers — 4
   Inflorescence bearing many flowers — **12. *E. littoralis***
4. Labellum red with yellow middle band, length ¾ from base — **13. *E. pauciflora***
   Labellum red with white margin, length ¾ from base — **14. *E. subterranea***

10. *Etlingera elatior* (Jack) R. M. Smith, Notes Roy. Bot. Gard. Edinburgh 43: 244. 1986. (Fig. 13)

Terrestrial, perennial herb. **Leafy stem** 3.0-5.0 m tall, tufted, 7-12 bladeless sheaths. **Leaves** petiolate; *petiole* 3.0-4.0 cm long; *blade* obovate-lanceolate, 30-70 by 10-15 cm, apex acute, base broadly cuneate, upper surface glabrous, lower surface glabrous; *ligule* 1.2-1.5 cm long, glabrous, apex 2-lobed; *leaf sheaths* glabrous, green. **Inflorescence** lateral, from rhizome near base of leafy stem, erect, peduncle 0.8-1.0 (-1.2) m, glabrous; *involucral bracts* 10-16, pink to red with white margins, broadly ovate, 4.0-8.2 by 2.5-5.5 cm, glabrous, vernicose, apex mucronate; *floral bracts* similar to involucral bracts but pinkish, smaller; *bracteoles* tubular, ca. 2 cm, deeply split on 1 side. **Flowers** pink to red; *calyx* tubular, 2.8-3.4 cm, bright red, glabrous, apex 3-lobed, split down one side; *corolla* tubular glabrous, 3.2-4.8 cm, white with

red apex; *staminodes* lanceolate, 1.8-2.6 by 0.6-0.8 cm, pink with red apex; *labellum* lanceolate, 1.5-2.6 by 1.8-2.2 cm, red with margins, apex rounded; *stamen*: *filament* flat, hairy, white 0.5-1.1 cm long, *anther* red, 1.2-1.5 cm long, connective red; *ovary* glabrous, 0.5 by 0.6 cm, *stigma* cup-shape, pinkish, ciliate. **Fruits** globose, ca. 2.5 cm in diam., greenish or reddish.

Specimen examined.- N. Kittipanangkul 179, 10 August 2006, Nakhon Si Thammarat (WU 1437).

Flowering : May - August

Fig. 13. *Etlingera elatior* (Jack) R. M. Smith A) inflorescence, B) infructescence, C) flower.

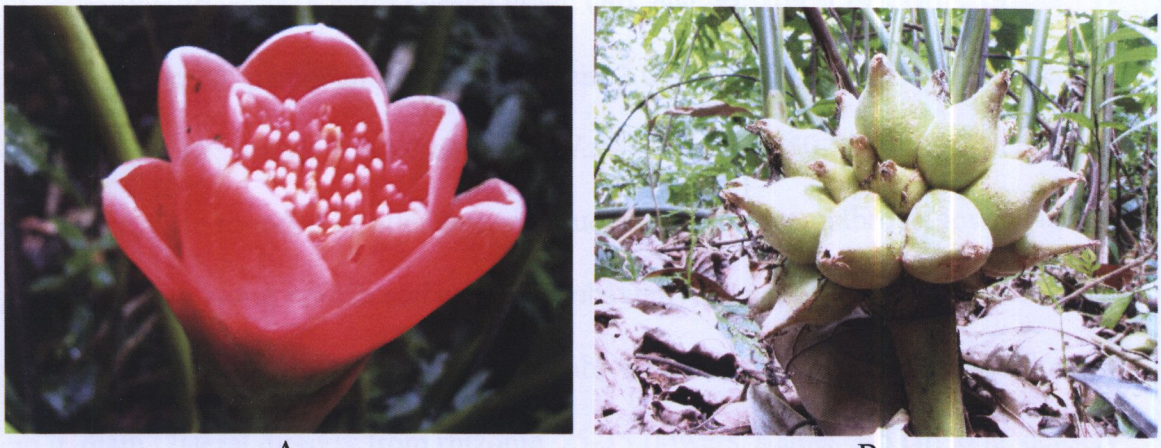
11. *Etlingera fulgens* (Ridl.) C. K. Lim, **comb. nov.** [fulgens = shiny] **Synon. nov.:** *Nicolaia fulgens* (Ridley) K. Larsen in *Nat. Hist. Bull. Siam Soc.* 23:574. 1970.

(Fig. 14)

Terrestrial, perennial herb. **Leafy stem** 4.0-5.0 m tall, tufted, 3-7 bladeless sheaths. **Leaves** petiolate; *petiole* 1.5-2.5 cm long; *blade* narrowly lanceolate, 45-85 by 10-12 cm, glabrous, apex caudate, base oblique, upper surface purplish green with white patches along midrib, lower surface purplish; *ligule* 1.0 cm long, glabrous, apex rounded; *leaf sheaths* glabrous, green. **Inflorescence** lateral, from rhizome near base of leafy stem, erect, peduncle 0.8-1.0 m, glabrous; *involucral bracts* 8-12, pink with white margins, lower half bright green, broadly ovate, 2.0-4.0 by 3.0-6.5 cm, glabrous, vernicose, apex mucronate; *bracteoles* tubular, ca. 1.5 cm, deeply split on 1 side. **Flowers** pink; *calyx* tubular, 3.0-3.5 cm, red with yellow apex, glabrous, apex hooded, split down one side, lower half densely hairy; *corolla* tubular glabrous, 4.5-6.5 cm, hairy; *staminodes* lanceolate, 0.5-0.8 by 0.5-0.8 cm, pink; *labellum* lanceolate, 1.5-2.2 by 0.8-1.2 cm, red with pale edge, apex emarginate; *stamen*: *filament* hairy, white 0.5-0.8 cm long, *anther* hairy, 0.8-1.0 cm long, connective glabrous; *ovary* glabrous, 0.3 by 0.5 cm, *stigma* cup-shape, pinkish. **Fruits** globula, pubescent, ca. 2.5 cm in diam., greenish.

Specimen examined.- N. Kittipanangkul 121, 29 April 2006, Nakhon Si Thammarat (WU 1422).

Flowering : April – May



A B

Fig. 14. *Etlingera fulgens* (Ridl.) C. K. Lim A) inflorescence, B) infructescence.

12. *Etlingera littoralis* (König) Giseke Prael. Ord. Nat. Pl. 209. 1792. (Fig. 15)

Terrestrial, perennial herb. **Leafy stem** 2.0-4.0 m tall, 5-10 bladeless sheaths. **Leaves** petiolate; *petiole* 3.0-5.0 cm long; *blade* lanceolate, 50-90 by 10-15 cm, apex acuminate, base rounded or attenuate, oblique, upper surface glabrous, lower surface glabrous, hairy along midrib and at margin abaxially; *ligule* oblong, 0.5-1.5 cm long, pubescent, apex acuminate; *leaf sheaths* glabrous, green. **Inflorescence** head, ca. 10 cm in diam., lateral directly from rhizome, 25-35 flowers, scapes 3-5 cm long, densely silky hairy; *bracts* obovate to ovate-oblong, green to dark brown, apex mucronate, 3.0-5.0 by 1.5-3.0 cm; *bracteoles* tubular, ca. 4.5 cm. **Flowers** 8-12 opening simultaneously; *calyx* glabrous, 5.6-6.7 cm, apex 3-toothed, split down one side; *corolla* tubular 3-5 cm; lobes oblong, glabrous, 2.2-2.6 cm by 5.0-7.0 mm, white with red apex; *staminodes* lanceolate, 1.5-1.8 by 0.6-0.8 cm, pink with red apex; *labellum* narrowly lanceolate or obovate-oblong, 5.5-6.0 by 1.2-1.5 cm, free part 4.5-5.5 by 1.5-2.0 cm, red with bright yellow margin or pure red, apex rounded or emarginated, margin revolute, base expanded and middle labellum slightly narrowed in red flowers; *stamen*: *filament* flat, ca. 1 cm long, *anther* red, ca. 1 cm long, apex emarginated, connective pink to red; *ovary* pubescent, 0.5 by 0.7 cm, *stigma* rhombic, pinkish, ciliate. **Fruits** globose, ca. 3 cm in diam., dark red to brown.

Specimen examined.- N. Kittipanangkul 132, 6 May 2006, Nakhon Si Thammarat (WU 1425).

Flowering : April - May

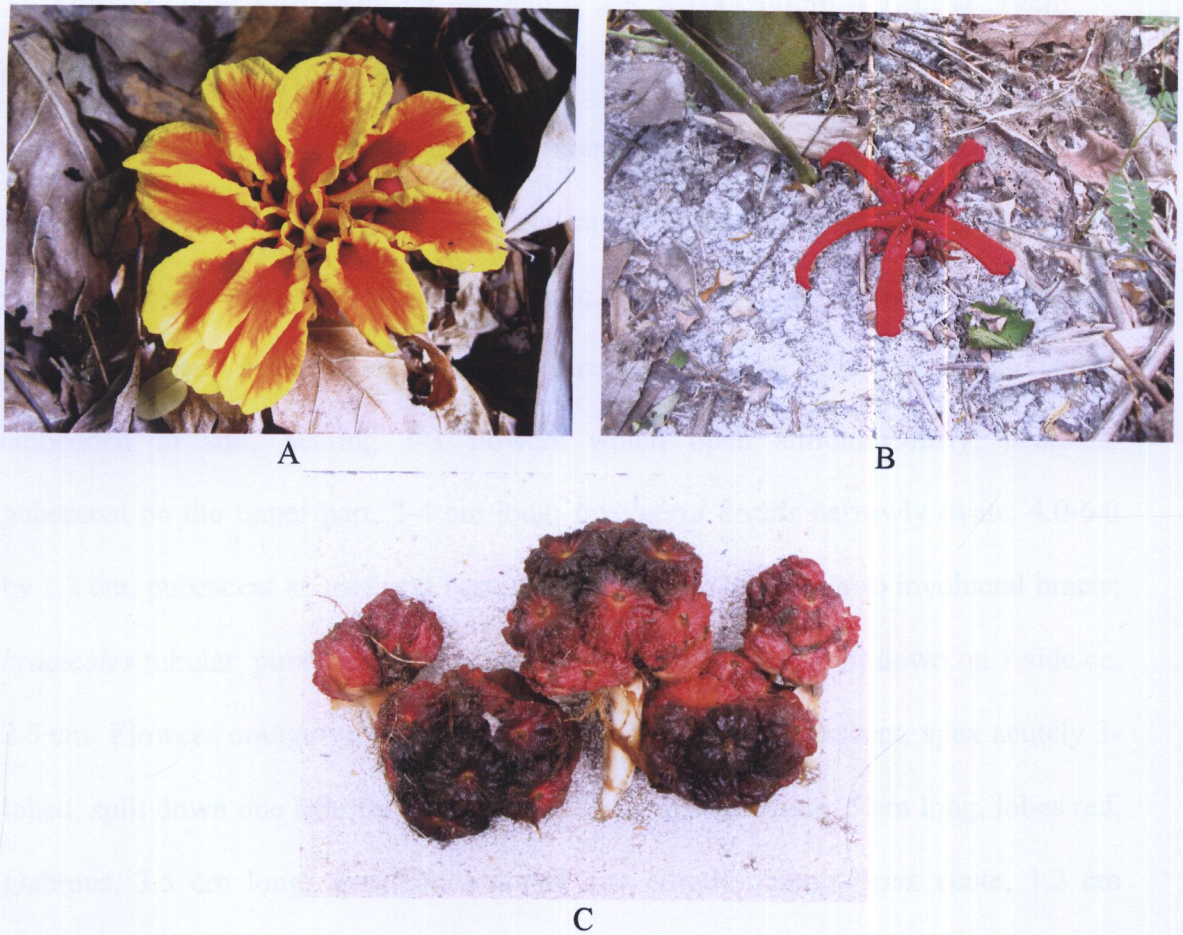


Fig. 15. *Etlingera littoralis* (König) Giseke A) red with yellow edge flowers, B) red flowers, C) infructescences (from red with yellow edge flower populations).

13. *Etlingera pauciflora* (Ridl.) R. M. Smith, Not. R.B.G. Edinb. 43(2):248. 1986. (Fig. 16)

Terrestrial, perennial herb. **Leafy stem** 2.0-3.0 m tall. **Leaves** sessile; *blade* narrowly lanceolate, 50-55 by 8.5-9.5 cm, apex caudate, base cuneate, both surface glabrous; *ligule* triangular, 1.2-1.7 cm long, glabrous, apex rounded; *leaf sheaths* glabrous, green. **Inflorescence** lateral, directly from rhizome, lower part often embedded in soil, bearing 1-3 flowers which open simultaneously; *peduncle* pubescent on the upper part, 3-4 cm long; *involucral bracts* narrowly ovate, 4.0-6.0 by 1.2 cm, pubescent at apex and base, apex acute; *bracts* similar to involucral bracts; *bracteoles* tubular, pubescent, 2.5-4.5 cm long, apex 2-lobed, split down on 1 side ca. 2.5 cm. **Flowers** orange-yellow; *calyx* tubular, 7 cm long, pubescent, apex acutely 3-lobed, split down one side for 2.5 cm; *corolla* tubular glabrous, 5 cm long, lobes red, glabrous, 3.5 cm long; *staminodes* dorsal one elliptic-oblong, apex acute, 1.2 cm wide; lateral ones narrowly obovate, apex rounded, 7 mm wide; *labellum* clawed, claw orange-yellow with red margin, blade orange-red with yellow middle band, length ¾ from base, 5 by 1 cm, apex rounded; *stamen*: *filament* glabrous, 3 mm long, ca 5 m wide, *anther* pilose along the line of dehiscence, 1 by 0.5 cm; *ovary* pubescent on upper part, 3 mm long, *stigma* white, ciliate. **Fruits** not seen.

Specimen examined.- N. Kittipanangkul 195, 17 January 2007, Nakhon Si Thammarat (WU 1442).

Flowering : January

A B

Fig. 16. *Etlingera pauciflora* (Ridl.) R. M. Smith A) flower, B) habit.

14. *Etlingera subterranea* (Holtt.) R. M. Smith, Not. R.B.G. Edinb. 43(2):250. 1986. (Fig. 17)

Terrestrial, perennial herb. **Leafy stem** 1.5-2.0 m tall. **Leaves** petiolate; *petiole* glabrous, 6-8 mm long; *blade* obovate-lanceolate, 35-55 by 8.5-9.5 cm, apex acuminate, base obtuse, both surface glabrous, green with purplish patches on either side of midrib; *ligule* triangular, 6 by 6 mm, glabrous, apex rounded; *leaf sheaths* glabrous, green. **Inflorescence** lateral, directly from rhizome appearing ca. 30 cm away from leafy stem, embedded in soil, bearing 2-4 flowers; *peduncle* erect, pubescent, 5-10 cm long; *involucral bracts* 2, ovate-oblong, 4 by 1.2 cm, rigid, pubescent, apex acute, ciliate; *bracts* similar to involucral bracts, the inner bracts narrower, pubescent; *bracteoles* tubular, pubescent, 2.5-3.0 cm long, apex 2-lobed, split down on 1 side ca. 1.5 cm. **Flowers** red; *calyx* tubular, 5 cm long, pubescent, apex 3-lobed, split down one side for 1 cm; *corolla* tubular glabrous, 4.5 cm long, lobes oblong, red, puberulent, apex ciliate, 2.0 cm long; *staminodes*: dorsal one apex acuminate, 5 mm wide; lateral ones apex rounded, 3 mm wide; *labellum* clawed, claw dark red with white edge, 6 cm long, blade red, obovate, apex 2-lobed, 1.5 cm wide; *stamen*: *filament* 3 by 3 mm, *anther* 1 by 0.4 cm; *ovary* pubescent, 5 mm long, *epigynous glands* connate, streaked on one side to base, apex lobed, *stigma* black or dark red, ciliate, 2.5 mm wide. **Fruits** not seen.

Specimen examined.- N. Kittipanangkul 151, 7 June 2006, Nakhon Si Thammarat (WU 1430).

Flowering : June

A B

Fig. 17. *Etlingera subterranea* (Holtt.) R. M. Smith A) flowers, B) habit.

5. *Hornstedtia* Retzius

Only one species was found in this study.

15. *Hornstedtia leonurus* (König) Retz., Obs. Bot. 6: 18. 1786. (Fig. 18)

Terrestrial, perennial herb. **Leafy stem** 3-4 m tall, tufted. **Leaves** petiolate; *petiole* glabrous, 1.5 cm long; *blade* oblong, 55-60 by 10.0-15.0 cm, apex acuminate, base unequally cordate, both surfaces glabrous, with pale green midrib; *ligule* 7 mm long, glabrous, apex rounded; *leaf sheaths* glabrous, dark brown-green. **Inflorescence** embedded in soil, 8.0-9.5 cm long; *involucral bracts* pubescent, 7.0-7.5 by 1.5-1.8 cm, apex acute; *bracts* ovate-lanceolate, narrowly tapering to apex, 6.0-6.8 by 0.8-1.2 cm, pilose outside; *bracteoles* tubular, puberulent, 5.5-7.0 cm long, apex acute or deeply 2-lobed. **Flowers** red; *calyx* tubular, 7 cm long, densely pubescent, apex acute, split down one side for 2 cm; *corolla* tubular glabrous, 6 cm long, lobes hooded, 3.0 cm long; *labellum* 3-lobed, dark red, 3.0 by 1.5 cm, middle lobe narrowly triangular, apex rounded, 1.0 by 0.8 cm; *stamen*: *filament* glabrous, 1.5 cm long, *anther* 1.2 by 0.4 cm, pubescent along the line of dehiscence; *ovary* densely pubescent, 5 mm long, *stigma* red, ciliate. **Fruits** not seen.

Specimen examined.- N. Kittipanangkul 144, 1 June 2006, Nakhon Si Thammarat (WU 1428).

Flowering : June

a) b)

Fig. 18. *Hornstedtia leonurus* (König) Retz. A) flower, B) inflorescences.

TRIBE GLOBBEAE

6. *Globba* Linnaeus

Two species were found in this study.

Key to the species

1. Flower yellow, peduncle and pedicel green **16. *G. pendula***

Flower white with bright yellow anther appendages, labellum and staminodes, peduncle and pedicel white **17. *G. leucantha***

16. *Globba pendula* Roxb. As. Res xi. 359. 1810. (Fig. 19)

Terrestrial or lithophytes, perennial herb. **Leafy stem** up to 35 cm tall. **Leaves** 4-6, sessile; *blade* narrowly ovate, 13.5-22.0 by 2.5-4.5 cm, apex caudate, base cuneate, glabrous; *ligule* 2-lobes, ovate, ca. 2 by 2 mm, apex rounded; *leaf sheaths* glabrous, deep red. **Inflorescence** panicle, terminal, lax; *peduncle* green, *bracts* absent, *bracteoles* pale green, ca. 3 mm long, apex acute. **Flowers** yellow, in cincinni of 2-3 flowers; *calyx* apex 3-lobed, ca. 4 mm long, apex of upper two lobes hooded; *corolla* tubular ca. 1.5 cm long; lobes slightly equal, dorsal lobe hooded, ca. 5 mm long; *staminodes* narrowly elliptic, ca. 6 mm long; *labellum* 2-lobe, upper part hairy, ca. 6 mm long; *stamen* appendages 2, basal, subulate, *anther* ca. 2 by 2 mm; *ovary* green, 2.0-2.5 by 1 mm, glabrous. **Fruits** globose, green, ca. 5 mm diam.; *bulbils* 7-1 by 5-8 cm, perulate.

Specimen examined.- N. Kittipanangkul 140, 1 June 2006, Nakhon Si Thammarat (WU 1427).

Flowering : June

A B

Fig. 19. *Globba pendula* Roxb. A) flower, B) inflorescence.

17. *Globba leucantha* Miq., Notes Roy. Bot. Gard. Edinburgh 31(2): 268. 1972.

(Fig. 20)

Terrestrial or lithophytes, perennial herb. **Leafy stem** 25 cm tall. **Leaves** 4-6, sessile; *blade* narrowly ovate, apex caudate, base cuneate, glabrous; *ligule* 2-lobes, ovate, ca. 2 by 2 mm, membranaceous, apex rounded; *leaf sheaths* glabrous, pale green. **Inflorescence** panicle, terminal, lax; *peduncle* white; *bracts* pale green to white, involute, ca. 0.6 cm, apex acute, soon falling; *bracteoles* white, involute or tubular, membranaceous, ca. 0.4 cm, apex acuminate. **Flowers** white, in cincinni of 2-3 flowers; *calyx* apex 3-lobed, apex of upper two lobes hooded, ca. 6 mm long; *corolla* tubular 1.5 cm long, white, membranaceous, apex acute, lobes slightly equal, dorsal lobe hooded, ca. 7 mm long; *staminodes* narrowly elliptic, apex 2-lobes, unequal, apex acute, bright yellow; *labellum* 2-lobe, white, glabrous, lower part bright yellow, ca. 1 cm long; *stamen* appendages 2, deltoid, ca. 3 by 2 mm, basal, pale yellow, *anther* ca. 1.5 by 1.5 mm; *ovary* white, 1.5 by 1 mm, glabrous. **Fruits** not seen, *bulbils* 7-1 by 5-8 cm, perulate, 5-8 shoots.

Specimen examined.- N. Kittipanangkul 109, 17 April 2006, Nakhon Si Thammarat (WU 1419).

Flowering : April - June

Fig. 20. *Globba leucantha* Miq. A) flower, B) inflorescence, C) bulbil, D) plants.

TRIBE ZINGIBEREAE

7. *Boesenbergia* O. Kuntze

Two species were found in this study.

Key to the species

1. Inflorescence basal directly from rhizome **18. *B. basispicata***

   Inflorescence terminal **19. *B. plicata***

18. *Boesenbergia basispicata* K. Larsen ex Sirirugsa, Nord. J. Bot. 7(4): 1987.

(Fig. 21)

Terrestrial, perennial herb. **Leafy stem** 40-60 cm tall. **Leaves** petiolate; *petiole* 6.0-15.0 cm long, glabrous; *blade* oblong, unequal, 12-30 by 5-8 cm, apex acuminate, base cuneate or obtuse, decurrent, upper surface glabrous, lower surface glabrescent; *ligule* broadly triangular or oblong, 3-5 mm long, glabrous; *leaf sheaths* up to 10 cm long, glabrous, 6-12 cm long. **Inflorescence** basal, ascending from rhizome, not enclosed by leaf sheaths, oblong-conical, 8-15 cm; *bracts* dark reddish, mottled with pink, glabrous, 2.5-3.0 by 1.5-1.8 cm; *bracteoles* folded, ca. 1.2 by 0.8 cm, glabrous. **Flowers** 1-3 opening together, white, flowers about 10-12; *calyx* pinkish, lobes short, truncate, 3-4 mm long; *corolla* tubular 2.0-2.5 cm long, lobes elliptic, apex rounded, incurved, glabrous; *staminodes* elliptic or ovate, 1.0 by 0.6 cm, longer than half the length of labellum, whitish, finely hairy and ciliate; *labellum* ovate or suborbicular, saccate, apex irregularly crenate and crinkled, 2.0 by 1.5 cm, hairy at base, finely ciliate; *stamen: filament* ca. 4 mm long, sparsely brownish-hairy, *anther* ca. 5 mm, connective almost glabrous; *crest* not produced beyond the thecae; *ovary* glabrous, 4 by 5 mm; *epigynous glands* linear, acute, ca. 5 mm long. **Fruits** ellipsoid, tapering

towards apex, ca. 1.5 by 0.6 cm; *seeds* ca. 6, arillate, 7-10 by 2-3 mm, aril whitish-hairy.

Specimen examined.- N. Kittipanangkul 166, 14 June 2006, Nakhon Si Thammarat (WU 1434).

Flowering : January - June

A B

Fig. 21. *Boesenbergia basispicata* K. Larsen ex Sirirugsa A) flower, B) plants with inflorescences.

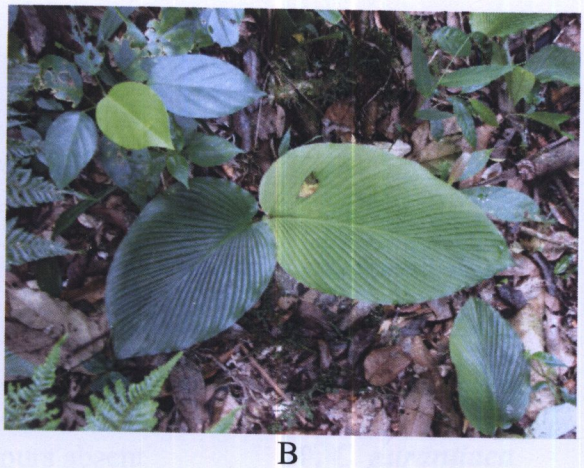
19. *Boesenbergia plicata* (Ridl.) Holtt., Gard. Bull. Sing. 13: 109. 1950. (Fig. 22)

Terrestrial, perennial herb. **Leafy stem** 30-60 cm tall. **Leaves** petiolate; *petiole* 6.0-15.0 cm long, hairy; *blade* oblong or elliptic-oblong, unequal, 15-25 by 6-10 cm, apex acuminate, base cuneate or rounded, upper surface glabrous, lower surface glabrescent; *ligule* triangular or oblong, 4-12 mm long, apex rounded, glabrous; *leaf sheaths* hairy, 6-12 cm long. **Inflorescence** terminal, between the two innermost leaf-sheaths, later elongate, 10-20 cm long; *bracts* alternate 2 ranked, facing one way, 3.0-4.0 by 1.0-1.2 cm, hairy; *bracteoles* folded, ca. 3.5-4.0 by 1.5-1.8 cm, hairy. **Flowers** 1-2 opening together, yellowish, flowers about 6-10; *calyx* reddish mottled, 8-12 mm long, lobes ca. 1.2-1.5 mm long; *corolla* tubular 3.0-3.5 cm long, lobes oblong, apex mucronate, incurved, glabrous, reddish mottled; *staminodes* obovate-oblong, apex rounded or lobed, 2.0-2.2 by 0.8-1.2 cm, hairy, finely ciliate; *labellum* elliptic or obovate, usually saccate, apex rounded, undulate and crinkled, 3.0-3.2 by 2.0-2.5 cm, base with margin folded up and overlapping staminodes, hairy at base; *stamen: filament* ca. 6 mm long, hairy, *anther* ca. 8 mm long; connective finely hairy, *crest* 3-lobed, shortly extended beyond thecae; *ovary* glabrous, 5 by 5 mm, reddish mottled; *stigma* inconspicuously lobed, ciliate; *epigynous glands* linears, ca. 5 mm long. **Fruits** not seen.

Specimen examined.- N. Kittipanangkul 189, 2 November 2006, Nakhon Si Thammarat (WU 1440).

Flowering : November

A



B

Fig. 22. *Boesenbergia plicata* (Ridl.) Holtt. A) flower, B) plant.

8. *Curcuma* Linnaeus

Three species were found in this study.

Key to the species

1. Inflorescences on separate shoots arising directly from rhizome 2

   Inflorescences terminal between inner most leaf-sheaths 3

2. Sheaths green, corolla pink **23. *C. zedoaria***

   Sheaths dark reddish, corolla yellow **22. *C. rubescens***

3. Coma bracts bright pink, labellum yellow, spurs absent **20. *C. aurantiaca***

   Coma bracts pale yellow, labellum white, spurs present **21. *C. longa***

20. *Curcuma aurantiaca* van Zijp., Recueil Trav. Bot. Neerl. xii. 345. 1915. (Fig. 23)

Terrestrial, perennial herb. **Leafy stem** up to 70 cm tall, hairy. **Leaves** 2-5, petiolate; *petiole* 3.5-5.0 cm long, pubescent; *blade* elliptic to ovate, 30-50 by 20-25 cm, upper part glabrous, lower part pubescent, apex acute, base cuneate; *ligule* 2-lobes, elliptic, ca. 8 mm long, apex rounded, ciliate, membranaceous; *leaf sheaths* glabrous, green to dark red-brown. **Inflorescence** terminal between inner most leaf-sheaths; *peduncle* 10-18 cm; *spike* cylindric, 15-20 by 5-8 cm; *bracts* greenish-orange, ovate or oblong, 4-6 cm, apex obtuse; *coma bracts* spreading, bright pink, 3-4 cm long, apex acute. **Flowers** yellow; *calyx* white, 0.6-1 cm, apex 3-lobed; *corolla* tubular 2.5 cm, 3-lobes, pale yellow, dorsal one hooded; *labellum* 3-lobes, yellow with darker yellow band in center, obovate, 1-1.5 cm, middle lobe slightly reflexed, apex 2-fid or rounded; *stamen: filament* flat, 3-5 mm long, *anther* ca. 3 by 2 mm, *anther crest* short, 2-3 mm long; *ovary* ca. 3 by 4 mm, hairy, *stigma* funnel shape, ciliate. **Fruits** globular or oblong, pubescent.

Specimen examined.- N. Kittipanangkul 183, 10 August 2006, Nakhon Si Thammarat (WU 1438).

Flowering : July - August

A B

Fig. 23. *Curcuma aurantiaca* van Zijp. A) flower, B) plants with inflorescences.

21. *Curcuma longa* L., Species Plantarum 2. 1753. (Fig. 24)

Terrestrial, perennial herb. **Leafy stem** up to 80 cm tall. **Leaves** petiolate; *petiole* 20-45 cm; *blade* green, oblong or elliptic, 30-80 by 15-20 cm, glabrous, apex shortly acuminate, base attenuate; *ligule* membranaceous; *leaf sheaths* pale green. **Inflorescence** terminal between inner most leaf-sheaths; *peduncle* 12-20 cm long; *spike* cylindric, 12-18 by 4-9 cm; *bracts* pale green or greenish yellow, ovate or oblong, 3-5 cm, apex obtuse; *coma bracts* spreading, pale yellow, apex acute, 5-8 cm long. **Flowers** white; *calyx* white, 0.8-1.2 cm, puberulent, apex 3-lobed; *corolla* pale yellow, tube 3 cm, 3-lobes, dorsal lobe convolute, 1.2-1.5 cm long, apex hooded or mucronate, ciliate, lateral lobes deltoid, 1.0-1.5 cm; *labellum* pale yellow with yellow band in center, obovate, 1.2-2.0 cm; *stamen: filament* flat, ca. 4 mm long; *anther* spurred at base, ca. 3 mm long; *ovary* globose, ca. 2 mm diam., ciliate. **Fruits** not seen.

Specimen examined.- N. Kittipanangkul 192, 17 November 2006, Nakhon Si Thammarat (WU 1441).

Flowering : November - December

A B

Fig. 24. *Curcuma longa* L. A) flower, B) inflorescence.

22. *Curcuma rubescens* Roxb., As. Res. xi. 336. 1810. (Fig. 25)

Terrestrial, perennial herb. **Leafy stem** up to 1.2 m tall. **Leaves** petiolate; *petiole* 30-60 cm; *blade* green with dark red along midvein, laceolate or elliptic, 60-80 by 20-30 cm, glabrous, apex acute, base attenuate; *ligule* 2-lobdes, apex acute, ciliate, ca. 4 mm long; *leaf sheaths* dark red, 50-65 cm long. **Inflorescence** on separate shoots arising from rhizome; *peduncle* 15-25 cm, dark red; *spike* cylindric, 20-25 by 8-10 cm; *bracts* pale green with pink at apex, ovate or oblong, 3-5 cm, apex obtuse; *coma bracts* spreading, mostly bigger than bracts, bright pink, apex acute or obtuse, ca. 10 cm long. **Flowers** pale yellow; *calyx* white, 0.6-0.8 cm, apex 3-lobed; *corolla* 3-lobes, cream to pale yellow, tube 3-4 cm, lobes deltoid, 1-1.2 cm, dorsal lobe pale yellow, apex hooded; *labellum* 3-lobes, middle lobe bright yellow with dark yellow band in center, obovate, 1-1.5 cm, apex retuse, ca. 1.5 by 2.0 cm, side lobes pale yellow, apex obtuse, ca. 1.2 cm wide; stamen: filament short, ca. 2 mm long, *anther* spurred at base, ca. 3 mm long; *ovary* globular, glabrous, ca 2 by 2 mm. **Fruits** not seen.

Specimen examined.- N. Kittipanangkul 158, 13 June 2006, Nakhon Si Thammarat (WU 1432).

Flowering : May - June

A B

Fig. 25. *Curcuma rubescens* Roxb. A) flower within inflorescence, B) plants.

23. *Curcuma zedoaria* Rosc., Trans. Linn. Soc. London 8: 354. 1807. (Fig. 26)

Terrestrial, perennial herb. **Leafy stem** 0.4-1.0 m tall. **Leaves** petiolate; *petiole* 10-30 cm, green; *blade* green with dark red along both side of midvein, midrib green, laceolate or elliptic, 30-50 by 10-15 cm, glabrous, apex acute, base attenuate; *ligule* 2-lobdes, apex rounded, entire, ca. 1 mm long; *leaf sheaths* green, 10-30 cm long. **Inflorescence** on separate shoots arising from rhizome; *peduncle* 10-20 cm, green; *spike* cylindric, 10-15 by 6-8 cm; *bracts* green with pink at apex, ovate or oblong, 5-8 cm long, apex obtuse; *coma bracts* spreading, mostly bigger than bracts, bright pink, apex acute or obtuse, pink, 8-12 cm long. **Flowers** pinkish yellow; *calyx* white, 0.5-0.6 cm, apex 3-lobed; *corolla* pale pink, tube 3-4 cm, lobes deltoid, ca. 1 cm, apex hooded to mucronate; *labellum* 3-lobes, middle lobe bright yellow with yellow band in center, obovate, 1-1.5 cm, apex retuse, side lobes ovate apex rounded; *stamen: filament* flat, short, ca. 2 mm long, *anther* spurred at base, ca. 3 mm long; *ovary* ca. 2 by 2 mm, globose. **Fruits** not seen.

Specimen examined.- N. Kittipanangkul 217, 3 August 2007, Nakhon Si Thammarat (WU 1449).

Flowering : May – June

A B

Fig. 26. *Curcuma zedoaria* Rosc. A) flower within inflorescence, B) plants.

9. *Hedychium* König

Only one species was found in this study.

24. *Hedychium khaomaenense* Picheansoonthon & Mokkamul, Folia malaysiana 6: 21. 2005. (Fig. 27)

Epiphyte, perennial herb. **Leafy stem** 38.0-45.0 cm tall, basal part red, 3-5 bladeless sheaths. **Leaves** petiolate; *petiole* 1.0-1.5 cm long; *blade* elliptic, 23.0-28.5 by 5.2-8.5 cm, apex acute, base cuneate, upper surface glabrous, lower surface glabrous; *ligule* oblong, membranous, 3.5-4.2 cm long, bright red, glabrous, apex 2-lobed, lobes rounded; *leaf sheaths* glabrous, green with red margin. **Inflorescence** terminal spike, erect, 15.0-18.2 cm; *peduncle* 4.0-5.5 cm, glabrous; *bracts* 4-6, green with reddish margin, broadly ovate, 5.4-6.5 by 2.8-3.0 cm, glabrous, 2-4 flowered, apex acute. **Flowers** white, fragrant; *calyx* tubular, red, 0.4-0.5 by 7.0-7.5 cm, apex acute, ciliate; *corolla* tubular narrow, twisted, 13.0-14.5 by 0.3 cm, 3-lobed, lobe linear, curled, reddish with greenish tip, 6.2-7.5 by 0.1-0.2 cm; *staminodes* lanceolate, 7.5-9.0 by 1.0-1.5 cm, white, claw long; *labellum* obovate, 6.5-7.2 by 3.2-3.7 cm, white with yellow patch at base, 2-cleft, halves pointed, claw 0.2-1.0 cm long; *stamen: filament* yellow, 5.2-5.7 cm long, *anther* yellow, 1.4-1.6 cm long; *ovary* glabrous, 0.4 by 0.7 cm, longitudinally ribbed; *epigynous glands* 2, 0.1 cm long, *stigma* cup-shape, greenish, ciliate. **Fruits** oblong, 3.0-3.2 by 1.0-1.2 cm, red, glabrous.

Specimen examined.- N. Kittipanangkul 216, 3 August 2007, Nakhon Si Thammarat (WU 1448).

Flowering: June – August

A B

Fig. 27. *Hedychium khaomaenense* Picheansoonthon & Mokkamul. A) flower, B) inflorescence.

10. *Kaempferia* Linnaeus

Only one species was found in this study.

25. *Kaempferia pulchra* Ridl. Journ. As. Soc. Straits, xxxii. 107. (Fig. 28)

Small herb, **Leafy stem** very short, often embedded in soil. **Leaves** petiolate, 2-3, horizontal, near the ground; *petiole* 2-3 cm long, green to brown; *blade* ovate to orbicular, glabrous, 15-18 by 12-15 cm, apex acute, base auriculate; *ligule* 2-lobes, membranaceous, apex rounded or obtuse. **Inflorescence** pedunculate, rising between the innermost leaf; *peduncle* 5-8 cm long, pale green; *bracts* dark brown or green, ovate, apex acute, ca. 4 by 3 cm; *bracteoles* dark brown, ca. 3 by 1 cm, lanceolate, apex acute. **Flowers** several, bright violet; *calyx* tubular, ca. 1 cm long; *corolla* tubular 3-lobes, oblong, ca. 2 cm long, apex acute; *staminodes* ovate to round, 2-3 by 1.5-2 cm; bright violet, glabrous; *labellum* divided to the base, each lobe ovate, often smaller than staminodes, 2-3 by 1.5-2 cm, apex obtuse or rounded; *anther crest* clawed, blade oblanceolate with acute apex, claw 3 mm long; *ovary* globose, ca. 2 mm diam., glabrous. **Fruits** not seen.

Specimen examined.- N. Kittipanangkul 128, 3 May 2006, Nakhon Si Thammarat (WU 1424).

Flowering : May - August

A B

Fig. 28. *Kaempferia pulchra* Ridl. A) flower, B) plants.

11. *Zingiber* Miller

Four species were found in this study.

Key to the species

1. Inflorescence borne on a procumbent peduncle **26. *Z. newmanii***

   Inflorescence borne on an erect peduncle 2

2. Leaves linear, ligule glabrous, labellum red mottled cream **27. *Z. officinale***

   Leaves lanceolate or oblong, ligule hairy, labellum pale yellow 3

3. Bracts dull red, labellum pale yellow with red-brown markings **28. *Z. ottensii***

   Bracts green turning red with a thin papery margin, labellum yellow **29. *Z. zerumbet***

26. *Zingiber newmanii* I. Theilade & J. Mood, Nord. J. Bot. 19(4). 407. 1999.

(Fig. 29)

Terrestrial, perennial herb. **Leafy stem** 3 m tall. **Leaves** petiolate; *petiole* 3 mm long, hairy; *blade* oblong, 40-45 by 9-11 cm, glabrous except on the midrib below, base attenuate, apex acute; *ligule* 0.8-1.0 cm long, hairy, 2-lobed, lobes broadly rounded; *leaf sheaths* slightly hairy towards the petiole. **Inflorescence** ovate, 10-15 by 3-6 cm, apex rounded; *peduncle* creep along the ground, 10-20 cm long; *bracts* obovate, 5 by 3 cm, concave, glabrous, bright red, apex obtuse; *bracteoles* elliptic, 3 by 1 cm. **Flowers** purple with white dot; *calyx* 2.8-3.2 cm long; *corolla* white, dorsal lobe 2.0 by 0.8 cm, lateral lobes 1.8 by 0.5 cm; *labellum* purple with whitish-cream dots throughout, middle lobe 1.3 by 1 cm, side lobes 0.7 by 0.5 cm; *anther* cream, 1 cm long, *crest* deep purple, ca 1.2 cm long. **Friuts** globular, 3-lobes, pinkish; *seeds* 7-10, black with white aril.

Specimen examined.- N. Kittipanangkul 117, 29 April 2006, Nakhon Si Thammarat (WU 1421).

Flowering : April – June

Fig. 29. *Zingiber newmanii* I. Theilade & J. Mood A) flowers within inflorescence, B) fruit, C) inflorescences, D) plants.

27. *Zingiber officinale* Rosc., Trans. Linn. Soc. 8: 348. 1828. (Fig. 30)

Terrestrial, perennial herb. **Leafy stem** 0.5-1 m. **Leaves** petiolate; *blade* linear, 15-20 by 1.0-2.5 cm, narrowed to a slender tip; *ligule* 3-5 mm long, slightly 2-lobes, glabrous; *leaf sheaths* glabrous except for short hairs near base of each leaf-blade. **Inflorescence** elliptic or oblong, 4-5 by 1.5-2 cm; *peduncle* radical, erect, slender 15-20 cm long; *bracts* obovate, 2-3 by 1.5-2.0 cm, light green turning yellow, glabrous with a thin, slightly incurved; *bracteoles* elliptic, 2.5-3.0 cm long, often longer than bract. **Flowers** dull purple mottled; *calyx* 1.2 cm long; *corolla* tubular 2.5 cm long, lobes yellow, dorsal lobe 1.8 by 0.8 cm, lateral lobes 1.6 by 0.6 cm; *labellum* dull purple mottled with cream, middle lobe circular, entire, 1.2 cm long, side lobes rather narrow, 0.6 by 0.4 cm, acute; *anther* cream; *crest* dark purple, capsule red. **Fruits** not seen.

Specimen examined.- N. Kittipanangkul 186, 11 October 2006, Nakhon Si Thammarat (WU 1439).

Flowering : October

A

B

Fig. 30. *Zingiber officinale* Rosc. A) flowers, B) inflorescence.

28. *Zingiber ottensii* Val., Bull. Jard. Bot. Buitenz. 27: 136. t. 19. 1918. (Fig. 31)

Terrestrial, perennial herb. **Leafy stem** to 1.5 m tall. **Leaves** petiolate; *petiole* 3-5 mm long, finely hairy; *blade* elliptic or widest above the middle, 35-40 by 6-8 cm, lower surface slightly hairy towards the base, apex acuminate; *ligule* broad, entire, ca. 1.2 cm long, hairy towards the base; *leaf sheaths* broad, slightly hairy. **Inflorescence** evenly ellipsoid to cylindrical with a broad apex, 10-12 by 4 cm; *bracts* obovate, 4 cm long and almost as wide, convex with incurved tips, dull red to bright red when old; *bracteoles* linear to lanceolate, 3.2 cm long. **Flowers** pale yellow; *corolla* 5.7 cm long, cream to yellow, dorsal lobe 2.2 by 1.1 cm, lateral lobes 2 by 0.6 cm; *labellum* 5.5 cm long, pale yellow with faint red-brownish markings, middle lobe oblong almost round, 2 by 1.5 cm, apex rounded and slightly cleft, side lobes ovate, 1.5 by 0.9 cm; *anther* pale yellow; *crest* pale yellow, longer than anther. **Fruits** not seen.

Specimen examined.- N. Kittipanangkul 147, 2 June 2006, Nakhon Si Thammarat (WU 1429).

Flowering : June – November

A B

Fig. 31. *Zingiber ottensii* Val. A) flower, B) inflorescence.

29. *Zingiber zerumbet* (L.) Smith, Exot. Bot. 2: 105 t. 112. 1805. (Fig. 32)

Terrestrial, perennial herb. **Leafy stem** 1.2-1.5 m. **Leaves** petiolate; *petiole* finely hairy; *blade* broadly lanceolate, 25-40 by 5-8 cm, apex acuminate; *ligule* papery, 1.5-2.0 cm long, scarious, hairy; *leaf sheaths* sparsely hairy. **Inflorescence** cylindric to ovate, 6-14 by 4-5 cm, apex obtuse; *peduncle* radical, erect, 10-25 cm long, sheaths green; *bracts* obovate, 3-4 by 2.5 cm, green when young, red when old, convex near upper edge, apex broadly rounded with a thin, papery margin; *bracteoles* linear to lanceolate, 2.5-3.5 long. **Flowers** pale yellow; *calyx* 2.5 cm long shorter than bracteoles, white; *corolla* 5.5 cm long, bright lemon-yellow, dorsal lobe 2.5 by 2 cm, lateral lobes 1.6 by 0.7 cm; *labellum* 5.5 cm long, pale yellow, margin crenate, middle lobe oblong, almost round, 1.5 cm long, apex cleft, side lobes ovate, 0.8 cm long; *anther* pale yellow, oblong, 1.5 cm long; *crest* pale yellow, as long as anther. **Fruits** not seen.

Specimen examined.- N. Kittipanangkul 137, 25 May 2006, Nakhon Si Thammarat (WU 1426).

Flowering : May – August

A B

Fig. 29. *Zingiber zerumbet* (L.) Smith A) flower within inflorescence, B) plants.

ECOLOGY AND DISTRIBUTION

Khao Nan and upper part of Khao Luang National Parks are Tropical Evergreen Rain Forest or Lower Montane Rain Forest, except the innermost of Klong Klai and Klong Tha Thon trails which are Upper Montane Rain Forest or Cloud Forest at up to 1,000 m in altitude (Santisuk, 2006). Most gingers in this study grow in Tropical Evergreen Rain Forest. Four species, *Amomum* sp., *Globba leucantha*, *Boesenbergia basispicata* and *Boesenbergia plicata*, can also grow in Lower Montane Rain Forest (Table 3).

All study sites are rather wet with many canals and sharp slopes caused by erosion. Sand spread throughout the forest. Soils that most gingers are found, are partly or mainly composed of sand (GLOBE® Program). *Globba* species always grow in sand with humus within nook of cliff at waterfall (Table 3).

Three species, *Amomum biflorum*, *Elettariopsis curtisii* and *Etlingera littoralis*, are tolerant species that are found in disturbed areas at all stations (Figs. 39, 43, 46). At least 12 species in this study are limited in distribution (Table 2). Two species, *Alpinia javanica* and *Etlingera pauciflora*, are rare, only one population each found. *Curcuma longa*, *C. zedoaria* and *Z. officinale* are cultivated species, never found in the primary forest. They are always growing at the old-camping sites, especially at Thape Chana Waterfall and Sunanta Waterfall (KN8).

Zingiber newmanii is found at the Klong Klai Basin (Fig. 60), the area between Khao Nan and Khao Luang National Parks; though Sirirugsa and Maknoi (2003) reported that it is endemic species of Khao Luang National Park (KL1). The distributions of other species show also the continuous distribution in the study site,

i.e. *Alpinia mutica* was found along the East side only of Khao Nan National Park (Fig. 35), or *Boesenbergia basispicata* and *B. plicata* were found along the West side only of Klong Klai Basin.

NETWORK OF BIODIVERSITY DATABASE SYSTEM (NBIDS)

All required information in each species were submitted to NBIDS website at http://www.nbids.org/ (Fig. 33). They are the distribution ranges, photos of the flowers and ecological data by using Google Earth Map (Fig. 34). Only the researchers or executives of BRT can access the data inside.

CHAPTER V

DISCUSSION

Totally 29 species in 11 genera and 3 tribes of the family Zingiberaceae were found in this study. Fifteen species in 5 genera are in Alpinieae. Two species are in Globbeae (*Globba*). Twelve species in 5 genera are in Zingibereae. This number are less than 30% of gingers reported by Sirirugsa and Maknoi (2003) including subsequently new records and new species, i.e. Kharukanant and Thohdam (2003), Picheansoonthon and Mokkamul (2004, 2005), which altogether counted at least 90 species from southern Thailand. The present data is possibly underestimated because some other parts of Khao Nan National Park are not yet investigated. It is expected that the number of Zingiberaceae species will rise with more exploration.

The study showed that Zingiberaceae species are distributed in all stations (Fig. 3). Especially, Klong Klai station (KN1) is the richest area of the family with 15 species (Table 4). This study site is rather wet as it is surrounded by many canals and lots of sharp slopes. Many species are especially abundant along riverbanks as well as in areas where are wet, moist and shaded as observed for Klong Klai (KN1), Sunanta Waterfall (KN8), Klong Kan (KN3), Huay Lak (KN5) and Krung Ching Waterfall (KL1) (Fig. 3). There are few species found in the interior part of the forest and they are less abundant and sparsely distributed. The diversity of species is mostly

distributed in altitude 90-300 m and the number of species decrease when altitude increases.

At least 6 species of Zingiberaceae of Khao Nan National Park (KN) are observed to be similar to the northern part of Khao Luang National Park (KL1), i.e. *Amomum hastilabium*, *Elettariopsis curtisii*, *Etlingera littoralis*, *Hornstedtia leonurus*, especially *Boesenbergia basispicata* are abundant at Klong Klai and Huay Lak (Fig. 52), and *Zingiber newmanii* are abundant at Klong Klai, Klong Kan and Klong Lum Pan (Fig. 60). This new distribution data obviously extends former distribution range. Only KL1 of *Z. newmanii* was reported by Sirirugsa and Maknoi (2003).

The numbers of species are highest at Klong Klai (15 species), while Klong Lum Pan (Tham Hong) has only 4 species because it is rocky mountainous area with less soil for growing any plants.

It is noted that *Etlingera* species were found at all stations in disturbed or intermediate-disturbed areas, especially *E. littoralis*. It is observed that most study sites (90-300 in altitude) are secondary forests that has bountiful treefall gaps.

Some species can be indicators of disturbed forests such as *Amomum uliginosum*, *Elettariopsis curtisii*, *Etlingera littoralis*, and *Z. ottensii*. They are present plentifully in low-altitude areas, implying that the areas around Khao Nan National Park are disturbed.

At least 8 species, *Alpinia mutica*, *A. zerumbet*, *E. elatior*, *E. fulgens*, *Curcuma aurantiaca*, *C. rubescens*, *Kaempferia pulchra* and *Z. newmanii* have a high potential to be developed into ornamental plants, while 7 species, *Amomum biflorum*, *E. elatior*, *E. fulgens*, *E. littoralis*, *C. longa*, *Z. officinale* and *Z. zerumbet* are edible.

A few species, in particular the seeds of *Z. newmanii*, *E. fulgens* and *E. elatior* may prove to be important resources for medicinally essential oils (Chomchalow, 1996, Daniel, 2005).

To ensure sustainable utilization of these Zingiberaceae species, it is strongly recommended to conserve the areas and their flora.

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APPENDIX

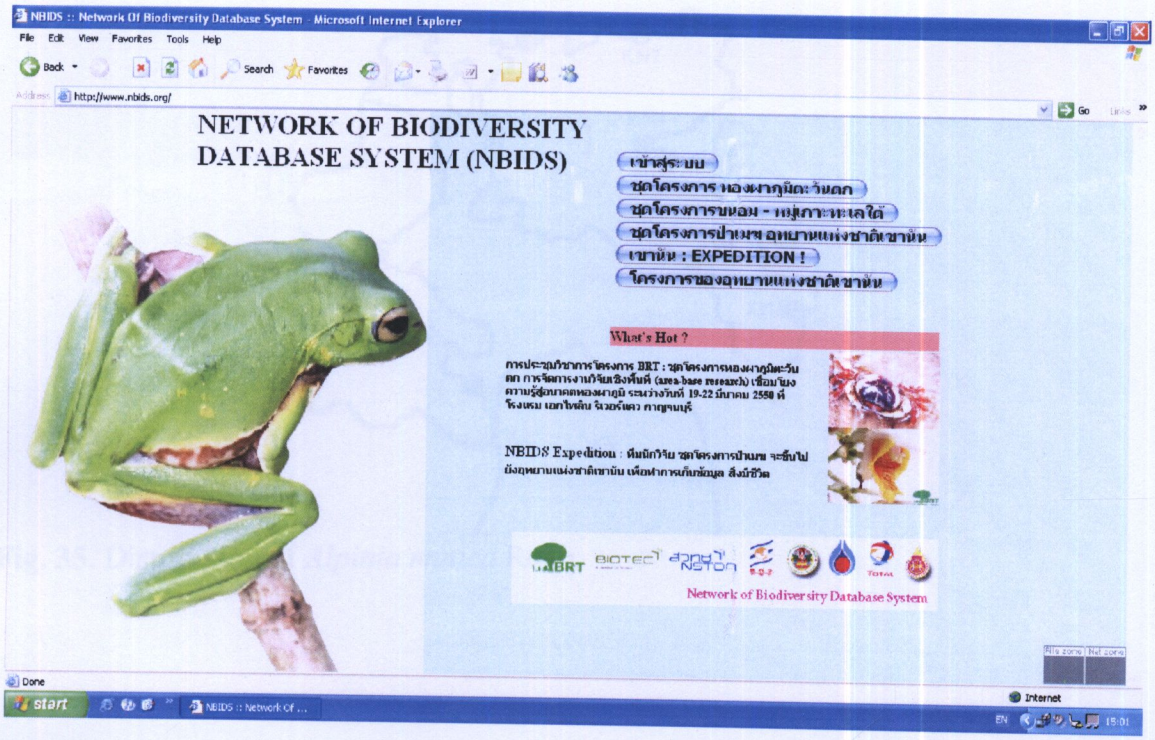

Fig. 33. Enter page of NBIDS website at http://www.nbids.org/.

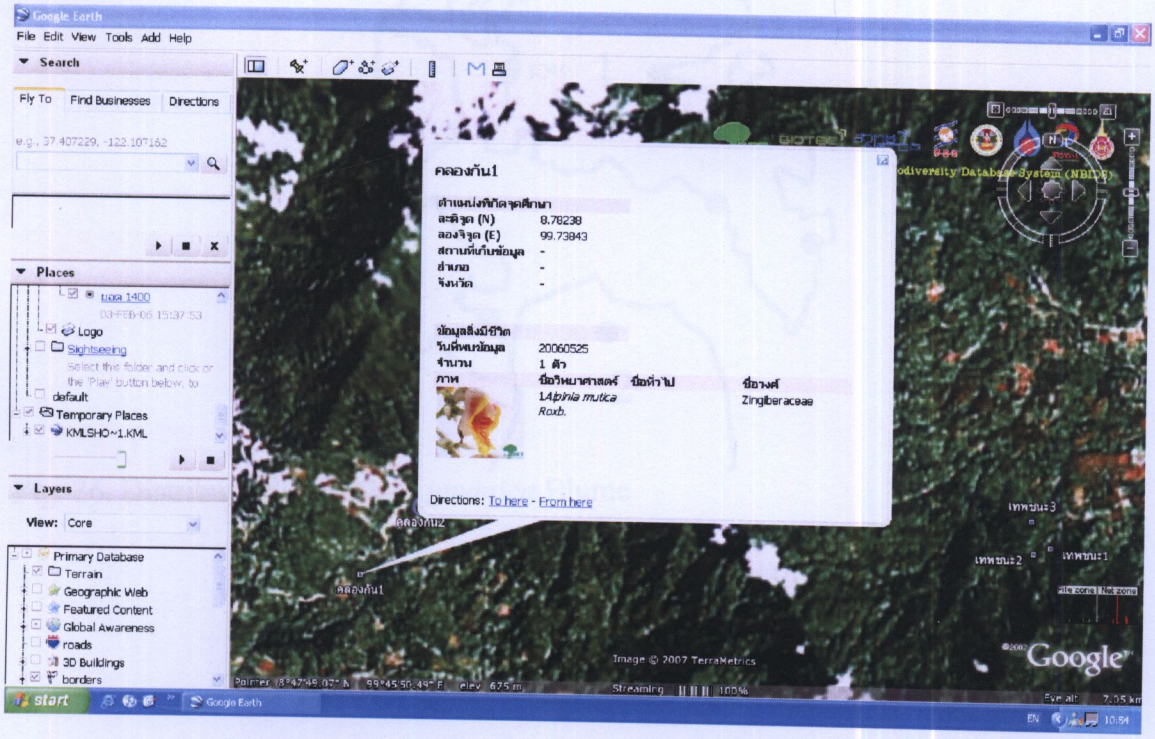

Fig. 34. Species details window shown on Google Earth Map.

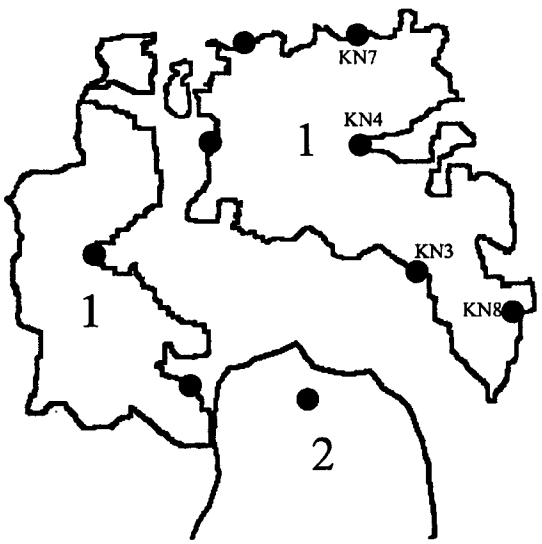

Fig. 35. Distribution of *Alpinia mutica* Roxb.

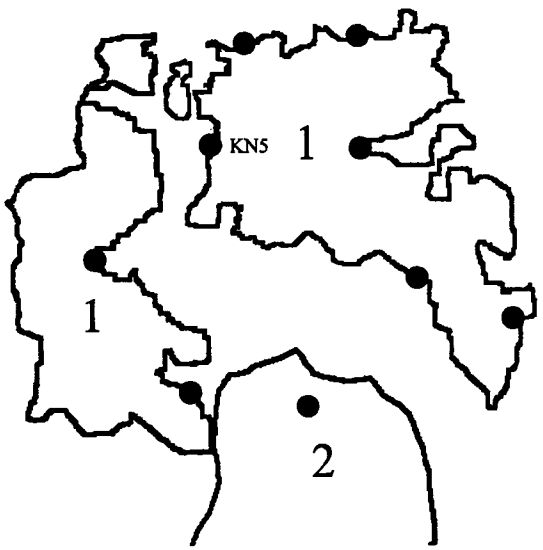

Fig. 36. Distribution of *Alpinia javanica* Blume

Fig. 37. Distribution of *Alpinia zerumbet* (Pers.) Burtt & R. M. Smith

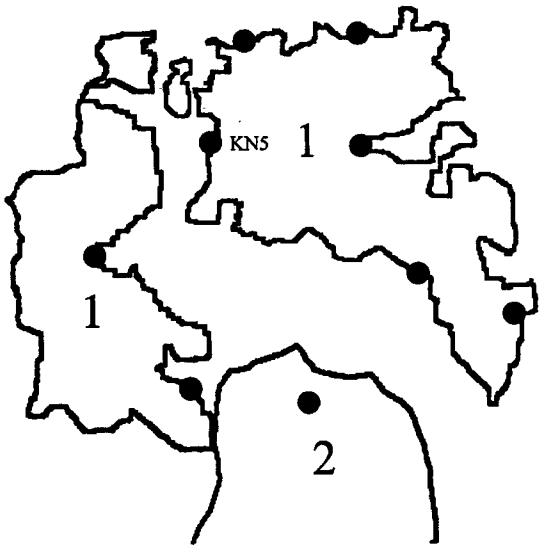

Fig. 38. Distribution of *Amomum aculeatum* Roxb.

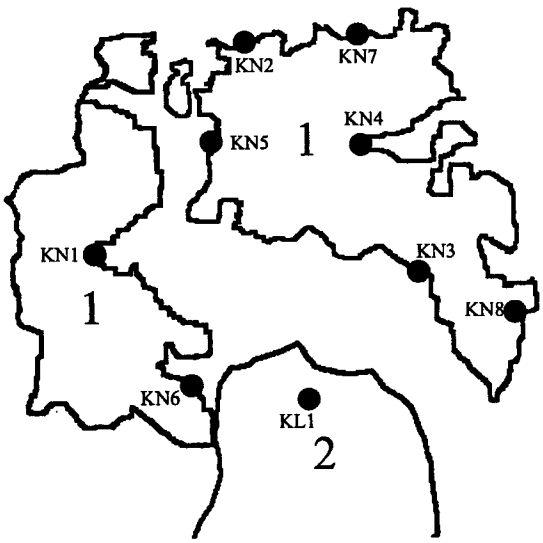

Fig. 39. Distribution of *Amomum biflorum* Jack

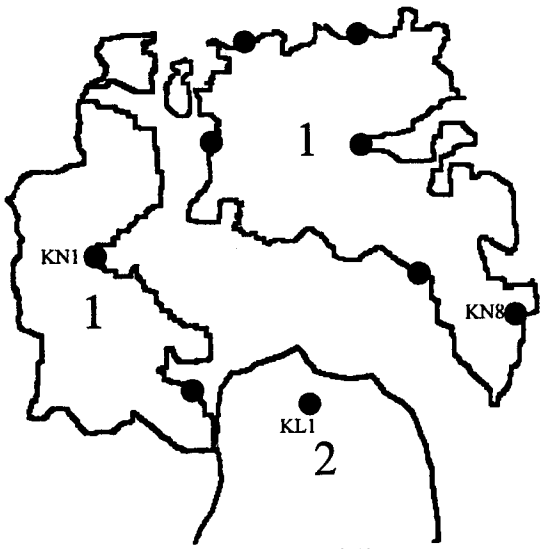

Fig. 40. Distribution of *Amomum hastilabium* Ridl.

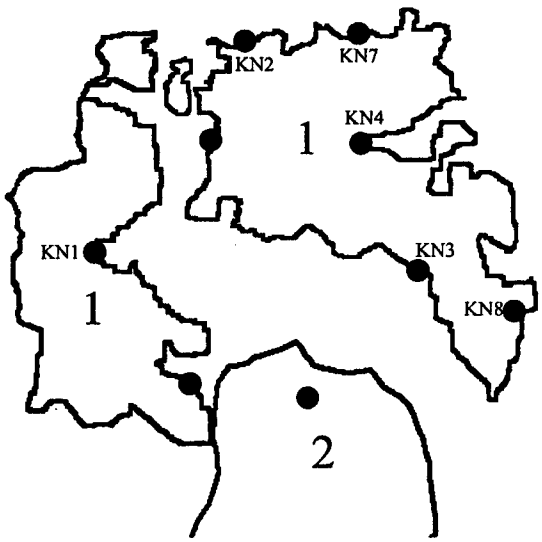

Fig. 41. Distribution of *Amomum uliginosum* König

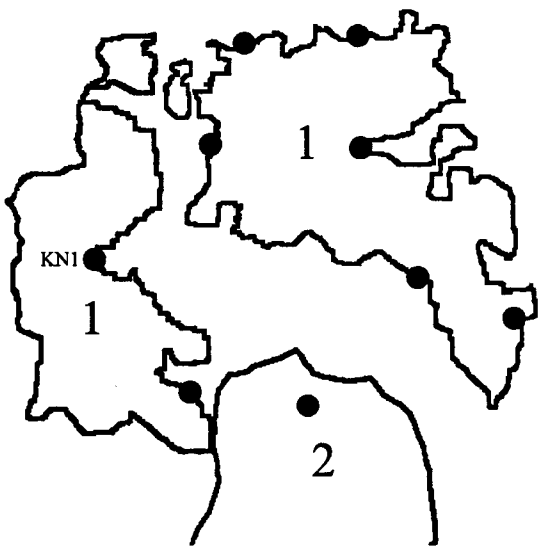

Fig. 42. Distribution of *Amomum* sp.

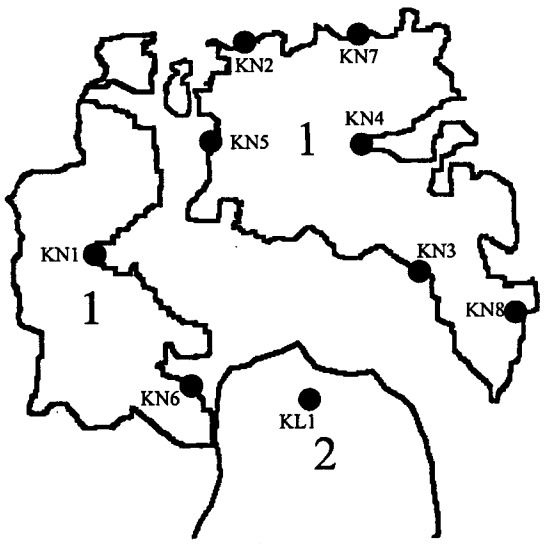

Fig. 43. Distribution of *Elettariopsis smithiae* Kam

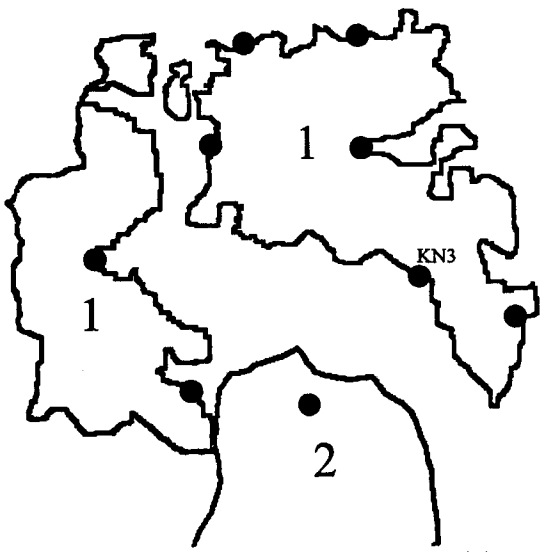

Fig. 44. Distribution of *Etlingera elatior* (Jack) R. M. Smith

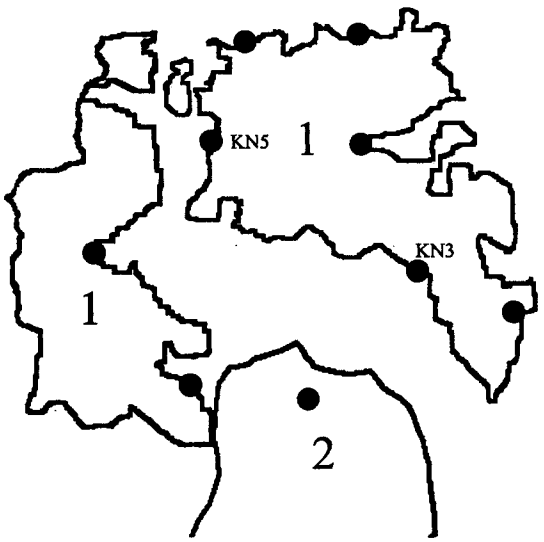

Fig. 45. Distribution of *Etlingera fulgens* (Ridl.) C. K. Lim

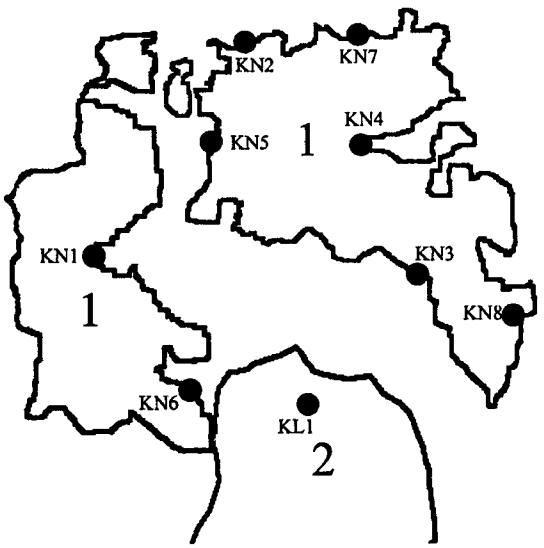

Fig. 46. Distribution of *Etlingera littoralis* (König) Giseke

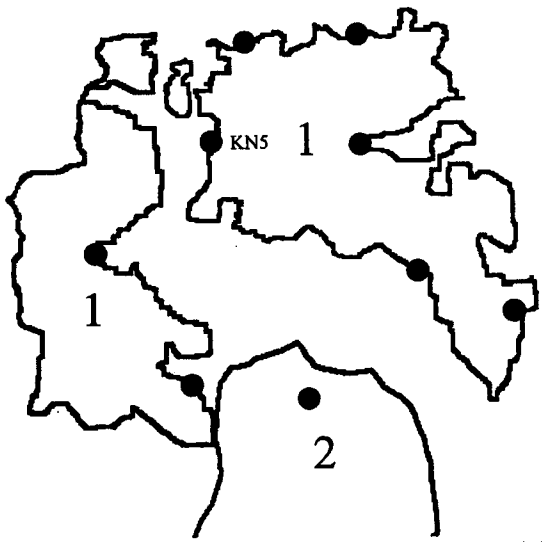

Fig. 47. Distribution of *Etlingera pauciflora* (Ridl.) R. M. Smith

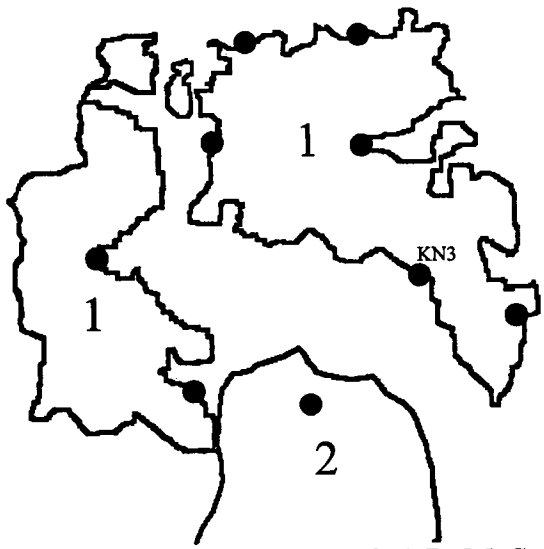

Fig. 48. Distribution of *Etlingera subterranea* (Holtt.) R. M. Smith

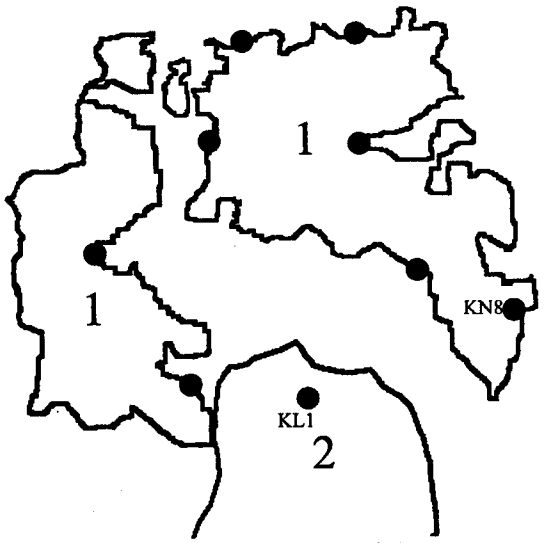

Fig. 49. Distribution of *Hornstedtia leonurus* (König) Retz.

Fig. 50. Distribution of *Globba pendula* Roxb.

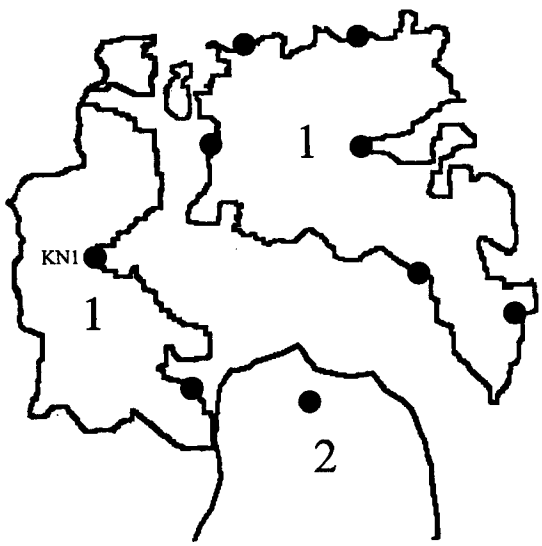

Fig. 51. Distribution of *Globba leucantha* Miq.

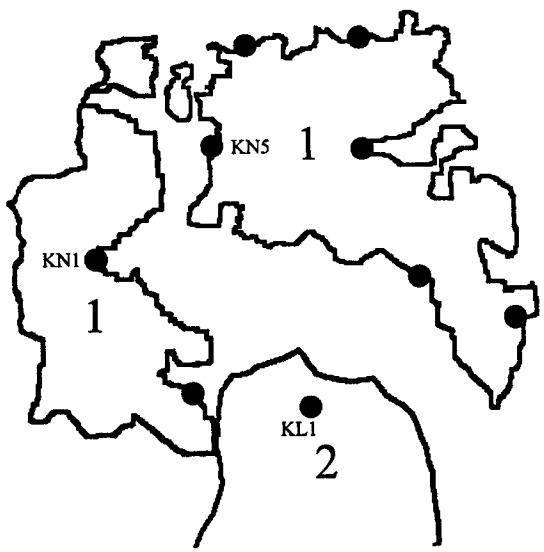

Fig. 52. Distribution of *Boesenbergia basispicata* K. Larsen ex Sirirugsa

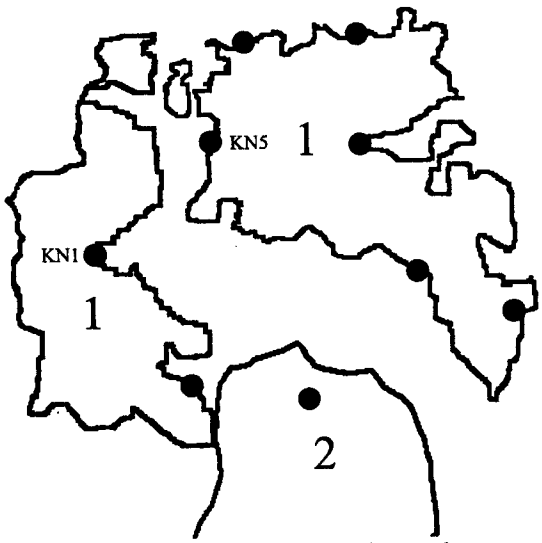

Fig. 53. Distribution of *Boesenbergia plicata* (Ridl.) Holtt.

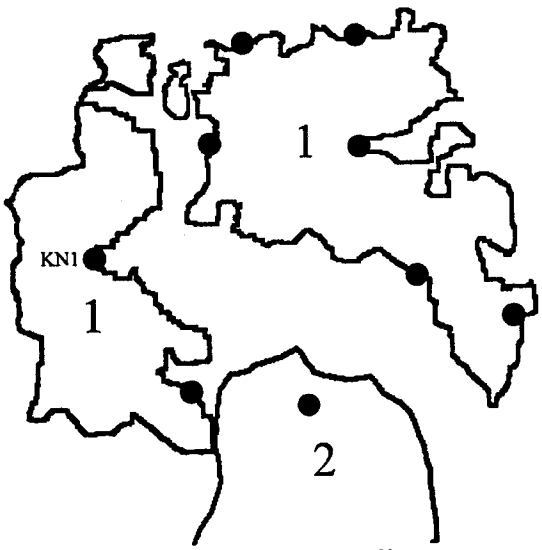

Fig. 54. Distribution of *Curcuma aurantiaca* van Zijp.

Fig. 55. Distribution of *Curcuma longa* L.

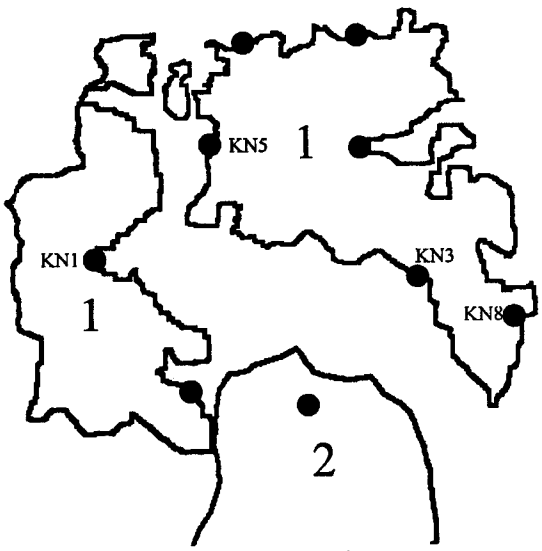

Fig. 56. Distribution of *Curcuma rubescens* Roxb.

Fig. 57. Distribution of *Curcuma zedoaria* Rosc.

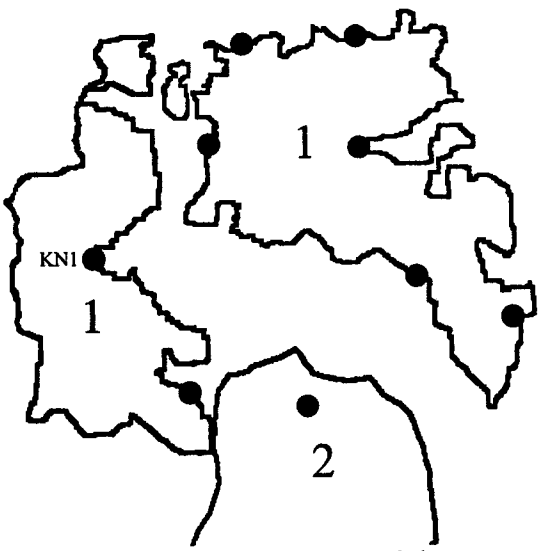

Fig. 58. Distribution of *Hedychium khaomaenense* Picheansoonthon & Mokkamul

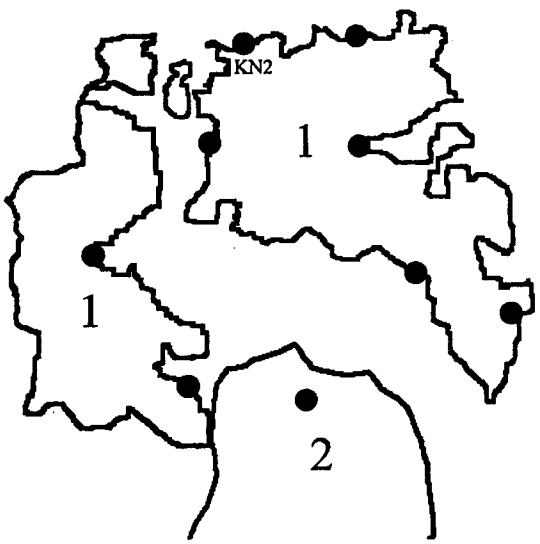

Fig. 59. Distribution of *Kaempferia pulchra* Ridl.

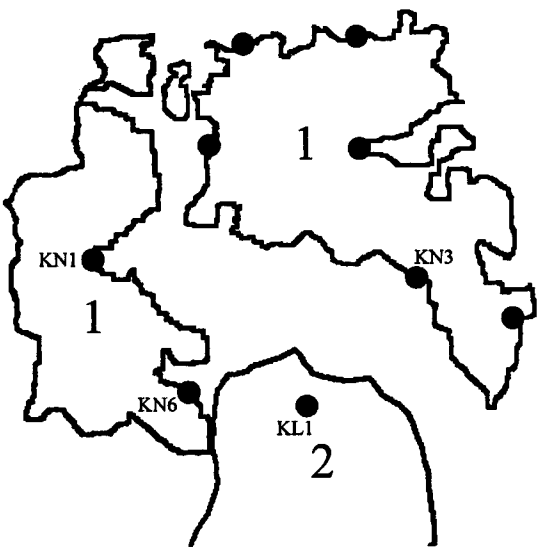

Fig. 60. Distribution of *Zingiber newmanii* I. Theilade & J. Mood

Fig. 61. Distribution of *Zingiber officinale* Rosc.

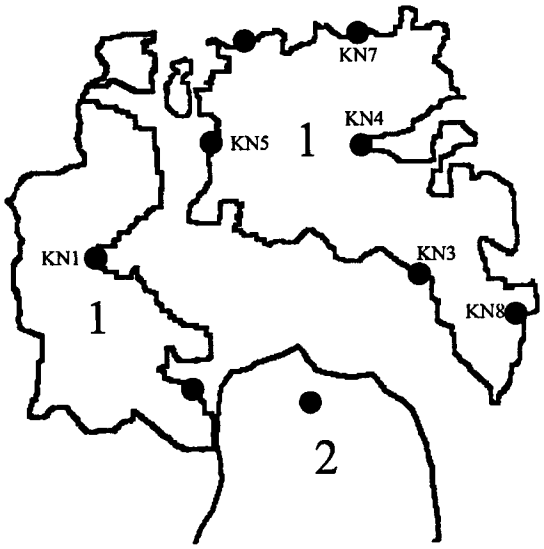

Fig. 62. Distribution of *Zingiber ottensii* Val.

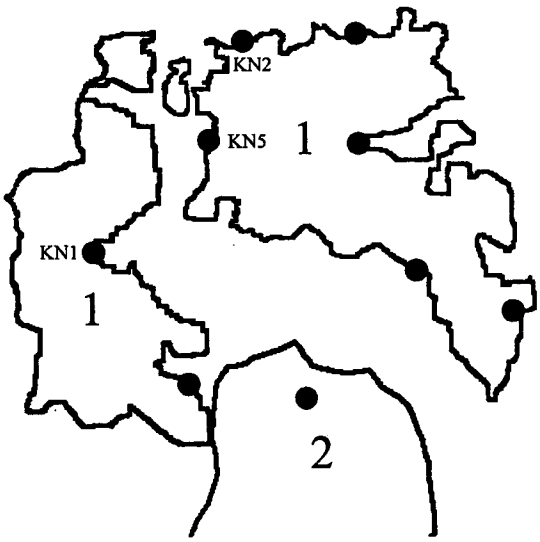

Fig. 63. Distribution of *Zingiber zerumbet* (L.) Smith

Table 3. Altitude, Ecological data and their uses of gingers found in this study

No	Scientific name	Altitude	Soil type	Forest type	Distribution	Uses
1	*Alpinia mutica*	90-350	Sandy Clay	TERF	Fig. 35	-
2	*Alpinia javanica*	240	Sandy Loam	TERF	Fig. 36	-
3	*Alpinia zerumbet*	160	Sandy Loam	TERF	Fig. 37	-
4	*Amomum aculeatum*	350	Loam	TERF	Fig. 38	-
5	*Amomum biflorum*	90-500	Sandy Clay	TERF	Fig. 39	Medicine, Food
6	*Amomum hastilabium*	90-200	Loamy Sand	TERF	Fig. 40	-
7	*Amomum uliginosum*	90-500	Loamy Sand	TERF	Fig. 41	-
8	*Amomum* sp.	350-500	Loamy Sand	TERF, LMRF	Fig. 42	-
9	*Elettariopsis curtisii*	90-800	Sandy Clay	TERF	Fig. 43	-
10	*Etlingera elatior*	280	Sandy Clay Loam	TERF	Fig. 44	Food, Ornament
11	*Etlingera fulgens*	200-300	Sandy Loam	TERF	Fig. 45	Food
12	*Etlingera littoralis*	90-200	Sandy Clay	TERF	Fig. 46	Medicine, Food
13	*Etlingera pauciflora*	240	Sandy Loam	TERF	Fig. 47	-
14	*Etlingera subterranea*	260-300	Sandy Loam	TERF	Fig. 48	-
15	*Hornstedtia leonurus*	90-200	Sandy Clay	TERF	Fig. 49	-

Table 3. (continued) Altitude, Ecological data and their uses of gingers found in this study

No	Scientific name	Altitude	Soil type	Forest type	Distribution	Uses
16	*Globba pendula*	90-200	Sand with humus	TERF	Fig. 50	-
17	*Globba leucantha*	500	Sand with humus	LMRF	Fig. 51	-
18	*Boesenbergia basispicata*	200-300	Sandy Clay Loam	TERF, LMRF	Fig. 52	Medicine
19	*Boesenbergia plicata*	240-1,000	Sandy Clay Loam	TERF, LMRF	Fig. 53	Medicine
20	*Curcuma aurantiaca*	200	Sandy Clay	TERF	Fig. 54	Ornament
21	*Curcuma longa*	100	Sandy Clay	TERF	Fig. 55	Cosmetics, Medicine, Food
22	*Curcuma rubescens*	90-300	Sandy Clay	TERF	Fig. 56	Ornament
23	*Curcuma zedoaria*	100	Sandy Clay	TERF	Fig. 57	Medicine
24	*Hedychium khaomaenense*	1200	-	UMRF	Fig. 58	-
25	*Kaempferia pulchra*	150-200	Sandy Loam	TERF	Fig. 59	Ornament
26	*Zingiber newmanii*	150-300	Sandy Clay Loam	TERF	Fig. 60	-
27	*Zingiber officinale*	100	Sandy Clay	TERF	Fig. 61	Medicine, Food
28	*Zingiber ottensii*	90-300	Sandy Clay	TERF	Fig. 62	Medicine
29	*Zingiber zerumbet*	90-200	Sandy Clay	TERF	Fig. 63	Medicine, Food

TERF: Tropical Evergreen Rain Forest or Tropical Rain Forest
LMRF: Lower Montane Rain Forest
UMRF: upper montane rain forest or cloud forest

Table 4. the number of species found in each station

Code	Name of station	Number of species	Species
KN1	Klong Klai (คลองกลาย)	15	*Amomum biflorum, A. hastilabium, A. uliginosum, A.* sp, *Elettariopsis curtisii, Etlingera littoralis, Globba leucantha, Boesenbergia basispicata, B. plicata, Curcuma aurantiaca, C. rubescens, Hedychium khaomaenense, Zingiber newmanii, Z. ottensii, Z. zerumbet*
KN2	Huay Kaew (ห้วยแก้ว)	7	*Alpinia zerumbet, Amomum biflorum, A. uliginosum, Elettariopsis curtisii, Etlingera littoralis, Kaempferia pulchra, Zingiber zerumbet*
KN3	Klong Kan (คลองกัน)	11	*Alpinia mutica, Amomum biflorum, A. uliginosum, Elettariopsis curtisii, Etlingera elatior, E. fulgens, E. Littoralis, E. subterranean, Curcuma rubescens, Zingiber newmanii, Z. ottensii*
KN4	Klong Tha Thon (คลองท่าทน)	6	*Alpinia mutica, Amomum biflorum, A. uliginosum, Elettariopsis curtisii, Etlingera littoralis, Zingiber ottensii*
KN5	Huay Lake (ห้วยเลข)	11	*Alpinia javanica, Amomum biflorum, Elettariopsis curtisii, Etlingera fulgens, E. Littoralis, E. pauciflora, Boesenbergia basispicata, B. plicata, Curcuma rubescens, Zingiber ottensii, Z. zerumbet*
KN6	Klong Lum Pan (คลองลำแพน)	4	*Amomum biflorum, Elettariopsis curtisii, Etlingera littoralis, Zingiber newmanii*
KN7	Klong Yod Num (คลองยอดน้ำ)	6	*Alpinia mutica, Amomum biflorum, A. uliginosum, Elettariopsis curtisii, Etlingera littoralis, Zingiber ottensii*
KN8	Sunanta Waterfall (น้ำตกสุนันทา)	13	*Alpinia mutica, Amomum biflorum, A. hastilabium, A. uliginosum, Elettariopsis curtisii, Etlingera littoralis, Hornstedtia leonurus, Globba pendula, Curcuma longa, C. rubescens, C. zedoaria, Zingiber officinale, Z. ottensii*
KL1	Krung Ching Waterfall (น้ำตกกรุงชิง)	7	*Amomum biflorum, A. hastilabium, Elettariopsis curtisii, Etlingera littoralis, Hornstedtia leonurus, Boesenbergia basispicata, Zingiber newmanii*

CURRICULUM VITAE

Name : Mr. Napat Kittipanangkul

Birth Date : February 17, 1981

Birth Place : Muang, Phatthalung

Educational Attainment :

Degree	Name of Institution	Year of Graduation
B.Sc. (Botany)	Chulalongkorn University	2002

Scholarship Awards during Enrolment :

Biodiversity Research and Training Program (BRT), grant no. BRT T_149002.

Walailak University Fund grant No. 04/2549