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RESEARCH & KNOWLEDGE

Research Article

Diversity and traditional uses of Zingiberaceae in Nakhon Phanom province, Thailand

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Abstract - The objective of this study was to determine the diversity, ecology, conservation status and traditional uses of three tribes, 12 genera and 57 species of Zingiberaceae that were identified during a botanical survey between January and December 2016 in Nakhon Phanom province, Thailand. *Curcuma*, *Globba* and *Zingiber* are the most diverse genera with nine each. *Alpinia* and *Kaempferia* are the second most diverse genera with eight species each. While the genera *Hedychium* and *Etlingera* are the least diverse with one species each. Scientific name, vernacular name, flowering and fruiting periods, ecological and distribution data, conservation status of each species and ecological and morphology-based key to the species are provided. Four species are reported as endemic to Thailand. Eighteen species are recorded as rare species. It was revealed that the traditional uses of Zingiberaceae species in Nakhon Phanom province were most frequency for medicine, food (including spices), ornamental plants and rituals. Rhizomes, roots, pseudostem, inflorescences, leaves and fruits are the parts of the plant used. This study is the first report from Nakhon Phanom province.

Keywords: Diversity, Zingiberaceae, traditional uses, Nakhon Phanom province

1. Introduction

Zingiberaceae (Ginger family) is an important source of natural products that are very beneficial to humans, such as food, spices, medicines, dyes, cosmetics and ornamental plants, such as ginger (*Zingiber officinale* Roxb.) and Patumma (*Curcuma alismatifolia* Gagnep.), etc.

The ginger family is a perennial plant that lives for many years. There are cells contain essential oils distributed in all parts of the plant, especially in the rhizomes. The ginger family has a unique smell, which is a prominent feature that can be used to identify the family. This family is found mainly in tropical and humid regions. It is estimated that about 52 species of 1,300 species in worldwide come from there. Distribution center is in Southeast Asia. It is a large family in monocotyledons. In Thailand, there are about 26 genera with 300 species (Larsen and Larsen, 2006). This study investigated the ginger family in Nakhon Phanom province, as the province has wide plant genetic diversity. The purpose of this study is to study the diversity, correct scientific name, distribution, ecology, conservation status and local uses of the ginger family in Nakhon Phanom province to produce a local biological database. Zingiberaceae was never been studied in this area.

2. Material and methods

Zingiberaceae specimens were collected from Nakhon Phanom province (Fig. 1), in the northeast of Thailand, monthly for one year from January 2016 to December 2016. (Fig. 1).

The specimens from many herbaria, including the Herbarium of theDepartment of National Parks, Wildlife and Plant Conservation (BKF), Bangkok Herbarium (BK), Queen Sirikit Botanical Gardens Herbarium (QBG) and Khon Kaen University Herbarium (KKU) were studied for correct species identification, ecological data, phenological data and notes on distinguishing characters.

The color of all the organs, ecological information and distribution data of each species were noted in the herbarium specimens. Specimens were collected 3–5 pieces per species and then dried in an oven at 60°C until completely dry. Flowers or other fragile organs of some species were preserved in 70% alcohol.The specimens were collected and deposited as reference specimens in the Mahasarakham University Herbarium, Thailand. The morphology - roots, rhizomes, pseudostems, leaves, inflorescences, flowers, fruit and seeds were described to verify the taxonomy under a stereo microscope.Identification was

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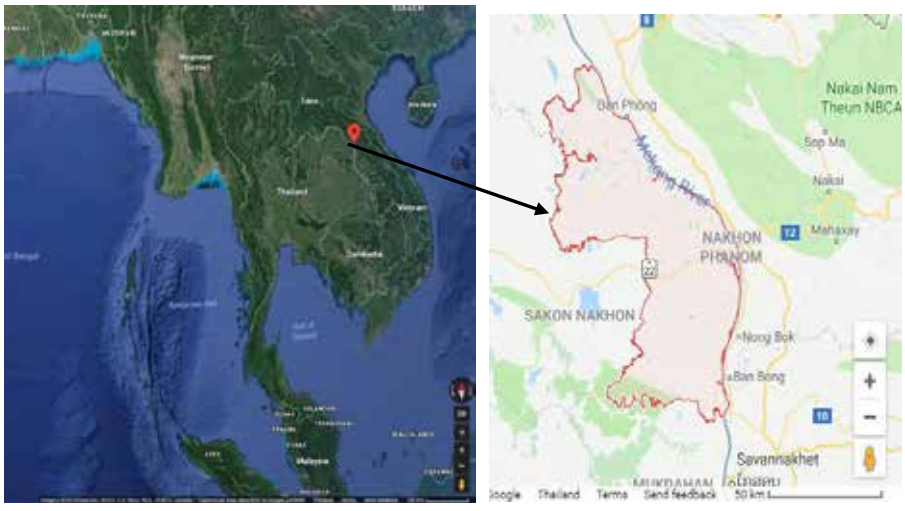
based on morphological data and on taxonomic references. Keys to species were constructed based on the morphology. Traditional uses data of the Zingiberaceae in Nakhon Phanom province was obtained through interviewing local villagers who were living in this province.

The conservation status of the plants was based on the evaluation criteria of the IUCN Red List (IUCN Red List of Threatened Species, 2016).



(A) (B)

Figure 1. General location (A) and detail (B) of NakhonPhanom province (https://www.google.co.th/maps/place/, 7 July 2017 (Nakhon Phanom province, 2017).

3. Results and discussion

3.1 Diversity of Zingiberaceae in Nakhon Phanom province

Three tribes, 12 genera and 57 species of Zingiberaceae were identified during the botanical survey and collection of specimens between January and December 2016 in Nakhon Phanom province, Thailand. Tribe Alpinieae contained four genera and 17 species, including *Alpinia* (eight species), *Amomum* (four species), *Elettariopsis* (four species) and *Etlingera* (one species). The smaller tribe, Globbeae, was comprised of two genera with 10 species, *Globba* (nine species) and *Gagnepainia* (one species). Tribe Zingibereae, the largest tribe, included six genera with 33 species – *Boesenbergia* (three species), *Curcuma* (nine species), *Hedychium* (one species), *Kaempferia* (eight species), *Stahlianthus* (three species) and *Zingiber* (nine species) (Table 1).

The key to tribes, genera and species of the Zingiberaceae in Nakhon Phanom province are constructed from the distinguishing characteristics of each species, such as rhizomes, organs of the pseudostem, inflorescence, bracteole, bract, fruitand the structure of the flowers (corolla, lateral staminodes, labellum, filament, anther-crest and ovary). This research agreed with the study of (Larsen and Larsen, 2006), Khamtang *et al*., 2014; Saensouk *et al*., 2016) in finding three tribes of Zingiberaceae in Thailand

3.1.1 Key to tribes of Zingiberaceae in Nakhon Phanom province

1.	Plane of distichy of leaves parallel to rhizome	2
1.	Plane of distichy of leaves transverse to rhizome	Alpinieae
2.	Appendages at anther	Globbeae
2.	No appendages on anther	Zingibereae

3.1.2 Key to genera of Zingiberaceae in Nakhon Phanom province

1.	Ovary unilocular with parietal placentation; filament long exerted	2
1.	Ovary 3-locular (very rarely unilocular) with central placentation; filament not long exerted	3
2.	No appendages on anther; flower greenish or whitish; labellum 3-lobed	*Gagnepainia*
2.	Appendaged at anther; flower yellow, orange or white; labellum 2-lobed	*Globba*
3.	Lateral staminodes reduced to small teeth at base of labellum or wanting, plane of distichy of leaves transverse to rhizome	4
3.	Lateral staminodes well developed, free from labellum, plane of distichy of leaves pararell to rhizome	7
4.	Inflorescence terminal on leafy shoot	*Alpinia*
4.	Inflorescence on separate shoot at base of leafy shoot	5

5. Labellum and filament connate into distinct tube above insertion of petals; anther crest absent	*Etlingera*
5. Labellum and filament not connate; anther usually crested	6
6. Bracteole tubular, inflorescence lax, leafy shoots, more than 1 m	*Amomum*
6. Bracteole not above, inflorescence dense, leafy shoots less than 1 m	*Elettariopsis*
7. Swollen petiole, anther-crest long, enclosing style forming horn-like structure	*Zingiber*
7. Not swollen petiole, anther-crest variously shaped, but not enclosing style forming horn-like structure	8
8. Anther-crest prominent	*Kaempferia*
8. Anther-crest inconspicuous or absent	9
9. Inflorescence surrounded by cup-shape involucral bracts with two slits	*Stahlianthus*
9. Inflorescence not above	10
10. Corolla tube long exerted; bract compact and indistinct	*Boesenbergia*
10. Corolla tube short not exerted; bract not compact and distinct	11
11. Inflorescence with coma bracts or without coma bract	*Curcuma*
11. Inflorescence without coma bract	*Hedychium*

3.1.3 Key to Zingiberaceae species in Nakhon Phanom province

Key to *Alpinia* species

1. Bract larger than flower	2
1. Bract smaller than flower	3
2. Leaf variegated green-white; bract variegated green-white	*A. vittata*
2. Leaf not variegated; bract red or pink	*A. purpurata*
3. Leaf margin denticulate	*A. mutica*
3. Leaf margin entire	4
4. Labellum yellow	5
4. Labellum white with red lines	6
5. Flower three on cincinnus	*A. zerumbet*
5. Flower seven on cincinnus	*A. macrostaminodia*
6. Bracteoles tubular	*A. siamensis*
6. Bracteoles not as above	7
7. Labellum with callus-like at base	*A. conchigera*
7. Labellum without callus-like at base	*A. galanga*

Key to *Amomum* species

1. Fruit smooth	
1. Fruit rough with soft spine	*A. villosum* var. *xantoides*
2. All parts glabresence; fruit many ridged	*A. repoense*
2. All parts pubescence; fruit not above	3
3. Leaf pubescence	*A. schmidtii*
3. Leaf glabrous	*A. uliginosum*

Key to *Elettariopsis* species

1. Leaf one	*E. monophylla*
1. Leaf more than one	2
2. Leaf two	*E. biphylla*
2. Leaf more than two	3
3. Bract reddish; leaf lower surface reddish	*E. wandokthong*
3. Bract green; leaf lower surface greenish	*E. triloba*

Key to *Globba* species

1. Bract absent	2
1. Bract present	3
2. Fruit spherical shape with rough	*G. pendula*
2. Fruit elliptic shape with smooth	*G. panicoides*
3. Inflorescence compact	4
3. Inflorescence not compact	6
4. Bract pink or dark pink	*G. globulifera*
4. Bract not as above	5
5. Bract white	*G. laeta*
5. Bract green	*G. marantina*
6. Cincinnus exerted from one bract	7

6. Cincinnus not exerted from more than one bract	*G. barthei*
7. Bract green	*G. schomburgii*
7. Bract white or pink	8
8. Bract white	*G. mogokensis*
8. Bract pink	*G. winitii*
Key to *Boesenbergia* species	
1. Pseudostem up to 6 cm tall	*B. parvula*
1. Pseudostem more than 15 cm tall	2
2. All part of pseudostem reddish	*B.* cf. *rotunda*
2. All part of pseudostem green	*B. rotunda*
Key to *Curcuma* species	
1. Inflorescence without coma bracts	*C. singularis*
1. Inflorescence with coma bract	2
2. Rhizome yellow	*C. longa*
2. Rhizome cream or white-cream	3
3. Flower yellow	4
3. Flower white with violet	6
4. Sheath and leaf sheath red or dark red	*C. rubescens*
4. Sheath and leaf sheath not as above	5
5. Rhizome branched; blade more than 7 cm wide	*C. comosa*
5. Rhizome unbranched; blade less than 6 cm wide	*C. angustifolia*
6. Coma bract shorter than bract	7
6. Coma bract longer than bract	8
7. Pseudostem up to 6 cm long; coma bract green	*C. gracillima*
7. Pseudostem 20-30 cm long; coma bract green	*C. parviflora*
8. Coma bract pink	*C. alismatifolia*
8. Coma bract white	*C. thorelii*
Key to *Kaempferia* species	
1. Inflorescence appears before leaves	*K. rotunda*
1. Inflorescence appears between the leaves	2
2. Inner rhizome purple	*K. parviflora*
2. Inner rhizome not as above	3
3. Leaf blade filiform shape	*K. filifolia*
4. Leaf blade broadly shape	5
5. Pseudostem erect from the ground	6
5. Pseudostem near the ground	7
6. Leaf variegated; all part of flower purple	*K. pulcha*
6. Leaf not variegated; only labellum purple	*K. angustifolia*
7. Leaf single	*K. siamensis*
7. Leaf two	8
8. Leaf margin purple	*K. marginata*
8. Leaf margin whitish	*K. galanga*
Key to *stahlianthus* species	
1. Pseudostem up to 3 cm tall	*S. campanulatus*
1. Pseudostem more than 7 cm tall	2
2. Bract green	*S. involucatus*
2. Bract reddish	*S. pedicelatus*
Key to *Zingiber* species	
1. Peduncle on separate shoot at base of leafy shoot, arising oblique with the ground	2
1. Peduncle on separate shoot at base of leafy shoot, arising vertical to ground	4
2. Apex inflorescence tip; labellum cream or pale purple	3
2. Apex inflorescence rounded; labellum pale yellow mixed red dots	*Z. mekongense*
3. Labellum pale purple	*Z. rubens*
3. Labellum cream	*Z. thorelii*
4. Bract brown-dark red	*Z. monatum*
4. Bract yellow, green or pale yellow when young and red when mature	5
5. Labellum red	6
5. Labellum yellow or cream	7
6. Bract yellow	*Z. chrysostachys*

6. Bract green	*Z. officinale*
7. Rhizime pale purple or pale blue	*Z. ottensii*
7. Rhizime cream	8
8. Apex inflorescence tip	*Z. junceum*
8. Apex inflorescence rounded	*Z. zerumbet*

3.2 Ecology

The ecology of the Zingiberaceae is reported in Table 1. The specimens were found in five ecology-types: deciduous dipterocarp forest (contained 19 species), mixed deciduous forest (contained 19 species), dry evergreen forest (contained 9 species), river or stream basin (only *Alpinia conchigera*) and cultivated (contained 22 species). The results showed that some species were found in more than one ecology-types (Table 1) which is according to the reports of (Larsen and Larsen, 2006), Khamtang *et al*., 2014) and Saensouk *et al*., 2016). *Elettariopsis biphylla* was found in new locality, differs from previously studied (Saensouk and Saensouk, 2014).

3.3 Phenology

The flowering period in this study was found during March to September, while and the fruiting period was recorded during June to October, according to Saensouk and Chantaranothai (2003), Khamtang *et al*. (2014) and Saensouk *et al*. (2016).

3.3.1 Flowering period (Table 1): The genus *Alpinia* can be separated into two flowering period, first period – three species began in March, while the second period – five species began in May. All species of genus *Amomum* began blooming in May, except *A.schmidtii* that bloomed in March. Most species of *Elettariopsis* began flowering in March except *E. wandokthong* (in January). *Etlingera elatior* started blooming in March. All *Globba* species began flowering in June. *Gagnepainia godefroyi* recorded blooming in March. Three species of *Boesenbergia* started flowering in June. *Curcuma* bloomed over two periods – two species began blooming in March and the other species began flowering in May. Moreover, the results showed that only *C. angustifolia* began flowering over two periods in March (inflorescences of specimens exerted from rhizome before the pseudostem) and June (inflorescences of specimens exerted from pseudostem). The popular cultivated plant, *Hedychium coronarium*, began blooming in June. *Kaempferia* found blooming in three periods – the first period began flowering in March, only *K. rotunda* (inflorescences exerted from rhizome before pseudostem), and the other species were found in the remaining two periods, in which the second period began blooming in May and the third period began blooming in June. All species of *Stahlianthus* started flowering in March. All *Zingiber* species began blooming in July. This research is similar to that of Saensouk and Chantaranothai (2003), Khamtang *et al*. (2014) and Saensouk *et al*. (2016).

3.3.2 Fruiting period (Table 1): The *Alpinia* began fruiting in two periods (June and August). Most of the *Amomum* species begin fruiting in June except *A. repoense* that had young fruit in August. Both genera, *Elettariopsis* and *Etlingera,* began fruiting in June. Fruit was not found in *Boesenbergia*, *Globba* and Stahlianthus. *Gagnepainia godefroyi* began fruiting in June. *Curcuma* species found two fruiting periods – the first period began fruiting in May and the second period began fruiting in August. *Hedychium coronarium* began fruiting in September. *Kaempferia* species had two fruiting periods – the first period began fruiting in March (only *K. rotunda*) and the second period began fruiting in June, but some species did not have fruit (Table 1). All *Zingiber* species began fruiting in August. This is in accordance to Saensouk and Chantaranothai (2003), Khamtang *et al*. (2014) and Saensouk *et al*. (2016).

Conservation status of Zingiberaceae in Nakhon-Phanom province Ten Zingiberaceae species were as indicated by the evaluation in the IUCN Red List (IUCN Red List of Threatened Species, 2016), and it included 10 species (Table 1) in total, as follows: least concern (eight species), data deficient (one species) and endangered (one species). Moreover, *Alpinia macrostaminodia*, *Curcuma gracillima*, *Elettariopsis biphylla*, *E. monophylla*, *Globba mogokensis*, *Kaempferia siamensis*, *K. filifolia* and *Stahlianthus pedicelatus* were recognized as rare species as well. Therefore, the rare plants in this study were 18 species. However, four species – *Elettariopsis biphylla*, *Kaempferia siamensis*, *K. filifolia* and *Stahlianthus pedicelatus* were recorded as endemic to Thailand.

3.5 Traditional uses of ginger family species in Nakhon-Phanom province

Zingiberaceous plants in Nakhon Phanom province had traditional uses as food, spices, medicines, rituals, cosmetics and ornamentation, which is consistant with study of Sirirugsa, (1998), Khamtang *et al*. (2014), Saensouk *et al*. (2016), Sirirugsa, (1998) and Chuakul and Boonpleng (2003).

Food (Table 1) – The main use of 24 Zingiberaceae species in Nakhon Phanom province was as food. Rhizomes, young inflorescences, young leaves, young pseudostems and roots were the parts of ginger plants used as food. The rhizomes of some famous plants (*Alpinia conchigera*, *A. galanga*, *A. siamensis*, *Boesenbergia rotunda* and *Zingiber officinale*) were used as food. The young inflorescences of *Curcuma angustifolia* and *C. singularis* were famous foods. The storage roots of *Boesenbergia rotunda* were a popular food. The young leaves of *Zingiber officinale* were usually food.

Medicines – Table 1 show that 42 species of zingiberaceous plants were used as medicines. Many parts (rhizomes, fruit, roots, leaves and young leaves) of ginger plants were used for medicines. The rhizomes of most species of Zingiberaceae were used as medicine, such as some species of *Alpinia* and all species of *Amomum*, *Boesenbergia*, *Elettariopsis*, *Etlingera*, *Gagnepainia*, *Kaempferia*, *Stahlianthus* and *Zingiber*. Moreover, the fruit

of most *Amomum* species and *Gagnepainia godefoyi* were used as medicine.

Spice – Rhizome of *Alpinia galanga*, *A. conchigera*, *A. macrostaminodia* and *A. siamensis* and storage roots of *Boesenbergia rotunda* were used as a spice.

Ornamentals – Twenty eight Zingiberaceae species were utilized as ornamental plants. Parts of Zinigiberaceae, namely the inflorescences, leaves and whole plants were used as ornamental plants (Table 1). The popular ornamentals were *Curcuma alismatifolia*, *Etlingera elatior*, *Kaempferia galanga* and *K. pulcha*.

Rituals plants – Three parts (inflorescences, rhizomes and whole plants) of 21 Zingiberaceae plants species were used as ritual plants especially *Elettariopsis wandokthong*.

Cosmetics – Only the rhizome of *Curcuma longa* was used as a cosmetic.

Table 1. Diversity, ecological data, phenological data, uses and conservation status of Zingiberaceae in Nakhon Phanom province.

Species	Phenology	Ecology	Conservation status (IUCN Red List)	Traditional uses					
				Food	Spice	Ornamentals	Cosmetics	Rituals	Medicines
Alpinia galanga (L.) Willd.	Fl: Jun-Sep Fr: Aug-Oct	DDF, MDF, Cult.		Rh, YPs, YIn	Rh				Rh
A. conchigera Griff.	Fl: May-Sep Fr: Aug-Oct	RB, Cult.		Rh, YPs, YIn	Rh				Rh
A. macrostaminodia Chaveer. &Sudmoon	Fl: Mar-Jun Fr: Jun-Oct	DDF		Rh, YPs, YIn	Rh				Rh
A. mutica Roxb.	Fl: Mar-Aug Fr: Jun-Oct	Cult.				WP		WP	
A. purpurata (Vieill.) K.Schum.	Fl:May Fr: Not seen	Cult.				In, WP			
A. siamensis K.Schum.	Fl: May-Sep Fr: Aug-Oct	Cult.		Rh, YPs, YIn	Rh				Rh
A. vittata W. Bull.	Fl: May-Sep Fr: Aug-Oct	Cult.				WP			
A. zerumbet (Pers.) B.L.Burtt & R.M.Sm.	Fl: Mar-May Fr: Jun-Oct	MDF		YIn					Rh
Amomum schmidtii (K.Schum.) Gagnep.	Fl: Mar-May Fr: Jun-Oct	DEF	LC					WP	Rh
A. repoense Pierre ex Gagnep.	Fl: May-Jul Fr: Aug-Sep	DEF	LC						Rh, F
A. uliginosum J.Koenig	Fl: May-Jun Fr: Jun-Oct	DEF	DD						Rh, F
A. villosum var. *xantoides* (Wall. ex Baker) T.L.Wu & S. J. Chen	Fl: May-Jun Fr: Jun-Oct	DEF	LC						Rh, F
Elettariopsis triloba (Gagnep.) Loes.	Fl: Mar-Apr Fr: Jun-Oct	MDF	LC						Rh, F
E. wandokthong Picheans. &Yuppa-rach	Fl: Jun-Apr Fr: Not seen	Cult.						WP	Rh
E. monophylla (Gagnep.) Loes.	Fl: Mar-Apr Fr: Jun-Oct	DEF		Yl					Rh

Table 1. Diversity, ecological data, phenological data, uses and conservation status of Zingiberaceae in Nakhon Phanom province. (Cont.)

Species	Phenology	Ecology	Conservation status (IUCN Red List)	Traditional uses					
				Food	Spice	Ornamentals	Cosmetics	Rituals	Medicines
E. biphylla Saensouk & Saensouk	Fl: Mar-Apr Fr: Jun-Oct	DEF		Yl					Rh
Etlingera elatior (Jack) R.M.Sm.	Fl: Mar-May Fr: Jun-Sep	Cult.		YIn		In			Rh
Globba barthei Gagnep.	Fl: Jun-Aug Fr: Not seen	MDF				WP, In		In	
G. globulifera Gagnep.	Fl: Jun-Jul Fr: Not seen	MDF				WP, In		In	
G. laeta K. Larsen	Fl: May-Aug Fr: Not seen	MDF	E			WP, In		In	
G. marantina L.	Fl: Jun-Jul Fr: Not seen	MDF				WP, In		In	
G. *mogokensis* W.Sm.&Banerji	Fl: Jun-Jul Fr: Not seen	DEF				WP, In		In	
G. panicoides Miq.	Fl: Jun-Jul Fr: Not seen	DEF				WP, In		In	
G. pendula Roxb.	Fl: Jun-Jul Fr: Not seen	DEF				WP, In		In	
G. schomburgii Hook.f.	Fl: Jun-Sep Fr: Not seen	Cult.				WP, In		In	
G. winitii C.H. Wright	Fl: Jun-Aug Fr: Not seen	DDF	LC			WP, In		In	
Gagnepainia godefroyi (Baill.) K.Schum	Fl: Mar-May Fr: Jun-Sep	MDF							Rh, F
Boesenbergia parvula (Wall. ex Baker) Kuntze	Fl: Jun-Jul Fr: Not seen	MDF							Rh
B. rotunda (L.) Mansf.	Fl: Jun-Jul Fr: Not seen	MDF, Cult.	LC	R h , R R					Rh, R
B. cf. *rotunda* (Roxb.) Schltr.	Fl: Jun-Jul Fr: Not seen	MDF, Cult.		R h , R					Rh, R
Curcuma angustifolia Roxb.	Fl: Mar-Jun / Jul-Sep Fr: May-Jul / Aug-Oct	DDF		YIn					Rh
C. alismatifolia Gagnep.	Fl: Jul-Aug Fr: Aug-Oct	DDF, Cult.	LC	YIn					Rh
C. comosa Roxb.	Fl: Mar-Aug Fr: May-Jul	DDF, Cult.							Rh
C. gracillima Gagnep.	Fl: Jul-Aug Fr: Aug-Oct	DDF							Rh
C. longa L.	Fl: Jun-Aug Fr: Aug-Oct	MDF, Cult.		YIn, Rh			Rh		Rh
C. parviflora Wall.	Fl: May-Aug Fr: Aug-Oct	DDF, MDF							
C. rubescens Roxb.	Fl: Jun-Aug Fr: Aug-Oct	Cult.							

Table 1. Diversity, ecological data, phenological data, uses and conservation status of Zingiberaceae in Nakhon Phanom province. (Cont.)

Species	Phenology	Ecology	Conservation status (IUCN Red List)	Traditional uses					
				Food	Spice	Ornamentals	Cosmetics	Rituals	Medicines
C. singularis Gagnep.	Fl: Mar-May Fr: May-Jun	DDF							
C. thorellii Gagnep.	Fl: Jun-Aug Fr: Aug-Oct	DDF							
Hedychium coronarium J. Koenig	Fl: Jun-Sep Fr: Sep-Oct	Cult.							
Kaempferia angustifolia Roscoe	Fl: Jun-Jul Fr: Not seen	DDF, Cult.				WP			Rh
K. filifolia Larsen	Fl: May-Jun Fr: Jun	DDF							Rh
K. galanga L.	Fl: Jun-Jul Fr: Jun-Aug	DDF				WP		WP	Rh, L
K. marginata Carey ex Roscoe	Fl: Jun-Aug Fr: Not seen	DDF		Yl					Rh, Yl
K. parviflora Wall. ex Baker	Fl: Jun-Aug Fr: Not seen	MDF, Cult.		Rh		WP		Rh	Rh
K. pulcha Ridl.	Fl: Jun-Aug Fr: Not seen	Cult.				WP, L		WP	Rh
K. rotunda L.	Fl: Mar-Apr Fr: Mar-May	DDF, MDF				WP		WP	Rh
K. siamensis P.Sirirugsa	Fl: May-Jun Fr: Jun	DDF		Yl		WP			Rh
Stahlianthus campanulatus Kuntze	Fl: Mar-May Fr: Not seen	DDF							Rh
S. involucatus (King ex Baker) Craib ex Loes.	Fl: Mar-May Fr: Not seen	DDF							Rh
S. pedicelatus A. Chaveerach & P. Mokkamul	Fl: Mar-May Fr: Not seen	DDF							Rh
Zingiber chrysos-tachys Ridl.	Fl: Jul-Sep Fr: Aug-Oct	MDF		YIn		WP			Rh
Z. junceum Gagnep.	Fl: Jul-Sep Fr: Aug-Oct	DDF	LC	YIn		WP			Rh
Z. mekongense Gagnep.	Fl: Jul-Sep Fr: Aug-Oct	MDF		YIn		WP			Rh
Z. montanum (J.Koenig) Link ex A.Dietr.	Fl: Jul-Sep Fr: Aug-Oct	Cult.		YIn		WP		Rh	Rh
Z. officinale Roscoe	Fl: Jul-Sep Fr: Aug-Oct	Cult.		YIn, L, Rh		WP		Rh	Rh
Z. ottensii Valeton	Fl: Jul-Sep Fr: Aug-Oct	Cult.		YIn		WP		Rh	Rh
*Z. rubens*Roxb.	Fl: Jul-Sep Fr: Aug-Oct	MDF				WP		Rh	Rh

Table 1. Diversity, ecological data, phenological data, uses and conservation status of Zingiberaceae in Nakhon Phanom province. (Cont.)

Species	Phenology	Ecology	Conservation status (IUCN Red List)	Traditional uses					
				Food	Spice	Ornamentals	Cosmetics	Rituals	Medicines
Z. thoreliiGagnep.	Fl: Jul-Sep Fr: Aug-Oct	DEF	LC	YIn		WP		Rh	Rh
Z. zerumbet (L.) Roscoe ex Sm.	Fl: Jul-Sep Fr: Aug-Oct	MDF, Cult.		YIn		WP		Rh	Rh

Remarks: DDF = deciduous dipterocarp forest, MDF = mixed deciduous forest, DEF = dry evergreen forest, RB = river basin, Cult. = cultivated, LC = least concern, DD = data deficient, E = endangered, Rh = rhizome, YPs = young pseudostem, YIn = young inflorescence, Yl = young leaf, WP = whole plant, L = leaf, R = root, In = inflorescence, F = fruit, Fl = flowering period, Fr = fruiting period

4. Conclusions

In this study, the Zingiberaceae in Nakhon Phanom province were recognized in three tribes, 12 genera and 57 species (Table 1). The most common genera were *Curcuma*, *Globba* and *Zingiber* (nine species each), followed by *Alpinia* and *Kaempferia* (eight species for each genera). The least common genera were *Gagnepainia*, *Hedychium* and *Etlingera* (one species for each genus). Keys to the tribes, genera and species were constructed from dominant characteristics of each species. The specimens were in deciduous dipterocarp forest, mixed deciduous forest, dry evergreen forest, river or stream basin and cultivated. The flowering period was during March to September and the fruiting period was during June to October. Ten species of Zingiberaceae (Table 1) had conservation statuses from the evaluation of the IUCN Red List (IUCN Red List of Threatened Species, 2016), which were least concern, data deficient and endangered. *Elettariopsis biphylla*, *Kaempferia siamensis*, *K. filifolia* and *Stahlianthus pedicelatus* were endemic to Thailand. Eighteen species were recognized as rare plants. Traditional uses of the Zingiberaceous plants in Nakhon Phanom province were as food, spices, medicines, rituals, cosmetic and ornamentation. The rhizomes, young pseudostems, young inflorescences, young leaves, whole plants, leaves, roots, inflorescences and fruit were the parts used in the traditional uses of the ginger plants in Nakhon Phanom province. This research is the first report of this information in Nakhon Phanom province.

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