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Zingiberaceae Diversity in Khao Nan and Khao Luang National Parks, Nakhon Si Thammarat, Thailand

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ABSTRACT

Zingiberaceae diversity in Khao Nan and Khao Luang National Parks was determined from September 2006 - August 2007. Twenty-nine species in 11 genera in 3 tribes of the family were collected from 9 stations, less than 30 % of the Zingiberaceae recorded in southern Thailand. Tribe Alpinieae, the highest diversity, comprises 5 genera and 15 species. Tribe Zingibereae, the second highest diversity, includes 5 genera and 12 species. The lowest diversity, tribe Globbeae consists of only 2 species in the genus *Globba*. The checklist, illustrations and distributions of the 29 species found are given. Most species of Zingiberaceae in this study grow in a Tropical Evergreen Rain Forest. Four species, *Amomum* sp.*, Globba leucantha, Boesenbergia basispicata* and *B. plicata* grow in the Lower Montane Rain Forest. Soils at the stations where most species are found are partly composed of sand. Only 1 species, *Amomum aculeatum* is found in a 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 at an altitude of 90 - 300 m and the number of species decrease as the 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* which is distributed around the Klong Klai Basin. At least 5 species, due to their bright distinctive flower parts, could be developed to be ornamental plants, i.e. *Alpinia mutica*, *A. zerumbet*, *Etlingera fulgens, Curcuma rubescens* and *Z. newmanii*, in addition to the well known ornamental species such as *E. elatior*, *C. aurantiaca* and *Kaempferia pulchra*. Eight species are edible, i.e. *Amomum biflorum, E. elatior, E. fulgens, E. littoralis, C. longa, C. zedoaria*, *Z. officinale* and *Z. zerumbet*. The seeds of 3 species, *Z. newmanii*, *E. fulgens* and *E. elatior* may prove to be important resources for medicinal essential oils because they produce a lot of seeds in natural conditions and their seeds are mainly composed of essential oils.

Keywords: Zingiberaceae, distribution, ecology, Khao Nan National Park, Khao Luang National Park

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. The most recent classification recognizes 4 subfamilies and 6 tribes: Siphonochiloideae (Siphonochileae), Tamijioideae (Tamijieae), Alpinioideae (Riedelieae, Alpinieae) and Zingiberoideae (Zingibereae, Globbeae) [1].

Thailand is one of the richest countries for Zingiberaceae in the world. At least 300 species in 26 genera in 4 tribes Riedelieae, Alpinieae, Zingibereae and Globbeae of Zingiberaceae are found throughout Thailand, however, the number of species will most certainly rise [2].

This research is a part of the Area-Based Research Project 'the Khao Nan Cloud Forest' supported by the Biodiversity Research and Training Program (BRT) [3]. The area is the most unexplored part of the Khao Luang Mountain Range, Southern Thailand. Zingiberaceae is a significant component 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 be fully exposed 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.

MATERIALS AND METHODS

1. Study site - 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 (**Figure 1**). There are 9 stations studied in the area, i.e. KN1-Klong Klai[1], KN2-Huay Kaew[2], KN3-Klong Kan[3], KN4-Klong Tha Thon[4], KN5-Huay Lake[5], KN6-Klong Lum Pan[6], KN7-Klong Yod Num[7], KN8-Sunanta Waterfall[8] and KL1-Krung Ching Waterfall[9].

2. Plant collection - The survey was conducted along 9 station main trails (**Figure 1**). All stations are secondary rainforest and close to streams, except the Yod Pansee trail at Klong Tha Thon station and the San Yen trail at Klong Klai station that are primary rainforest and cloud forest at the end of the trails.

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[1] คลองกลาย, [2]ห้วยแก้ว, [3]คลองกัน, [4]คลองท่าทน, [5]ห้วยเลข, [6]คลองลำแพน, [7]คลองยอดน้ำ, [8]น้ำตกสุนันทา และ [9]น้ำตกกรุงชิง

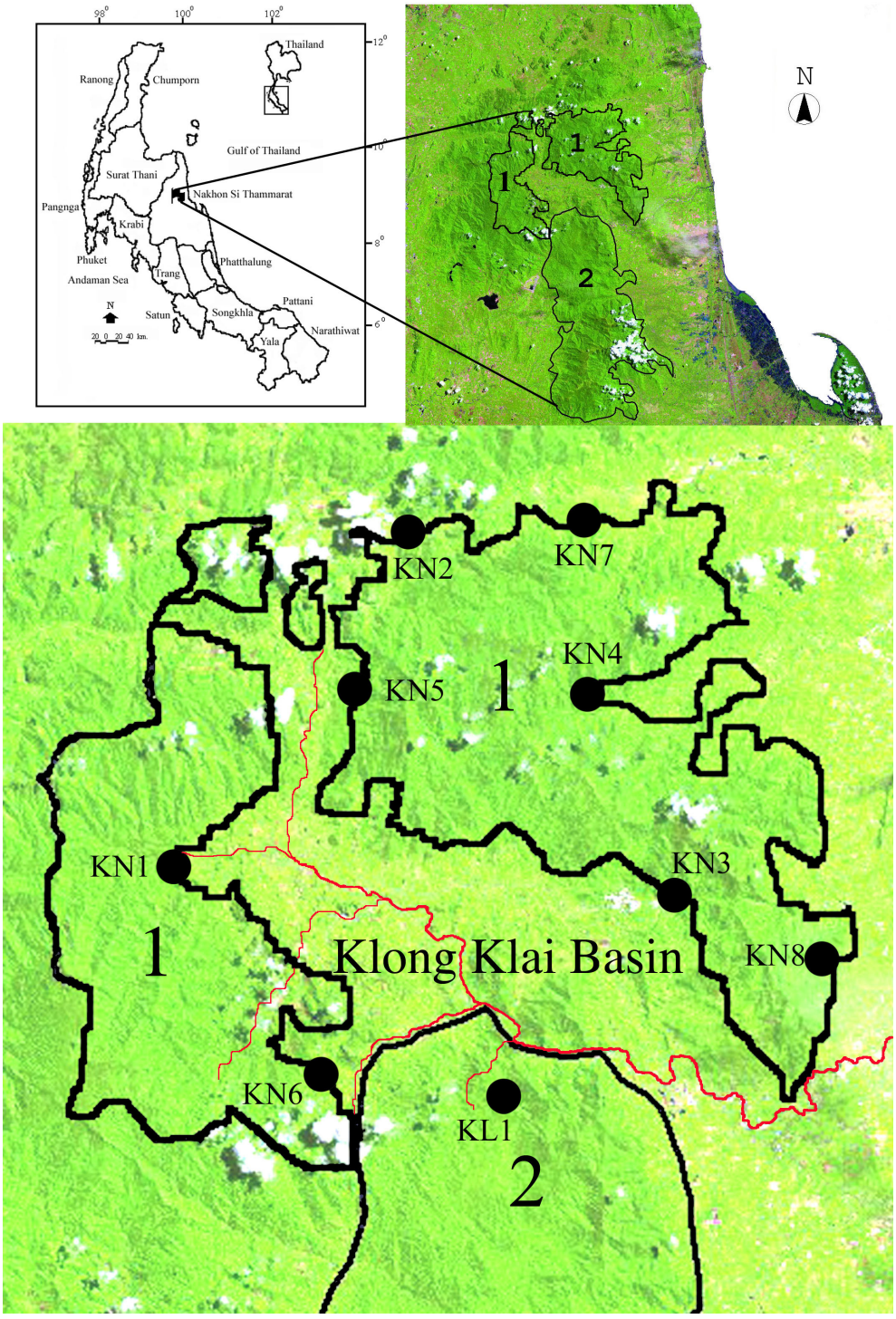

Figure 1 Maps of Khao Nan (1) and Khao Luang (2) National Parks, and all stations (represented by dots). The red line shows the canals in the Klong Klai Basin. Adapted from Google Earth 2006.

For each station investigated, plants were collected, documented and processed for herbarium specimens [4]. Details of descriptions, distributions and ecology of the plant species collected can be found in the work by Kittipanangkul [5]. Flowers and/or fruit were preserved in a liquid preservative (70 % Ethyl alcohol). Voucher specimens are deposited at the Walailak University Herbarium [5]. 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. Uses of the plants collected were from locals and park rangers, together with two references [6,7].

RESULTS

1. Zingiberaceae diversity - Twenty-nine species in 11 genera and 3 tribes of Zingiberaceae were collected from 9 stations (**Table 1**). Tribe Alpinieae, the highest diversity, comprises 5 genera and 15 species. Tribe Zingibereae, the second highest diversity, consists of 5 genera and 12 species. The least diverse, tribe Globbeae includes only 2 species in the genus *Globba*.

The illustrations of 29 species are provided (**Figure 2**). Ecological data, i.e. altitude, soil types [8], forest types [9] and uses are provided in **Table 1**.

2. Ecology and distribution - Khao Nan and the upper part of Khao Luang National Parks are Tropical Evergreen Rain Forest or Lower Montane Rain Forest, except the innermost parts of the Klong Klai and Klong Tha Thon trails which are Upper Montane Rain Forest or Cloud Forest at up to 1,000 m in altitude [9]. Most gingers in this study grow in Tropical Evergreen Rain Forest. Four species, *Amomum* sp., *Globba leucantha* Miq., *Boesenbergia basispicata* K. Larsen ex Sirirugsa and *Boesenbergia plicata* (Ridl.) Holtt., can also grow in Lower Montane Rain Forest (**Table 1**).

All study sites are rather wet with many canals and sharp slopes caused by erosion. Sand is spread throughout the forest. Soils where most gingers are found are partly or mainly composed of sand [8]. *Globba* species always grow in sand with humus within nooks of cliff at waterfalls (**Table 1**).

Three species, *Amomum biflorum* Jack, *Elettariopsis curtisii* Bak. and *Etlingera littoralis* (König) Giseke [10], are tolerant species that are found in disturbed areas at all stations. At least 15 species in this study are limited in distribution because they are found only at 1 station (**Table 1**). Two species, *Alpinia javanica* Blume and *Etlingera pauciflora* (Ridl.) R. M. Smith, are rare, only 1 population of each was found. *Curcuma longa* L., *C. zedoaria* Rosc. and *Zingiber officinale* Rosc. 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).

Figure 2 29 species of Zingiberaceae.
Line 1, left to right; *Alpinia mutica*, *Alpinia javanica*, *Alpinia zerumbet*, *Amomum aculeatum*, *Amomum biflorum*.
Line 2, left to right; *Amomum hastilabium*, *Amomum uliginosum*, *Amomum* sp., *Elettariopsis curtisii*, *Etlingera elatior*.
Line 3, left to right; *Etlingera fulgens*, *Etlingera littoralis*, *Etlingera pauciflora*, *Etlingera subterranea*, *Hornstedtia leonurus*.
Line 4, left to right; *Globba pendula*, *Globba leucantha*, *Boesenbergia basispicata*, *Boesenbergia plicata*, *Curcuma aurantiaca*.
Line 5, left to right; *Curcuma longa*, *Curcuma rubescens*, *Curcuma zedoaria*, *Hedychium khaomaenense*, *Kaempferia pulchra*.
Line 6, left to right; *Zingiber newmanii*, *Zingiber officinale*, *Zingiber ottensii*, *Zingiber zerumbet*.

Zingiber newmanii I. Theilade & J. Mood is found at the Klong Klai Basin, the area between Khao Nan and Khao Luang National Parks, though Sirirugsa and Maknoi [6] reported that it is an 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 (KN3, 4, 7, 8), or *Boesenbergia basispicata* and *B. plicata* were found along the West side only of the Klong Klai Basin (KN1, KN5, KL1).

DISCUSSION

In total, 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 [6] including subsequently new records, i.e. *Alpinia scabra* (Blume) Baker, *A. blepharocalyx* K. Schum [11], *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. [12] and new species, i.e. *Boesenbergia regalis* B. Kharuk. & S. Tohdam [13], *Alpinia peninsularis* Saensouk [11], *Caulokaempferia khaomaenensis* Picheansoonthon & Mokkamul [14], *Hedychium thaianum* Mokkamul & Picheansoonthon and *H. khaomaenense* Picheansoonthon & Mokkamul [15], 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. Interestingly, the study showed that this study site is the northernmost range of 5 species, i.e. *Alpinia javanica*, *Etlingera fulgens*, *Etlingera pauciflora*, *Etlingera subterranea* and *Hornstedtia leonurus* [6].

Zingiberaceae species are found in all stations (**Figure 1**). In particular, Klong Klai station (KN1) is the richest area of the family with 15 species. This study site is rather wet as it is surrounded by many canals and lots of sharp slopes. Many species are especially abundant along the riverbanks as well as in areas which are wet, moist and shaded as observed for Klong Klai (KN1), Sunanta Waterfall (KN8), Klong Kan (KN3), Huay Lake (KN5) and Krung Ching Waterfall (KL1) (**Figure 1**). There are few species found in the interior part of the forest and they are less abundant and sparsely distributed. This could due to, unlike KN1, there are fewer open gaps and the soil might not be suitable for Zingiberaceae species. The diversity of species is mostly distributed between 90 - 300 m and the number of species decrease when the altitude increases.

Three species, i.e. *Boesenbergia basispicata*, *Hedychium khaomaenense* and *Zingiber newmanii*, are endemic species to the Khao Luang Mountain Range, Southern Thailand [6,15]. From a previous study [6], *Alpinia zerumbet*, a common species of

southern China, is found in Thailand at Khao Sok, Surat Thani Province, but this study shows that it also occurs in Khao Luang Mountain Range, a new distribution area.

At least 6 species of Zingiberaceae of Khao Nan National Park (KN) are also present in the northern part of Khao Luang National Park (KL1), i.e. *Amomum hastilabium* Ridl., *Elettariopsis curtisii*, *Etlingera littoralis*, *Hornstedtia leonurus* (König) Retz., especially *Boesenbergia basispicata* are abundant at Klong Klai (KN1) and Huay Lake (KN5), and *Zingiber newmanii* are abundant at Klong Klai (KN1), Klong Kan (KN3) and Klong Lum Pan (KN6). This new distribution data obviously extends the former distribution range. Only KL1 of *Z. newmanii* was reported by Sirirugsa and Maknoi [6].

The numbers of species are highest at Klong Klai (15 species), while Klong Lum Pan (KN6) has only 4 species because it is a 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 noteworthy that most study sites (90 - 300 in altitude) are secondary forests that have bountiful treefall gaps. Some species can be indicators of disturbed forests such as *Amomum uliginosum* König, *Elettariopsis curtisii*, *Etlingera littoralis*, and *Z. ottensii* Val. They are present plentifully in low-altitude areas, implying that the areas around Khao Nan National Park are disturbed.

At least 5 species, due to their bright distinctive flower parts, *Alpinia mutica* Roxb., *A. zerumbet* (Pers.) Burtt & R. M. Smith, *E. fulgens* (Ridl.) C. K. Lim, *C. rubescens* Roxb. and *Z. newmanii* have a high potential to be developed into ornamental plants, in addition to the well known ornamental species such as *Etlingera elatior* (Jack) R. M. Smith, *Curcuma aurantiaca* van Zijp. and *Kaempferia pulchra* Ridl. Eight species are edible, *Amomum biflorum*, *E. elatior*, *E. fulgens*, *E. littoralis*, *C. longa*, *C. zedoaria*, *Z. officinale* and *Z. zerumbet* (L.) Smith.

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 [16,17] because they produce a lot of seeds in natural conditions and their seeds are mainly composed of essential oils.

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

Table 1 Species list of Zingiberaceae found in this study along with altitude, ecological data, distribution and their uses.

No.	Tribe	Scientific name	Thai name	Altitude (m)	Soil type	Forest type	Distribution	Uses
1	Alpinieae	*Alpinia javanica* Blume	ข่าชวา, ปุดหนู	240	Sandy Loam	TERF	KN5	-
2		*Alpinia mutica* Roxb.	ข่าน้ำ, ข่าลิง	90-350	Sandy Clay	TERF	KN3, 4, 7, 8	-
3		*Alpinia zerumbet* (Pers.) Burtt & R. M. Smith	ข่าปลี, ข่างาม	160	Sandy Loam	TERF	KN2	-
4		*Amomum aculeatum* Roxb.	เร่วช้าง	350	Loam	TERF	KN5	-
5		*Amomum biflorum* Jack	ว่านสาวหลง	90-500	Sandy Clay	TERF	KN1-8, KL1	Medicine, Food
6		*Amomum hastilabium* Ridl.	กระวานป่า	90-200	Loamy Sand	TERF	KN1, 8, KL1	-
7		*Amomum uliginosum* König	เร่ว	90-500	Loamy Sand	TERF	KN1, 2, 3, 4, 7, 8	-
8		*Amomum* sp.	กระวานเขานัน	350-500	Loamy Sand	TERF, LMRF	KN1	-
9		*Elettariopsis curtisii* Bak.	ปุดหางสิงห์	90-800	Sandy Clay	TERF	KN1-8, KL1	-
10		*Etlingera elatior* (Jack) R. M. Smith	ดาหลา	280	Sandy Clay Loam	TERF	KN3	Food, Ornament
11		*Etlingera fulgens* (Ridl.) C. K. Lim	ดาหลาปากนกแก้ว	200-300	Sandy Loam	TERF	KN3, 5	Food
12		*Etlingera littoralis* (König) Giseke	ปุดคางคก	90-200	Sandy Clay	TERF	KN1-8, KL1	Medicine, Food
13		*Etlingera pauciflora* (Ridl.) R. M. Smith	ปุดข้อนทอง	240	Sandy Loam	TERF	KN5	-
14		*Etlingera subterranea* (Holtt.) R. M. Smith	ปุดใบลาย	260-300	Sandy Loam	TERF	KN3	-
15		*Hornstedtia leonurus* (König) Retz.	ปุดเขย่งแดง	90-200	Sandy Clay	TERF	KN8, KL1	-
16	Globbeae	*Globba leucantha* Roxb.	หงส์เหินขาว	500	Sand with humus	LMRF	KN1	-
17		*Globba pendula* Miq.	หงส์เหิน	90-200	Sand with humus	TERF	KN8	-
18	Zingibereae	*Boesenbergia basispicata* K. Larsen ex Sirirugsa	กระชายเขาหลวง	200-300	Sandy Clay Loam	TERF, LMRF	KN1, 5, KL1	Medicine
19		*Boesenbergia plicata* (Ridl.) Holtt.	กระชายถิ่นใต้	240-1,000	Sandy Clay Loam	TERF, LMRF	KN1, 5	Medicine
20		*Curcuma aurantiaca* van Zijp.	เพชรทักษิณ	200	Sandy Clay	TERF	KN1	Ornament
21		*Curcuma longa* L.	ขมิ้น	100	Sandy Clay	TERF	KN8	Cosmetics, Medicine, Food
22		*Curcuma rubescens* Roxb.	กระเจียวแดง	90-300	Sandy Clay	TERF	KN1, 3, 5, 8	Ornament
23		*Curcuma zedoaria* Rosc.	ขมิ้นอ้อย	100	Sandy Clay	TERF	KN8	Cosmetics, Medicine, Food
24		*Hedychium khaomaenense* Picheansoonthon & Mokkamul	มหาหงส์เขาเหมน	1200	(Epiphyte)	UMRF	KN1	-
25		*Kaempferia pulchra* Ridl.	เปราะป่า	150-200	Sandy Loam	TERF	KN2	Ornament
26		*Zingiber newmanii* I. Theilade & J. Mood	ขิงเขาหลวง	150-300	Sandy Clay Loam	TERF	KN1, 3, 6, KL1	-
27		*Zingiber officinale* Rosc.	ขิง	100	Sandy Clay	TERF	KN8	Medicine, Food
28		*Zingiber ottensii* Val.	ไพล	90-300	Sandy Clay	TERF	KN1, 3, 4, 5, 7, 8	Medicine
29		*Zingiber zerumbet* (L.) Smith	กระทือ	90-200	Sandy Clay	TERF	KN1, 2, 5	Medicine, Food

TERF: Tropical Evergreen Rain Forest or Tropical Rain Forest, LMRF: Lower Montane Rain Forest, UMRF: Upper Montane Rain Forest or Cloud Forest

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บทคัดย่อ

ณภัทร กิตติพนังกุล และ ฉัตรชัย งามเรียบสกุล

ความหลากหลายของพืชวงศ์ขิงในเขตอุทยานแห่งชาติเขานัน และอุทยานแห่งชาติเขาหลวง จังหวัดนครศรีธรรมราช ประเทศไทย

การศึกษาความหลากหลายของพืชวงศ์ขิงในเขตอุทยานแห่งชาติเขานันและอุทยานแห่งชาติเขาหลวง ในช่วงเดือนกันยายน 2549 ถึงเดือนสิงหาคม 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 ได้จัดทำรายชื่อ การกระจายตัว และบันทึกภาพถ่าย ของพืชวงศ์ขิงทั้ง 29 ชนิดที่พบ พืชวงศ์ขิงที่ศึกษาส่วนใหญ่เติบโตในป่าดิบชื้น มีเพียง 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 นอกจากนี้พบว่ามีพืชวงศ์ขิงประมาณ 6 ชนิดจากเขตอุทยานแห่งชาติเขานันที่สามารถพบได้ทางด้านเหนือของอุทยานแห่งชาติเขาหลวง เช่น ขิงเขาหลวง (*Zingiber newmanii*) ที่กระจายตัวอยู่รอบต้นลำน้ำคลองกลาย จากการศึกษานี้ มีพืชวงศ์ขิงจำนวนอย่างน้อย 5 ชนิด มีลักษณะของช่อดอกที่สวยงามเด่นชัด สามารถพัฒนาเป็นไม้ดอกไม้ประดับได้ คือ *Alpinia mutica*, *A. zerumbet*, *Etlingera fulgens, Curcuma rubescens* และ *Z. newmanii* ทั้งนี้มี 3 ชนิดที่เป็นไม้ประดับอย่างแพร่หลายแล้วคือ *E. elatior, C. aurantiaca* และ *Kaempferia pulchra* พืชวงศ์ขิงจำนวน 8 ชนิดที่เป็นอาหาร คือ *Amomum biflorum, E. elatior, E. fulgens, E. littoralis, C. longa, C. zedoaria*, *Z. officinale* และ *Z. zerumbet* เมล็ดของพืชวงศ์ขิง 3 ชนิด คือ ขิงเขาหลวง (*Z. newmanii*) ดาหลาปากนกแก้ว (*E. fulgens*) และ ดาหลา (*E. elatior*) อาจสามารถนำมาสกัดสารสำคัญทางยาเพื่อใช้ในการรักษาโรคได้ เพราะสามารถพบเมล็ดที่เกิดตามธรรมชาติได้มาก และเมล็ดประกอบด้วยน้ำมันหอมระเหยเป็นหลัก

หน่วยวิจัยความหลากหลายทางชีวภาพ สำนักวิชาวิทยาศาสตร์ มหาวิทยาลัยวลัยลักษณ์ อำเภอท่าศาลา จังหวัดนครศรีธรรมราช 80161