

Diversity of Wild Gingers (Zingiberaceae) in Southern Peninsular Malaysia: Panti Forest Reserve and Labis Forest Reserve

Aimi Syazana Sedek¹, Salasiah Mohamad^{1*}, Nazrin Abd-Aziz^{2,3}, Mohd. Nadzreen Hidayat Sarjuni³, Nurul Hidayah Hadzuha⁴ and Ahmad Meisery Abd Hakim⁴

¹Department of Technology and Natural Resources, Faculty of Applied Sciences and Technology, Universiti Tun Hussein Onn Malaysia (Pagoh Campus), KM 1, Jalan Panchor, 84600 Pagoh, Johor, Malaysia

²Department of Biosciences, Faculty of Science, Universiti Teknologi Malaysia, 81310 Johor Bahru, Johor, Malaysia

³Innovation Centre in Agritechology for Advanced Bioprocessing, Universiti Teknologi Malaysia (Pagoh Campus), 84600 Pagoh, Johor, Malaysia

⁴Jabatan Perhutanan Negeri Johor, Tingkat 2, Bangunan Dato' Mohamad Ibrahim Munsyi Kota Iskandar, 79626 Nusajaya, Johor, Malaysia

ABSTRACT

Family Zingiberaceae is well distributed in Peninsular Malaysia, including the southern region of Johor. A preliminary survey updated the current checklist of wild gingers from Panti Forest Reserve and Labis Forest Reserve. During the brief survey, 28 taxa from 8 genera were recorded. The genera include *Amomum*, *Alpinia*, *Boesenbergia*, *Conamomum*, *Etilingera*, *Globba*, *Hornstedtia*, *Meistera*, *Scaphochlamys*, *Sundamomum*, and *Zingiber malaysianum*. Three endemic species to Johor were recorded from the study sites: *Scaphochlamys lanceolata*, *Scaphochlamys klossii* var. *glomerata*, and *Zingiber*.

Keywords: Conservation, endemic, Johor, threatened, Zingiberales

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E-mail addresses:

aimisyazana67@gmail.com (Aimi Syazana Sedek)

salasiah@uthm.edu.my (Salasiah Mohamad)

nazrin.abdaziz@utm.my (Nazrin Abd-Aziz)

hidayat@utm.my (Mohd. Nadzreen Hidayat Sarjuni)

nurul@forestry.gov.my (Nurul Hidayah Hadzuha)

meisery@forestry.gov.my (Ahmad Meisery Abd Hakim)

*Corresponding author

INTRODUCTION

Tropical Asia, as the richest zone for the family Zingiberaceae, harbours a total of 1,449 accepted species across 56 genera, of which 21% are currently classified as threatened (Banaticla-Hilario & Altamirano, 2023). As defined by biogeographic area, Southeast Asia, notably the Sundaland, comprising Peninsular Malaysia, Borneo, and Sumatra, is home to significant numbers of threatened species of wild ginger. With at

least 150 species from 21 genera, Malaysia recorded the largest number of threatened ginger taxa, followed by Indonesia (113 species; 24 genera), Thailand (30 species; 11 genera), and Vietnam (26 species; 8 genera) (Banaticla-Hilario & Altamirano, 2023). In terms of endemism, the highest number of endemic species are found in Malaysia and Indonesia, where there are 86 species and 66 genera, respectively. With 96 species across 20 genera, Borneo is the most diversified hotspot for vulnerable gingers at high risk of wild extinction. Borneo has 87 species and three endemic genera (*Epiamomum* A. D. Poulsen, *Myxochlamys* A. Takano and Nagam.). Likewise, Peninsular Malaysia is home to the hyperendemic and The International Union for Conservation of Nature (IUCN)-unevaluated genera, particularly *Kedhalia* C. K. Lim, *Perakalia* C. K. Lim, and *Johoralia* C. K. Lim.

Johor is situated at the southern tip of Peninsular Malaysia, with a total area of 19,984 km², making it the third largest state after Pahang and Perak. It has 334,292.46 ha of permanent forest reserves consisting of various forest types such as ericaceous forest, montane-oak forest, dipterocarp forest, and peat swamp forest that are rich in flora and fauna diversity (Jabatan Perhutanan Negeri Johor [JPNJ], 2021). Panti Forest Reserve is a dipterocarp forest within Bandar Kota Tinggi with many native flora species and a unique collection of avian diversity (Holttum, 1950; Normaisharah & Norazlimi, 2019). Meanwhile, Labis Forest Reserve is in the district of Segamat. It is known for playing a significant role as a buffer zone between national parks and oil

palm plantations and is directly connected to Endau–Rompin National Park (Aqilah et al., 2019).

Wild ginger is one of the important herbs in Malaysia. It is broadly utilised not only for medication and daily spices but also as an ornamental plant (Dissanayake et al., 2020; Kress et al., 2002; Lim, 2002). Being the largest family under order Zingiberales, this aromatic plant is widely distributed from southern to northern Peninsular Malaysia (Larsen et al., 1999; Plants of World Online [POWO], 2023). These rhizomatous herbs are commonly found in a wide range of habitats, such as lowland primary and secondary forests occurring in karsts, stream banks, plateau areas, ravines, as well as roadsides (Mohamad & Kalu, 2019; Setiawan et al., 2022). They prefer shady environments with low-intensity sunlight; nevertheless, some species flourish well in sunny areas (Larsen et al., 1999).

Holttum (1950) documented Zingiberaceae throughout Peninsular Malaysia based on Ridley's drawings, besides Corner's and Valetton's descriptions in his comprehensive account. Twenty-one genera with 156 species of Zingiberaceae in Peninsular Malaysia were documented by Holttum (1950); nevertheless, many of the taxa classifications need revision following the current classification based on molecular evidence (de Boer et al., 2018; Kress et al., 2002). Approximately 160 species of Zingiberaceae are dispersed in Peninsular Malaysia (Larsen et al., 1999), but information on the diversity of wild gingers in southern Peninsular Malaysia, especially Johor, is very limited. Thus, this

paper provides data on Zingiberaceae and their endemism in two forest reserves of Johor, namely Pantı Forest Reserve and Labis Forest Reserve.

MATERIALS AND METHODS

Study Sites

The study was conducted in two forest reserves in Johor, specifically Pantı Forest Reserve (13,150 ha) and Labis Forest Reserve (70,024 ha) (JPNJ, 2021). Pantı Forest Reserve is located in the southeast of Johor; meanwhile, Labis Forest Reserve is situated in the northern part of Segamat, Johor. The distance between these two forest reserves is approximately 143 km apart. Both forest reserve study sites were humid (consistent moisture and access to water) and partially to a fully shady environment. A few sites are near the waterfall and full of rocks. Sites with favourable conditions for wild gingers to grow were selected, such as along the stream banks, swampy areas, and lowland forests (200–500 m above sea level [a.s.l.]).

Zingiberaceae Sampling

A series of fieldwork was conducted from August 2022 to June 2023 to document and collect the fertile specimens of ginger at selected trails in the forest reserves. Each ginger locality was tagged with The Global Positioning System (GPS) coordinate. Each specimen was assigned a serial collection number, and duplicates received the same number. Photographs and field notes were taken accordingly.

Plant Description and Identification

Specimens were identified solely based on their morphological characteristics. All plant parts, including floral and vegetative, were examined and measured using a measuring tape and a calliper. In contrast, a USB digital microscope (1000×) (Model MX200-B, T TAKMLY, China) was used to observe their morphology in more detail. The specimens were identified using protologues, online databases, and related published materials (International Plant Names Index [IPNI], 2023; POWO, 2023). Samples were soaked in 70% ethanol (System Chemicals, Malaysia), pressed, and dried in an oven at 50°C for a week. The herbarium specimens were deposited at the herbarium of Universiti Tun Hussein Onn Malaysia. The conservation status of the collected Zingiberaceae was assessed based on the IUCN (2023).

RESULTS AND DISCUSSION

Diversity of Zingiberaceae

A total of 8 genera of Zingiberaceae comprising 28 taxa were found during our recent trip to Pantı Forest Reserve (Table 1) and Labis Forest Reserve (Table 2), which updated the current checklist of Zingiberaceae in Pantı Forest Reserve and Labis Forest Reserve to 24 taxa (21 species with 3 varieties) and 4 taxa (4 species with 1 variety) correspondingly (Table 3). At present, only three species, namely *Z. malaysianum*, *S. klossii* var. *glomerata*, and *S. lanceolata*, were found to be endemic to Johor (Holtum, 1950; IPNI, 2023; POWO, 2023).

Based on our observation, the distribution pattern of the species collected in both forest reserves overlaps between Sumatra and Thailand. The presence of overlapping species may be because of the impact on ecological conditions since they are under the same biogeographic region. Furthermore, soil nutrition, climate conditions, and elevation ranges contribute to the occurrence of these overlapping species (Ordoñez et al., 2009). Six wild gingers that overlap within the regions are as follows: *Alpinia conchigera*, *Globba leucantha*, *Globba pendula*, *Conamomum xanthophlebium*, *Etingera megalocheilos*, and *Hornstedtia scyphifera* (Tables 1 and 2). Furthermore, *Boesenbergia prainiana*

and *Globba fragilis* only occur in Peninsular Malaysia and Thailand. Meanwhile, two Zingiberaceae species, namely *A. conchigera* and *G. pendula*, are extensively distributed from Peninsular Malaysia, Bangladesh, and Myanmar to Vietnam (Holtum, 1950; Hanh et al., 2014; Phuong et al., 2020; IPNI, 2023; POWO, 2023) (Tables 1 and 2).

The genera *Globba* L. and *Scaphochlamys* Baker were found in four different trails of Panti Forest Reserve with three and two species, respectively, *G. leucantha*, *S. lanceolata*, and *S. klossii* var. *klossii* (Figures 1e, 1g, and 1h). They were abundantly seen during the fieldwork. The *S. lanceolata* is categorised as endangered and endemic to Peninsular Malaysia (particularly

Table 1
 List of wild gingers in Panti Forest Reserve

Panti Forest Reserve						
No.	Taxa	Localities	GPS coordinates	IUCN conservation status	Endemism	Occurrence
1	<i>Alpinia conchigera</i> Griff.	Roadside of Kg. Temenin near Lukut Trail	1°46'N 103°52'E	LC – Stable	-	Peninsular Malaysia, Andaman Island, Bangladesh, Cambodia, Myanmar, Philippines, Sumatera, Thailand, and Vietnam
2.	<i>Amomum</i> sp.	Sungai Segun	1°51'N 103°53'E	-	-	-
3.	<i>Boesenbergia prainiana</i> (King ex Baker) Schltr.	Bunker Trail (phenology plot)	1°51'N 103°53'E	LC – Decreasing	-	Peninsular Malaysia, Thailand, and Indochina
		Bunker Trail (D1)	1°51'N 103°53'E			

Table 1 (Continue)

No.	Taxa	Localities	Panti Forest Reserve		Endemism	Occurrence
			GPS coordinates	IUCN conservation status		
4.	<i>Conamomum xanthophlebium</i> (Baker) Škorničk. & A.D.Poulsen	Bunker Trail (D2)	1°52'N 103°55'E	NE	-	Peninsular Malaysia, Borneo, and Sumatra
5.	<i>Etilingera megalocheilos</i> (Griff.) A.D.Poulsen	Roadside towards Bunker Trail	1°51'N 103°53'E	LC – Unknown	-	Borneo, Jawa, Peninsular Malaysia, and Sumatera
6.	<i>Etilingera</i> aff. <i>pauciflora</i> R.M. Sm.	Roadside towards Bunker Trail	1°52'N 103°55'E	LC – Unknown	-	Indonesia, Thailand, and Malaysia
7.	<i>Hornstedtia scyphifera</i> (J.Koenig) Steud.	Roadside towards Muntahak Trail	1°45'N 103°51'E	NE	-	Borneo, Peninsular Malaysia, and Sumatera
		Roadside towards Bunker Trail	1°51'N 103°53'E			
8.	<i>Globba fragilis</i> S.N.Lim	Bunker Trail (phenology plot)	1°51'N 103°53'E	LC – Decreasing	-	Thailand and Peninsular Malaysia
		Sungai Segun	1°50'N 103°56'E			
9.	<i>Globba leucantha</i> Miq.	Roadside towards Lukut Trail	1°51'N 103°53'E	NE	-	Peninsular Malaysia, Thailand, and Sumatera
		Bunker Trail (phenology plot)	1°51'N 103°53'E			
		Lebak Trail	1°48'N 103°48'E			
		Bunker Trail (D2)	1°52'N 103°55'E			

Table 1 (Continue)

No.	Taxa	Localities	Panti Forest Reserve			
			GPS coordinates	IUCN conservation status	Endemism	Occurrence
10.	<i>Globba pendula</i> Roxb.	Bunker Trail (phenology plot)	1°51'N 103°53'E	LC – Stable	-	Peninsular Malaysia, Andaman Island, Assam, Bangladesh, Borneo, Myanmar, Sri Lanka, Sumatera, Thailand, and Vietnam
11.	<i>Globba</i> aff. <i>unifolia</i>	Lebak Trail	1°48'N 103°48'E	-	-	-
12.	<i>Scaphochlamys klossii</i> var. <i>klossii</i> (Ridl.) Holttum	Bunker Trail (phenology plot)	1°51'N 103°53'E	NE	Johor	Johor
		Lukut Trail	1°47'N 103°54'E			
		Lebak Trail	1°48'N 103°48'E			
		Batu Tenggek	1°31'N 103°53'E			
13.	<i>Scaphochlamys lanceolata</i> (Ridl.) Holttum	Lukut Trail	1°47'N 103°54'E	EN – Category B1 ab (iii) + 2ab (iii)	Panti Forest Reserve	Johor
		Bunker Trail	1°49'N 103°55'E			
		Sungai Padang	1°52'N 103°55'E			
14.	<i>Sundamomum hastilabium</i> (Ridl.) A.D. Poulsen & M.F. Newman	Sungai Segun	1°50'N 103°56'E	LC – Unknown	-	Peninsular Malaysia, Thailand, Indonesia, and Brunei

Note. GPS = The Global Positioning System; IUCN = The International Union for Conservation of Nature; - = None; LC = Least concern; NE = Not evaluated; EN = Endangered; D1 = Name of the trail; D2 = Name of the trail

Johor, in Pantı Forest Reserve [IUCN, 2023; IPNI, 2023; POWO, 2023]) (Table 1). Ten individuals per locality were recorded throughout the trip. Another interesting finding was *Sundamomum hastilabium* (formerly *Amomum hastilabium*) near Sungai Segun. It is the only species found in Peninsular Malaysia within the genus *Sundamomum*. Unfortunately, the absence of flowers and fruits of *Zingiber* and *Globba* aff. *unifolia* during sample collections poses a significant challenge in accurately describing these species. Another notable rare species under the order Zingiberales was *Phrynium villosulum* at Sungai Segun, which increased the number of species found for Marantaceae to three species in Pantı Forest Reserve (Holttum, 1950).

Scaphochlamys klossii var. *glomerata* thrived well at Sungai Bantang in Labis Forest Reserve, where the species was discovered in a shady environment. At first glance, *S. klossii* var. *glomerata* was identified as *Scaphochlamys endauensis* because of the channelled petiole and tomentose at the abaxial leaf, including the midrib (Figures 2a and 2b) (Sam et al., 2015). Nevertheless, *Scaphochlamys klossii* var. *glomerata* is quite different with its loosely elongated bract inflorescence compared to the red compact inflorescence of *S. endauensis*. Moreover, *S. klossii* var. *glomerata* has prominently veined leaves with sparse hairs on the adaxial surface, contrasted to *S. lanceolata*, which possesses glabrous leaves (Figures 2c and 2d). These conspicuous characteristics are further

corroborated in detail and verified by comparing them with herbarium specimens, which have fewer leaf blades with 1–2 compared to 2–6 blades in *S. klossii* var. *klossii*.

Commonly known as beehive ginger, *Zingiber spectabile* flourished in its habitat. So far, *Z. spectabile* has the largest inflorescence among Malayan species (Figures 3a and 3b) (Holttum, 1950). A large and spectacular inflorescence with exquisite yellow and purple flecks makes *Z. spectabile* easy to distinguish. Based on observation, the flowers of *Z. spectabile* in Taka Melor Eco Forest opened at about 11 in the morning. This plant reached 3 m in height compared to the species found in Thailand, which was only 2 m tall (Larsen & Larsen, 2006). The leafy shoots of *Z. spectabile* arch downward, a common feature in the *Zingiber* genus. This common, gigantic species is widely distributed in Peninsular Thailand, India, Australia, and Peninsular Malaysia (Holttum, 1950; IPNI, 2023; POWO, 2023) (Table 2). The IUCN categorises *Z. spectabile* as Data Deficient (DD) (IUCN, 2023). Another noticeable wild ginger was *Meistera* aff. *ochrea*. This species was spotted within the same area as *Z. spectabile*. The green thorny fruits of *Meistera* aff. *ochrea* were hidden under thick leaf litter.

Zingiber malaysianum was found at low slopes (300 m a.s.l.) at Sungai Bantang, where the environment was shady and humid (Figures 3f, 3g, and 3h). This species is considered least concerned with a stable

population trend in the IUCN (IUCN, 2023). According to Lim (2002), *Z. malaysianum* can easily be missed due to its dark reddish-brown leaf and small plant. This attractive plant was only found in a small, confined area at Sungai Bantang, with about two to ten individuals per locality. The distinct leaf features of *Z. malaysianum* enable species identification even without flowers and fruits. Some of the *Z. malaysianum* was damaged by the recent flood in Bekok, Johor. Based on our observation, *S. klossii* var. *glomerata* and other *Zingiber* sp. are sympatric with *Z. malaysianum*; they were found in sandy loam with leaf litter. *Zingiber* Mill. species that flourished well on rocks were also observed in Panti Forest Reserve and Labis Forest Reserve. Nonetheless, they could not be identified at the species level since no blooming flowers or fruits were present.

Current work on Zingiberaceae in the Panti Forest Reserve and Labis Forest Reserve in Johor Peninsular Malaysia has yielded some interesting findings and updates to the checklist of these plants. Discovering and documenting plant species in their natural habitats is important for conservation and biodiversity research. The initial checklist of Zingiberaceae in this forest reserve was based on Holttum's collection in 1950, which identified 16 taxa with 2 varieties. These included various species such as *Boesenbergia plicata*, *Conamomum parvula*, *Globba aurantiaca*, *Etingera pauciflora*, *Etingera metriocheilos*, *Amomum trilobum*, *Hornstedtia conica*,

Hornstedtia leonurus, *Plagiostachys albiflora*, *Scaphochlamys lanceolata*, *Scaphochlamys klossii*, *Scaphochlamys klossii* var. *glomerata*, *Scaphochlamys klossii* var. *minor*, *Zingiber puberulum*, *Zingiber puberulum* var. *chryseum*, and *Wurfbainia uliginosa* (Holttum, 1950). Nevertheless, only three species were rediscovered, which are *Etingera* aff. *pauciflora* encountered in Sungai Padang, besides the other two common species in Panti Forest Reserve, *S. lanceolata* and *S. klossii* var. *klossii*.

Additionally, *S. klossii* var. *glomerata* was found in Labis Forest Reserve rather than Panti Forest Reserve. This sighting suggests that the distribution of certain Zingiberaceae species extends to the northern part of Segamat, Johor, and beyond what was previously known. Another eight notable findings in Panti Forest Reserve are *Alpinia conchigera*, *Boesenbergia prainiana*, *Conamomum xantophlebium*, *Globba fragilis*, *Globba leucantha*, *Globba pendula*, *Globba* aff. *unifolia*, and *Sundamomum hastilabium* were added to the list. The only Zingiberaceae species in Labis Forest Reserve that Holttum revealed was *Boesenbergia clivalis*. The exploration in this forest reserve documented several findings, such as *Z. malaysianum*, *Z. spectabile*, and *Meistera* aff. *ochrea*. The encounters indicate the need for further research and investigation to understand better and conserve the biodiversity in these areas.

Table 2

List of wild gingers in Labis Forest Reserve

Labis Forest Reserve						
No.	Taxa	Localities	GPS coordinates	IUCN conservation status	Endemism	Occurrence
1.	<i>Meistera</i> aff. <i>ochrea</i>	Pavement towards the waterfall at Taka Melor Eco Forest	2°28'25"N 103°06'25"E	-	-	-
2.	<i>Scaphochlamys klossii</i> var. <i>glomerata</i>	Sg. Bantang	2°20'50"N 103°09'24"E	-	Johor	Johor
3.	<i>Zingiber malaysianum</i> C.K.Lim	Sg. Bantang	2°20'48"N 103°09'22"E	LC – Stable	Labis FR	Johor
4.	<i>Zingiber spectabile</i> Griff.	Pavement towards the waterfall at Taka Melor Eco Forest	2°21'06"N 103°09'23"E 2°28'25"N 103°06'25"E	DD	-	Malaysia, Thailand, India, and Australia
5.	<i>Zingiber</i> sp. 4	Sg. Bantang	2°20'51"N 103°09'24"E	-	-	-
6.	<i>Zingiber</i> sp. 5	Sg. Bantang	2°20'54"N 103°09'23"E	-	-	-

Note. - = None; LC = Least concern; DD = Data deficient; FR = Forest Reserve

Table 3

Checklist of Zingiberaceae collected by Holttum (1950) and current collections in Pantii Forest Reserve and Labis Forest Reserve

Species	Holttum (1950)		Current collections	
	Pantii FR	Labis FR	Pantii FR	Labis FR
<i>Alpinia conchigera</i> Griff. Synonym: <i>Languas conchigera</i> Griff.			/	
<i>Boesenbergia prainiana</i> (King ex Baker) Schltr. Synonym: <i>Gastrochilus prainianus</i> (King ex Baker) Ridl., <i>Kaempferia prainiana</i> King ex Baker			/	
<i>Boesenbergia clivalis</i> (Ridl.) Schltr. Synonym: <i>Gastrochilus clivalis</i> Ridl., <i>Kaempferia clivalis</i> (Ridl.) K.Schum.		/		

Table 3 (Continue)

Species	Holttum (1950)		Current collections	
	Panti FR	Labis FR	Panti FR	Labis FR
<i>Boesenbergia plicata</i> (Ridl.) Holttum Synonym: <i>Gastrochilus plicatus</i> Ridl.	/			
<i>Camptandra parvula</i> (King ex Baker) Ridl. Synonym: <i>Kaempferia parvula</i> King ex Baker	/			
<i>Conanomum xanthophlebium</i> (Baker) Škorničk. & A.D.Poulsen Synonym: <i>Amomum xanthophlebium</i> Baker			/	
<i>Globba aurantiaca</i> Miq.	/			
<i>Globba fragilis</i> S.N.Lim			/	
<i>Globba leucantha</i> Miq.			/	
<i>Globba pendula</i> Roxb. Synonym: <i>Ceratanthera pendula</i> (Roxb.) T.Lestib.			/	
<i>Globba</i> aff. <i>Unifolia</i>			/	
<i>Etlintera pauciflora</i> (Ridl.) R.M.Sm. Synonym: <i>Achasma pauciflorum</i>	/		/	
<i>Etlintera metriocheilos</i> (Griff.) R.M.Sm. Synonym: <i>Achasma metriocheilos</i> Griff., <i>Amomum metriocheilos</i> (Griff.) Baker	/			
<i>Amomum trilobum</i> Gagnep. Synonym: <i>Elettariopsis triloba</i> (Gagnep.) Loes.	/			
<i>Hornstedtia conica</i> Ridl.	/			
<i>Hornstedtia leonurus</i> (J.Koenig) Retz. Synonym: <i>Amomum leonurus</i> J.Koenig, <i>Cardamomum leonurus</i> (J.Koenig) Kuntze	/			
<i>Meistera</i> aff. <i>Ochrea</i>				/
<i>Plagiostachys albiflora</i> Ridl.	/			
<i>Scaphochlamys lanceolata</i> (Ridl.) Holttum Synonym: <i>Gastrochilus lanceolatus</i> Ridl.	/		/	
<i>Scaphochlamys klossii</i> var. <i>klossii</i> (Ridl.) Holttum Synonym: <i>Boesenbergia klossii</i> (Ridl.) Loes.	/		/	
<i>Scaphochlamys klossii</i> var. <i>glomerata</i> Holttum	/			/
<i>Scaphochlamys klossii</i> var. <i>minor</i> Holttum	/			
<i>Sundamomum hastilabium</i> (Ridl.) A.D.Poulsen & M.F.Newman Synonym: <i>Amomum hastilabium</i> Ridl.			/	
<i>Zingiber malaysianum</i> C.K.Lim				/
<i>Zingiber puberulum</i> Ridl.	/			

Table 3 (Continue)

Species	Holttum (1950)		Current collections	
	Panti FR	Labis FR	Panti FR	Labis FR
<i>Zingiber puberulum</i> var. <i>chryseum</i> (Ridl.) Holttum Synonym: <i>Zingiber chryseum</i> Ridl.	/			
<i>Zingiber spectabile</i> Griff.				/
<i>Wurfbainia uliginosa</i> (J.Koenig) Giseke Synonym: <i>Amomum uliginosum</i> J.Koenig	/			

Symbol: / = Available species in that forest; FR = Forest Reserve

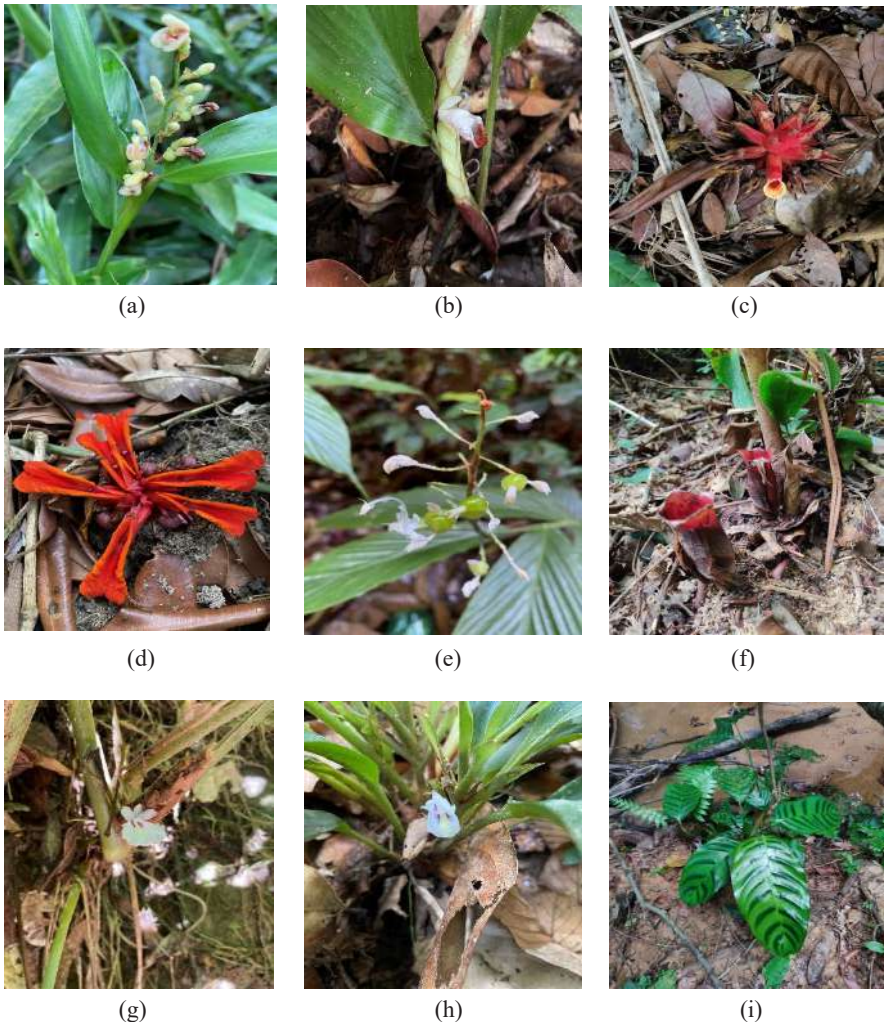


Figure 1. Selected Zingiberaceae species and notable *Phrynium* (family Marantaceae) in their habitat in Pantii Forest Reserve. (a) *Alpina conchigera*, (b) *Boesenbergia prainiana*, (c) *Conamomum xanthophlebium*, (d) *Etlingera megalochelios*, (e) *Globba leucantha*, (f) *Hornstedtia scyphifera*, (g) *Scaphochlamys klossii* var. *klossii*, (h) *Scaphochlamys lanceolata*, and (i) *Phrynium villosulum*

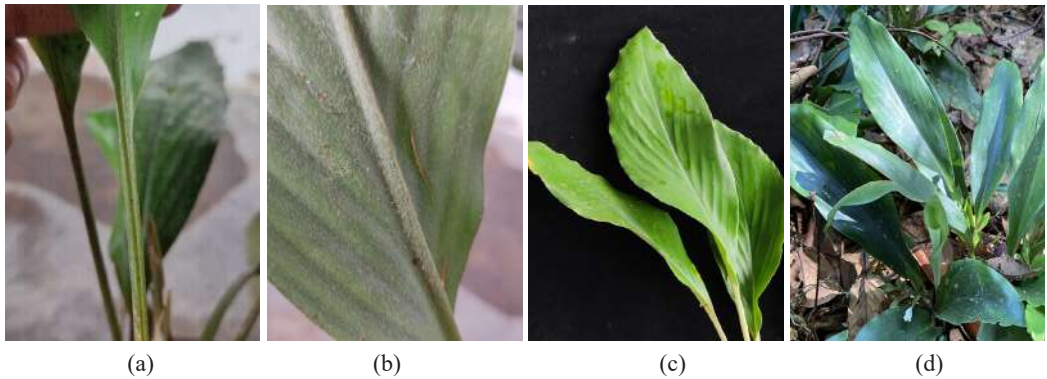


Figure 2. Notable characteristics for *Scaphochlamys klossii* var. *glomerata* and *Scaphochlamys lanceolata*. (a) Channelled petiole of *S. klossii* var. *glomerata*, (b) Tomentose at the abaxial of the leaves of *S. klossii* var. *glomerata*, (c) Prominent veined of *S. klossii* var. *glomerata*, and (d) Glabrous leaves of *S. lanceolata*



Figure 3. Zingiberaceae in Labis Forest Reserve. (a–c) *Zingiber spectabile* (left to right) inflorescence, flower, habitat, (d–e) *Scaphochlamys klossii* var. *glomerata*, (f–h) *Zingiber malaysianum*, and (i) Fruit of *Meistera* aff. *ochrea*

CONCLUSION

The southern region of Peninsular Malaysia is very rich in wild ginger such *S. lanceolata*, *S. klossii* var. *glomerata*, and *Z. malaysianum*. The present study updated the wild ginger checklist for Pantı Forest Reserve and Labis Forest Reserve. This valuable information aids in the conservation efforts of Zingiberaceae species to preserve the planet's biodiversity. In the future, systematic study, phytochemical profiling, and tissue culture will be conducted on selected potential Zingiberaceae species.

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REFERENCES

- Aqilah, A. A. R., Maryati, M., & Syahrir-Azrin, M. S. (2019). Diversity and species composition of butterflies (Lepidoptera: Papilionoidea) in Taka Melor Amenity Forest, Labis Forest Reserve, Segamat, Johor, Malaysia. *Serangga*, 24(2), 72-80.
- Banaticla-Hilario, M. C. N., & Altamirano, M. R. B. (2023). Conservation of IUCN threatened Zingiberaceae species in tropical Asia: Challenges, gaps, and opportunities. In S. Ramamoorthy, I. E. Buot Jr., & C. Rajasekaran. (Eds.), *Plant diversity in biocultural landscapes* (pp. 673-724). Springer. https://doi.org/10.1007/978-981-19-8649-9_30
- de Boer, H., Newman, M., Poulsen, A. D., Droop, A. J., Fér, T., Hièn, L. T. T., Hlavatá, K., Lamxay, V., Richardson, J. E., Steffen, K., & Leong-Škorničková, J. (2018). Convergent morphology in Alpinieae (Zingiberaceae): Recircumscribing *Amomum* as a monophyletic genus. *Taxon*, 67(1), 6-36. <https://doi.org/10.12705/671.2>
- Dissanayake, K. G. C., Liyanage, W. A., Waliwita, C., & Liyanage, R. P. (2020). A review on medicinal uses of *Zingiber officinale* (Ginger). *International Journal of Health Sciences and Research*, 10(6), 142-148.
- Hanh, N. P., Binh, N. Q., & Adhikari, B. S. (2014). Distribution of *Alpinia* (Zingiberaceae) and their use pattern in Vietnam. *Journal of Biodiversity and Endangered Species*, 2(2), 1-5.
- Holtum, R. E. (1950). The Zingiberaceae of the Malay Peninsula. *Gardens' Bulletin Singapore*, 13(4), 1-249.
- International Plant Names Index. (2023). *Welcome to the International Plant Names Index (IPNI)*. IPNI. <http://www.ipni.org/>
- International Union for Conservation of Nature. (2023). *The IUCN Red List of Threatened Species™*. IUCN. <https://www.iucnredlist.org>
- Jabatan Perhutanan Negeri Johor. (2021). *Sumber hutan: Jenis-jenis hutan* [Forest sources: Types of forests]. JPNJ. <https://forestry.johor.gov.my/perhutanan/sumber/jenis-jenis-hutan>
- Kress, W. J., Prince, L. M., & Williams, K. J. (2002). The phylogeny and a new classification of the gingers (Zingiberaceae): Evidence from molecular data. *American Journal of Botany*, 89(11), 1682-1696.
- Larsen, K., & Larsen, S. S. (2006). *Gingers of Thailand*. Queen Sirikit Botanical Garden.
- Larsen, K., Ibrahim, H., Khaw, S. H., & Saw, L. G. (1999). *Gingers of Peninsular Malaysia and Singapore*. Natural History Publications (Borneo).

- Lim, C. K. (2002). A new endemic species of *Zingiber Boehm.* from Johor, Malaysia. *Folia Malaysiana*, 3, 25-30.
- Mohamad, S., & Kalu, M. (2019). Assessment of Zingiberaceae (Tribe Alpinieae) from North East Sarawak, Malaysia. In *IOP Conference Series: Earth and Environmental Science* (Vol. 269, No. 1, p. 012032). IOP Publishing. <https://doi.org/10.1088/1755-1315/269/1/012032>
- Normaisharah, M., & Norazlimi, N. (2019). Review on avian diversity in Johor state, Malaysia. In *IOP Conference Series: Earth and Environmental Science* (Vol. 269, No. 1, p. 012038). IOP Publishing. <https://doi.org/10.1088/1755-1315/269/1/012038>
- Ordoñez, J. C., Van Bodegom, P. M., Witte, J.-P. M., Wright, I. J., Reich, P. B., & Aerts, R. (2009). A global study of relationships between leaf traits, climate and soil measures of nutrient fertility. *Global Ecology and Biogeography*, 18(2), 137-149. <https://doi.org/10.1111/j.1466-8238.2008.00441.x>
- Plants of World Online. (2023). *Welcome to Plants of the World Online*. POWO. <https://powo.science.kew.org/>
- Phuong, N. T., Thanh, D. T., Huyen., Hoa, B. T. H., Hung, L. N., & Ha, L. M. (2020). A New Polyoxygenated Cyclohexene From the Rhizomes of *Globba pendula* Roxb. *Natural Product Communication*, 15(4), 1-4.
- Sam, Y. Y., Ibrahim, H., Saw, L. G. (2015). Four new species of *Scaphochlamys* (Zingiberaceae) from Peninsular Malaysia. *Phytotaxa*, 221(1), 021–034.
- Setiawan, E., Ardiyani, M., Miftahudin, M., Poulsen, A. D., & Chikmawati, T. (2022). The diversity and distribution of *Alpinia zerumbet* clade in West Malesia. *Journal of Biological Diversity*, 23(4), 1734-1744. <https://doi.org/10.13057/biodiv/d230403>