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CHAPTER 10

Gingers of Malaysia: Their taxonomy and conservation

MEEKIONG, K.[1]*, SALASIAH MOHAMAD[2],
AIMI SYAZANA SEDEK[2] and NURUL KHALEEDA RIDZUAN[1]

Abstract: Malaysia is a global centre of biodiversity for the Zingiberaceae, harbouring ca. 750 species in 31 genera. This chapter examines the taxonomic composition, ecological roles, and conservation status of gingers in Malaysia. In Peninsular Malaysia, the flora is characterised by high niche specialisation, including unique limestone endemics and recently described state-specific genera such as *Johoralia*, *Perakalia*, and *Kedhalia*. Conversely, the Bornean states of Sabah and Sarawak exhibit distinct evolutionary trajectories driven by insular isolation and diverse geological substrates, resulting in high rates of endemism (40 – 50%) and the presence of specialised genus such as *Burbidgea*. Beyond their ecological significance as nutrient cyclers and food sources for pollinators, these plants hold deep ethnobotanical value for Malaysian indigenous and local communities. However, the family faces critical threats from habitat fragmentation and land-use change, particularly for species restricted to micro-habitats like ultramafic soils or sky island montane systems. The study highlights the Wallacean shortfall, the gap between known and actual diversity, and emphasises the necessity of integrating traditional morphological taxonomy with molecular phylogenetics to inform nationwide conservation strategies and protect Malaysia's botanical heritage.

INTRODUCTION

Malaysia is recognised as one of the world's megadiverse countries, and within its tropical rainforests, the family Zingiberaceae stands as one of the most significant groups of monocotyledonous herbs. Distributed across both Peninsular Malaysia and the states of Sabah and Sarawak, the family comprises ca. 750 species and approximately 31 genera (Govaerts *et al.* 2022). These plants are not merely structural components of the forest understorey; they are ecologically pivotal, serving as primary food sources for specialised pollinators, ranging from halictid bees to spiderhunters, and playing a critical role in the nutrient cycling of the humid tropical floor (Larsen *et al.* 1999).

Members of the family typically occupy humid, shaded environments with organic-rich soils, although they may also persist in disturbed habitats, secondary forests, and limestone formations, reflecting a degree of ecological plasticity across taxa. At the genus level, species of *Zingiber* shows distribution patterns closely governed by environmental variables, with species distribution modelling that indicates climatic factors strongly shape habitat suitability and thereby influence their occurrence and spatial distribution (Huang *et al.* 2024). This ecological dependence suggests an association with relatively stable forest conditions, where deviations in occurrence may reflect changes in habitat quality or microclimatic stability. Such sensitivity highlights their potential role as bioindicators in tropical forest ecosystems, as vascular plants are increasingly used in forest health biomonitoring to assess ecosystem integrity and environmental change (Abas 2023).

[1] Faculty of Resource Science and Technology, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia.
[2] Department of Technology and Natural Resources, Faculty of Applied Sciences and Technology, Universiti Tun Hussein Onn Malaysia (Pagoh Campus), KM1, Jalan Panchor, 84600, Muar, Johor, Malaysia
***Corresponding author: aqmuzzammil@unimas.my**

The diversity of Malaysian gingers is deeply influenced by the country's complex biogeographical history (Burtt and Smith 1972). While the Peninsula shares many floral elements with the Asian mainland (the Indo-China influence) (Zhu and Tan 2022), the states of Sabah and Sarawak on the island of Borneo exhibit a distinct evolutionary trajectory. This insular isolation, combined with varied geological substrates such as the karst limestones of Sarawak and the ultramafic soils of Sabah, has fostered an extraordinary rate of endemism. In fact, while genera like *Alpinia*, *Amomum* and *Zingiber* are found nationwide, the species composition often shifts dramatically across the South China Sea, with Borneo hosting an endemic genus like *Burbidgea* (now extended to the Philippines) (Mazo *et al.* 2022).

Beyond their ecological contributions, the Zingiberaceae hold immense ethnobotanical and economic importance across all Malaysian cultures. From the ubiquitous use of *Etlingera elatior* (locally known as Bunga Kantan) in culinary traditions to the medicinal application of *Curcuma* and *Zingiber* species by indigenous communities like the Orang Asli in the Peninsula as well as the Dayak and Kadazan-Dusun in Borneo, gingers are woven into the country's heritage. Despite this, many species remain under-documented and are highly vulnerable to localised disturbances, particularly those driven by anthropogenic activities such as rapid land-use change, deforestation and urbanisation as documented across multiple regions (Akram *et al.* 2023; Sedek 2026). A comprehensive understanding of the taxonomic landscape in Sabah and Sarawak is therefore essential to complete the picture of Malaysia's botanical heritage and to inform nationwide conservation strategies.

THE ZINGIBERACEAE OF PENINSULAR MALAYSIA

Taxonomic composition, diversity patterns and major genera

The study of Zingiberaceae in Peninsular Malaysia reveals a botanical landscape of immense complexity and historical significance. As a core component of the Sundaic flora, the Peninsula serves as a critical bridge between the seasonal ginger floras of Indochina and the ever-wet, hyper-diverse assemblages of Borneo. With over 165 species recorded across approximately 26 genera, the Peninsular Malaysian gingers are characterised by a high degree of niche specialisation, particularly within the shaded understorey of lowland dipterocarp forests and the unique microclimates of limestone karsts.

Historically, the family was classified into four principal tribes: Alpinieae, Hedychieae, Globbeae, and Zingibereae. However, advances in molecular phylogenetics especially analyses based on internal transcribed spacer (ITS) and *matK* sequences have refined this into four subfamilies: Siphonochiloideae, Tamijioideae, Alpinioideae and Zingiberoideae (Kress *et al.* 2002). The taxonomic framework of Peninsular Malaysian gingers is dominated by the latter two subfamilies, Alpinioideae and Zingiberoideae, which together encompass most native taxa.

There are several key genera that define the structure of the forest floor in this region. Members of Alpinioideae, particularly within the tribe Alpinieae, such as *Alpinia*, *Amomum* (including recently segregated genera like *Meistera*, *Wurfbainia*, *Conamomum*) (De Boer *et al.* 2018), and *Etlingera* represent the larger, more robust members of the family, often reaching several meters, and frequently co-dominates understory vegetation in open areas and along stream banks.

In contrast, the smaller-statured taxa belonging to Zingiberoideae especially within the tribe Zingibereae (e.g., *Zingiber* and *Boesenbergia*), exhibit a range of morphological and phenological adaptations to shaded forest floor environments. This includes the development of underground rhizomes, seasonal dormancy, and rapid regeneration under favourable conditions reflecting their specialisation to seasonally dynamic tropical forests (Kress 2011).

Members of the tribe Globbeae, represented by *Globba* specifically in Peninsular Malaysia, are delicate understorey herbs distinguished by distinctive inflorescences morphology and strong reliance on vegetative reproduction through bulbils. Although vegetative propagation via bulbils is relatively uncommon among tropical angiosperms, *Globba* is notable for its substantial investment in this reproductive strategy, which facilitates rapid establishment and clonal spread (Box and Rudall 2006).

Of particular ecological and taxonomic interest is *Scaphochlamys*, a genus notable for its species richness and endemism in Peninsular Malaysia (Sam *et al.* 2015). The genus continues to yield new taxa through on-going taxonomic works, highlighting its diversity and the likelihood of further undiscovered species in the region (Sam and Ibrahim 2018). Many species are associated with specific forest habitats and microenvironments, making the genus a useful indicator of local ecological conditions and habitat integrity.

Another noteworthy taxon is *Camptandra*, a relatively small genus comprising four recognised species (POWO 2025), three of which occur in Peninsular Malaysia, with a fourth species recently described from Cambodia (Tanaka *et al*. 2025). The occurrence of such narrowly distributed and recently described taxa underscores the Peninsula's role as a centre of ginger diversity and highlights the incompletely documented nature of its flora.

Habitat heterogeneity and limestone endemism

Lowland forest up to altitudes of 600 m is the principal habitat for Zingiberaceae, and species richness drops at higher altitude. A defining feature of the Peninsular Malaysian ginger flora is its intrinsic link with the region's complex geological formations, which facilitate a diverse range of ecological niches. Species of Zingiberaceae occupy varied environments, including lowland primary and secondary forests, on karst formations, stream banks, plateaus, ravines, and even roadside habitats (Mohamad and Kalu 2019; Setiawan *et al.* 2022). Majority of Zingiberaceae species are adapted to shaded, low-light understory environments, particularly smaller and medium-sized gingers such as species of *Boesenbergia*, *Scaphochlamys*, *Conamomum*, *Meistera*, and *Zingiber*. In contrast, some species exhibit significant tolerance to more open, sunlit habitats, including those with more robust and taller leafy shoots (approximately 3 – 4 m), such as *Etlingera* and *Hornstedtia*, which are frequently encountered along roadsides and tourist trails.

The ecological diversity is further reflected in substrate preferences. Most species thrive in deep leaf litter with well-drained soils including sandy loam, clay loam, and alluvial soils, with a pH range of 5.0 – 6.5, and are scarce at limestone, heath, ultramafic and other non-fertile soils (Larsen *et al.* 1998). Nevertheless, some species demonstrate high ecological specialisation for calcium-rich limestone and ultramafic substrates (Sam 2015). Limestone formations in states such as Perak, Kelantan, and Pahang host a distinctive assemblage of calcicolous (lime-adapted) gingers, however, their diversity remains poorly documented. Appalasamy *et al.* (2022a) reported a relatively high representation of *Zingiber* species in Kelantan suggested that limestone-associated gingers remain underexplored. This indicates that limestone ecosystem are still under-sampled and may harbour additional undescribed taxa.

Pronounced patterns of narrow endemism are evident across several genera. For example, *Boesenbergia basispicata* is often restricted to a single limestone massif in Perak (Sam 2015; Abd Karim *et al*. 2025), while *Camptandra* are frequently found on rocky substrates or in boulder-rich environments (Syahida-Emiza *et al.* 2021). The genus *Geostachys* is comparatively rare and is generally associated with cooler, higher-elevation habitats, with several species regarded as highly endemic (Lau 2014). In addition, although *Geocharis* is more widely distributed in Sumatera and Borneo, the presence of two species endemic to Peninsular Malaysia (*G. aurantiaca* and *G. secundiflora*) highlights the region's importance

as a centre of diversity for many genera within the family (Nurainas *et al.* 2024). The edaphic conditions of limestone substrates, including high calcium content and low nutrient availability, together with the insular nature of karst outcrops, likely promote ecological specialisation and restricted gene flow, thereby driving high levels of local endemism (Clements *et al.* 2006; Meng *et al.* 2023). These highly localised distributions also make many limestone-associated species particularly vulnerable to habitat disturbance, especially from quarrying and land-use change (Clements *et al.* 2006).

The State-Named Endemics

In addition to the broadly recognised genera, Peninsular Malaysia is home to a unique group of endemic or nearly endemic genera that have been described or re-circumscribed in recent decades. These genera, often named after the states where they were first discovered, represent micro-endemic lineages that are frequently restricted to very specific river systems or forest reserves. These genera were established by the Malaysian botanist C.K. Lim and highlight the extreme localisation of certain ginger species (Table 1).

Table 1. State-named endemic genera of Zingiberaceae in Peninsular Malaysia: distribution, habitat, and endemism status.

Genus	Primary location	Forest type	Status
Johoralia	Johor	Lowland MDF	Rare/Narrow Endemic
Perakalia	Perak	Hill MDF	Localised Endemic
Kedhalia	Kedah	Seasonal Forest	Localised Endemic
Scaphochlamys	Peninsula-wide	Varied (Limestone/Clay)	High Endemism (> 80%)

- *Johoralia*: This is a monotypic genus (consists only one species, *J. lada* C.K. Lim; Figure 1). It is currently known only from the southern tip of the Peninsula, specifically within the lowland wet forests of Johor, such as the Panti and Labis Forest Reserves. Its discovery underscored the importance of the southern Malay Peninsula as a distinct floristic province (Lim 2015).
- *Perakalia*: Named after the state of Perak, this genus represents another localised lineage. Its species are often found in the shaded, humid understories of central and northern Perak. Like *Johoralia*, it is distinguished by specific floral architectures, particularly the shape of the labellum and anther, that do not fit into the broader definitions of *Amomum* or *Alpinia*. [*P. perakensis* C.K. Lim; Figure 2] (Lim 2016).
- *Kedhalia*: Found in the northern state of Kedah, this genus further illustrates the state-level endemism that characterizes Malaysian gingers. These plants are often adapted to the slightly more seasonal climates of the north, bridging the gap between the ever-wet rainforests of the south and the deciduous forests of Thailand. [*K. flaviflora* C.K. Lim; Figure 3] (Lim 2009).

The recognition of these genera is part of a larger trend in Southeast Asian botany to split large, polyphyletic genera (like *Amomum* or *Elettaria*) into smaller, more natural groups that reflect their true evolutionary history. These genera are often separated based on subtle but consistent differences in their inflorescence structure (whether they flower from the base or the tip) and the presence of specialised anther appendages. Because these plants often look identical to more common gingers when not in flower, they remained hidden in herbaria for decades. Their formal description requires precise timing to catch them in their brief flowering windows.



Figure 1. *Johoralia lada* C.K. Lim.



Figure 2. *Perakalia perakensis* C.K. Lim.



Figure 3. *Kedhalia flaviflora* C.K. Lim.

Ethnobotanical significance and heritage

In Peninsular Malaysia, the Zingiberaceae is deeply embedded in the cultural and medicinal practices of the Malay, Chinese, and Indian communities, as well as the indigenous Orang Asli. Beyond globally recognised *Zingiber officinale* (Ginger), *Curcuma longa* (Turmeric), and *Elettaria cardamomum* (Buah Pelaga), the Malayan native taxa *Etlingera elatior* (*Bunga Kantan*), serves as culinary staples in many parts of the region. The main uses of Zingiberaceae in this region include their use as food and vegetables, condiments and flavourings in the daily diet, medicines for treating gastrointestinal issues, general health and skin care, as well as as spices and in cultural rituals (Ibrahim *et al.* 2000; Appalasamy *et al.* 2022b; Ramli *et al.* 2021; Tan *et al.* 2025). An ethnobotanical documentation conducted in 14 selected villages in the states of Kelantan, Selangor and Wilayah Persekutuan recorded at least 16 ginger species used for various purposes. These include the native species such as *Alpinia conchigera* (Lengkuas genting), *Alpinia galanga* (Lengkuas), *Curcuma zanthorrhiza* (Temulawak), *Elettariopsis curtisii* (Pepijat), *Kaempferia galanga* (Cekur), and *Zingiber zerumbet* (Lempoyang).

Within the Peranakan Chinese community, ginger holds notable ethnobotanical significance due to its carminative properties, especially in relation to women's health practices. This functional importance is reflected in its pervasive use across Peranakan cuisine, where it is incorporated into steamed dishes, soups, stir-fries, and stews (Nik Halman *et al.* 2022). The Orang Asli possesses a profound depth of knowledge regarding the wild gingers, utilising species of *Boesenbergia* and *Zingiber* from postpartum care to the treatment of digestive ailments (Ibrahim *et al.* 2007). This biocultural heritage highlights the importance of conserving not just the plants themselves, but the traditional knowledge associated with them. Likewise, in Kota Tinggi, Johor, the ethnobotanical knowledge of wild gingers among indigenous communities, particularly the Orang Kanaq and Orang Jakun, is centred on their use in traditional medicine, daily sustenance, and cultural rituals. The table below provides examples of ethnobotanical records from Johor.

Table 2. List of ginger species associated with traditional uses among Orang Asli in Johor.

Species	Vernacular names	Communities	Traditional uses	References
Amomum curtisii	Semomok (Orang Kanaq), Cawak (Jakun)	Jakun	Used as an amulet to ward off disease. The whole plant is used by the healer during medication sessions.	Perbadanan Bioteknologi dan Biodiversiti Negeri Johor (2008)
Etlingera elatior	Kantan	Jakun	Used in cooking.	Tan *et al*. (2025)
		Orang Kanaq	Used in cooking. The stem is also used as a symbolic marker during house construction to signify the site is safe for habitation.	
Etlingera megalocheilos	Tepus gunung	Orang Kanaq	Used to treat coughs, sore throats, fevers, and general vitality – The rhizome is cleaned, sliced and boiled before consumption.	

Globba leucantha Miq.	Meroyan Berok, Bunga Putih, Merian darah (Temuan)	Jakun	Used for postnatal care by consuming a decoction made from the roots.	Ong *et al*. (2011)
Scaphochlamys aff. *klossii*	Kunyit landak, Tepus landak Orang Kanaq)	Jakun	Used for heartburn (dyspepsia) - The fresh rhizome is consumed raw.	Perbadanan Bioteknologi dan Biodiversiti Negeri Johor (2008)
		Orang Kanaq	Treatment for stomachache. The leaves are warmed and applied externally.	Ab. Hadi and Mohamad (2026)
Scaphochlamys aff. *lanceolata*	Kunyit landak	Jakun	Used for heartburn (dyspepsia). The fresh rhizome is consumed raw.	Ab. Hadi and Mohamad (2026)
		Orang Kanaq	Treatment for stomach-ache. The leaves are warmed and applied externally.	

Conservation challenges of Zingiberaceae in Peninsular Malaysia

Despite a long history of botanical documentation, dating back to the seminal works of Ridley and Holttum, the gingers of Peninsular Malaysia face modern pressures from habitat fragmentation and land-use conversion. Many species are low-density plants, meaning they occur in small, scattered populations that are easily wiped out by localised disturbances (Sedek *et al.* 2024). These patterns highlight the importance of safeguarding primary forest reserves and the remaining limestone karsts, which serves as critical habitats for these understorey taxa. Addressing these challenges requires an integrated approach that combines traditional herbarium-based taxonomy with modern molecular techniques to better identify and protect the most evolutionarily significant lineages.

Within genera such as *Geostachys*, the assumption that high-altitude habitats provide natural protection is increasingly questionable. Although these species are typically associated with montane environments, they face conservation pressures similar to those affecting lowland forest taxa. In areas such as Cameron Highlands and Genting Highlands, expanding ecotourism and related land-use changes have contributed to habitat encroachment and environmental degradation (Lau 2014), indicating that highland ecosystems are not as secure as often assumed. A similar situation is observed in *Zingiber*, where taxa such as *Z. multibracteatum* var. *viride* are frequently found near main trails and popular hiking routes. Their proximity to these areas increases their exposure to trampling, habitat disturbance, and long-term ecological stress. In addition, *Z. longibracteatum* has been recorded in sites cleared for camping, demonstrating direct human modification of its habitat and highlighting the extent of ongoing disturbance (Sedek 2026).

At the same time, the limited documentation of Zingiberaceae in limestone ecosystems points to a significant gap in current knowledge. Limestone habitats function as specialised microenvironments that often support unique and endemic plant species. However, these systems are increasingly threatened by quarrying and other forms of habitat destruction. The combination of ecological specialisation and insufficient research in Peninsular Malaysia suggests that the conservation risks facing these taxa may be substantially underestimated (Kiew *et al.* 2019).

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THE ZINGIBERACEAE OF SABAH AND SARAWAK

The taxonomic landscape of Zingiberaceae in Sabah and Sarawak is characterised by a high degree of complexity and a significant rate of species discovery. As research into the Bornean understorey continues, the traditional morphological classifications are increasingly being supplemented by molecular phylogenetics, revealing a richness that places these two states among the most significant centres of ginger diversity globally. Current records indicate that Borneo harbours approximately 25 – 28 genera and over 300 named taxa within the family. Sarawak, in particular, is noted for its exceptional diversity, with a checklist that currently includes roughly 210 species (Meekiong and Teo 2022), many of which are exclusive to the state. Sabah mirrors this richness, particularly in high-biodiversity areas like the Crocker Range and Mount Kinabalu. While some genera like *Alpinia* and *Etlingera* are widespread across both states, the distribution of specific species often follows strict geographical boundaries or specialised geological substrates. For instance, the silver-leaved group of *Zingiber* was long thought to be a Bornean endemic before recent records appeared in Peninsular Malaysia (Tan *et al.* 2024).

The classification of gingers in Malaysian Borneo has transitioned from the classic four-tribe system (Alpinieae, Hedychieae, Globbeae and Zingibereae) to a more nuanced molecular framework.

- Alpinioideae: This is the most species-rich subfamily in the region, encompassing major genera such as *Alpinia*, *Amomum*, *Etlingera*, *Hornstedtia*, and *Plagiostachys*. These are often larger herbs characterised by terminal or radical inflorescences.
- Zingiberoideae: Represented heavily by the tribes Zingibereae (including *Zingiber*, *Boesenbergia*, and *Scaphochlamys*) and Globbeae (primarily the genus *Globba*).
- Endemic genera: Borneo is home to several endemic or near-endemic genera that underscore its evolutionary isolation, such as *Tamijia*, *Burbidgea*, *Haplochorema* (recently being reduced to *Boesenbergia* by Mood *et al.* 2020), and the recently described *Borneocola* (Sam *et al*. 2016 – need further clarification).

A defining feature of the ginger flora in Sabah and Sarawak is the high level of local endemism. Many species are restricted to specific forest types:

- Limestone specialists: In areas like Bau (Sarawak) and the karst regions of Sabah, specialised species of *Boesenbergia* and *Scaphochlamys* have evolved to thrive in nutrient-poor, alkaline environments.
- Ultramafic endemics: Sabah's unique ultramafic soils, particularly around Mount Kinabalu, support distinct taxa such as *Zingiber lambii*, which are physiologically adapted to high metal concentrations.
- Peat swamp resilience: In the fragmented peat swamps of Sarawak, species from genera like *Amomum* and *Zingiber* show remarkable resilience, although they are highly sensitive to hydrological changes.

The taxonomy of Bornean gingers remains in a state of flux. Large genera like *Etlingera*, with over 42 species in Borneo (Poulsen 2006) and *Boesenbergia* (ca. 100 species across Asia) frequently see the addition of new species, such as the recently described *Sulettaria*, a genus segregated from *Elettaria* (Poulsen *et al.* 2018). The primary challenge for researchers in Sabah and Sarawak remains cryptic morphology; many species look nearly identical in their vegetative state and can only be accurately identified during their brief flowering windows. This highlights the ongoing necessity for integrated taxonomic approaches that combine traditional field botany with DNA barcoding to ensure accurate conservation assessments.

The species richness and endemism of Zingiberaceae in Sabah and Sarawak reflect the high biodiversity of the Sundaland region, with each state boasting unique botanical assemblages driven by their distinct geological and topographical features. While exact numbers fluctuate as new species are discovered and genera are re-circumscribed (such as the recent creation of *Sulettaria* (Poulsen *et al.* 2018) and *Borneocola* (Sam *et al.* 2016)), the following overview summarises the diversity patterns based on current botanical records.

Sarawak generally exhibits a slightly higher documented species richness compared to Sabah, partly due to its larger landmass and extensive history of botanical exploration in areas like the Dered Krian National Park (Bau Limestone) and the Lambir Hills National Park (Sakai and Nagamasu 2003) (Table 2).

Table 3. The distribution of genera across the two states reveals fascinating patterns of localised evolution.

State	Total Estimated Species	Approx. Endemism	Key High-Diversity Genera
Sabah	ca. 150 – 180	35 – 45%	*Etlingera*, *Alpinia*, *Globba*, *Burbidgea*
Sarawak	ca. 200 – 220	40 – 50%	*Alpinia*, *Etlingera*, Zingiber, *Boesenbergia*, *Burbidgea*, *Scaphochlamys*, *Sundamomum*, *Sulettaria*

Subfamily Alpinioideae (The large gingers)

- *Etlingera*: This genus is hyper-diverse in Borneo. Sabah is particularly famous for its spectacular Etlingera species, including several endemics found in the Crocker Range. Sarawak holds significant diversity in the earth ginger types that flower at ground level.
- *Amomum sensu lato* : Historically the largest genus in Sarawak (often cited with 30+ species). Recent taxonomic splits have moved many species into *Meistera*, *Wurfbainia*, and *Sundamomum* (de Boer *et al.* 2018).
- *Alpinia*: Widespread in both states, with many species being common understorey components. Endemism is lower compared to smaller-statured genera but still significant in montane regions.
- *Plagiostachys*: A Bornean specialty with a high concentration of endemic species in Sarawak's lowland dipterocarp forests (e.g., Lambir Hills National Park).

Subfamily Zingiberoideae (The understorey herbs)

- *Zingiber*: Sarawak has seen a surge in descriptions recently, with roughly 18 – 20 species now recorded, many being narrow endemics to limestone or kerangas forests. Sabah hosts unique silvery-leaved endemics like *Z. lambii*.
- *Boesenbergia*: This genus shows extreme micro-endemism. A single hill in Sarawak or a specific valley in Sabah may harbour a species found nowhere else on Earth.
- *Burbidgea*: Previously known as a Bornean endemic genus (recently was also recorded from Zamboanga region of Mindanao in the Philippines (Mazo *et al.* 2022)). While found in both states, species like *B. stenantha* are iconic representatives of the damp, shaded rocks of Sarawak and Sabah's highland forests.
- *Globba*: Highly diverse in the seasonal and moist forests of both states, often exhibiting complex bulbils for asexual reproduction.

Overview of the diversity and distribution of endemic and geographically restricted Zingiberaceae genera in Malaysia, emphasising the high level of hyper-endemism in Peninsular Malaysia alongside more regionally confined distributions spanning Peninsular Malaysia and Borneo (Table 4.).

Table 4. Endemic and restricted genera of Zingiberaceae in Malaysia.

Genus	Species count (approx..)	Region	Endemism status
Johoralia	1	Peninsular Malaysia	Hyper endemic (*J. lada*)
Perakalia	1	Peninsular Malaysia	Hyper endemic (*P. perakensis*)
Kedhalia	1	Peninsular Malaysia	Hyper endemic (*K. flaviflora*)
Burbidgea	5 – 6	Borneo (Sabah & Sarawak)	Endemic (except *B. nitida* – also recorded in the Philippines)
Scaphochlamys	ca. 40 – 50	Peninsular Malaysia & Sarawak	80% endemic (with many localised species)
Haniffia	ca. 3 – 4	Peninsular Malaysia & Sarawak	Species distribution not overlapped (*H. albiflora*, *H. cyanescens*, *H. flavescens*, *H. santubongensis*)
Tamijia	2	Borneo (Brunei & Sarawak)	Endemic to Borneo (*T. flagellaris* – Brunei and Sarawak) Hyper endemic (*T. eractifolia*)

*Not including *Borneocola*, *Conamomum*, *Epiamomum*, *Meistera*, *Sulettaria*, *Sundamomum* and *Wurfbainia*



Figure 2. A. *Burbidgea schizocheila* Hackett, **B.** *Hornstedtia merahjambu* Angela, Tawan & Meekiong, **C.** *Sulettaria meekiongii* Ripen & Teo, and **D.** *Epiamomum epiphyticum* (R.M.Sm.) A.D. Poulsen & Škorničk.

Endemic to the island of Borneo, the genus *Tamijia* represents a fascinating and highly specialised lineage within the Zingiberaceae, currently comprising two recognised species: *T. flagellaris* (distributed across Brunei and Sarawak) and the hyper-endemic *T. erectifolia*, which is restricted to Sarawak. Originally established as a distinct genus to accommodate unique morphological variations not captured within broader classification schemes (Sakai and Nagamasu 2000), *Tamijia* highlights the evolutionary isolation driven by Borneo's complex insular landscapes.

Taxonomically, *Tamijia* is distinguished by specialised structural features that separate it from other understorey Bornean gingers, reflecting a high degree of evolutionary adaptation to local forest conditions. Its confinement to specific micro-locations in Sarawak and Brunei underscores the broader biogeographical pattern observed across Sabah and Sarawak, where specialised geological substrates and localised habitats foster narrow endemism. Because these populations are often small and restricted to fragile forest pockets, ongoing taxonomic and ecological documentation of genera like *Tamijia* is crucial for understanding the full spectrum of Bornean plant evolution and implementing targeted conservation strategies against habitat loss.

Phytogeographical significance and the island effect
The high levels of endemism in Sarawak and Sabah, often exceeding 40% at the species level, can be attributed to the fragmented nature of the Bornean landscape. In Sarawak, the isolated limestone karsts of Bau and Padawan act as terrestrial islands, where restricted gene flow has led to the evolution of site-specific taxa, particularly within the genera *Boesenbergia* and *Scaphochlamys*. Similarly, the extreme altitudinal gradients of the Crocker Range and Mount Kinabalu in Sabah have created sky islands. These high-elevation habitats host specialised species that are physiologically distinct from their lowland counterparts, emphasising that topography is a primary driver of taxonomic separation in the region.

Edaphic specialisation and ecological niches
A critical point of discussion is the role of soil chemistry in shaping ginger distribution. The preference of certain Zingiberaceae for specific substrates, such as the nutrient-poor *kerangas* forests of Sabal (Sarawak) or the ultramafic soils of central Sabah, indicates a high degree of evolutionary adaptation. In Sarawak's peat swamp ecosystems, the presence of resilient monocot understory species demonstrates the family's ability to occupy niches that are often too acidic or waterlogged for other flora. This niche specialisation suggests that Zingiberaceae are excellent bio-indicators for identifying High Conservation Value Areas (HCVA), as the presence of certain endemic gingers often signals a unique or undisturbed habitat.

Taxonomic flux and the Wallacean shortfall
The difference between the number of known species and the actual diversity in the field (the Wallacean shortfall) remains a significant hurdle. Recent taxonomic revisions, such as the segregation of *Sulettaria* from *Elettaria* (Poulsen *et al.* 2018); separation of Sarawak's *Scaphochlamys* to *Borneocola* (Sam *et al.* 2016), illustrate that much of Borneo's ginger diversity has been historically hidden under broadly defined genera (authors believed that these molecular works need more evidences before accepted). The frequent discovery of new species in relatively well-explored areas like the Lambir Hills National Park or the Kinabalu foothills suggests that the current species counts for Sarawak and Sabah are likely underestimates. Integrating molecular phylogenetics with traditional morphological analysis is no longer optional; it is a necessity for resolving cryptic species complexes that look identical in their vegetative states.

Conservation implications in fragmented landscapes
The discussion must address the vulnerability of these plants to land-use changes. Because many ginger species in Sabah and Sarawak are narrow endemics, found only in a single valley or on a specific hillside, they are disproportionately affected by forest fragmentation and logging. The loss of a relatively small patch of forest could result in the total extinction of a localised species. Furthermore, as many gingers rely on specific pollinators like halictid bees or spiderhunters, the degradation of the surrounding forest canopy can disrupt reproductive cycles even if the gingers themselves are not cleared. Conservation strategies must therefore move toward protecting entire micro-habitats rather than just broad forest tracts.

Ethnobotanical value and future research
The cultural importance of Zingiberaceae to the indigenous communities of Borneo adds a layer of biocultural significance to their conservation. The documented use of various species for food, medicine, and ritual purposes across Sarawak and Sabah highlights a deep reservoir of traditional ecological knowledge. Future research should prioritise gap-filling expeditions in under-surveyed regions, such as the interior highlands of the Sarawak-Kalimantan border, and focus on the reproductive biology of these plants to better understand how they will respond to a changing climate.

CONCLUSION

The Zingiberaceae of Malaysia represent a pinnacle of tropical plant evolution, characterised by a sophisticated array of morphological adaptations and complex ecological interdependencies. Across the diverse landscapes of Peninsular Malaysia, Sarawak, and Sabah, Zingiberaceae exhibits a dual nature: a broad presence of common, widespread genera such as *Alpinia* and *Etlingera*, juxtaposed against the extreme micro-endemism of localised genera like *Johoralia*, *Perakalia*, and *Kedhalia*. The discovery and subsequent description of these state-specific taxa in the Peninsula, alongside the unique Bornean lineages like *Burbidgea*, underscore the fact that Malaysia's botanical inventory is far from complete. These plants are more than taxonomic curiosities; they are vital components of the forest understory, driving nutrient cycles and supporting specialised pollination networks that maintain the health of the rainforest. However, the survival of this rich taxonomic heritage faces unprecedented challenges. As understory specialists, many Malaysian gingers, particularly those restricted to fragmented peat swamps, limestone karsts, or sky island montane systems, possess narrow environmental tolerances. The loss of even a small forest fragment can result in the irrevocable extinction of a species found nowhere else on Earth. Moving forward, conservation strategies must shift from broad-scale forest management to the protection of specific micro-habitats and the integration of modern molecular phylogenetics with traditional morphological studies. By prioritising the documentation and protection of these hidden lineages, Malaysia can continue to lead in the study of tropical biodiversity, ensuring that the aromatic and functional wealth of its ginger flora remains a permanent feature of the Southeast Asian landscape.

REFERENCES

Ab. Hadi, A. and Mohamad, S. 2025. Ethnobotanical documentation of medicinal plants from Panti Forest Reserve, Johor. Undergraduate thesis. Johor: Universiti Tun Hussein Onn Malaysia. [Unpublished].

Abd. Karim, H.A., Usman, N.A.H., Ishak, I.S., Rahman, N.A., Ideris, S. and Osman, C.P. 2025. Exploring the metabolites of *Boesenbergia plicata* from Pulau Tuba: A dereplication approach. *Malaysian Journal of Chemistry* 27(1): 74–83.

Akram, S., Khamis, S., Zulkifly, S., Talib, R. and Nurul Izza, A.G. 2023. Phylogeny study of 20 selected species of Zingiberaceae from *ex situ* collections in Peninsular Malaysia. *Pertanika, Journal of Tropical Agricultural Science* 46(1): 329–345.

Appalasamy, S., Arumugam, N., Ahmad Zamri, N.S., Fadhlina, A., Kumaran, J.V. and Subramaniam, S. 2022a. First report on wild ginger (family: Zingiberaceae) species composition with new records in limestone forests of Kelantan, Peninsular Malaysia. *Tropical Life Sciences Research* 33(3): 33–46.

Appalasamy, S., Ahmad Zamri, N.S., Arumugam, N., Mohamad Nor, M., Zakaria, S. and Subramaniam, S. 2022b. Conservation of indigenous knowledge on the consumption of medicinal Zingiberaceae by locals in Kelantan, Peninsular Malaysia. *IOP Conference Series: Earth and Environmental Science* 1102(1): 012064. https://doi.org/10.1088/1755-1315/1102/1/012064

Burtt, B.L. and Smith, R.M. 1972. Key species in the taxonomic history of Zingiberaceae. *Notes from the Royal Botanic Graden Edinburgh* 31: 177–227.

Box, M.S. and Rudall, P.J. 2006. Floral structure and ontogeny in *Globba* (Zingiberaceae). *Plant Systematics and Evolution* 25: 107–122.

Clements, R., Sodhi, N.S., Schilthuizen, M. and Ng, P.K.L. 2006. Limestone karsts of Southeast Asia: Imperiled arks of biodiversity. *BioScience* 56(9): 733–742.

de Boer, H., Newman, M., Poulsen, A.D., Droop, A.J., Fér, T., Hiền, L.T.T., Hlavatá, K., Lamxay, V., Richardson, J.E., Steffen, K. and Leong-Škorničková, J. 2018. Convergent morphology in Alpinieae (Zingiberaceae): Recircumscribing *Amomum* as a monophyletic genus. *Taxon* 67(1): 6–36

Govaerts, R., Newman, M.F. and Lock, J.M. 2022. World Checklist of Zingiberaceae. *Plants of the World Online*. https://checklistbuilder.science.kew.org/reportbuilder.do
Holttum, R.E. 1950. The Zingiberaceae of the Malay Peninsula. *Gardens' Bulletin Singapore* 13: 1–249.
Ibrahim, H., Ong, H.C. and Hassan, R. 2000. Ethnobotanical survey of the ginger family in selected Malay villages in Peninsular Malaysia. *Malaysian Journal of Science* 19: 93–99.
Ibrahim, H., Khalid, N. and Hussin, K. 2007. Cultivated gingers of Peninsular Malaysia: Utilization, profiles and micropropagation. *Gardens' Bulletin, Singapore* 59(1–2): 71–88.
Kiew, R., Ummul-Nazrah, A.R., Ong, P.T., Imin, K., Aliaa-Athirah, A.M. and Rafidah, A.R. 2019. Distribution and conservation implications of limestone plant species in FELDA Chiku limestone flora, Kelantan, Malaysia. *Journal of Tropical Forest Science* 31(1): 19–36.
Kress, W.J. 2011. The evolution and ecology of dry tropical forest gingers (Zingiberaceae) in Southeast Asia. In *The Ecology and Conservation of Seasonally Dry Forests in Asia*, W.J. McShea, S.J. Davies and N. Bhumpakphan (Eds.), pp. 115–130. Washington, D.C.: Smithsonian Institution Scholarly Press.
Larsen, K., Ibrahim, H., Khaw, S.H. and Mood, J.D. 1999. *Gingers of Peninsular Malaysia and Singapore*. Kota Kinabalu: Natural History Publications (Borneo).
Lau, K.H. 2014. The conservation of Peninsular Malaysian *Geostachys* (Zingiberaceae). *Gardens' Bulletin Singapore* 66(1): 3–14.
Lim, C.K. 2009. A new Zingiberaceae genus from Kedah, Peninsular Malaysia. *Folia Malaysiana* 10(1): 1–10.
Lim, C.K. 2015. A new monotypic Zingiberaceae Genus from Johor, Peninsular Malaysia. *Folia Malaysiana* 16(1): 1–8.
Lim, C.K. 2016. Another new monotypic Zingiberaceae genus from Peninsular Malaysia. *Folia Malaysiana* 17(2): 69–76.
Mazo, K.R.F, Docot, R.V.A. and Poulsen, A.D. 2022. The ginger genus *Burbidgea* confirmed in the Flora of the Philippines. *Webbia* 77(2): 321–325.
Meekiong, K. and Teo, S.P. 2022. *Zingiberaceae of Sarawak*. Kuching: Walinga.
Meekiong, K. 201). *Tamijia erectifolia*, a second species (Zingiberaceae) from Sarawak, Malaysia. *Folia Malaysiana* 17(2): 29 – 34.
Meng, W., Ran, J., Dai, Q., Tu, N., Leng, T. and Ren, Q. 2023. Morphological and physiological adaptation characteristics of lithophytic bryophytes to karst high calcium environment. *BMC Plant Biology* 23: 160. https://doi.org/10.1186/s12870-022-03980-4
Mood, J.D., Ardiyani, M., Veldkamp, J.F., Mandakova, T., Prince, L.M. and de Boer, H.J. 2020. Nomenclatural changes in Zingiberaceae: *Haplochorema* is reduced to *Boesenbergia*. *Gardens' Bulletin Singapore* 72(1): 77–95.
Mohamad, S. and Kalu, M. 2019. Assessment of Zingiberaceae (Tribe Alpinieae) from North East Sarawak, Malaysia. *IOP Conference Series: Earth and Environmental Science* 269(1): 012032. https://doi. org/10.1088/1755-1315/269/1/012032
Nik Halman, N.N.A., Abdullah, A. and Lyndon, N. 2022. Ethnobotanical study and benefits of Malaysian Peranakan Chinese medicinal plants. *Mathematical Statistician and Engineering Applications* 71(3): 735–741.
Nurainas, N., Zulaspita, W., Febriamansyah, T.A., Syamsuardi, S. and Poulsen, A.D. 2024. A recircumscription of *Geocharis* (Zingiberaceae) as a result of the discovery of a new species in Sumatra, Indonesia. *PhytoKeys* 244: 15–22.
Ong, H.C., Chua, S. and Millow, P. 2011b. Ethno-medicinal plants used by the Temuan villagers in Kampung Jeram Kedah, Negeri Sembilan, Malaysia. *EthnoMed* 5(2): 95–100.
Perbadanan Bioteknologi dan Biodiversiti Negeri Johor. 2008. *Khazanah Endau Rompin Herba, Edisi Kedua*. Johor: Perbadanan Bioteknologi dan Biodiversiti Negeri Johor. pp.177.
Poulsen, A.D. 2006. *Etlingera of Borneo*. Kota Kinabalu: Natural History Publications (Borneo) in association with the Royal Botanic Garden Edinburgh.
Poulsen, A.D., Mathisen, H.B., Newman, M.F., Ardiyani, M., Lofthus, O. and Bjora, C.S. 2018. *Sulettaria*: A new disjunct from *Elettaria cardamomum*. *Taxon* 67(4): 725–738.
Sakai, S. and Nagamasu, H. 2000. Systematic Studies of Bornean Zingiberaceae: III. *Tamijia*: A new genus. *Edinburgh Journal of Botany* 57(2): 245 – 255.
Sakai, S. and Nagamasu, H. 2003. Systematic studies of Bornean Zingiberaceae. IV. Alpinioideae of Lambir Hills, Sarawak. *Edinburgh Journal of Botany* 60: 181–216.

Sam, Y.Y., Ibrahim, H. and Saw, L.G. 2015. Four new species of *Scaphochlamys* (Zingiberaceae) from Peninsular Malaysia. *Phytotaxa* 221(1): 21–34.
Sam, Y.Y., Takano, A., Ibrahim, H., Zaveska, E. and Aziz, F. 2016. *Borneocola* (Zingiberaceae), a new genus from Borneo. *Phytokeys* 75: 31–55.
Sam, Y.Y. and Ibrahim, H. 2018. *Scaphochlamys disticha* (Zingiberaceae), a new species with distichous inflorescence from Peninsular Malaysia. *PhytoKeys* 99: 85–92.
Sedek, A.S., Mohamad, S., Nazrin, A.A., Mohd Nadzreen, H.S., Hadzuha, N.H. and Abd Hakim, A.M. 2024. Diversity of wild gingers (Zingiberaceae) in Southern Peninsular Malaysia: Panti Forest Reserve and Labis Forest Reserve. *Pertanika, Journal of Tropical Agricultural Science* 47(1): 11–24.
Sedek, A.S. 2026. Taxonomic revision, palynology and phylogeny of genus *Zingiber* Mill. (Zingiberaceae) in Peninsular Malaysia. PhD thesis. Johor: Universiti Tun Hussein Onn Malaysia. [Unpublished].
Setiawan, E., Ardiyani, M., Miftahudin, M., Poulsen, A.D. and Chikmawati, T. 2022. The diversity and distribution of *Alpinia zerumbet* clade in West Malesia. *Journal of Biological Diversity* 23(4): 1734–1744.
Smith, R.M. 1984. Zingiberaceae of Gunung Mulu National Park. In *Studies on the Flora of Gunung Mulu National Park Sarawak*, A.C. Jermy (Ed.), pp. 85–96. Kuching: Forest Department Sarawak.
Syahida-Emiza, S., Sam, Y.Y., Alia-Athirah, A.M., Imni K., Siti-Munirah, M.Y., Nor-Ezzawanis, A.W., Wan Syafiq, W.P. and Angan, A. 2021. Botanical discoveries of Gunung Sarut, Terengganu. *Conservation Malaysia* 33: 1–3.
Tan, S.H., Sandin, D., Ghazalli, M.N., Rani, R., Yong, C.Y.S., Besi, E.E. and Go, R. 2024. A new species of *Zingiber* (Zingiberaceae) from Taman Negeri Rompin, Pahang, Malaysia. *Malayan Nature Journal* 76(3) : 221–227.
Tan, A.L., Kamarulzaman, F., Sharuddin, M.F. and Amir, M. 2025. Diversity of the medicinal plants species utilised by the Orang Kanaq community In Panti Forest Reserve, Kota Tinggi, Johor. *Malaysian Forester* 88 (2): 265–294.
Tanaka, N., Ohi-Toma, T., Hun, S., Ith, S., Peou, Y., Sam, Y.Y. and Funakoshi, H. 2025. *Camptandra kampucheaensis* (Zingiberaceae): A new addition to the genus after a 120-year hiatus and the first generic record from Indo-China. *Journal of Japanese Botany* 100(1): 31–39.
Zhu, H. and Tan, Y. 2022. Flora and vegetation of Yunnan, southwestern China: Diversity, origin and evolution. *Diversity* 14(5): 340.