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Review article

Recent Discoveries in Zingiberaceae: A Review Highlighting New Species from Asia Over the Last Six Years

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Abstract

The increasing pace of habitat loss and environmental changes necessitates urgent research into the biodiversity of plant families such as Zingiberaceae. This review explores the discovery of new species within the Zingiberaceae family in Asia over the past six years, focusing on their distribution, characteristics, and the significance of these findings. The literature review involved searching various databases, including ScienceDirect, Scopus, Web of Science, Google Scholar, Google Books, and the Internet Archive, for references on new Zingiberaceae species. Specific search terms such as "new Zingiberaceae species," "discovery," "Asia," and "characterization" were used to identify pertinent articles. After collecting and analysing data, a total of 119 new species were identified across 11 countries, namely Cambodia, China, India, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Taiwan, Thailand, and Vietnam. The genera include *Alpinia, Boesenbegia, Curcuma, Etlingera, Globba, Hedychium, Kaempferia, Monolophus, Plagiostachys, Pleuranthodium, Sundamomum, Wurfbaiana, Conamomum*, and *Zingiber*. Notably, the genus *Curcuma* was the most prolific, with 37 new species. Thailand emerged as the leading country in terms of new species discoveries. This comprehensive review highlights the diverse characteristics of these species and underscores the critical role of Zingiberaceae in ecological and economic contexts. The findings emphasize the importance of continued botanical exploration and research to enhance our understanding of biodiversity and to unlock potential applications in medicine, agriculture, and other industries.

Keywords: Asia; literature review; new species; Zingiberaceae

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1. Introduction

The Zingiberaceae family, commonly known as the ginger family, is a highly diverse and significant group of plants, both ecologically and economically. This family is one of the largest families within the order Zingiberales, encompassing over 50 genera and more than 1,600 species distributed globally (Saha et al., 2020). These plants are widely distributed in tropical and subtropical regions, with the highest concentration of diversity found in Southeast Asia (Sedek et al., 2023). Southeast Asia, particularly countries like Thailand, Indonesia, and Malaysia, has been identified as a hotspot for Zingiberaceae diversity (Banaticla-Hilario & Altamirano, 2023), owing to its favorable climate and unique ecological conditions. The Zingiberaceae family includes various species of high commercial value, such as ginger (*Zingiber officinale*), turmeric (*Curcuma longa*), and galangal (*Alpinia galanga*), which are utilized in culinary applications, traditional medicine, and the cosmetic industry. These species are not only vital as spices and flavoring agents but also play a crucial role in traditional and modern medicine, providing a wide range of bioactive compounds used to treat numerous ailments. Zingiberaceae is a family of medicinal plants that is extensively used and holds significant economic value (Suryani, 2022).

One example of utilization of Zingiberaceae is found in Indonesia. According to the Central Statistics Agency (BPS) of Indonesia, cardamom seeds are the most produced non-rhizome bio-pharmaceutical product in Indonesia, with an annual production reaching 81,724 tons. Additionally, *Zingiber zerumbet* is also one of the main pharmaceutical commodities in Indonesia, with rhizome production reaching 9,150 tons per year (BPS, 2024). The Zingiberaceae family is crucial to the food industry as a source of spices or cooking ingredients and to the pharmaceutical industry as a source of raw materials for medicines. Research shows that cardamom seed extract possesses various pharmacological activities, including antibacterial (Juwitaningsih et al., 2020), antifungal (Ujilestari et al., 2018), anticancer (Subehan et al., 2006), anti-inflammatory (Seo et al., 2011), and anti-asthma (Lee et al., 2010) properties. The extract of bitter ginger rhizome also exhibits pharmacological activities such as antitumor (McIntosh & Jones, 2003), antibacterial (Yusmaniar et al., 2015), antiviral (Kiat et al., 2006), and larvicidal (Sofian et al., 2019) properties. Further studies have focused on the cultivation, biochemical properties, and bioactivity of cardamom and bitter ginger.

Research and exploration of new species within the Zingiberaceae family are crucial due to the immense potential these plants hold. The discovery of new species not only enhances biodiversity but also provides opportunities to find new bioactive compounds beneficial to human health and commercial product development. However, exploring new Zingiberaceae species often faces significant challenges, such as accessing difficult habitats, the need for detailed taxonomy, and the importance of environmental conservation (Atmaja et al., 2023). Many species in the Zingiberaceae family are found in remote or ecologically sensitive areas, requiring extensive fieldwork and collaboration with local communities and authorities to ensure sustainable exploration practices. Modern approaches such as genetic analysis and molecular techniques have paved the way for new avenues in species exploration and identification. Technologies like Next-Generation Sequencing (NGS) and DNA barcoding allow researchers to identify and characterize species more accurately and efficiently. Extensive field exploration and collaboration with local communities are also essential in discovering undescribed species. Such collaborations are vital for integrating traditional knowledge with scientific research, fostering a holistic understanding of plant diversity and its potential applications.

With this background, research on the exploration of new Zingiberaceae species not only contributes to our scientific understanding of biodiversity but also has broad practical implications. The discovery of new species can provide deep insights into plant ecology and evolution and offer new genetic resources that can be developed for various applications, from medicine to agriculture (Handayani et al., 2022). Therefore, continued exploration and research in this field are necessary to maximize the benefits that can be obtained from this remarkable plant family. The ongoing efforts to explore and catalog new Zingiberaceae species are critical, not just for science, but also for promoting biodiversity conservation, sustainable development, and the discovery of new resources that could benefit humanity. These plants thrive and proliferate in the Asian region. The discovery of new species results from exploration aimed at uncovering the various potentials of Zingiberaceae in future research.

2. Data Collections

Review articles have become increasingly important in order to stay up-to-date with developments in specific research areas (Bahishti, 2021). A well-crafted review article offers readers a comprehensive understanding of the field and highlights key gaps and challenges for future research (Dhillon, 2022). Our approach to understanding the distribution and discovery of new Zingiberaceae species involves several key criteria: the species must be newly discovered (not new genera, subspecies, new records, or revisions), found in Asia, published within the last six years (2019-2024), contain data on different characterizations, be written in English, and be formally published (not preprints or drafts).

To collect relevant data, we utilized a comprehensive framework to categorize the documents, integrating data from a literature review. The literature review involved searching various databases, including ScienceDirect, Scopus, Web of Science, Google Scholar, Google Books, and the Internet Archive, for references on new Zingiberaceae species. We used specific keyword search terms such as "new Zingiberaceae species," "discovery," "Asia," and "characterization" to identify pertinent articles. The identified documents were reviewed thoroughly, and the study results were analyzed and synthesized based on thematic topics and various aspects outlined within the main objectives. The review process focused on ensuring that only articles meeting all the specified criteria were included. These criteria ensured that the data collected was relevant and up-to-date and provided a comprehensive overview of new Zingiberaceae species discoveries in Asia.

3. Species Discovered

Research and exploration of new species within the Zingiberaceae family are crucial due to the immense potential these plants hold. The discovery of new species not only enhances biodiversity but also provides opportunities to find new bioactive compounds beneficial to human health and commercial product development. Table 1 presents data on the discovery of new Zingiberaceae species in Asia over the past five years. This report includes the species names, discovery year, country of origin, and key morphological characteristics. Such comprehensive data is crucial for understanding the ongoing patterns of species discovery and the regions contributing most significantly to these findings.

Table 1. Recent data on new species discovered in Asia

No	Species	Years	Country	Different Characteristics	Author
1	*Curcuma pulcherrima*	2020	Thailand	*Curcuma pulcherrima* has pubescent sheathing bracts, leaf sheaths, petioles, peduncles, and ovaries. The ligule measures 5-8 mm in length. The leaf blades have a cuneate to slightly rounded base and an abaxial surface tinged with various shades of brownish-red, with glabrous surfaces except for hairy margins, tips, and sparsely hairy midribs. The floral tube is white and measures 3.6-3.8 cm in length. The lateral staminodes are asymmetrical and narrowly elliptic with an acute apex and slightly undulate margin, predominantly white with a pinkish tinge, and feature a pale yellow middle line along the inner side of the mid-lobe extending from the base to about one-third of the length. The outer side is white with a pinkish tinge and a white midrib. The labellum is obovate. The epigynous glands measure 7.0-7.2 mm in length, and the ovary is ellipsoid.	(Saensouk et al., 2022b)
2	*Curcuma ruiliensis*	2017	China	*Curcuma ruilensis* is characterized by its yellow rhizome and purple stripes on the upper surface of the leaf blades. It has a much smaller stature with un-branched rhizomes and smaller leaf blades. The leaves are glabrous on the adaxial surface and pubescent on the abaxial surface. The species also features lanceolate coma and fertile bracts. Additionally, it has a distinctively shaped labellum and seed setting.	(Chen et al., 2021)
3	*Curcuma siamensis*	2018	Thailand	*Curcuma siamensis* is distinguished by its terminal inflorescences that emerge between the leaf sheaths at the base of the pseudo-stem and lack coma bracts. The plant produces yellow flowers and has epigynous glands and anther spurs. Its leaves are narrowly elliptic, measuring 18–36 × 6–8.5 cm, with an upper midrib that is reddish. The thyrse is shorter and smaller, measuring 5–6.5 cm in length and 4–5 cm in diameter. The peduncle is glabrous, and there are 10–15 bracts per inflorescence, fused almost only at the base. The corolla lobes are white, longer, and narrower, measuring 17–18.3 × 6–7.8 mm. The staminodes are uniquely obovate-rhombic, and the labellum is ovate-trullate. The filament is 4.4–4.5 mm long, and the anther is approximately 8 mm long with spurs pointing outward in front view and an anther crest apex that is retuse.	(Saensouk et al., 2021a)

Table 1. Recent data on new species discovered in Asia (continued)

No	Species	Years	Country	Different Characteristics	Author
4	*Curcuma suraponii*	2021	Thailand	*Curcuma suraponii* features an ovoid primary rhizome with branched rhizomes that are yellow internally. The leaf sheaths, petioles, peduncle, bracteoles, calyx, floral tube, and corolla lobes are all pubescent. Its terminal inflorescence emerges through lateral slits of the pseudostem, positioned 15-20 cm above the ground. The plant has a coma bract and fertile bracts that are pubescent on both surfaces and margins, ruby pink only at the distal part, and pale green towards the base. The anther measures 7.2 × 2 mm with spurs that are 2.5 mm long. The anther crest is slightly longer than the anther lobes. Additionally, the ovary is ellipsoid, measuring 4 × 3 mm.	(Boonma, 2023)
5	*Curcuma tuanii*	2017	Vietnam	*Curcuma tuanii* is characterized by rich yellow staminodes that are as long as the labellum and an L-shaped anther. This species can be readily distinguished by having 5–15 leafy shoots per plant, forming a larger clump, compared to other species. Its leaf lamina is oblong, measuring 40–80 cm in length, with a prominent petiole up to 40 cm long. The inflorescence is terminal only and features a spike composed of more dense bracts, with 25–45 bracts, and a bract-to-spike length ratio of 2.50–3.3. The staminodes are narrower, measuring 18–21 × 11–13 mm. The labellum has an incision extending more than half its length. The anther is longer, measuring 10–11 mm, with a longer anther crest of 1.0–1.5 mm and an entire rounded apex.	(Nguyen et al., 2023a)
6	*Curcuma yingdeensis*	2017	China	*Curcuma yingdeensis* is distinguished by its green leaf blades with obvious purple stripes on the adaxial surface. The species has creamy to pale yellow-colored rhizomes and narrower leaf blades. It features laxer inflorescences and smaller flowers. The coma bracts are pink with purple tips, while the fertile bracts are pale green with brown tips and purple dots at the adnate portion. The labellum is sub-orbicular with rounded lobes and two pale purple lines at the base.	(Chen et al., 2019)

Table 1. Recent data on new species discovered in Asia (continued)

No	Species	Years	Country	Different Characteristics	Author
7	*Curcuma ubonensis*	2022	Thailand	*Curcuma ubonensis,* distinguished by its greenish inflorescence with small purple flowers lacking epigynous glands, exhibits several differences from *Curcuma prasina*. Notably, *Curcuma ubonensis* has a larger brownish rhizome, brownish-red margin on the petiole, elliptic leaf lamina with acute apex, coma bracts, triangular-obovate fertile bracts, longer bracteoles, longer calyx with unilateral incision, broader bilobed labellum with reddish-purple coloration and white stripes, and anther crest that is not obvious, setting it apart from *Curcuma prasina*.	(Saensouk et al., 2023)
8	*Curcuma wanenlueanga*	2017	Thailand	*Curcuma wanenlueanga* is characterized by its terminal inflorescence. Its leaves are green adaxially with reddish-purple along the midrib, and the leaf sheaths exhibit a reddish-brown tinge. These distinct features differentiate it from other species within the *Curcuma* genus. Additionally, the rhizome of *Curcuma wanenlueanga* is yellow with a darker core internally.	(Saensouk et al., 2021d)
9	*Curcuma suphanensis*	2021	Thailand	*Curcuma suphanensis* stands out with its lanceolate lamina, sparsely hairy midrib, and pubescent ligule measuring 16.5–18 mm long. Its fertile bracts are white with a reddish tinge at the distal part and connate almost only at the base to the lower 1/4. Unlike some species, it has bracteoles. Flowers are arranged in cincinni of 3–4, with a calyx length of about 13 mm, sparsely hairy at the distal part. The floral tube is 2.4–2.5 cm long, exhibiting sparse hairiness. Both dorsal and lateral corolla lobes feature unique characteristics. Staminodes and labellum display distinctive pubescence patterns. Anther spurs are approximately 0.5 mm long, and the ovary is pubescent.	(Saensouk et al., 2022c)
10	*Curcuma rosea*	2021	Thailand	*Curcuma rosea* is distinguished by its leaves featuring a dark reddish patch along the midrib and a glabrous texture. The calyx is 11–12 mm long and white, while the ligule measures 12–14 mm long. Notably, it lacks bracteoles and has a white floral tube. Staminodes have a rounded apex and are glabrous on both sides, and the labellum is white with pale yellow at the tip, gradually transitioning to a white median band. Additionally, the filament is 1.5–1.8 mm long.	(Saensouk et al., 2022c)

Table 1. Recent data on new species discovered in Asia (continued)

No	Species	Years	Country	Different Characteristics	Author
11	*Curcuma papilionacea*	2019	Thailand	*Curcuma papilionaceae* is distinguished by its unique flower color, blending violet, dark red, white, and yellow hues. It shares prominently plicate leaf blades with some species in the subgenus Hitcheniopsis but can be easily distinguished by its inflorescences lacking coma. Additionally, it lacks coma bracts, contrasting with other species.	(Soonthornkalump et al., 2020)
12	*Curcuma aruna*	2020	Thailand	*Curcuma aruna* is characterized by its early flowering habits, short peduncle, absence of coma, and yellow flowers. Its leaves are ovate and glabrous on both surfaces, distinguishing it from *C. flaviflora*, which has elliptic to oblanceolate leaves that are pubescent on both surfaces. The corolla tube of *C. aruna* is shorter than that of C. flaviflora, measuring 2.3–2.8 cm compared to 3.8–4.2 cm. Additionally, the staminodes of *C. aruna* are obovate and larger than those of *C. flaviflora*, measuring 2.2–2.6 × 1.4–1.6 cm versus 2.0 × 1.2 cm.	(Maknoi et al., 2021)
13	*Curcuma pitukii*	2020	Thailand	*Curcuma pitukii* is characterized by its terminal inflorescence, absence of coma bracts, and small filiform anther spurs. Its leaves are densely puberulent on the adaxial surface. The bracts of *C. pitukii* are purplish white to purple, and the calyx is longer compared to *C. eburnea*. Additionally, the corolla tube of *C. pitukii* is shorter, and its corolla lobes are purplish white to pale purple and sparsely puberulent at the apex. The filament of *C. pitukii* is longer, and the anther is shorter compared to *C. eburnea*.	(Maknoi et al., 2021)
14	*Zingiber natmataungense*	2019	Myanmar	*Zingiber natmataungense* is distinguished by its unique characteristics. Its leaf blade exhibits a light green color on the abaxial surface, while the ligule is sparsely pubescent and the bracts are glabrous. The calyx is white and glabrous, featuring an apex with three obvious teeth. The lateral lobes of the calyx measure approximately 1.5–1.7 × 0.6–0.7 cm. Additionally, the stamen displays sparse pubescence, with a white and glabrous filament measuring 1–2 mm. The anther connective appendage transitions from yellowish proximally to purplish distally. The ovary is white with sparse white pubescence, and the epigynous glands are tapering and yellow.	(Li et al., 2020)

Table 1. Recent data on new species discovered in Asia (continued)

No	Species	Years	Country	Different Characteristics	Author
15	*Curcuma chantaranothaii*	2019	Thailand	*Curcuma chantaranothaii* stands out with its terminal inflorescence enclosed by leaf-sheaths and narrowly sized leaves (4–6 cm wide) with a puberulous upper surface. Its staminodes are rhomboid, and the labellum features unique paler yellow curves resembling a crescent moon, extending parallel along each side of the embossed yellow patch to half of the labellum's length. The epigynous glands have a blunt apex measuring 4 mm long.	(Saensouk et al., 2021c)
16	*Curcuma rangsimae*	2018	Thailand	*Curcuma rangsimae* is characterized by narrowly elliptic to oblanceolate leaves measuring 12–20 cm wide and 40–70 cm long, with a slightly oblique attenuate base. Its spike measures 12–20 cm long and 7.8–9.5 cm in diameter at the middle, with a glabrous calyx and asymmetrical trullate to ovate lateral staminodes. The anther spurs are conical, measuring 2.8–3.4 mm long, and the ovary is prolate spheroid-shaped, measuring 3.5–4.0 × 2.5–3.0 mm, and glabrous.	(Saensouk et al., 2021c)
17	*Curcuma charanii*	2019	Thailand	*Curcuma charanii* is recognized by its ovoid rhizome with white internal coloration. The bladeless sheaths are mostly glabrous, with only a few hairs at the tip. Its ligule is triangular and bilobed, while the leaves have an acute to acuminate apex. Bracteoles are larger, and flowers emerge from the bracts. The calyx is pale purple, and the dorsal corolla lobe is ovate and white with a pale yellow tip, featuring an acute, hooded apex. Lateral staminodes are narrowly obovate to oblanceolate, pale pinkish-purple to pale purple with white at the base. The labellum apex is bilobed, with a deep incision up to 5 mm, pale pinkish-purple to purple, and adorned with fine glandular hairs in the middle.	(Saensouk et al., 2021c)
18	*Curcuma phrayawan*	2019	Thailand	*Curcuma phrayawan* features a terminal inflorescence emerging between leaf-sheaths, with a red-toned peduncle and deep yellow internally branched rhizome. Its leaves are oblanceolate, with green upper surfaces and red along the midrib. Coma bracts are white with pink tips, while corolla lobes exhibit various shades of pink and yellow. Staminodes are pale yellow, and the labellum is pale yellow with a yellow patch in the middle.	(Saensouk et al., 2021c)

Table 1. Recent data on new species discovered in Asia (continued)

No	Species	Years	Country	Different Characteristics	Author
19	*Curcuma puangpeniae*	2018	Thailand	*Curcuma puagpeniae* features an ovoid rhizome with creeping branches and root tubers situated far from the rhizome. Its bladeless sheaths are reddish-brown with a green tip and white base, mostly glabrous except for a few hairs at the tip. Leaves are asymmetrical lanceolate to narrowly elliptic with undulating margins. Fertile bracts are broadly obovate, green with dark green veins, and pale green at the base. Flowers are exerted from the bracts, with a longer floral tube and a trilobed calyx. Corolla lobes are ovate, with the dorsal lobe obtuse and slightly hooded, and lateral lobes obtuse and slightly hooded. Lateral staminodes are white, while the labellum is lilac with veins gradually fading to white at the base. Filaments are white, and the anther crest is also white.	(Saensouk et al., 2021c)
20	*Curcuma purpurata*	2019	Thailand	*Curcuma purpurata* is distinguished by sparsely pubescent leaf-sheaths and petioles. Its narrowly ovate leaves are minutely pubescent on both sides, with an acuminate apex and undulating margins. Green bracts and coma bracts are pubescent, while bracteoles are white with pale green tips. The corolla tube protrudes conspicuously from the inflorescence, measuring 3 cm long. Staminodes are oblanceolate and white, with the labellum broadly obovate and bilobed, featuring purple at the base fading to pale purple at the tips, with yellow bands flanked by white stripes.	(Saensouk et al., 2021c)
21	*Curcuma peramoena*	2014	Laos	*Curcuma peramoena* is a perennial herb with fragrant, creamy white rhizomes and ovate tuberous roots. It grows 28–45 cm tall, with brownish-red or green-tipped sheaths and narrowly elliptic, pubescent leaves. The terminal inflorescence bears 1–5 flowers, with ovate reddish-brown bracts. Flowers are 4–5 cm long, with a white calyx and lanceolate pink corolla lobes. The bilobed labellum has deep incisions, whitish with yellow patches and reddish-orange spots. Flowering occurs from May to September.	(Souvannakhoummane & Maknoi, 2014)
22	*Curcuma tongii*	2013	China	*Curcuma tongii* is distinguished by its spike with few bracts and well-exserted white flowers. Its labellum features two bright yellow swollen bars along the median, accompanied by deep purple or dark red bands adjacent to the yellow ones. Additionally, its lateral staminodes are pure cream white, while fertile bracts exhibit a cream-white base with a progressively reddish tinge towards the apex and margins.	(Zhang et al., 2019)

Table 1. Recent data on new species discovered in Asia (continued)

No	Species	Years	Country	Different Characteristics	Author
23	*Curcuma achrae*	2021	Thailand	*Curcuma achrae* is distinguished by several characteristics: its pubescent petioles, green leaves with a reddish tinge and sparsely hairy adaxial surface along the midrib. Additionally, its fertile bracts are connate in the lower 1/7 with a mucronate apex. The labellum features a white base transitioning into a golden yellow middle and apical part, marked by two golden yellow median bands divided into Y-shaped patches at the base. Its staminodes are irregularly ovate with an acute apex, gradually fading from golden yellow to pale yellow at the base, often with a reddish V-shaped or triangle patch at the base. Furthermore, its anther appears almost straight, with shorter spurs and a crest length of 3–4 mm, characterized by an acute to a rounded or slightly truncate apex, unlike other similar species.	(Saensouk et al., 2022e)
24	*Boesenbegia eburnea*	2018	Philippines	*Boesenbegia eburnea* stands out with its shorter stature, typically reaching up to 40 cm in height compared to similar species that may grow up to 60 cm tall. Additionally, its ligule lobes are subulate rather than ovate, and its lamina is narrowly ovate and plicate rather than narrowly linear and smooth. Another distinctive feature is the apex of its labellum, which is entire rather than ± bilobed. Furthermore, its anther crest is white and entire, contrasting with the yellow and 4-lobed crest found in other related species.	(Docot et al., 2020)
25	*Boesenbegia leonardocoi*	2017	Philippines	*Boesenbegia leonardocoi* is distinguished by its taller habit, typically ranging from 9 to 40 cm compared to related species that can reach heights of 20 to 60 cm. Additionally, its lamina is broader, measuring 4 to 9 cm wide, in contrast to the 5 to 13 cm width found in other species. Another notable difference is the coloration of the labellum, which is lavender with a dark violet patch at the throat, unlike the white with a yellow patch seen in other species. Moreover, its lateral staminodes are lavender instead of white, and the apex of its anther crest is white rather than purplish.	(Docot et al., 2020)
26		2019	Thailand	*Curcuma cordata* is identifiable by its flowers, which display a darker tone of yellow or orange-yellow compared to the paler hue of *C. petiolata*. In its natural habitat, *C. cordata* tends to grow larger and more statelier, with leaves that are distinctly cordate, soft, and villous, while *C. petiolata* typically has glabrous leaves. Additionally, *C. cordata* features a spike with villous texture, setting it apart from *C. petiolata,* which has a smooth spike.	(Saensouk et al., 2021b)

Table 1. Recent data on new species discovered in Asia (continued)

No	Species	Years	Country	Different Characteristics	Author
27	*Curcuma rangjued*	2017	Thailand	*Curcuma rangjued* distinguishes itself by several key features. Unlike *C. amada* and *C. sichuanensis*, its rhizome lacks aroma. Furthermore, its leaves exhibit sparse hairiness along the vein, and its peduncles are notably longer, ranging from 25 to 37 cm. Additionally, it bears fewer fertile bracts per inflorescence (7–12), and its calyx is light pale yellow, measuring 1.64–1.75 cm long. The floral tube of *C. rangjued* extends 3.3–3.5 cm, and its corolla lobes are hairy at the distal part. Anther spurs of *C. rangjued* measure 3–4 mm in length, further setting it apart from *C. amada* and *C. sichuanensis*.	(Saensouk et al., 2021b)
28	*Kaempferia maculifolia*	2018	Thailand	*Kaempferia maculifolia* is characterized by its erect rhizome, emitting a fragrant aroma, and its pubescent leafless sheaths, leaf sheaths, petioles, and bracts. Its leaves are pubescent on both surfaces, with a unique adaxial surface featuring green coloration with dark green spots. The calyx is distinctly 3-lobed, and the anther crest is narrowly oblong to spatulate,and white with light pale yellow at the base. Additionally, the ovary is cylindrical and light pale green with sparse hairs. These features distinguish *K. maculifolia* from other Kaempferia species.	(Boonma et al., 2020)
29	*Kaempferia takensis*	2019	Thailand	*Kaempferia takensis* stands out with its unique traits. Its inflorescences emerge directly from the rhizome before the pseudostem, with the plant growing up to 90 cm tall. Its leaves have scabrous upper surfaces and pubescent lower surfaces, with green upper leaf surfaces featuring white or light pale green patches between the veins, while the lower surface is brownish-red. The petioles measure 4–5 cm in length and are pubescent. The floral tube is long, slender, and sparsely hairy. The lateral staminodes have an acute apex, and the labellum is light pale pink with dark pink reaching almost to the base, complemented by white at the base.	(Boonma et al., 2020)
30	*Kaempferia napavarniae*	2020	Thailand	*Kaempferia napavarniae* can be distinguished by several key characteristics. It has pubescent leaf sheaths, whereas in other species they are glabrous. The leaves are adaxially green with distinct dark green spots and are pubescent on both surfaces, unlike other species where they are mottled dark green and glabrous. Additionally, its bracts are triangular and pubescent, unlike the oblong and glabrous bracts of other species. The calyx is longer, apex mucronate, and sparsely hairy compared to other species. Furthermore, its anther crest is broadly ovate and larger in size, and the epigynous glands are longer.	(Saensouk et al., 2022d)

Table 1. Recent data on new species discovered in Asia (continued)

No	Species	Years	Country	Different Characteristics	Author
	Kaempferia sakonensis	2019	Thailand	*Kaempferia sakonensis* differs from other species in several characteristics. Its leafless sheaths and leaf sheaths are sparsely hairy, while others are typically glabrous. The petiole is sessile, unlike those of other species which are longer. Its ligule is emarginate, with rounded to truncate apexes, and pubescent, contrasting with the glabrous and broadly triangular ligules of other species. *K. sakonensis* typically has only 2 leaves, which are ovate, elliptic, or obovate in shape, dark red on the upper surface, and pubescent on the lower surface. The peduncle is very short, and the bracts are lanceolate with mucronate apexes and pubescent, unlike the linear and glabrous bracts of other species. Additionally, its calyx is longer, white with a reddish tinge at the apex, and the corolla lobes are larger. The labellum is bilobed, deeply divided, and pale purple with dark purple at the base, while other species typically have different colors or shapes.	(Saensouk et al., 2022d)
32	*Curcuma nakhonphanomensis*	2021	Thailand	*Curcuma nakhonphanomensis* is identified by its green leaf sheaths, ligule, and petiole tinged with brownish red. The broad lamina, measuring 8–13 cm wide, features a cordate to slightly rounded base with red patches along the midrib, and both leaf surfaces are pubescent. The peduncle and fertile bracts are also pubescent. Its flowers are 6.2–6.5 cm long, with a 22–25 mm long calyx. The labellum is obovate, white with a yellow distal half of the median band transitioning to yellowish orange, and with dark red lines. Staminodes are asymmetrical, and the filament is white.	(Saensouk et al., 2022a)
33	*Curcuma stahlianthoides*	2022	Thailand	*Curcuma stahlianthoides* is characterized by its inflorescence comprising multiple green bracts and the overall shape of its flowers. However, it differs in having branched rhizomes with short and stout branches, cream in cross-section. Additionally, its leaf blades are narrowly elliptic, up to 25 by 2.9 cm, with obscure plication. The labellum of *Curcuma stahlianthoides* is white with a yellow median band, unlike the red-based median band seen in other species.	(Soonthornkalump et al., 2022)

Table 1. Recent data on new species discovered in Asia (continued)

No	Species	Years	Country	Different Characteristics	Author
34	Zingiber chengii	2014	Taiwan	*Zingiber chengii* sp. nov. exhibits distinct features setting it apart from its Taiwanese counterparts. It has deciduous leafy shoots, narrow lanceolate to linear leaves, and bears yellow flowers, unlike the reddish-purple flowers of other native species. The number of flowers per spike ranges from 1-3, and its fruit shape is ovoid. Additionally, *Z. chengii* has ellipsoidal pollen grains with spiro-striate sculpturing and its inflorescence is borne on a radical, procumbent peduncle. These unique characteristics distinguish *Z. chengii* as a new species in Taiwan.	(Wang et al., 2020)
35	*Kaempferia sipraiana*	2019	Myanmar	Green leaf with short white stripes along the edges, apex acuminate with a slight mucronate, and attenuate-oblique base. Its peduncle is glabrous, and the bracts are red with dark red veins and a mucronate apex. The floral tube is shorter than the calyx, which is glabrous. The staminodes are oblanceolate with a curly bracket-like apex, while the labellum transitions from white at the base to pinkish-purple in the middle, fading to pale pink and white at the tip and edge, respectively. The apex of the labellum features four lobes, with the outer lobes acute and the inner lobes obtuse, sometimes combined to truncate. The stigma has pink lips, and the epigynous glands are shorter (6–7 mm long).	(Boonma et al., 2022)
36	*Kaempferia pseudoparviflora*	2020	Myanmar	*Kaempferia pseudoparviflora* is a perennial herb with yellowish rhizomes and short pseudostems. Its bladeless sheaths are green with a red tinge, and the single leaf is broadly obovate to suborbicular, with a dark green upper surface and a pale green lower surface. The inflorescence is terminal, with lanceolate bracts and keeled bracteoles. The flowers have a tubular calyx and a white corolla tube, with lanceolate dorsal corolla lobes and narrowly lanceolate lateral corolla lobes. The bilobed labellum is whitish or pale purple with dark purple patches towards the base and a white spot at the base. The lateral staminodes are obovate and white.	(Boonma et al., 2022)
37	*Alpinia nelumboides*	2019	Laos	*Alpinia nelumboides* shares the closest morphological similarity with *A. kwangsiensis*, particularly in terms of inflorescence shape and flower coloration. However, it also exhibits resemblances to *A. roxburghii* Sweet and *A. malaccensis* (Burm.f.) Roscoe. This species is distinguished by its exceptionally elongated inflorescence, reaching up to 50 cm in length, and its ovoid fruits with a hirsute surface.	(Tanaka et al., 2023)

Table 1. Recent data on new species discovered in Asia (continued)

No	Species	Years	Country	Different Characteristics	Author
38	*Kaempferia aurora*	2019	Thailand	*Kaempferia aurora* differs from other species with its short anthesis period, fully open only from 06 a.m. to 07 a.m. and then immediately wilting within an hour, unlike those that remain open until midday. Additionally, the color of its lateral staminodes and labellum changes to brownish orange when dry and shriveled, unlike others that are white with deep purple to blue hues. Its anther crest is tridentate instead of bilobed, usually with 1–3 small teeth, and it has longer epigynous glands, approximately 10mm long, compared to 2–5mm long in other species.	(Nopporncharoenkul et al., 2020)
39	*Kaempferia caespitosa*	2019	Thailand	*Kaempferia caespitosa* stands out with its pure white flowers, but it differs from others in key aspects: it blooms during the day (diurnal anthesis), has torulose rhizomes with long, slender, cylindrical tubers, grows in clumps with multiple leafy shoots per rhizome, and features longer petioles, ranging from 5.5 to 11.5cm.	(Nopporncharoenkul et al., 2020)
40	*Zingiber calcicola*	2020	China	*Zingiber calcicola* shares a terminal inflorescence and similar labellum with other species, but it differs notably. Its lamina is prominently plicate and oblong, unlike the triangular shape of others, and its lateral staminodes are longer, measuring 1.3–1.6 cm compared to 0.2–0.6 cm. Additionally, the elliptic lamina of Z. calcicola is larger, measuring 13–19 × 4–6.5 cm, whereas others have narrowly elliptic lamina measuring 18–25 × 2–3 cm. Moreover, Z. calcicola has a dwarf habit, reaching only 40–55 cm tall, whereas others can grow taller, ranging from 65 to 100 cm tall.	(Ding et al., 2021)
41	*Alpinia hoangviet*	2023	Vietnam	*Alpinia hoangviet* is characterized by a small, glabrous habit and narrowly lanceolate leaves. It features an erect panicle inflorescence with a few cincinnus. Distinct features include bladeless leaf sheaths with purplish-red blotches, a longer ligule of about 10 mm, narrowly tubular pinkish bracteoles, and a smaller labellum approximately 3 cm long.	(Nguyen et al., 2023b)
42	*Kaempferia jenjittikuliae*	2020	Thailand	*Kaempferia jenjittikuliae* has a habit and leafy shoot, distinguished by its upright to slightly arcuate lateral staminodes, deflexed distal half of the labellum, flat labellum base, and an incision around half the length of the labellum. Its broadly ovate to suborbicular leaves lie adpressed to the ground. The anther crest is ovate, broadly elliptic to obdeltoid, with an irregular trilobed to tetralobed apex.	(Nopporncharoenkul et al., 2021)

Table 1. Recent data on new species discovered in Asia (continued)

No	Species	Years	Country	Different Characteristics	Author
43	*Kaempferia sakolchaii*	2020	Thailand	*Kaempferia sakolchaii* features lamina that are narrowly ovate to broadly ovate, with a striking adaxial dark green color alternated with silver or white longitudinal stripes and small black dots along the margin. The abaxial side is pale green with small black dots. The anther crest measures approximately 6 × 3 mm, is bilobed, and each lobe apex has four sub-lobes. The ovary is about 3 × 2 mm, complemented by epigynous glands that are around 3 mm long.	(Saensouk et al., 2024a)
44	*Kaempferia phuphanensis*	2022	Thailand	*Kaempferia phuphanensis* features a green lamina on the adaxial surface with translucent white margins and a green abaxial surface. It has bladeless sheaths, bracteoles, and a green calyx. The floral tube is pale green.	(Saensouk et al., 2024a)
45	*Kaempferia subglobosa*	2019	Thailand	*Kaempferia subglobosa* is characterized by branched storage roots with numerous, tiny, lateral and terminal subglobose to ovoid tubers. The ligules are 7–14 mm long and opaque. The labellum is narrowly obovate with an incision around one-third of its length. The anther crest has a bifid apex with aristate apices, a serrate to undulate incision, and an angular incision base.	(Nopporncharoenkul & Jenjittikul, 2024)
46	*Curcuma kayahensis*	2017	Myanmar	*Curcuma kayahensis* is characterized by orange-red lateral staminodes and a rhombic-shaped labellum. It has yellow rhizomes inside and a lower surface of the lamina densely covered with silver scales. The inflorescence is positioned centrally, with light green bracts accented by red veins. The flowers feature a longer, gently curved anther.	(Tanaka & Aung, 2020)
47	*Kaempferia nemoralis*	2017	Cambodia	*Kaempferia nemoralis* features a tall, glabrous plant with parallel-veined, erect leaf blades. The leaf sheath and young shoot apex are green, and the petiole is absent. The flowers are oriented, colored, and sized distinctly compared to *K. larsenii*. The inflorescences and flowers, similar to *K. rotunda* in the presence of white staminodes and labellum size, are distinguished by a peduncle and a longer floral tube measuring 95 mm. The labellum is purple with a white line at the center, and the anther crest is obovate, bifid, with an irregularly rounded apex. The ovary is glabrous, and the vegetative parts differ in the shape and indumentum of the leaf blade, with no petiole present.	(Insisiengmay et al., 2020)

Table 1. Recent data on new species discovered in Asia (continued)

No	Species	Years	Country	Different Characteristics	Author
48	*Kaempferia pascuorum*	2017	Cambodia	*Kaempferia pascuorum* is typically around 6–10 cm tall, with erect leaf blades that are similar in shape, parallel-veined, and glabrous. It is distinguished by several characteristics: the leaf sheath and young shoot apex are green, while the staminodes are white. The labellum is white with a purple patch, and the crest is flabellate with a bifid, irregularly rounded white apex.	(Insisiengmay et al., 2020)
49	*Curcuma fimbriata*	2019	Thailand	*Curcuma fimbriata* is characterized by its ecomate inflorescence composed solely of green fertile bracts and cincinni containing 10–12 flowers at the base. Its staminodes are white, while the labellum is white with a pale yellow patch in the basal half, transitioning to pale purple distally with a prominently fimbriate margin. This contrasts with Curcuma prasina, where the cincinni typically contain 4 or 5 flowers, and the staminodes and labellum range from pale to dark purple, with entire margins and a bright yellow, swollen median line extending to two-thirds of the labellum.	(Leong-Škorničková et al., 2020a)
50	*Curcuma micrantha*	2020	Thailand	*Curcuma micrantha* exhibits a small habit, with an inflorescence adorned by distinct white coma bracts and flowers featuring a purple labellum. Notably, it differs from Curcuma parviflora in several aspects: its fertile bracts support 4–6 flowers, the flowers themselves are small and sunken into the subtending bract, with the labellum facing upwards and not reflexing out of the bract. Additionally, its staminodes and filament are purple	(Leong-Škorničková et al., 2020a)
51	*Curcuma spathulata*	2020	Thailand	*Curcuma spathulata* is characterized by its small habit and an inflorescence adorned with distinct white coma bracts. The flowers of this species feature a labellum that is deeply bilobed and prominently spathulate, with red blotches at the base. The coma bracts are pure white without green tips, and the fertile bracts typically support 4–6 flowers. Additionally, the staminodes of Curcuma spathulata are almost linear in shape, with red streaks at the base, contributing to its unique botanical profile.	(Leong-Škorničková et al., 2020a)

Table 1. Recent data on new species discovered in Asia (continued)

No	Species	Years	Country	Different Characteristics	Author
52	*Curcuma globulifera*	2020	Thailand	*Curcuma globulifera* is characterized by its dense, globular to elliptic inflorescences on short peduncles, comprising green bracts and yellow flowers. However, it differs from similar species such as *Curcuma strobilifera* in several key aspects. Curcuma globulifera features a prominently branched rhizome structure, with lateral inflorescences emerging just before the leaves. Its flowers exhibit pale yellow staminodes and a pale yellow labellum with a darker median band, setting it apart from *C. strobilifera*, where the rhizome consists of a series of a few unbranched globular rhizomes, the inflorescences are central, and the flowers have a uniformly warm yellow labellum and lateral staminodes.	(Leong-škorničková et al., 2020a)
53	*Boesenbegia isanensis*	2018	Thailand	*Boesenbegia isanensis* is a perennial herb, typically 70–80 cm tall. Its rhizome and roots are dark yellow inside, and the leaf blades are glabrous with a dark red midrib on the upper surface and dense pubescence on the lower surface. The cream-colored flowers have a red apical half and a cream basal half, with pubescence at the center. The bladeless leaf sheaths are dark green and pubescent, while the foliage leaves are elliptic-oblong. The inflorescence is terminal, about 6–7 cm long, with approximately 7 flowers opening sequentially. Each flower has a green lanceolate bract and appears mainly during the rainy season.	(Saensouk & Saensouk, 2021)
54	*Zingiber longii*	2022	China	*Zingiber longii* is characterized by terminal inflorescences and rufous-pilose leaf sheaths and ligules. It differs from similar species by its lamina with a caudate apex extending to 5 cm and a broadly ovate labellum with an emarginate apex. The laminae and ostiole margins are glabrous, distinguishing it from related species with pilose laminae margins and ciliate ostioles.	(Ding et al., 2023)

Table 1. Recent data on new species discovered in Asia (continued)

No	Species	Years	Country	Different Characteristics	Author
55	*Boesenbegia ashihoi*	2024	India	*Boesenbegia ashihoi* is characterized by its small globular rhizome, long-petioled leaves, horn-like spike, and anther connectives lacking crests. However, it differs from similar species in several aspects. Its leaves are elliptic, in contrast to the oblong-lanceolate leaves of others. Additionally, the bracteoles are much shorter than the bracts, unlike those of similar species where they almost equal the bracts in length. The labellum is orbicular with an orangish throat, differing from others where it is ovate to obovate or cuneate with a reddish or yellowish throat. Furthermore, the corolla tube of Boesenbegia ashihoi is 9–10 cm long, while in similar species it ranges from 1 to 6 cm in length.	(Debnath et al., 2024)
	Zingiber cornigerum	2016	India	*Zingiber cornigerum* differs from the latter in several ways. Its ligules are glabrous rather than villous, and its leaves are purple on the abaxial surface, not green. The inflorescence is creamy white and narrowly ovate, with bracteoles having a horned apex. Flowers are longer at 8–10 cm, with a creamy white labellum adorned with reddish-pink blotches and a rounded apex. Lateral staminodes have a beaked apex and are 1/3 adnate to the labellum. Additionally, the epigynous glands match the length of the ovary.	(Jayakrishnan et al., 2021)
57	*Zingiber campanulatum*	2016	India	*Zingiber campanulatum* differs from *Z. mizoramensis* and *Z. arunachalensis* with its pubescent ligule, longer peduncle (6–13 cm versus 1.0–1.5 cm), and triangular narrowly-ovate bracteole. Its corolla lobes are creamy, and lateral staminodes are adnate, whereas in the other species they are free. *Z. campanulatum* also has oblong laminae, a 7.5–25 cm long inflorescence with a creamy oblong spike, and narrowly obovate bracts with cream coloration and purple margins. The flower mouth is bell-shaped, and the labellum is elliptic with a round apex, unlike the ovate shape and acute apex of the latter.	(Jayakrishnan et al., 2021)
58	*Zingiber aguingayae*	2018	Vietnam	*Zingiber aguingayae* is distinguished by several characteristics. Its ligule is much longer (2–3 mm) and pubescent, whereas in other species it is typically glabrous and shorter (5–6 mm). The corolla of *Z. aguingayae* is yellow, contrasting with the light pink corolla of related species. Additionally, its labellum is obovate and yellow, while in other species it is light pink and orbicular. Furthermore, the ovary of *Z. aguingayae* is slightly pubescent, whereas it is typically glabrous in other species.	(Docot et al., 2019)

Table 1. Recent data on new species discovered in Asia (continued)

No	Species	Years	Country	Different Characteristics	Author
59	*Zingiber subroseum*	2018	Vietnam	*Zingiber subroseum* is characterized by several distinctive features. Its lamina is petiolate, unlike the sessile lamina of related species. Additionally, it has a significantly shorter peduncle (9–11 cm long) and a wider spike (8–10 cm wide), in contrast to the longer peduncle (10–30 cm long) and narrower spike (4–6 cm wide) of other species. Furthermore, its floral bract is cream-pink, while in other species it is mid-green. Finally, the fruiting spike of *Z. subroseum* is cream-pink, whereas it is bright red in related species.	(Docot et al., 2019)
60	*Zingiber capitatum*	2017	India	*Zingiber capitatum,* a perennial herb reaching 1-2 m in height, is known for its terminal spike inflorescences atop leafy stems. Its rhizomes are thick and aromatic, bearing yellow root tubers. The leaves are linear, recurved, and measure 30-40 cm long by 1-3.7 cm wide, with hairy sheaths and minutely hairy undersides. The terminal spike starts deep dark green and matures to bright red, with pale yellow flowers clustered within green bracts. Bracteoles are light green with sparse hairiness. Flowers have a white, membranous calyx and a cylindrical, glabrous corolla with deep yellow lobes. Yellow anthers bear a beak equal in length to the anther lobes. The stigma is funnel-shaped, the style is short, and the ovary is long and pubescent. Capsules are three-sided and oval, bright red, containing many black seeds with a white aril.	(Zode et al., 2021)
61	*Zingiber collinsii*	2019	Laos	*Zingiber collinsii* is identified by its glabrous leaves, silvery along the veins above and burgundy below, and inflorescences with orange bracts. Its cream labellum is tessellated with dark purple. However, in Lao plants, the upper leaf surfaces are bright green without silvery lines, while the lower surfaces are burgundy and pubescent. The petiole consists of a densely hairy pulvinus, and leafy stems are pubescent throughout.	(Tanaka et al., 2020)
62	*Zingiber vuquangense*	2015	Vietnam	*Zingiber vuquangense* is distinguished by its smaller size, longer ligules that become ragged and red-brown with age, and longer petiole. Its lamina is broadly elliptic to elliptic–ovate and mostly glabrous, except for dense pubescence along the midrib on the underside. Bracts and bracteoles are pale yellow at the base and brown-red distally. The corolla lobes are bright yellow, and the labellum is pink-purple with pale yellow spots. Lateral staminodes are yellow with a pink-purple apex, and the fruit is ovoid in shape.	(Lê et al., 2019)

Table 1. Recent data on new species discovered in Asia (continued)

No	Species	Years	Country	Different Characteristics	Author
63	*Zingiber dimapurense*	2018	India	*Zingiber dimapurense* has creamy white bracteoles with purplish red tinges and purplish pink corolla lobes with a white base. It differs from Z. skornickovae N.S.Lý with its hairy ligule and petiole, pubescent lamina, and densely pubescent bracts, calyx, and corolla tube. Notably, its ligule is leathery and up to 1 cm long, and its petiole is larger, reaching up to 1 cm. The spike bears 15–28 floral bracts, pale green to creamy white with purplish red blotches. Additionally, it has an apically bidentate calyx, a white labellum with dense dark purplish red blotches and an acuminate apex, and white lateral staminodes, triangular to ovate-lanceolate in shape.	(Odyuo et al., 2019a)
64	*Zingiber flavofusiforme*	2016	Myanmar	*Zingiber flavofusiforme* displays a notable variation in the shape of its inflorescence, which changes significantly as the plant ages. In younger plants, the inflorescence appears more fusiform and cylindrical, primarily due to the intact bracts. However, as the plant matures, the inflorescence takes on a more flattened appearance as the bracts loosen over time. Additionally, the color of the rhizome varies, becoming more intense only in mature or older rhizomes, typically after two or three years of growth.	(Deiji et al., 2020)
65	*Zingiber magang*	2019	Vietnam	*Zingiber magang* is distinguished by its unique combination of features. Its leafy shoots consist of only 3–5 prominently petiolate leaves with weakly plicate and somewhat shiny leathery laminae. The inflorescences are characterized by the basal part of basal bracts being convex and slightly inflated, lending them a somewhat bullate appearance.	(Lý et al., 2021)
66	*Zingiber tamii*	2019		*Zingiber tamii* is characterized by leafy shoots comprising prominently petiolate, broadly elliptic, and prominently plicate laminae. However, it differs in its overall smaller size (0.5–0.7 m), shorter ligules (3–5 mm long), and smaller abaxially glabrous laminae (15.8–21.5 × 7.5–9.5 cm). The bracts are narrowly ovate, the calyx is shorter (10–12 mm long), and the corolla lobes are pale yellow with sparse external pubescence. Lateral staminodes are also pale yellow, and the labellum is ovate to elliptic ovate with a very dark purple color and small yellow blotches and a yellow margin. This differs from Z. vuquangense, which has a larger size (1.2–1.8 m), longer ligules (12–30 mm long), larger abaxially pubescent laminae (26–50.8 × 9–14.7 cm), oblong to club-shaped bracts, longer calyx (17–18 mm long), bright yellow glabrous corolla lobes, yellow lateral staminodes with a pink-purple apex, and an obovate pink-purple labellum with pale yellow spots.	(Lý et al., 2021)

Table 1. Recent data on new species discovered in Asia (continued)

No	Species	Years	Country	Different Characteristics	Author
67	*Zingiber perenense*	2018	India	*Zingiber perenense* is distinguished by its pubescent, bilobed ligule and oblong-lanceolate bracteole, longer than the corolla tube, with a 2-dentate apex. Its corolla tube is pubescent, with red lobes, and the labellum is white with purplish red streaks. Additionally, it features a stalked anther with a 3–4 mm long filament and a comparatively shorter style, measuring 4.5–5 cm long. This sets it apart from Z. roseum, which has ovate to oblanceolate leaf blades pubescent on both sides, a shorter peduncle (1.5–3 cm long), oblong-lanceolate to oblong-linear pale green to creamy white bracts, a corolla tube shorter than the bracts, and a labellum with reduced, ovate, 2-dentate lateral staminodes. Furthermore, the pollen grains of Z. perenense have non-confluent striae at their apices.	(Odyuo et al., 2019b)
68	*Zingiber porphyrochilum*	2018	China	*Zingiber porphyrochilum* is notable for its peduncle, which is partly or fully embedded in the ground. Morphologically, it bears the closest resemblance to Z. densissimum, featuring bilobed ligules, suborbicular or obovate labellum, and obovate lateral staminodes.	(Ding et al., 2020a)
69	*Kaempferia albiflora*	2002	Thailand	*Kaempferia albiflora* is distinguished by its inflorescence appearing before the vegetative parts and its white flower with a yellowish patch at the base. In contrast, K. grandifolia has broadly ovate leaves appressed to the ground, lobes of the labellum with an acuminate apex, and a bilobed anther crest. Additionally, K. albiflora features erect, lanceolate to elliptic leaves and a trilobed anther crest.	(Jenjittikul & Ruchisansakun, 2020)
70	*Kaempferia nigrifolia*	2018	Thailand	*Kaempferia nigrifolia* is characterized by its sessile leaves, shorter peduncle (approximately 1 cm long), and broadly obovate light purple staminodes with a white spot at the base, which are longer than the labellum. Its labellum is deeply divided, light purple, with a white spot at the base and obovate lobes. Additionally, it features sessile stamens and a white triangular anther-crest that is bent backward and lower than the plane of the petals.	(Boonma et al., 2021)

Table 1. Recent data on new species discovered in Asia (continued)

No	Species	Years	Country	Different Characteristics	Author
71	*Kaempferia minuta*	2001	Thailand	*Kaempferia minuta* features a terminal inflorescence with 2–6 flowers tightly enclosed by leaf sheaths. Its bracts are triangular to linear, measuring 7–11 × 3–10 mm, while bracteoles are narrowly triangular to linear, approximately 1.1 × 0.3 mm. The calyx is bright green, 1.8–2.2 cm long, split on one side to about 7 mm, with an acute apex. It shares similarities with *Kaempferia attapeuensis* Picheans. & Koonterm in its flower structure but is distinguished by its orbicular to suborbicular laminae, unlike the oblong-elliptic to ovate laminae of *K. attapeuensis*.	(Jenjittikul & Larsen, 2020)
72	*Kaempferia pardi*	1999	Thailand	*Kaempferia pardi* is distinguished by its larger laminae adorned with numerous dark spots on the upper surfaces, contrasting with the dark green hue or occasional white variegated pattern of *K. koratensis*. Additionally, it bears larger flowers that are white with two dull purple blotches at the sinus, compared to the white flowers with a pale yellow patch at the base of the labellum seen in *K. koratensis*. Moreover, *Kaempferia pardi* features strikingly larger anther thecae.	(Jenjittikul & Larsen, 2020)
73	*Kaempferia mahasarakhamensis*	2016	Thailand	*Kaempferia mahasarakhamensis* is distinguished by several features. These include having two leaves, a higher pseudostem, a broadly elliptic blade with an acute leaf apex, differing lengths of the leaf sheath and petiole, a distinct number of flowers per inflorescence, and white flowers with a labellum bearing two darker purple patches towards the base.	(Saensouk & Saensouk, 2019)
74	*Curcuma lampangensis*	2021	Thailand	*Curcuma lampangensis* is characterized by a glabrous lamina on both surfaces, a short peduncle, a specific spike shape and size, and an inflorescence without coma bracts. It has an elliptic, small, long-branched, and creeping rhizome, whitish to pale green or pale pink-tinged bracts, white to pale pink corolla lobes, and a white or pale yellow labellum with red-brown spots at the base of the staminode. The anther spur is longer, measuring 4–6 mm.	(Rakarcha et al., 2022)

Table 1. Recent data on new species discovered in Asia (continued)

No	Species	Years	Country	Different Characteristics	Author
75	*Curcuma sabhasrii*	2021	Thailand	*Curcuma sabhasrii* is distinguished by its terminal inflorescences, short peduncles, and inflorescences without coma bracts but with conical anther spurs. Its flowers are notably longer, measuring 5.2–6 cm, with a longer calyx of 16–20 mm, and larger staminodes measuring 18–22 × 13–16 mm. The staminodes are white with reddish-purple mottling to reddish-purple, featuring a dark reddish-purple patch at the base. The labellum is ovate-oblong, larger at 22–24 × 14–18 mm, and reddish-purple with an embossed yellow path along the center and mottling on the lower half. The anther spur is longer, measuring 3.2–4 mm.	(Rakarcha et al., 2022)
76	*Curcuma ignea*	2019	Thailand	*Curcuma ignea* has anther spurs pointing outwards, remotely pilose corolla lobes, and vivid red, green to white bracts.	(Ruchisansakun & Jenjittikul, 2023)
77	*Wurfbainia ellipticarpa*	2004	Thailand	*Wurfbainia ellipticarpa* has a narrower labellum, a lax inflorescence, and ellipsoid fruit.	(Kaewsri & Sangvirotjanapat, 2022)
78	*Wurfbainia geostachyoides*	2010	Thailand	*Wurfbainia geostachyoides* has a shorter ligule (approximately 2 mm, a glabrous abaxial blade surface, and a truncate lateral staminode apex.	(Kaewsri & Sangvirotjanapat, 2022)
79	*Wurfbainia globosa*	2004	Thailand	*Wurfbainia globosa* has a bilobed ligule apex, a bilobed calyx apex, and a bilobed labellum apex.	(Kaewsri & Sangvirotjanapat, 2022)
80	*Wurfbainia longiflora*	2004	Thailand	*Wurfbainia longiflora* has shorter leafy shoots, smaller inflorescences, a longer floral tube, and young fruit that is white.	(Kaewsri & Sangvirotjanapat, 2022)
81	*Wurfbainia parviflora*	2004	Thailand	*Wurfbainia parviflora* has blades of size 11–21 × 2–4 cm, which are pubescent on both sides, and a calyx tube with a bilobed apex.	(Kaewsri & Sangvirotjanapat, 2022)
82	*Wurfbainia yingyongii*	2003	Thailand	*Wurfbainia yingyongii* has an ovate labellum and an orange middle band on the labellum.	(Kaewsri & Sangvirotjanapat, 2022)
83	*Plagiostachys lourdesiae*	2018	Philippines	*Plagiostachys lourdesiae* has a petiolate lamina attachment, a lax arrangement of flowers along the rachis, a red labellum strongly curved upward, and globose to subglobose, maroon, and smooth fruit.	(Docot, 2020)

Table 1. Recent data on new species discovered in Asia (continued)

No	Species	Years	Country	Different Characteristics	Author
84	*Wurfbainia rubrofasciata*	2018	Philippines	*Wurfbainia rubrofasciata* has white flowers with a clawed and saccate labellum, an entire ligule, 7−11 mm long petioles, 2−4 flowers open at a time, congested rachis, white calyx tube and corolla lobes, 10−12 red stripes at the base of the labellum, and ovate and petaloid lateral lobes of the anther crest.	(Docot et al., 2022)
85	*Pleuranthodium corniculatum*	2016	Indonesia	*Pleuranthodium corniculatum* has a dark reddish brown calyx with at least two appendices at the apex, dark reddish brown corolla lobes, and a pale yellow-green labellum with a reddish center. The lamina has strigose hairs on the veins beneath.	(Lofthus et al., 2020)
86	*Pleuranthodium sagittatum*	2016	Indonesia	*Pleuranthodium sagittatum* has shorter leafy shoots, a pale red and distinctly wrinkled calyx, and an entire apex of the labellum.	(Lofthus et al., 2020)
87	*Etlingera comosa*	2020	Indonesia	*Etlingera comosa* has spiny bracts and thecae that dehisce through their entire length. It has tufted sheaths, a bilobed and asymmetric ligule , peduncular bracts that only loosely enclose the base of the spike and partly expose the axis, fertile bracts that are densely pubescent, longer stamens, longer filaments, and shorter anthers.	(Ardiyani et al., 2021a)
88	*Hedychium mechukanum*	2019	India	*Hedychium mechukanum* has glabrous ligules, larger flowers, a labellum that is white with a yellow tinge towards the base, a glabrous calyx, an internally glabrous corolla tube, and longer stamens.	(Sabu & Hareesh, 2020)
89	*Globba amicitia*	2020	Laos	*Globba amiticia* has an erect inflorescence, a dark reddish brown peduncle, and yellow-orange flowers without spots on the labellum. It features sessile cincinni, puberulent lateral staminodes, and a small plant size of about 15–25 cm tall.	(Souvannakhoummane et al., 2023)
90	*Zingiber purpureoalbum*	2018	Myanmar	*Zingiber purpureoalbum* has bifid hairy ligules, prominent plicate lamina, loosely imbricated and strongly incurved bracts, white flowers with a purple-tinged labellum, and a purple anther crest.	(Tanaka & Aung, 2020)
91	*Zingiber reflexum*	2018	Myanmar	*Zingiber reflexum* is characterized by its bilobed villous ligules, two-colored bracts, and larger reflexed labellum.	(Tanaka & Aung, 2020)

Table 1. Recent data on new species discovered in Asia (continued)

No	Species	Years	Country	Different Characteristics	Author
92	*Boesenbegia igorota*	2021	Philippines	*Boesenbegia igorota* is characterized by its smaller stature at 4–18 cm tall, cordate to narrowly ovate lamina, absence of ligule, lavender labellum with a white patch tinged with light yellow at the throat, and bidentate anther crest with lavender at both apices.	(Range et al., 2022)
93	*Kaempferia kamthornii*	2015	Thailand	*Kaempferia kamthornii* is characterized by its hairy petiolate leaves, white markings on the upper leaf surfaces, hairy lower leaf surfaces, pubescent ligules, pubescent stalks, and pubescent corolla tube.	(Meechonkit & Picheansoonthon, 2021)
94	*Kaempferia uttaraditensis*	2016	Thailand	*Kaempferia uttaraditensis* is characterized by its elliptic to lanceolate leaves with sparse hairs at the midrib base, a petiole length, a peduncle length, hairy bracteoles and calyx, a clawed labellum that is white with a purplish patch at the base, and a glabrous ovary.	(Meechonkit & Picheansoonthon, 2021)
95	*Curcuma lindstormii*	2022	Thailand	*Curcuma lindstromii* is distinguished by its prominently clawed labellum with dark maroon tips, staminodes with dark maroon tips, and anthers with 3–4 mm long narrowly conical spurs that produce mucilage	(Leong-Škorničková et al., 2022)
96	*Globba ruiliensis*	2019	China	*Globba ruiliensis* has oblong or ovate-lanceolate leaves that are strigose along the veins on the adaxial side, lateral staminodes nearly equal in size to the corolla lobes, a yellow to orange labellum, and a verrucose ovary and fruit.	(Ma et al., 2021)
97	*Etlingera tjasmantoi*	2020	Indonesia	*Etlingera tjasmantoi* exhibits entire ligules with a somewhat emarginate apex, long petiole, elongated elliptic to narrowly ovate leaves, pointed calyces, and generally pink flowers. However, it differs from other species by having thecae that dehisce through their entire length (as opposed to just the upper part) and by bearing obovoid, glabrous, and spineless fruits, unlike the pyriform or round, pubescent fruits with small spines found in other species.	(Ardiyani et al., 2021b)
98	*Globba depingiana*	2020	China	*Globba depingiana* shares similarities with *G. depingiana*, such as a pendent inflorescence with persistent bracts. However, it differs in having hairy leaves instead of glabrous ones, a shorter ligule (1 mm compared to 5 mm), and greenish-yellow flowers with two dark yellow-green spots on the labellum instead of yellowish-orange flowers with brown spots.	(Ding et al., 2022)

Table 1. Recent data on new species discovered in Asia (continued)

No	Species	Years	Country	Different Characteristics	Author
99	*Plagiostachys subsessiliflora*	2021	Philippines	*Plagiostachys subsessiliflora* is morphologically allied to *P. escritorii* Elmer and *P. lourdesiae* by the presence of a gullet-type labellum. It is readily distinguished by its unequally 2(–3)-lobed ligules, lanceolate leaf blades, short pedicels, and a trilobed anther crest.	(Mazo, 2022)
100	*Plagiostachys longipetiolata*	2021	Philippines	*Plagiostachys longipetiolata* stands out notably with its conspicuously petiolate lamina, larger and emarginate ligules, longer bracteoles, and calyx tubes. Additionally, it features an orbicular labellum and a trilobed anther crest, distinguishing it from other species.	(Mazo, 2022)
101	*Curcuma cinnabarina*	2019	Thailand	*Curcuma cinnabarina* has a compact inflorescence with dark red bracts with rounded tips. It features an ovoid rhizome with occasional short branches, broadly ovate to elliptic-ovate and densely pubescent lamina with a rounded base, and an inflorescence composed of 35–50 bracts that are puberulent on both sides. Its flowers are pale yellow to yellow	(Leong-Škornicková et al., 2020b)
102	*Curcuma eburnea*	2019	Thailand	*Curcuma eburnea* has a compact inflorescence composed of cream-white bracts and anthers with small filiform spurs. It features leaves with round to subcordate bases, 30–40 bracts, white staminodes, and anther spurs facing straight forwards.	(Leong-Škornicková et al., 2020b)
103	*Conamomum vietnamense*	2017	Vietnam	*Conamomum vietnamense* has yellow flowers, a trilobed labellum with reflexed margins, a trilobed yellow anther crest, 20–50 cm tall stilt roots, elliptic to obovate-elliptic leaves, narrowly ovate bracts, abaxially pubescent bracteoles, a bilobed calyx with truncate tips, a broadly obovate to orbicular labellum, a filament 16–18 mm long, and a glabrous style.	(Lý et al., 2022)
104	*Boesenbegia isanensis*	2018	Thailand	*Boesenbegia isanensis* is 70–80 cm tall with a dark yellow rhizome and roots. The leaf blades are glabrous with a dark red midrib on the upper surface and densely pubescent on the lower surface. The flowers are cream-colored, with a labellum that is red in the apical half and cream in the basal half, and pubescent at the center.	(Saensouk & Saensouk, 2021)
105	*Sundamomum corrugatum*	2019	Malaysia	*Sundamomum corrugatum* is recognized by its deeply corrugated leaf blades (three to four on each leafy shoot), pubescent inflorescence, and dark yellow gullet-type labellum.	(Mohamad et al., 2020)

Table 1. Recent data on new species discovered in Asia (continued)

No	Species	Years	Country	Different Characteristics	Author
106	*Sundamomum bungoense*	2017	Malaysia	*Sundamomum bungoense* is recognized by its bilobed and tomentose ligule with marginal black stripes, elliptic to oblong-elliptic laminae with caudate apices, slightly corrugated leaf blades, and gullet-type orange labellum. It also features a distinctly trilobed anther crest and large, showy, thick-walled brown fruit.	(Mohamad et al., 2020)
107	*Monolophus odontochilus*	2018	Myanmar	*Monolophus odontochilus* is characterized by its white flowers with a yellow blotch at the base of the labellum. It features elliptic to oblong leaves, bilobed ligules, a semi-orbicular crenate labellum, and a purely white corolla.	(Ding et al., 2020b)
108	*Boesenbegia sugudensis*	2016	Malaysia	*Boesenbegia sugudensis* is characterized by its non-thickened leaf sheaths and anther thecae dehiscing longitudinally. It also features a longer petiole, exceeding 10 cm, and a bilobed apex of the calyx.	(Lam et al., 2022)
109	*Boesenbegia truncata*	2016	Malaysia	*Boesenbegia truncata* is characterized by a short petiole of approximately 2 cm, a bilobed calyx, a truncate leaf base, and an acute leaf apex. This species has paired opposite leaves with laminae that lie parallel to the ground, anther thecae dehiscing by pores, and slightly narrower laminae measuring 3.4–3.6 cm.	(Lam et al., 2022)
110	*Globba amnicola*	2013	Thailand	A small species, averaging 15 cm in height, with green-bracted inflorescences. It features cream-colored flowers with a red spot on the labellum and produces verrucose fruit.	(Sangvirojtanapat et al., 2020)
111	*Globba amplectens*	2001	Thailand	Recognized for its green imbricate bracts and pendent inflorescence. It has short cincinni and pale yellow flowers with a brown spot on the labellum.	(Sangvirojtanapat et al., 2020)
112	*Globba conferta*	1999	Thailand	Often mistaken for *Globba annamensis*, this species is distinguished by its red bracts and bright yellow flowers. It may also resemble G. candida, but differs in having yellow rather than white floral parts.	(Sangvirojtanapat et al., 2020)

Table 1. Recent data on new species discovered in Asia (continued)

No	Species	Years	Country	Different Characteristics	Author
113	*Globba dasycarpa*	2002	Thailand	Characterized by its compact size, variegated leaves, and dense inflorescences bearing rich yellow flowers. The fruit has unique soft prickles, serving as a key diagnostic trait.	(Sangvirojtanapat et al., 2020)
114	*Globba grandis*	2013	Thailand	A tall species, reaching up to 1.3 meters, with robust stems and large ornamental inflorescences. It has white imbricate bracts and striking orange flowers, with distinctive scaly bulbils.	(Sangvirojtanapat et al., 2020)
115	*Globba hilaris*	2013	Thailand	Recognized by its condensed inflorescences with greenish-white bracts and yellow-orange flowers that feature a dark-red spot on the labellum. The mature inflorescence develops a few bulbils at the lower bracts.	(Sangvirojtanapat et al., 2020)
116	*Globba impar*	2008	Vietnam	A pendent-inflorescence species with white bracts and large white bracteoles. It has lateral corolla lobes measuring approximately 3 mm in width.	(Sangvirojtanapat et al., 2020)
117	*Globba nitida*	2006	Thailand	Noted for its pendent inflorescence with reflexed, shiny white bracts. It has caducous, flat, elliptic bracteoles and yellow flowers, differing from G. grandis, which has yellow-orange bracteoles and rich orange flowers.	(Sangvirojtanapat et al., 2020)
118	*Globba verecunda*	2013	Thailand	A large-leaved species that conceals its small inflorescence. It exhibits two color forms: one with green bracts, yellow-orange bracteoles, and orange calyces, and another with white bracts, bracteoles, and calyces.	(Sangvirojtanapat et al., 2020)
119	*Globba wiliamsiana*	2009	Thailand	A well-known ornamental plant with large, brightly colored bracts. It is frequently hybridized for horticulture and closely resembles *Globba winitii*, but differs by having cuneate rather than cordate leaf bases.	(Sangvirojtanapat et al., 2020)

4. Distribution of New Species Discoveries in the Zingiberaceae Family in Asia

The discovery of new species within the Zingiberaceae family has demonstrated broad geographical variation, reflecting high biodiversity across various tropical and subtropical regions (Sirirugsa, 1999). The Zingiberaceae family consists of perennial herbaceous plants that thrive in tropical and subtropical areas with high humidity. A distinctive characteristic of Zingiberaceae is the unique aroma produced by the entire plant, particularly the rhizome. Plants within the ginger family have diverse uses, including the use as food ingredients, spices, medicines, dyes, cosmetics, perfumes, and ornamental as plants (Kress et al., 2002; de Castro et al., 2023). Globally, Zingiberaceae comprises approximately 57 genera with a total of around 1,600 species. The primary distribution center of this family is in Southeast Asia, at elevations ranging from 0 to 2,000 m above sea level (Sirirugsa, 1999). Recent studies have documented the discovery of new species in Southeast Asia, particularly in countries such as Thailand, Malaysia, Indonesia, and Vietnam.

According to Figure 1, the family Zingiberaceae is found in 11 countries: China, Thailand, Cambodia, Malaysia, Vietnam, the Philippines, Myanmar, Laos, Taiwan, Indonesia, and India. The highest number of new species was found in Thailand, with 65 new species. In Vietnam, 10 new species were discovered; in China and Myanmar, eight new species were found; in India and the Philippines, seven new species were identified; in Indonesia and Malaysia, four new species were discovered; in Laos, four new species were found; in Cambodia, two new species were identified; and in Taiwan, only one new species was discovered. These results indicate that Thailand has become a focal point for numerous botanical studies, including the exploration of new species. Many botanists are actively researching Thailand's flora, documenting new species, and conducting taxonomic studies. This is due to Thailand's location in the Indo-China biodiversity hotspot, recognized as one of the primary distribution centers for the family, providing rich species diversity (Sirirugsa, 1992, 1999). The variation in soil types, humidity, and elevation creates diverse conditions that allow new species to adapt and proliferate in different environments, promoting species diversity.

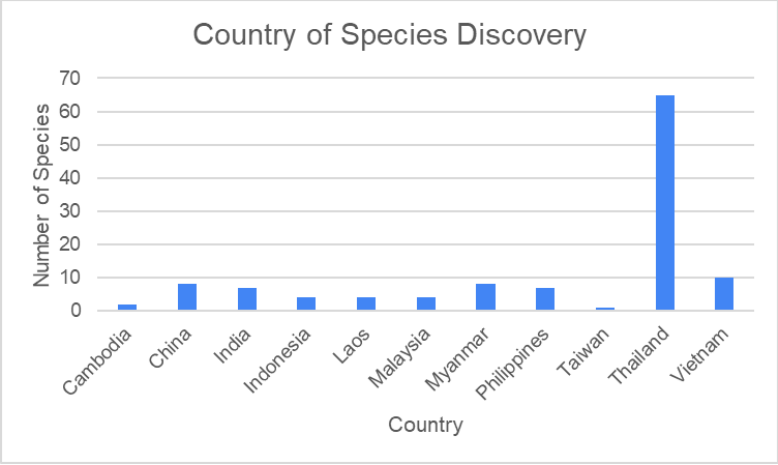

Figure 1. Distribution of new species discoveries in the Zingiberaceae family in Asia

According to a study by Saensouk & Saensouk (2021), Thailand was reported to have around 26 genera and 300 species of Zingiberaceae family. However, more recent data from Sangvirojtanapat & Newman (2023) reveals an increase, with 28 genera and 394 species now recognized in the country. It shows that numerous botanists have studied Zingiberaceae in Thailand. Additionally, many researchers have studied the ethnomedicinal plants and traditional uses of Zingiberaceae in Thailand. A total of 48 Zingiberaceae species have been reported for traditional use for the first time in 22 provinces (Ragsasilp et al., 2022). These studies highlight the importance of the Zingiberaceae family not only in the context of biodiversity but also in the cultural and economic contexts of local communities. The influence of collaboration between local and international institutions in botanical research in Thailand has increased the number of new species discoveries. Research in Thailand receives significant support from various universities, botanical gardens, and research institutions working with international organizations, facilitating the exploration and documentation of new species (Sirirugsa, 1992). Additionally, Thailand has a well-developed research infrastructure and access to various remote and underexplored areas, allowing researchers to discover undocumented species (Saensouk et al., 2016). This support and infrastructure significantly impacted the number of new species discoveries within the Zingiberaceae family.

Based on Figure 2, it can be seen that the most commonly discovered genus in Asia over the last six years was *Curcuma*, which was recorded in multiple countries, including China, India, Thailand, Vietnam, and Laos. Among these, Thailand had the highest number of newly discovered *Curcuma* species, highlighting its prominence in the region. Other frequently found genera included *Zingiber*, which was reported in India, Myanmar, Taiwan, and Vietnam, as well as *Kaempferia*, which were identified in Cambodia, Laos, and Thailand. The widespread distribution of these genera suggests that they thrive in diverse tropical and subtropical habitats across Asia, reinforcing the region's significance as a hotspot for Zingiberaceae biodiversity.

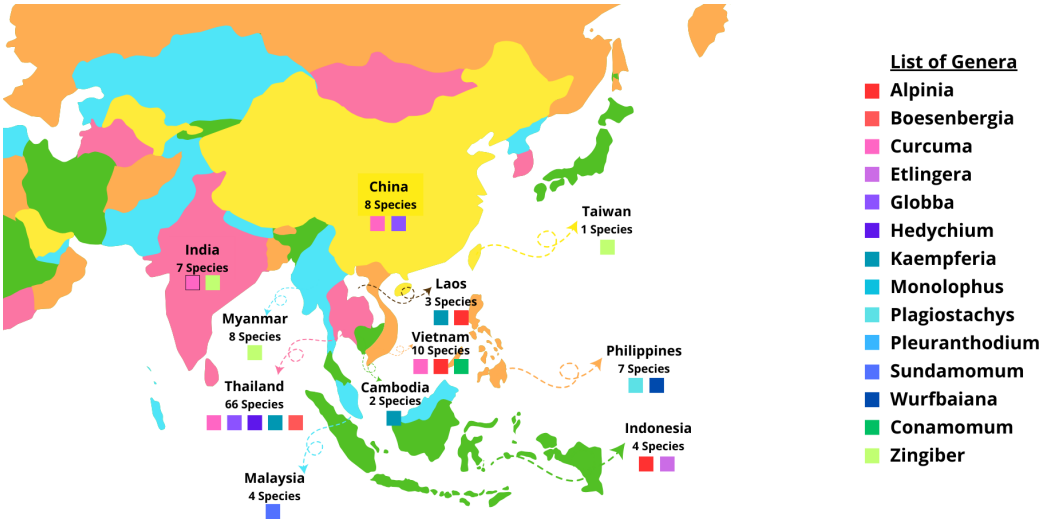

Figure 2. Geographical distribution of newly discovered Zingiberaceae genera in Asia (2019-2024)

5. Trends in the Discovery of New Zingiberaceae Species Over the Years

Figure 3 presents data on species discoveries by year, showing fluctuations over time. The earliest recorded discoveries were in 1999, with 2 species found. From 1999 to 2010, the number of species discovered per year remained relatively low, mostly ranging between 1 to 2 species, except for 2004 (4 species) and 2013 (5 species). A significant increase began in 2016, with 9 species, followed by a steady rise in 2017 (12 species) and 2018 (18 species), reaching a peak in 2019 with 24 species. After this peak, discoveries declined slightly but remained relatively high in 2020 (15 species) and 2021 (10 species). However, in 2022, the number dropped to 5 species, followed by a further decline in 2023 and 2024, with just 1 species per year. This trend suggests that species discoveries surged in the late 2010s, peaking in 2019, but have gradually decreased in recent years.

These discoveries reflect an increase in botanical research and exploration activities, particularly in Southeast Asia, which is the center of Zingiberaceae diversity (Kress et al., 2002). The discovery of new species in 2019 was not only significant for scientific knowledge but also crucial for conservation efforts, ethnobotanical development, and enhancing support for biodiversity research (de Castro et al., 2023). The identification of 25 new species in 2019 enriched the taxonomic and biodiversity knowledge of Zingiberaceae, providing deeper insights into genetic variation and evolutionary relationships within this family. Such research often leads to revisions in classification and a better understanding of the ecology and biogeography of Zingiberaceae (Sirirugsa, 1992). Advancements in molecular and genetic technologies, such as DNA barcoding and phylogenetic analysis, have enabled researchers to identify new species more quickly and accurately. These technologies became more commonly used during these years, accelerating the process of new species discovery (Kress & Erickson, 2012). The year 2019 also saw an increase in international collaboration among scientists from various countries. These collaborations facilitated access to previously hard-to-reach areas and improved the sharing of knowledge and resources (Saensouk et al., 2016).

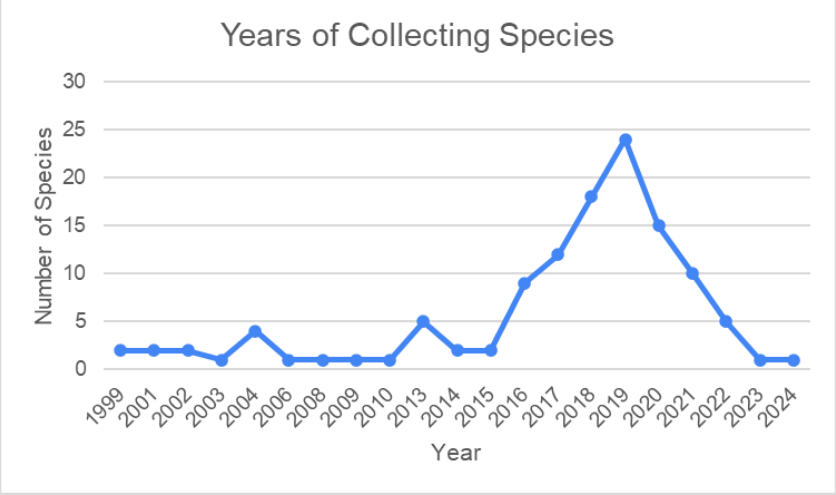

Figure 3. Trends in the discovery of new Zingiberaceae species over the years

The fluctuations in the number of discoveries also indicate periods of increased and decreased research activity, which can be influenced by various factors such as funding, research collaborations, and the technology used in species identification. Many Zingiberaceae species have significant economic and cultural value, including uses in traditional medicine, cuisine, and horticulture. The discovery of new species can open new opportunities for commercial exploration and the development of plant-based products (Sirirugsa, 1999).

6. Morphological Characteristics and Number of Species in Each Genus

The genera represented among the new species in this study include *Alpinia*, *Boesenbergia*, *Curcuma*, *Etlingera*, *Globba*, *Hedychium*, *Kaempferia*, *Monolophus*, *Plagiostachys*, *Pleuranthodium*, *Sundamomum*, *Wurfbaiana*, *Conamomum*, and *Zingiber*. Among these, the genus *Curcuma* is the most dominant, with 37 new species discovered (Figure 4). Morphologically, species from the genus *Boesenbegia* are characterized by solitary inflorescences, and the plants possess bracts or leaf structures that are modified to resemble flower petals. In some plants, these bracts may exhibit conspicuous or inconspicuous colors and are typically not very large. Bracts in the genus *Boesenbegia* generally have distichous bracts and basipetal flowers. Another characteristic of *Boesenbegia* species is the type of inflorescence. There are two types of inflorescences in the genus *Boesenbegia*: the distichous type, where the bracts overlap on one side only, and the second type, where the bracts are arranged on one side, relatively short, dense, and hidden within leaf sheaths (Prince et al., 2024).

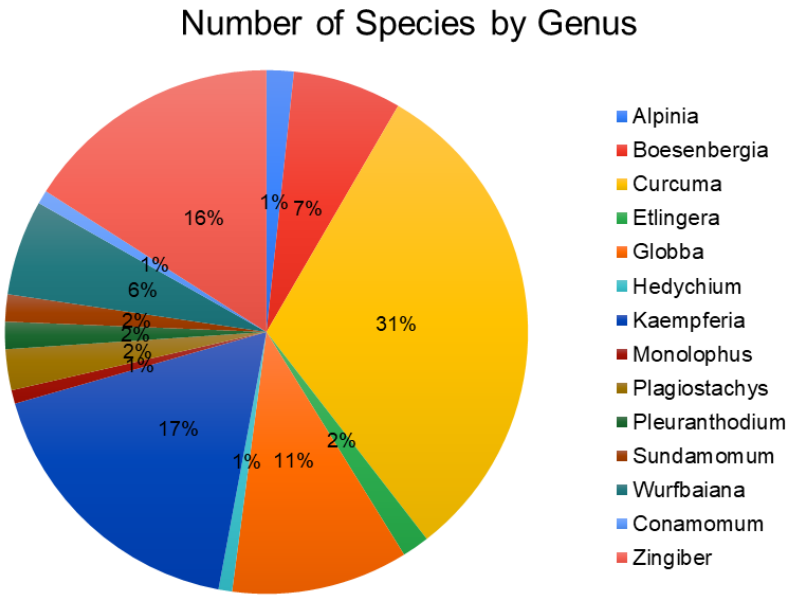

Figure 4. Diagram of new species discovered by genus

Next, species within the genus *Curcuma* have characteristics of leaves that are glabrous on both upper and lower surfaces, with pinnate venation and leaf tips that are rounded or pointed. The leaves can be elliptical, oblong-lanceolate, ovate, or lanceolate in shape. For example, *Curcuma aeruginosa* possesses 2-7 lanceolate to elliptical leaves, each measuring approximately 15-66 cm in length and 5-22 cm in width, with rounded apices, wavy margins, an ovoid base, and a dark green upper surface. The leaf sheaths envelope the petiole and exhibit a distince coloration (Sungkawati et al., 2019).The morphological variations of *Curcuma* genus may be due to environmental and genetic factors, as samples from different locations with varying environmental conditions can influence plant morphological characteristics (Syahid & Heryanto, 2017). Another characteristic of the genus *Curcuma* is the rhizome structure. The rhizomes of *Curcuma* consist of the epidermis, cortex, and stele and have a closed collateral type. The endodermis in *Curcuma* consists of a single layer with vascular bundles scattered in the stele and cortex. *Curcuma* species such as *Curcuma aeruginosa, Curcuma heyneana, Curcuma mangga, Curcuma soloensis, Curcuma xanthorrhiza,* and *Curcuma zedoaria* have round secretory cells, while in *Curcuma domestica*, these cells are polyhedral. The secretory cells in *Curcuma zedoaria* and *Curcuma aeruginosa* appear yellowish-brown. In *C. aeruginosa* and *C. soloensis*, these cells tend to exhibit a brighter yellow hue compared to those in other examined species, while in *Curcuma xanthorrhiza*, secretory cells were not observed (Trimanto et al., 2018). Leaf anatomy consists of three types of tissues: epidermis, mesophyll, and vascular bundles (xylem and phloem). The epidermis of *Curcuma* is composed of a single layer of cells. In *Curcuma domestica* (accessions from Sleman and Gunungkidul) and *Curcuma xanthorrhiza* (accessions from Bantul and Sleman), uniseriate non-glandular trichomes were found on the adaxial epidermis, while trichomes were not observed in other species. Trichomes are well-documented in taxonomy; some families can be easily identified through their type and shape, while in other cases, trichomes are important for genus and species classification. The mesophyll of *Curcuma* observed was composed of parenchyma cells and vascular bundles. The vascular bundles were closed collateral, with air channels between the bundles on the abaxial side. Paradermal sections of the adaxial epidermis showed paracytic stomata in all observed species. *Curcuma* stomata are generally tetracytic and paracytic, most commonly found in the Zingiberaceae, Commelinaceae, Cyperaceae, and other families (Furmuly & Azemi, 2020).

Kaempferia is a genus from the Zingiberaceae family, distributed in Southeast Asia, India, southern China, and Africa. Species in this genus are morphologically characterized by purple or white flowers that are usually inconspicuous, non-fleshy, and short rhizomes. Some species possess fibrous root types in fascicles with terminal tubers ranging from round to fusiform. This group features leaves that are either erect or ground-hugging, with shapes ranging from filiform to broad, growing from the rhizome, mostly with sheathing leaf bases, long to short petioles, and generally small leaves. However, it is essential to note that these characteristics vary significantly among species. This genus also has a short flowering season, making species-level identification of *Kaempferia* challenging. Most species in this genus have a dormancy or inactive period lasting from three to six months (Furmuly & Azemi, 2020). Some species in this genus, such as *Kaempferia maculifolia* sp. nov., resemble *Kaempferia mahasarakhamensis* Saensouk & P. Saensouk and *Kaempferia marginata* Carey ex Roscoe, particularly in floral characteristics. The rhizomes of *Kaempferia maculifolia* are oblong, erect, pale yellow inside, and fragrant. The rhizomes of *Kaempferia marginata* are greenish-yellow and sheathed. Another distinguishing characteristic is the leaf type: *Kaempferia maculifolia* has pubescent leaves with fine hairs on the surface, while *Kaempferia mahasarakhamensis*

and *Kaempferia marginata* have glabrous leaves, which are smooth and hairless. The adaxial surface of *Kaempferia maculifolia* is green with dark green spots, a distinguishing feature from other species in the genus *Kaempferia*. The flower calyxes of *Kaempferia mahasarakhamensis* and *Kaempferia marginata* have a bilobed apex or a node with separated tips, while *Kaempferia* maculifolia has a three-lobed calyx. The anther head of *Kaempferia maculifolia* is narrowly oblong to spatulate, white with pale yellow at the base, emarginate at the apex, and glabrous. The other heads of *Kaempferia mahasarakhamensis* and *Kaempferia marginata* are deeply split. The ovary of *Kaempferia maculifolia* is cylindrical pale green with sparse hairs, while the ovaries of *Kaempferia mahasarakhamensis* and *Kaempferia marginata* are glabrous (Boonma et al., 2020).

The genus *Zingiber*, belonging to the family Zingiberaceae, has significant economic value as many species in this genus are traded as spices, culinary ingredients, and medicinal herbs. Generally, *Zingiber* species have easily recognizable morphological characteristics, both floral and vegetative. Floral characteristics include prominent anthers surrounded by crest-like structures that encircle the anther and stigma. Vegetatively, *Zingiber* species are known for the presence of a pulvinus or a swelling at the petiole base (Yeh et al., 2012; Huang et al., 2019). Based on the inflorescence position, *Zingiber* is classified into four sections: 1) Sect. *Zingiber cryptanthium* Horan, which is characterized by long stalks with spikes on the stalk characterize. 2) Sect. *Cryptanthium horan*, which is characterized by radical inflorescences consisting of spines that emerge at ground level and erect, short stalks. 3) Subspecies *Pleuranthesis benth*, which is characterized by spines penetrating the leaf sheath laterally, and 4) Subspecies *Dymczewiczia benth*, which is characterized by terminal inflorescences at the tips of main stems or branch, the apical region. Additionally, Zingiber species have spherical pollen grains (Bai et al., 2015).

Alpinia is the largest genus in the family Zingiberaceae, consisting of 230 described species. *Alpinia* species are also of economic importance, with recent research highlighting their medicinal potential (de Boer et al., 2018). Morphologically, *Alpinia* species have non-fleshy fruits with inflorescences arranged in a pinnate manner. Floral characteristics include corolla tubes longer than the calyx. The *Alpinia* genus has unique floral and vegetative characteristics that distinguish it from other genera in the family Zingiberaceae. The genus *Alpinia* is also known for its high variation in inflorescence types and flower structures, which can vary greatly among species (de Boer et al., 2018; Karunarathne et al., 2021). For example, *A. warburgii*, recently described as a terrestrial herb, has creeping rhizomes reaching up to 2.8 m, oblong leaves, terminal to subterminal flowers, upright flower stalks, red stalks, white or red sepals, and red stigmas. The fruit is green when young and turns yellow when ripe (Ardi & Ardiyani, 2016).

Globba is an endemic genus from Thailand, belonging to the family Zingiberaceae. The *Globba* genus consists of approximately 100 species. Morphologically, the *Globba* genus is characterized by lateral flowers and fruits, mostly perennial plants. The plants in this genus are small, with stems reaching about 0.5-1.5 m in height. The rhizomes are tuberous, with creeping or spreading structures, and the flowers have unique features such as elongated bracts and bracteoles. Pollinators, especially bees, play a significant role in the reproduction of *Globba* species. Pollen morphology and leaf anatomy are essential for identifying species within the genus *Globba* (Kajornjit et al., 2018).

Etlingera is a genus of large annual herbaceous plants belonging to the family Zingiberaceae. Species within this genus are characterized by their large inflorescences, which can be strikingly red with pinkish-red internodes and yellow or white edges. The genus *Etlingera* is known for its creeping rhizomes, generally smooth surfaces, and unique sheath characteristics. The inflorescence structure is a defining feature, with flowers arranged in dense, terminal clusters (Rayhannisa et al., 2024).

Pleuranthodium is a genus of plants in the family Zingiberaceae, characterized by terminal or subterminal inflorescences. The flowers of *Pleuranthodium* species are diverse in color and shape, often attracting pollinators such as bees and other insects. The bracteoles in this genus are tubular, and the flowers are typically showy, contributing to their appeal in horticulture (Jia et al., 2015). Furthermore, the flower parts range in color from white-cream-yellow-red, though colors are rarely specified in original descriptions and are usually lost in dried specimens (Lofthus, 2014).

Plagiostachys indicates that these plants have inflorescences similar to those in the genus *Alpinia*, with lateral flowers emerging near the tips. This characteristic differs from earlier descriptions stating that this genus's flowers emerged near the ground. Plants in this genus have two types of flowers: mucilaginous and dry or non-mucilaginous (Docot, 2020). Meanwhile, *Monolophus* is a genus of annual herbaceous plants in the family Zingiberaceae, characterized by short rhizomes, oblong to elliptical leaves, and distinct floral characteristics. The flowers of *Monolophus* species are often bright and attract various pollinators. The genus is also known for its unique inflorescence structure, with flowers arranged in a terminal spike (de Boer et al., 2018).

Wurfbainia is a genus in the family Zingiberaceae, distinguished by its unique anther structure, featuring a crown with three small lobes. The genus *Wurfbainia* is also characterized by its terminal inflorescences, with flowers arranged in dense clusters. The leaves are typically lanceolate to elliptical, with a smooth surface and prominent veins (de Boer et al., 2018).

Sundamomum is a genus of plants in the family Zingiberaceae, characterized by coriaceous bracts supporting single flowers. The flowering and fruiting periods in *Sundamomum* species are usually brief but intense, with rapid transitions from flowering to fruiting. The flowers are often brightly colored, contributing to their ornamental value (Mohamad et al., 2020). Furthermore, based on De Boer et al. (2018), the genus *Sundamomum* is defined by several distinctive characteristics: a leathery bract that supports a single flower and remains until the fruiting stage, flowers that range from open to gullet-type, a faintly trilobed anther crest with side lobes typically reduced to a thickened, angled edge, and fruits that are ribbed or grooved.

Conamomum is a genus in the family Zingiberaceae, characterized by elliptical leaves with short petioles and brightly colored flowers (Ly et al., 2022). The flowers of *Conamomum* species are typically large and showy, attracting a wide range of pollinators. The genus is also known for its distinctive bract and bracteole structures, which vary among species (Truong et al., 2019; Ly et al., 2022).

The genera within the Zingiberaceae family exhibit distinct and diverse morphological characteristics, particularly in their inflorescence type and structure. For instance, the Zingiberaceae family is distinguished by diverse inflorescence and floral structures. Inflorescences form in cymes or spikes that are often terminal. Flowers are bracteate, zygomorphic, and irregular, with a fused calyx and corolla, the latter featuring an enlarged median petal. The androecium typically has five members, with a petaloid labellum and a single fertile stamen. The gynoecium consists of three united carpels, forming an inferior ovary with a long style extending between the anther’s thecae (Watson & Dallwitz, 1992). Furthermore, A summary of the floral morphological characteristics is presented in Table 2.

Table 2. Floral morphological characteristics in genera of the Zingiberaceae family

No	Genus Name	Flower Characteristics	Reference
1.	*Boesenbergia*	- Has a terminal and distichous inflorescence type (bracts overlapping on one side). - Bracts are arranged on one side, relatively short in size, dense, and hidden within the leaf sheath.	(Lam et al., 2024; Saensouk et al., 2025)
2.	*Curcuma*	- The flower is bell-shaped. - Has epigynous glands. - Possesses bracts. - The labellum is obovate in shape.	(Saensouk et al., 2022b; 2024b)
3.	*Kaempferia*	- Has a Racemose-umbel flower type. - Floral organs on the thalamus are epigynous. - The flower is white with purple patterns.	(Furmuly & Azemi 2020)
4.	*Zingiber*	- Has a prominent anther. - Possesses a crest or horn-like structure surrounding the anther and pistil.	(Yeh et al., 2012; Huang et al., 2019)
5.	*Alpinia*	- The inflorescence is pinnate. - Has a single flower. - The flower bract is relatively small. - Has a split calyx. - Possesses lateral staminodes and a broad labellum.	(De Boer et al., 2018; Karunarathne et al., 2021)
6.	*Globba*	- Terminal flower type. - Calyx is stalked to campanulate. - Corolla tube is long. - Lateral staminodes are petaloid in shape.	(Kajornjit et al., 2018)
7.	*Hedycium*	- Has bracts on the spike. - The inflorescence is a spike or raceme that grows from the leaf axils or the stem tip. - The flower calyx is generally white or red. - Possesses a labellum and has a distinctive fragrance to attract insects.	(Hu et al., 2024)
8.	*Etlingeria*	- Cone-shaped with a reddish hue. - Flowers grow directly from the rhizome. - Flowers are brightly colored.	(Rayhannisa et al., 2024)
9.	*Pleuranthodium*	- The flower is pendant-shaped, either hanging or inverted. - Has terminal or subterminal flowers. - Measures between 5 to 50 cm. - The calyx is bell-shaped, resembling a sheath. - Possesses a cup-shaped labellum.	(Lofthus, 2014)

Table 2. Floral morphological characteristics in genera of the Zingiberaceae family (continued)

No	Genus Name	Flower Characteristics	Reference
10.	*Plagiostachys*	- The flower is cone-shaped. - Has terminal or lateral flowers. - The flower type is either mucilaginous or dry.	(Docot, 2020)
11.	*Monolophus*	- The labellum is oval to ovate in shape. - Possesses a ligula. - The corolla is short. - The flower terminal is pointed. - Is generally colored yellow, purple, red, or white.	(Bhaumik et al., 2017)
12.	*Wurfbainia*	- The flower is ear-shaped. - The corolla consists of three small lobes.	(De Boer et al., 2018)
13.	*Sundamomum*	- Has both open and closed flower types. - The anther is trilobed with sidelobes. - Possesses ribbed and grooved fruit.	(Mohamad et al., 2020)
14.	*Conamomum*	- The flower is ovate in shape. - The calyx is pubescent. - The corolla is generally cream-colored. - Possesses a yellow, oval-shaped labellum.	(Lý et al. 2022; Truong et al., 2019)

7. Phylogenetic Classification and Recent Taxonomic Changes in the Zingiberaceae Family

According to the revised classification of the Zingiberaceae family proposed by Kress et al. (2002), various genera have been reassigned to different tribes and subfamilies. For instance, the genera *Alpinia*, *Amomum*, *Plagiostachys*, and *Etlingera* are classified under the tribe Alpinieae, which is part of the subfamily Alpinioideae. In contrast, the genus *Pleuranthodium* is grouped under the tribe Riedelieae, which also belongs to the subfamily Alpinioideae. This suggests that, despite belonging to different tribes, both Alpinieae and Riedelieae are included in the same subfamily, Alpinioideae. On the other hand, the genera *Boesenbergia*, *Curcuma*, *Kaempferia*, and *Hedychium* are categorized under the tribe Zingibereae, while *Globba* is assigned to the tribe Globbeae. Along with *Caulokaempferia*, these six genera are grouped under the subfamily Zingiberoideae.

Phylogenetic studies by Kress et al. (2002) and Selvaraj et al. (2008) further support these classifications, showing a distinct separation at the subfamily level and clarifying the kinship relationships among these genera. For example, both studies highlight a close phylogenetic relationship between *Alpinia* and *Plagiostachys*, while also revealing a more distant relationship between the genera *Kaempferia* and *Curcuma*, suggesting distinct evolutionary pathways within these groups.

The genus *Monolophus* represents another interesting case of reclassification within the Zingiberaceae family. It was only separated from *Caulokaempferia* by Mood et al. (2014), indicating that, in earlier classifications, *Monolophus* was likely considered a part of the *Caulokaempferia* genus. This recent taxonomic revision reflects the evolving understanding of species differentiation and relationships within the family.

Wallich first described *Monolophus* in 1832, incorporating three species, two of which had been previously described in 1820 (Ding et al., 2020b). In 1964, Larsen established the genus *Caulokaempferia*, arguing against the recognition of *Monolophus*. However, later taxonomic revisions reinstated *Monolophus* as a valid genus, incorporating some species previously classified under *Caulokaempferia*, while the remaining species were reassigned to *Boesenbergia*. As a result, *Caulokaempferia* is now considered a superfluous name for *Monolophus* (Mood et al., 2014).

Similarly, the genus *Sundamomum* is another example of a taxonomic update resulting from recent phylogenetic insights. It emerged from the recircumscription of the genus *Amomum* within the Zingiberaceae family, as proposed by De Boer et al. (2018). This revision indicates that, in older classifications, species now grouped under the genus *Sundamomum* were previously classified under the genus *Amomum*. Such taxonomic updates underscore the dynamic nature of botanical classifications, which continue to evolve with ongoing research and phylogenetic studies.

The urgency of documenting new species within the Zingiberaceae family cannot be overstated. With increasing habitat loss and environmental changes, there is a pressing need to understand and conserve plant biodiversity. The Zingiberaceae family, with its high diversity and wide range of applications, represents a critical area for botanical research. Over the past six years, significant efforts have been made to explore and document new species in this family across Asia. These efforts have resulted in the discovery of numerous species, each contributing to our understanding of plant diversity and potential uses. The collection of data on new Zingiberaceae species over six years is essential for several reasons. Firstly, it helps to fill gaps in our knowledge about the distribution and characteristics of these species. Secondly, it provides a basis for conservation strategies, ensuring that these valuable plants are protected for future generations. Thirdly, the discovery of new species can lead to the identification of novel bioactive compounds, which can be developed into new medicines, agricultural products, and other commercial applications. Finally, documenting new species contributes to our understanding of plant evolution and ecology, offering insights into how these plants have adapted to their environments over time.

8. Conclusions

The Zingiberaceae family has been extensively surveyed across various Asian countries, resulting in the discovery of 119 new species within this family. These species were identified in 11 countries: Cambodia, China, India, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Taiwan, Thailand, and Vietnam. The genera represented among these new species include *Alpinia*, *Boesenbegia*, *Curcuma*, *Etlingera*, *Globba*, *Hedychium*, *Kaempferia*, *Monolophus*, *Plagiostachys*, *Pleuranthodium*, *Sundamomum*, *Wurfbaiana*, *Conamomum*, and Zingiber. Among these, the genus *Curcuma* is the most dominant, with 37 new species discovered. In additionn, Thailand stands out as the country with the highest number of new species found among the surveyed Asian countries.

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10. Authors' Contributions

A.F.M.A collected the articles and wrote the manuscript; A.N.A and W.D.A analysed data and wrote the manuscript; C.C and N.H.W. analysed data and wrote the manuscript; F.R.P.D supervised and wrote the manuscript; B.I generated research design. All the authors reviewed the manuscript.

11. Conflicts of Interest

The authors and the institutes where the work was carried out declare that there are no conflicts of interest regarding the publication of this article.

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