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**Research Article**

# Species Richness, Assessment, and Distribution of Zingiberaceae in the Forest Patches of Barangay Kalabugao, Impasug-ong, Bukidnon

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## ABSTRACT

This study was conducted to identify the Zingiberaceae species, assess their conservation status and endemism, and generate a distribution map of the species within the forest patches of Barangay Kalabugao, Impasug-ong, Bukidnon. Transect walks were performed along established trails, with 5 meters on each side, covering 200 meters for every 2 kilometers. Opportunistic sampling was also carried out across four selected study sites: Site 1 (mid-elevation of Sitio Nasandigan), Site 2 (Mt. Palusongan in Sitio Nasandigan), Site 3 (secondary forest in Sigayan Forest, Sitio Ulayanon), and Site 4 (dipterocarp forest in Barangay Kalabugao). Data revealed 17 Zingiberaceae species (13.05% of the total Zingiberaceae species in the Philippines), representing seven genera, two tribes (Alpinieae and Zingibereae), and two subfamilies (Alpinioideae and Zingiberoideae). The cluster analysis revealed three major groups: Cluster I with eight species, Cluster II with four species, and Cluster III with five species. The study identified two endangered species – *Etlingera lacerata* Naive and *Hedychium philippinense* K.Schum., and 10 species of gingers are endemic to the Philippines. Zingiberaceae species were widely distributed across the four forest patches in the area, with only one species found in site 1, eleven species in site 2, three species in site 3, and four species in site 4. The findings of this study are helpful to the local government of Barangay Kalabugao to guide management and promote conservation strategies that could help protect and preserve the remaining Zingiberaceae species in the area.

**Keywords:** Wild gingers; morphological characteristics; endemic; conservation status.

## INTRODUCTION

Members of the Zingiberaceae family are aromatic, perennial, terrestrial, rarely epiphytic herb plants with spreading horizontal or tuberous rhizomes (Alolga et al., 2002). They have more than 1,500 species belonging to at least 53 genera worldwide, with around 80% of all known tropical forests home to many species (Lamb et al., 2013). The Philippines has around 141 species of gingers distributed in 20 genera (Pelser et al., 2011 onwards). These plants are found across the tropics and subtropics, but they are notably common in Southeast Asia (Lamb et al., 2013). Based on morphological and genetic investigations, Zingiberaceae is divided into four subfamilies and six tribes: Siphonochiloideae (Siphonochileae), Tamijioideae (Tamijieae),

Alpinioideae (Alpinieae, Riedelieae), and Zingiberoideae (Zingibereae, Globbeae) (Kress et al., 2002). Zingiberaceae can also be used in food, medicines, dyes, and perfumes (Bhunia & Mondal, 2012).

Despite the high diversity of Zingiberaceae in Mindanao, the forest patches of Barangay Kalabugao remain biologically unexplored, with no existing documentation of its ginger species, their conservation status, or their spatial distribution. This lack of baseline information limits local conservation planning, especially as the area is increasingly threatened by habitat loss, poaching, and anthropogenic disturbance. This study addresses this knowledge gap by documenting Zingiberaceae species present in Kalabugao, assessing their conservation status and endemism, and mapping their distribution across the forest patches of Kalabugao in Bukidnon, to provide data essential for local biodiversity management.

## METHODOLOGY

### Entry protocol

Before conducting the study, a letter was sent to the mayor's office at Impasug-ong, Bukidnon, to ask permission to carry out the study in the selected forest patches of Kalabugao, Impasug-ong, Bukidnon. The approved letter from the mayor's office was forwarded to the office of the Barangay Captain of Barangay Kalabugao as a courtesy letter before the actual field collection. A Wildlife Gratuitous Permit (WGP) No. R10-2024-28, with the name of the holder – Jorengel Mae M. Labo, was obtained from the office of the Department of Environment and Natural Resources (DENR) - Region X. A ritual ceremony was then performed with locals to express respect in the area.

### Place and duration of the study

The study was conducted in the selected forest patches of Barangay Kalabugao, Impasug-ong, Bukidnon, from March 2024 (Fig. 1). The identification and description of the species were carried out from March to April.

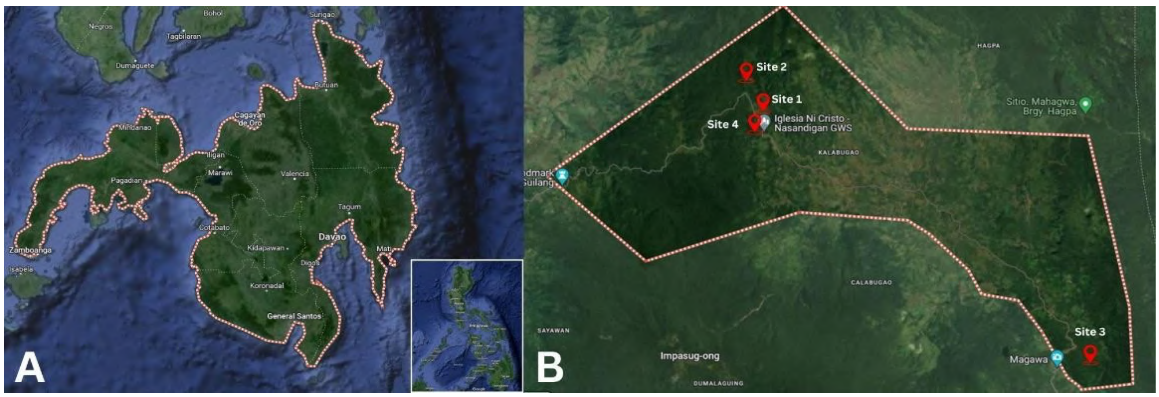


**Figure 1:** Map of the Study Area. **A.** Philippine map and Mindanao map. **B.** Kalabugao map.

Four sampling sites were established in Kalabugao, Impasug-ong, Bukidnon. The first site was in mid-elevation in Sitio Nasandigan at 1,230 m a.s.l., characterized by a mossy forest with a dense cover of mosses draping tree trunks, branches, and leaves, forming a thick low canopy. The second site was on Mt. Palusongan in Sitio Nasandigan, at 1,250 m a.s.l., classified as a primary forest with abundant vascular epiphytes and terrestrial species. The third site was a

secondary forest in Sigayan Forest, Sitio Ulayanon, at 880 m a.s.l., representing a lower montane forest with a diverse variety of plant species, including tall, straight trees with broad canopies and a rich understory of shrubs, ferns, and epiphytes. The fourth site was a Dipterocarp forest at 1,182 m a.s.l. (Fig. 2). The selection of the sampling stations was based on recommendations and suggestions from the Barangay Captain and officials of Barangay Kalabugao, Impasug-ong, Bukidnon.


**Figure 2:** Study areas. **A.** First site – Sitio Nasandigan view of the forest. **B.** Second site – Mt. Palusongan, Sitio Nasandigan view of the forest. **C.** Third site – Sigayan Forest at Sitio Ulayanon view of the forest. **D.** Fourth site – Dipterocarp Forest in Sitio Nasandigan view of the forest.

## Sampling procedure

The start of the belt transect was established 100 meters from the base. Repeated transect walks were employed following the established forest trails in the selected forest patches located at Sitio Nasandigan and Sitio Ulayanon. Four transects were established in each site, in which a belt transect of 200 m was followed to collect ginger species, by considering the collection within 5 m on each side of the trail. Opportunistic sampling was also employed when Zingiberaceae species were found outside the forest trail. Samples were collected and placed in labelled plastic cellophane bags. Each plant was recorded with the following data: date and place of collection, local name, description, collection number, habitat, and local uses.

## Collection and preservation of herbarium specimens

Using pruning shears, a portion of the leafy shoot (with at least two leaves) was cut. For species bearing inflorescences and/or infructescences at the terminal end of the leaves, the pseudostem with at least two leaves was cut to ensure the flowers and fruits remained intact. Conversely, those inflorescences and/or infructescences that were found rooted to the base, at least 6 inches of pseudostem from the ground with its rhizome bearing flowers and fruits, were collected. These specimens were then placed in cellophane bags to prevent dehydration. They were spread out between the folds of old newspapers or blotting sheets. Large specimens were folded

into 'N' or 'W' shapes. Information about each species and other necessary data was written on the newspapers. The specimens were then tied with twine, placed inside a transparent cellophane bag, and soaked in denatured alcohol. Afterwards, the specimens were transported to Central Mindanao University and dried using a mechanical dryer.

The dried specimens were mounted on standard-sized herbarium sheets (41 x 29 cm). Mounting was done with the use of glue, adhesive, or cello-tape. Bulky plant parts, such as dry fruits, seeds, and inflorescence, were dried without pressing and placed in a glass container with 70% ethyl alcohol. Labels were pasted on the lower right corner of the mounting sheet. The label indicated the information about the locality, altitude, habitat, date and time of collection, name of collector, common name, and scientific name. Plant specimens were properly dried, pressed, identified, and placed in thin paper folds (specimen covers) and kept together in thick paper folders before being incorporated into the herbarium cupboards in their proper position.

Pickled collections were also prepared to preserve plant structures, such as flowers and fruits, to record their characteristics. Flowers and fruits were placed in a glass container with 70% ethyl alcohol. All herbarium specimens and pickled collections were then deposited at the Botany section of Central Mindanao University Herbarium (CMUH).

**Identification of the specimens**

The roots, stems, leaves, and inflorescence of each ginger species were examined for classification and identification. The Co's Digital Flora of the Philippines by Pelser et al. (2011 onwards) was used as a reference material in the identification and comparison of the Zingiberaceae species. The final verification of the taxonomic identities of each species was confirmed by NPM using fresh materials during the field collection and its dried herbarium.

**Species composition and morphological description**

The Zingiberaceae species were collected and classified according to their genera, subfamily, tribes, and species. All species that were collected during the transect walks and opportunistic samplings in the four selected sites were tabulated. Each specimen was then described in terms of the diagnostic morphological characteristics following the work on Mendez (2022), such as position, diameter and colour of the rhizome; shape, size, and indumentum of base; shape, size, colour, base, apex, indumentum, and margin of the leaf; shape, size, colour, and indumentum of ligule; length, diameter, indumentum, and colour of petiole; and other characters.

**Assessment of conservation status and endemism**

The species were evaluated for conservation status following the criteria of DAO (2017-11), Fernando et al. (2022), and IUCN (2025). The endemism of each species was determined by browsing the list from the online e-Flora of Co's Digital Flora of the Philippines by Pelser et al. (2011 onwards).

**Cluster analysis**

Plant morphological characteristics were described and documented using descriptive analysis. Cluster analysis was performed to group or classify species based on similarities in certain characteristics. In the analysis, Paleontological Statistics (PAST) software was used to tabulate the morphological characteristics of the Zingiberaceae species.

**Distribution of zingiberaceae species**

The determination of the distribution of Zingiberaceae species was done using the Global Positioning System (GPS) GAIA mobile app. The data gathered during the sampling were

utilized to generate a species distribution map through Geographic Information System (GIS) software with the help of a GIS specialist.

## RESULTS

### Species composition of zingiberaceae

This study recorded 17 species of Zingiberaceae in the selected forest patches of Barangay Kalabugao, Impasug-ong, Bukidnon. These species belong to seven genera, two tribes (Alpinieae and Zingibereae), and two sub-families (Alpinioideae and Zingiberoideae) (Table 1). The species with the largest number of individuals was *Plagiostachys* sp. 1, with six individuals in all sites. The sampling site that had the largest number of species was site 2, which is a primary forest with 12 species. It is noteworthy that sites 3 and 4 may have lower richness because of past disturbances in the area, and some species may be influenced by microhabitat availability, such as in the case of *Hedychium philippinense*, a Philippine endemic and endangered species, which is only present in undisturbed sites.

**Table 1:** List of species of Zingiberaceae with their classification in the forest patches of Barangay, Kalabugao, Impasug-ong, Bukidnon, with subfamily and tribe.

| | SUBFAMILY/TRIBE/GENUS/SPECIES | Site | | | |
|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 |
| | **I. ALPINIOIDEAE** | | | | |
| A. | Alpinieae | | | | |
| A.1. | *Adelmeria* | | | | |
| 1. | *Adelmeria alpina* Elmer | | ✓ | | |
| A.2. | *Alpinia* | | | | |
| 2. | *Alpinia haenkei* C. Presl | ✓ | ✓ | | |
| 3. | *Alpinia rufa* C. Presl | | | ✓ | |
| 4. | *Alpinia* sp. | | | | ✓ |
| A.3. | *Etlingera* | | | | |
| 5. | *Etlingera dostseiana* Naive, Demayo, and Alejandro | | ✓ | | |
| 6. | *Etlingera elatior* (Jack) R.M.Sm. | | ✓ | | |
| 7. | *Etlingera fimbriobracteata* (K.Schum.) R.M.Sm. | | ✓ | | ✓ |
| 8. | *Etlingera lacerata* Naive | | | | ✓ |
| 9. | *Etlingera* sp. | | ✓ | | |
| A.4. | *Hellwigia* | | | | |
| *10.* | 11. *Hellwigia musifolia* (Ridl.) Senjaya & A.D.Poulsen | | ✓ | | |
| | **II. ZINGIBEROIDEAE** | | | | |
| B. | Zingibereae | | | | |
| B.1. | *Hedychium* | | | | |
| 11. | *Hedychium philippinense* K.Schum. | | ✓ | | ✓ |
| B.2. | *Hornstedtia* | | | | |
| 12. | *Hornstedtia conoidea* Ridl. | | ✓ | | ✓ |
| 13. | *Hornstedtia lophophora* Ridl. | | ✓ | | |
| B.3. | *Plagiostachys* | | | | |
| 14. | *Plagiostachys escritorii* Elmer | | ✓ | | ✓ |
| 15. | *Plagiostachys* sp. 1 | | | ✓ | |
| 16. | *Plagiostachys* sp. 2 | | | ✓ | |

| | | | | | |
|---|---|---|---|---|---|
| B.4. | *Zingiber* | | | | |
| 17. | *Zingiber* sp. | | ✓ | | |
| | **TOTAL** | 1 | 12 | 3 | 6 |

In this study, the 17 recorded species are as follows:

***Adelmeria alpina* Elmer.** Terrestrial, perennial herb, 0.5–0.8 m, recorded alongside the established trail. Rhizome short, creeping, yellow to brownish. Ligule brown, 0.3–0.5 cm. Leaves distichous; sessile; lanceolate, 15–36 cm long × 3–7 cm wide, margin entire, rounded base, cuspidate apex; pale green glabrous abaxially and yellow green glabrous adaxially. Stem elongated, 3 cm distance between internodes. Inflorescence clustered with brown bracts. 1.Fruits globose to subglobose, 1.3–1.4 × 0.9–2.1 cm, glabrous texture, green when young and red when mature. Seeds subglobose, 1–2 mm, cream white when young and turning brownish to black when mature (Fig. 3A).
**Elevation.** 1,292 m a.s.l.

***Alpinia haenkei* C.Presl.** Terrestrial, perennial herb, 1–1.2 m. Habitat was recorded alongside the established trail. Rhizome creeping, whitish to pinkish when young. Ligule bifid, pinkish to pale green, 2–3 cm, indumentum present. Leaves distichous; petiolate, 1–2 cm; cuneate, 21–50 cm × 7–10 cm wide, margin undulate, attenuate to bolique base, acute apex to acuminate; glabrous abaxially and adaxially, green adaxial when young, pink abaxial when young. Pseudostem elongated, 9 cm distance between internodes, completely enclosed with leaf sheath. Fruits globose to subglobose, 2.0–2.6 × 1.2 0–1.4 cm, pubescent texture, green when young and orange turning red when mature. Seeds subglobose, 1–2 mm, cream white when young and black when mature.
**Elevation.** 1,227 m a.s.l.

***Alpinia rufa* C.Presl.** Terrestrial, perennial herb, 1–1.5 m, recorded 2 m away from the trail. Rhizome creeping, brown, 10–15 cm, glabrous. Pseudostem green, up to 1.5 cm diam., pubescent. Ligule yellow-green, 1 cm, indumentum present. Leaves distichous, sessile, lanceolate, 18–20 cm long × 6–7 cm wide, margin entire, attenuate base, acuminate apex; pale green glabrous abaxially and yellow green hairy adaxial, pubescent. Inflorescence at the terminal of leafy shoots, erect, up to 5 cm. Flowers white, 2.1–2.3 × 0.8–1.0 cm. Infructescence globose, pubescent, green when young, red when ripe. Fruits globose with a white aril, turning black when mature (Fig. 3B).
**Elevation.** 878–880 m a.s.l.

***Alpinia* sp.** Terrestrial, perennial herb, 1.5–2 m. Rhizome long, creeping, creamy white to brown, 45–50 cm in length, glabrous. Pseudostem green, 3.5–4.7 cm diam., glabrous. Ligule yellow-green, 2–2.5 cm, apex entire with fine hairs. Leaves distichous, petiolate, lanceolate, 25–28 cm long × 14–15 cm wide, margin entire, obtuse base, attenuate apex; abaxial surface green, glabrous; adaxial surface dark green, leathery.
**Elevation.** 960 m a.s.l.

***Etlingera dostseiana* Naive, Demayo & Alejandro.** Terrestrial, perennial herb, 1–1.5 m, recorded along the established trail. Rhizome creeping, with raised, reddish stilt roots. Ligule reddish, 0.8–1 cm. Leaves distichous, petiolate, 1 cm; lanceolate, 41–50 cm long and 7–15 cm wide, margin entire, oblique base, acuminate apex; pale green glabrous abaxially and green glabrous adaxially. Stem elongated, 8–10 cm distance between internodes, completely

enclosed with leaf sheath. Inflorescence fused bracts or ovoid spike and papery sterile and fertile bracts red and white; bracteole white with pinkish tip, linear, 2 cm, calyx white, 2.1 cm; corolla white, 2 cm; labellum yellow, 0.5 cm; anther yellow; filament white, 2 cm; stigma white; style white, 3cm; ovary cream white (Fig. 3C).
**Elevation.** 1,332 m a.s.l.

***Etlingera elatior* (Jack) R.M.Sm.** Terrestrial, perennial herb, 4–5 m. Rhizome long, creeping, thick, and fleshy. Ligule yellow-green, 2–3 cm. Leaves distichous; petiolate, 2 cm; lanceolate, 74–80 cm long × 15–18 cm wide, margin entire, oblique base, obtuse apex; vibrant green in colour. Inflorescence torch or cone-like, consists of numerous tightly packed bracts that range in colour from pink to red; flowers are small and inconspicuous, nestled within the bracts, 15–20 flowers; bracteole oblong, 6 cm; calyx red, 2 cm; corolla red, 1.8 cm; labellum red, 1 cm; anther yellow; filament white, 1.7 cm; stigma black; red, 3 cm; ovary red (Fig. 3D).
**Elevation.** 1,267–1,303 m a.s.l.

***Etlingera fimbriobracteata* (K.Schum.) R.M.Sm.** Terrestrial, rhizomatous, perennial herb, 3–5 m tall. Rhizome long, creeping, brown, glabrous. Pseudostem light green, 3.4–4.4 cm diam., glabrous. Ligule oblong, green, 2 cm. Leaves distichous, petiolate, 2 cm, oblong, 80–100 cm long × 14–18 cm wide, margin entire, obtuse base, pointed apex; adaxial surface, dark green, glabrous; abaxial surface, light green, glabrous. Inflorescence attached to the rhizome, close to the base of the pseudostem. Bracts spirally arranged, fused in truncate form at the top; bracteoles tubular, yellow; anther reddish; stigma red with white colour at the center; corolla lobe yellow in colour; ovary cream white colour (Fig. 3E).
**Elevation.** 1253 m a.s.l.

***Etlingera lacerata* Naïve.** Terrestrial, rhizomatous, perennial herb, 1–2 m tall. Rhizome creeping, 32–36 cm, creamy white when young, brown when mature. Ligule oblong, 1 cm, margin entire, yellow-green to reddish margin. Leaves distichous, 39–40 cm length × 6–7 cm width, margin entire, attenuate base, acuminate apex, green in colour. Petiole, 2 cm in length, green to dark green, glabrous. Adaxial surface green, glabrous; abaxial surface light green, glabrous. Inflorescence directly attached to the rhizome, crimson red with white undulate margins, up to 6.5 cm. Infructescence clustered, light green when young, turning brownish when mature, radical in position (Fig. 3F).
**Elevation.** 965–1,139 m a.s.l.

***Etlingera* sp.** Terrestrial, rhizomatous, perennial herb, 1.5–3 m tall. Rhizome long, creeping, 128–135 cm, pinkish to red, with peduncular bracts ranging from 13-14 cm in length. Ligule brown, dried, papery, and leathery, 2.3 cm × 1.6 cm. Leaves distichous, 48–64 cm length, 13.5–15 cm width; petiolate, 0.8 cm; glabrous on both surfaces; entire margin, attenuate base, acuminate apex, light green. Inflorescence directly attached from the rhizome, 20–30 cm distance from the base of pseudostem; bracts clustered, whitish to red; bracteoles tubular or linear, 3 cm, yellow; anther yellow to reddish; stigma red at the center; style white; corolla lobe yellow, 2 cm; labellum white to yellow, 3.2 cm; anther yellow; filament white to yellow, 3 cm; stigma red; style white, 3.3 cm; ovary white (Fig. 3G).
**Elevation.** 1,332 m a.s.l.

***Hellwigia musifolia* Ridl.** Terrestrial, perennial herb, 3–5 m, recorded along the established trail. Rhizome creeping, whitish, with raised stilt roots. Pseudostem 3.4–4.2 cm diam., green, with brownish margins. Ligule yellow-green to green, 0.4–0.5 cm, apex entire, g; glabrous with minute fine hairs in the margins. Petiole 1.1–1.4 cm, green to brownish, glabrous. Leaves

distichous, lanceolate, 30–40 × 4–7 cm, margin entire, oblique base, acuminate apex; glabrous abaxially and adaxially, green. Stem elongated, 10 cm distance between internodes, completely enclosed with leaf sheath. Infructescence spike hooded in bracts spatulate in shape, green, fleshy, rounded (Fig. 3H).
**Elevation.** 1,337 m a.s.l.

***Hedychium philippinense* K.Schum.** Epiphytic herb, 0.3–0.5 m in height. Rhizome creeping with roots fully attached to the trunk of the trees, 15–26 cm in length, whitish to brown. Ligule papery, light green to yellow-green, 1–2 cm in length. Leaves distichous, 36–40 cm long × 8 cm wide, green; sessile; glabrous on both surfaces; margin entire, base attenuate, apex acuminate. Infructescence 9.3–11.4 cm × 6.5–7.2 cm, bearing 2–3 flowers at a time. Infructescence with orange pericarp, 7.3–9.0 cm, dehiscent opening 3 slits, glabrous. Fruits dehiscent, with multiple seeds inside, dropping upon their opening. Seeds orange to reddish with orange aril.
**Elevation.** 1,301 m a.s.l.

***Hornstedtia conoidea* Ridl.** Terrestrial, perennial herb, 1–1.5 m, recorded along the established trail. Rhizome creeping, brownish. Ligule light brown, 0.5–0.8 cm. Leaves distichous; petiolate, 0.8–1 cm; lanceolate, 65–80 cm long × 10–12 cm wide, margin entire, acute base, acute apex; pale green glabrous abaxially, green glabrous adaxially. Stem elongated, 12 cm distance between internodes, completely enclosed with leaf sheath. Inflorescence attached to the rhizomes; yellow to red bracts. Calyx elongated, membranous, light pink to red, 38–42 × 4– 5 cm. Corolla oblong, red, 1.5 × 0.5cm. Labellum oblong, without staminodes, red, 1.5 × 0.8cm. Only 1–(2 flower/s open at a time during anthesis (Fig. 3I).
**Elevation.** 1,242 m a.s.l.

***Hornstedtia lophophora* Ridl.** Terrestrial, perennial herb, 1–2 m; recorded alongside the river. Rhizome creeping, brownish. Ligule brownish, 1.5–2 cm, hairy, oblong. Leaves distichous; petiolate, 1–1.5 cm; acuminate, 60–75 cm long and 15–20 cm wide, brown margin entire, rounded base, acuminate apex; yellow-green pubescent abaxially, green glabrous adaxially. The stem is completely enclosed by the leaf sheath. Inflorescence spike; whitish to pinkish bracteole; calyx pink; corolla pink to white, 13.1 cm. Flowers pink, with showy pollen found at the petaloid labellum (Fig. 3J).
**Elevation.** 1,250 m a.s.l.

***Plagiostachys escritorii* Elmer.** Terrestrial, perennial herb, 1–2 meters, recorded along the established trail. Rhizome creeping, whitish to brownish, glabrous. Ligule pale green to light brown, 1–2 cm. Leaves distichous; petiolate, 1–2 cm; lanceolate, 35–40 cm long × 8–12 cm wide, margin entire, base acute, apex acuminate; pale green, adaxial surface green, glabrous; abaxial surface light green, pubescent. Pseudostem elongated, 8 cm distances between internodes, green, completely enclosed with a coriaceous leaf sheath. Infructescence emerged at the pseudostem at ca. 10 from the ground, clustered, red to maroon. Fruits globose, fleshy, radial in position, pubescent (Fig. 3K).
**Elevation.** 1,233 m a.s.l.

***Plagiostachys* sp. 1.** Terrestrial, perennial herb, 0.5 – 0.7 m tall. Rhizome creeping, whitish to red. Ligule yellow-green with pinkish light, pubescent, 1 cm. Leaves distichous, petiolate, 0.7 cm, lanceolate, 20–23 cm long × 5–8 cm wide, margin entire, base acute, apex acuminate, yellow-green, glabrous; abaxial surface green, glabrous, adaxial surface yellow-green, glabrous.

Inflorescence is attached directly from the stem; bracts are whitish to yellow; corolla is red (Fig. 3L).
**Elevation.** 877–878 m a.s.l.

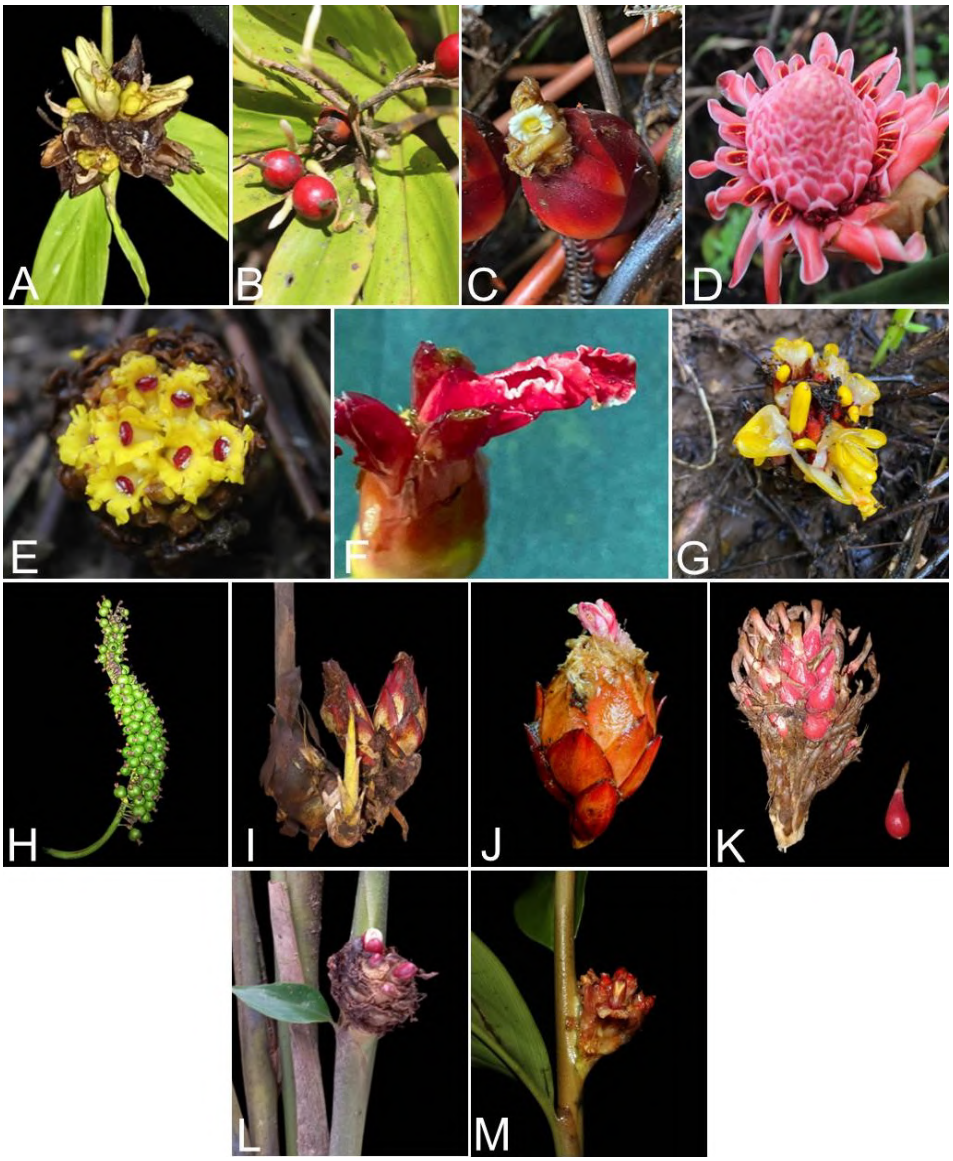


**Figure 3:** Representative species of Zingiberaceae in Brgy. Kalabugao, Impasug-ong, Bukidnon. **A.** *Adelmeria alpina* Elmer. **B.** *Alpinia rufa* C.Presl. **C.** *Etlingera dostseiana* Naive, Demayo & Alejandro. **D.** *Etlingera elatior* (Jack) R.M.Sm. **E.** *Etlingera fimbriobracteata* (K.Schum.) R.M.Sm. **F.** *Etlingera lacerata* Naïve. **G.** *Etlingera* sp. **H.** *Hellwigia musifolia* (Ridl.) Senjaya & A.D.Poulsen. **I.** *Hornstedtia cooidea* Ridl. **J.** *Hornstedtia lophophora* Ridl. **K.** *Plagiostachys escritorii* Elmer. **L.** *Plagiostachys* sp. 1. **M.** *Plagiostachys* sp. 2.

***Plagiostachys* sp. 2.** Terrestrial, perennial herb, 0.5–0.8 meters tall. Rhizome creeping, whitish to brown. Ligule pinkish, 0.7 cm. Leaves distichous; petiolate, 1 cm; lanceolate, 18–20 cm long × 7–10 cm wide, margin entire, base attenuate, apex acuminate; adaxial surface dark green, glabrous, abaxial surface pale green. Infructescence attached directly from the stem, yellow-green, fleshy capsule (Fig. 3M).
**Elevation.** 880 m a.s.l.

***Zingiber* sp.** Terrestrial, perennial herb, 0.8–1 m, recorded along the established trail. Rhizome creeping, yellowish to brownish. Ligule pale brown, 0.5–0.7 cm. Leaves distichous; absence of petiole or sessile; lanceolate, 30–35 cm long × 5–8 cm wide, margin entire, base acute, apex acuminate; adaxial surface dark green, glabrous, abaxial surface pale green. Inflorescence, flowers, and fruits not observed.
**Elevation.** 1,292 m a.s.l.

**Numerical phenetic analysis**
Numerical phenetic analysis of Zingiberaceae species was carried out using the Paleontological Statistics (PAST) Software program version 4.03 (Hammer et al., 2001). The analysis considered 17 species and examined 43 morphological characters. The list of these characters and character states was scored 0 if absent and 1, 2, 3, etc., if present for each morphological character. The data was analyzed and grouped through neighbour joining using the Euclidean distance method.

The cluster analysis resulted in three major clusters: Cluster I is composed of eight species, these were *E. lacerata*, *Etlingera* sp., *E. fimbriobracteata*, *E. elatior*, *E. dostseiana*, *H. philippinense*, *H. conoidea*, and *H. lophophora.* Cluster II is composed of four species, which were *P. escritorii*, *Plagiostachys* sp. 1, *Plagiostachys* sp. 2, and *Zingiber* sp., and Cluster III is composed of five species, which were *A. alpina*, *A. haenkei*, *A. rufa*, *Alpinia* sp., and *H. musifolia* (Fig. 4).

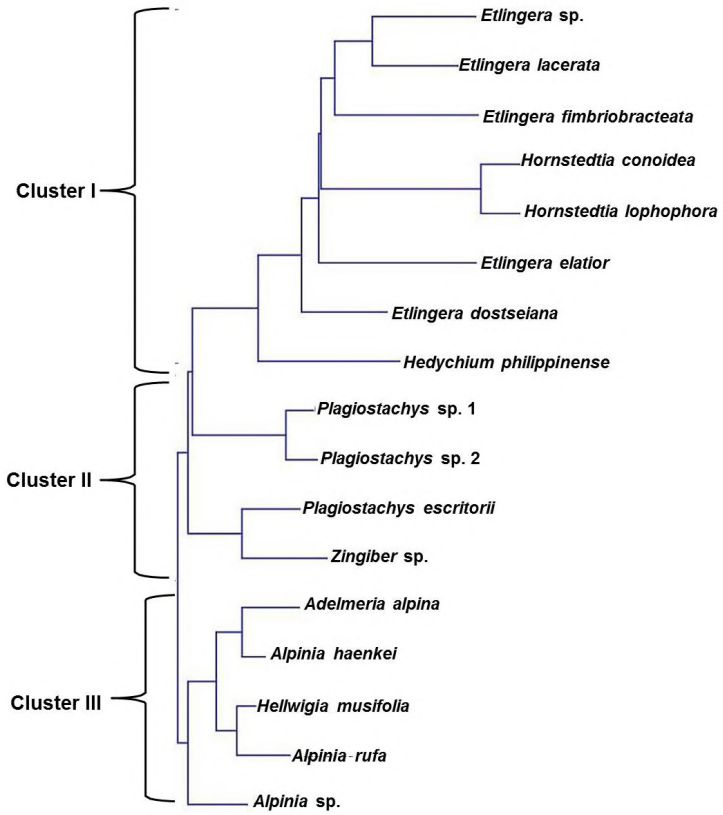


**Figure 4:** Cluster Analysis of Zingiberaceae species in neighbouring joining clustering using Euclidean.

## Conservation status and endemism of zingiberaceae

Assessment of the conservation status showed that *E. lacerata* and *H. philippinense* are endangered species, according to Pelser et al. (2011 onwards) and Fernando et al. (2022). On the other hand, the endemism showed that 10 species are endemic in the Philippines, following the online database of Pelser et al. (2011 onwards), DAO 2017-11, and Fernando et al. (2022) (Table 2). Three species are possibly new to science, *viz.*, *Etlingera* sp., *Plagiostachys* sp. 1, and *Plagiostachys* sp. 2.

**Table 2:** List of Zingiberaceae species found in the forest patches of Barangay Kalabugao with their endemism and distribution.

| Species | Conservation Status (DAO 2017-11; Fernando et al., 2022, IUCN, 2025) | Endemism (Pelser et al., 2011 onwards) |
|---|---|---|
| *Adelmeria alpina* Elmer | | PE |
| *Alpinia haenkei* C.Presl | | PE |
| *Alpinia rufa* C.Presl | | PE |
| *Etlingera dostseiana* Naive, Demayo & Alejandro | | PE |
| *Etlingera lacerata* Naive | EN | PE |
| *Hellwigia musifolia* (Ridl.) Senjaya & A.D.Poulsen | | PE |
| *Hedychium philippinense* K.Schum. | EN | PE |
| *Hornstedtia conoidea* Ridl. | | PE |
| *Hornstedtia lophophora* Ridl. | | PE |
| *Plagiostachys escritorii* Elmer | | PE |

Remarks: EN – Endangered; PE – Philippine Endemic

A total of 10 Zingiberaceae species are endemic to the Philippines. Of these, seven Zingiberaceae species are endemic to the Philippines, and three species are distributed only in Mindanao**.** The Philippine endemic species include *A. alpina*, *A. haenkei*, *A. rufa*, *H. musifolia*, *H. philippinense*, *H. conoidea*, and *P. escritorii*, while the Mindanao endemic species are *E. dostseiana*, *E. lacerata*, and *H. lophophora.*

## Distribution of zingiberaceae species

In this study, only the *A. haenkei* species was recorded in site 1 due to its vegetation. In Site 2, 12 species have been recorded, namely *A. alpina*, *A. haenkei*, *E. dostseiana*, *E. elatior*, *E. fimbriobracteata*, *Etlingera* sp., *H. musifolia*, *H. philippinense*, *H. conoidea*, *H. lophophora*, and *Zingiber* sp. In site 3, three species have been recorded, namely *A. rufa*, *Plagiostachys* sp. 1, and *Plagiostachys* sp. 2. In site 4, six species have been recorded, namely *Alpinia* sp., *E. fimbriobracteata*, *E. lacerata*, *H. philippinense*, *H. conoidea*, and *P. escritorii* (Fig. 5). Many species are being threatened because of habitat loss or disturbed habitats in some sites or forest patches in Barangay Kalabugao, Impasug-ong, Bukidnon.

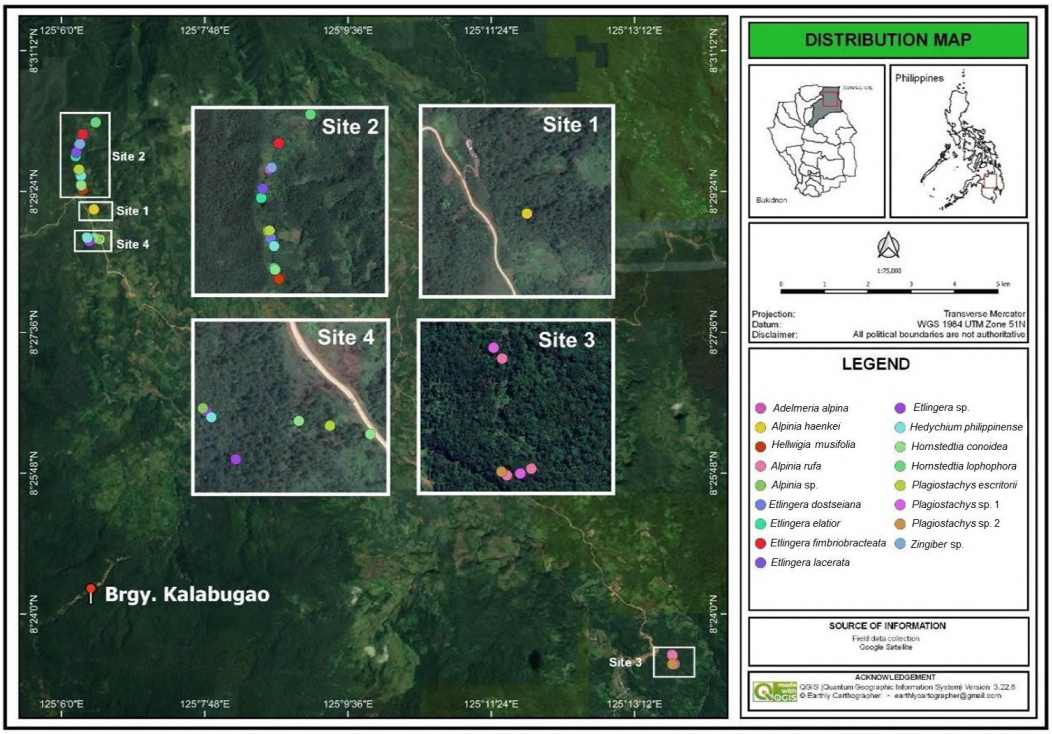


**Figure 5:** Distribution map of Zingiberaceae species in the forest patches of Barangay Kalabugao, Impasug-ong, Bukidnon.

## DISCUSSION

### Species composition

The Philippines has 20 genera and more than 140 species of gingers (Pelser et al., 2011 onwards). Recently, the Philippines recorded the occurrence of several new Zingiberaceae species, representing new records for the area or locally within the country. The majority of Zingiberaceae collected in the Philippines are found in the Luzon islands, followed by the Visayas, and the Mindanao islands (Coquilla, 2012). Zingiberaceae in the Marilog forest comprised about 27 species, which is 23% of the total number of Philippine Zingiberaceae (Acma et al., 2020).

The 17 recorded species in this study are higher than the species collected by Naive (2017) in Mt. Kalatungan Range, Bukidnon, with 12 species; Acero et al. (2019) in Mt. Hamiguitan with 14 species; Jayme et al. (2020) in Cinchona Forest Reserve, Lantapan, Bukidnon, with 11 species; and Mendez et al. (2023) in Mt. Musuan, Maramag, Bukidnon, with 11 species. However, these species are lower than those collected by Acma et al. (2020) in Marilog District, Davao City, with 27 species.

Zingiberaceous plants exhibit several distinctive morphological traits. For instance, many species within this family feature rhizomatous growth, such as *Zingiber officinale* Roscoe, where underground rhizomes store nutrients and facilitate vegetative propagation. The leaves of Zingiberaceae often display a distichous arrangement as seen in the foliage of turmeric ginger (*Curcuma longa* L.). Inflorescences in Zingiberaceae are typically spikes or racemes, enclosed by brightly coloured bracts, as exemplified by the inflorescence of the torch ginger, *Etlingera elatior* (Jack.) R.M.Sm. The floral morphology of Zingiberaceae is characterized by zygomorphic flowers with three sepals and three petals, one of which is often modified into a

showy labellum, as observed in the flowers of the shell ginger, *Alpinia zerumbet* (Pers.) B.L.Burtt & R.M.Sm. Stamens consist of one fertile stamen and two staminodes per flower. The ovary is inferior, and the fruits are capsules containing numerous seeds (Kress et al., 2002; Newman et al., 2009).

**Numerical phenetic analysis**

The result of cluster analysis revealed that Zingiberaceae species are distinct from one another, with some species from different genera sharing few closely related morphological characteristics while being classified as different genera. The cluster analysis helps in identifying key diagnostic characteristics that distinguish between closely related species or varieties.

**Conservation status and endemism of zingiberaceae**

A total of 10 Zingiberaceae species are endemic to the Philippines. Of these, seven Zingiberaceae species are endemic to the Philippines, and three species are distributed only in Mindanao**.** The Philippine endemic species include *A. alpina*, *A. haenkei*, *A. rufa*, *H. musifolia*, *H. philippinense*, *H. conoidea*, and *P. escritorii*, while the Mindanao endemic species are *E. dostseiana*, *E. lacerata*, and *H. lophophora.*

**Distribution of zingiberaceae species**

The location and distribution map revealed that Zingiberaceae species are widely distributed in four selected forest patches in Barangay Kalabugao, Impasug-ong, Bukidnon. Zingiberaceae are found in a wide range of tropical and subtropical areas, particularly in tropical Asia, where the region's long history of a stable, humid, and hot climate, along with a diverse range of habitats, likely promoted the growth and differentiation of these plants (Chen, 1989).

The study included a detailed assessment of Zingiberaceae species within the forest ecosystem. It involved recording the specific locations where different Zingiberaceae species are found, their abundance, and their associations with various microhabitats. The study also examines environmental factors that influence their distribution, such as vegetation type, light availability, and forest canopy structure.

## CONCLUSIONS

This study documents 17 species of Zingiberaceae, representing 13.05% of the total Zingiberaceae species found in the Philippines. These species belong to seven genera, two tribes (Alpinieae and Zingibereae), and two subfamilies (Alpinioideae and Zingiberoideae). Notably, two species are endangered (*E. lacerata* and *H. philippinense*), and 10 are endemic to the Philippines. The study revealed that Zingiberaceae species are widespread across four forest patches in the study area, with the following distribution: site 1 with one species, site 2 with eleven species, site 3 with three species, and site 4 with four species.

To ensure the preservation of these ginger species for future research and use, it is recommended that local communities and stakeholders give special attention and protection to these study sites. It is also recommended that field expeditions on Zingiberaceae should be done in the other mountain ecosystems in the Philippines to generate concrete data on different species.

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## DECLARATIONS

**Research permit(s).** A letter was sent to the mayor's office at Impasug-ong, Bukidnon, to ask permission to carry out the study in the selected forest patches of Kalabugao, Impasug-ong, Bukidnon. A Wildlife Gratuitous Permit (WGP) No. R10-2024-28 was obtained from the office of the Department of Environment and Natural Resources (DENR) - Region X.
**Ethical approval/statement**. Not applicable.
**Generative AI use.** I/we declare that generative AI was not used in this study nor in the writing of this article.

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