
Research Article

Species Composition and Distribution of Zingiberaceae in Mt. Hamiguitan Expansion Site, Davao Oriental, Philippines

Krystal Mae L. Acero¹, Victor B. Amoroso^{1,2}, Hannah P. Lumista^{1,2}, Noe P. Mendez^{1,2} & Florfe M. Acma^{1,2*}

¹Department of Biology, College of Arts and Sciences, Central Mindanao University, University Town, Musuan, 8710 Bukidnon, Philippines

²Center for Biodiversity Research and Extension in Mindanao (CEBREM), Central Mindanao University, University Town, Musuan, 8710 Bukidnon, Philippines

*Corresponding author: flmacma@gmail.com

Abstract

This study was conducted to assess the composition and distribution of gingers (Zingiberaceae) in Mt. Hamiguitan expansion site, Tumulite, San Isidro, Davao Oriental, Philippines. Transect walk and opportunistic sampling were carried out along established forest trails, rivers, creeks and streams. Fourteen (14) ginger species were found, of which 10 species are endemic to the Philippines, two species are introduced, and two species are unidentified to the species level. The species belong to two subfamilies (Alpinoideae and Zingiberoideae) and three tribes (Alpinieae, Globbeae, and Zingibereae). The species recorded include *Alpinia haenkei* C.Presl, *Alpinia* cf. *vulcanica* Elmer, *Alpinia rufa* C.Presl, *Alpinia* sp., *Curcuma zedoaria* (Christm.) Rosc., *Curcuma longa* L., *Etilingera dalican* (Elmer) A.D.Poulsen, *Etilingera hamiguitanensis* Naive, *Etilingera* sp., *Geocharis fusiformis* (Ridl.) R.M.Sm., *Globba campophylla* K.Schum., *Hornstedtia conoidea* Ridl., *Hornstedtia microcheila* Ridl., and *Meistera muricarpa* (Elmer) Škorničk. & M.F.Newman. These species represent 47% of the total genera and 14% of the total species of Zingiberaceae in the Philippines. Cluster analysis (numerical analysis) using morphological descriptions supported present taxonomic placements of the species. The data indicated that *G. fusiformis* is the most abundant ginger in the area.

Keywords: *Etilingera hamiguitanensis*, *Geocharis fusiformis*, Gingers, *Meistera muricarpa*, Philippine endemic

Introduction

Zingiberaceae or the ginger family has at least 1,500 species distributed in 53 genera (Kress et al., 2002; Lamb et al., 2013). Many of the species are commercially cultivated in several regions of the world, such as in Africa, India, China, Japan, Indonesia, Australia, Nigeria and the West Indies. In the Philippines, this family has 15 genera and more than 100 species (Pelser et al., 2011 onwards). The species are mostly characterized as small to large perennial plants with creeping horizontal or tuberous rhizomes and are usually aromatic in all plant parts. The inflorescence can be branched or lax in some species, with reduced pedicels, or even forming a spike, or with congested rachis (Leong-Škorničková & Newman, 2015).

Knowledge about Zingiberaceae in many parts of the world is still insufficient (Larsen & Larsen, 2006). This could be due to inadequate collection of herbarium specimens from the respective areas (Larsen, 1980), which makes the identification of gingers in those areas inaccurate and hence insufficiently known in terms of taxonomy (Larsen & Larsen, 2006). Although the works of Merrill (1924) and Steiner (1959) on gingers are accessible, the information reported by them is inadequate and needs updating. Madulid (1996) stated that a revision of the family is needed to understand its taxonomy, biology and ecology.

Mt. Hamiguitan Range Wildlife Sanctuary (MHRWS) is one of the wildlife sanctuaries in the Philippines that has unique biodiversity resources (Amoroso & Aspiras, 2010). It was designated as a World Heritage Site in June 2014 and an ASEAN Heritage Park in 2016. It is also a Mindanao Long Term Ecological Research (LTER) Site. Mt. Hamiguitan is a home to 152 species of plants belonging to 27 families and 72 genera (Amoroso et al., 2016), and hosts quite a number of endemic and endangered flora species in the Philippines especially the *Nepenthes* (Gronemeyer et al. 2016). Recently, Amoroso et al. (2019) recorded 228 taxa of plants in Mt. Hamiguitan, which consist of 74 species of ferns and lycophytes, six species of gymnosperms, 30 species of herbs and vines, and 118 species of trees and shrubs. Different plant species which have been particularly studied in MHRWS were pteridophytes, *Nepenthes*, and pandans. However, the wild gingers of Mt. Hamiguitan are still little understood, and so far only studies by Acma (2010) and Acma & Mendez (2018) are available literature on Zingiberaceae of this mountain. Thus, this study was carried out to determine the species composition and distribution of Zingiberaceae in Mt. Hamiguitan expansion site. This study covered only the expansion site of the mountain which is found at the periphery of the

protected zone of MHRWS. It is predominantly a dipterocarp forest in which trees grow very tall and large, and form a large proportion of the forest canopy.

Materials and Methods

Entry Protocol

Permission to carry out the study was obtained from the respective government authorities and units (e.g., the Barangay Council, Municipal Mayor), Protected Area Superintendent (PASu), and Department of Environment and Natural Resources (DENR) of MHRWS. The field sampling was conducted in March 2017.

Sampling, Collection and Preservation of Specimens

Transect walk was carried out along established forest trails, covering the selected study area including rivers, creeks and streams (Fig. 1). Likewise, opportunistic sampling was done whenever there was the presence of ginger species and an opportunity to collect the said species at the area. One to three live specimens were collected and placed inside labeled plastic bags. The specimens were brought to the research cabin for measurement of parts, photo documentation, and preparation of voucher specimens. Global Positioning System (GPS) was used to determine the exact elevation and coordinates of the collected specimens.

Representative vegetative plant parts from the terminal part, middle, and basal portions of the plant body were prepared. Collected specimens were numbered and documented as to the collector, date of collection, locality, common name, habitat, height and inflorescence. Specimens were then laid out between folded sheets of newspapers with leaves flattened for pressing. The plant materials were pressed using a wood presser, tightened by ropes and dried in a mechanical dryer. Those dried specimens were mounted in herbarium sheets measuring $11 \frac{1}{2} \times 16 \frac{1}{2}$ in. Corresponding labels were affixed and specimens were deposited at the Central Mindanao University Herbarium (CMUH).

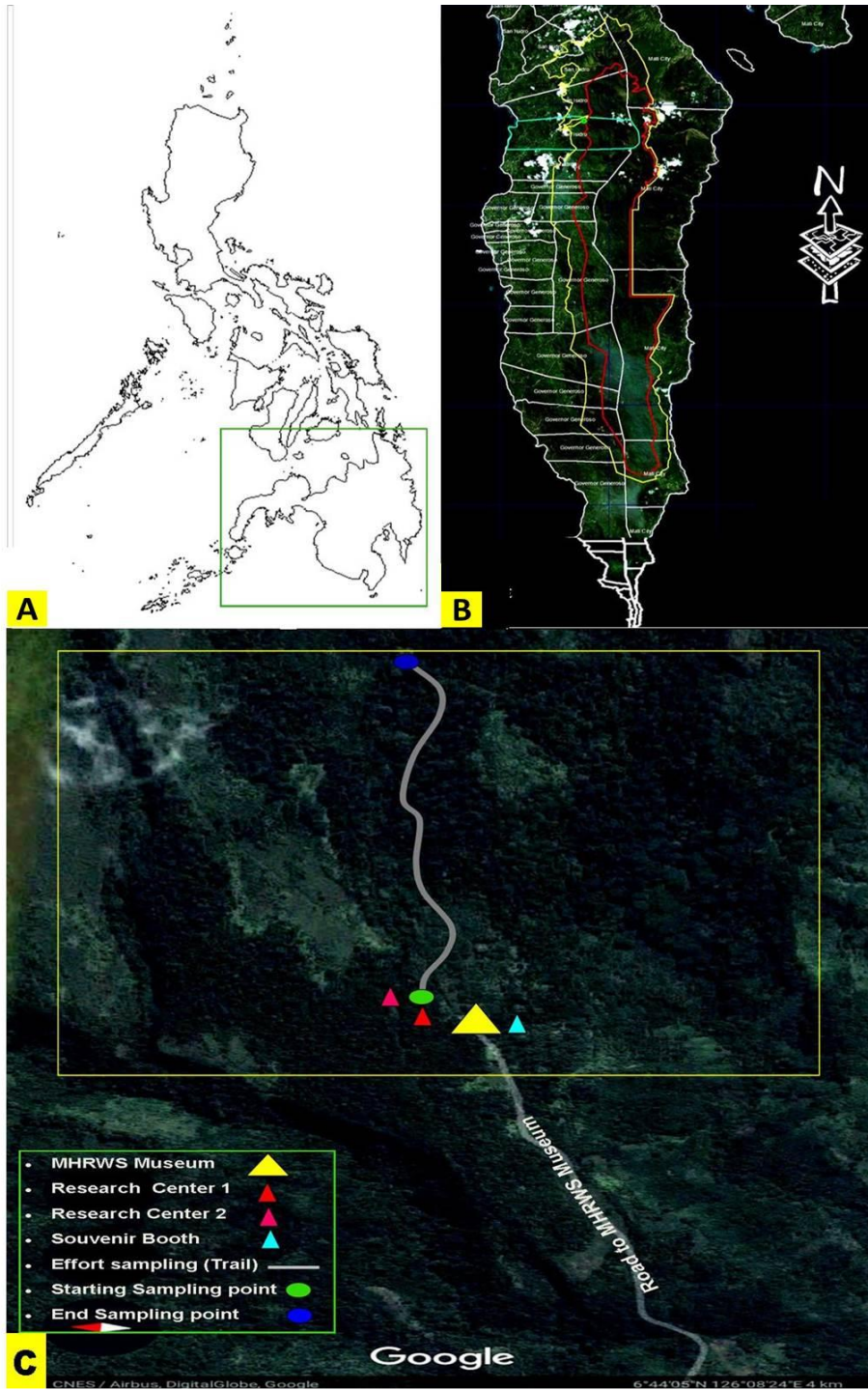


Figure 1. Study site. A) Map of the Philippines, B) Map of Davao Oriental province, C) Sampling trail in Mt. Hamiguitan expansion site.

Likewise, pickled collections of the floral parts were placed inside small plastic containers and preserved using 70% ethanol and pure glycerine which comprised about 10% of the total preservation mixture. The specimens were also deposited at the CMUH.

Species Identification, Distribution and Ecological Status Assessment

The morphological and taxonomic descriptions and numerical analyses were carried out at the College of Arts and Sciences of Central Mindanao University (CMU), Musuan, Bukidnon, Philippines. The specimens were first identified to genera and species by comparing with pre-identified specimens on gingers in the herbarium of CMU. Affinities of the species were determined through the Bray-Curtis cluster analysis. The elevations and coordinates for each species obtained using GPS were used in preparing the distribution map. A line graph indicating the species along with number of elevations in which those species occurred were utilized to determine whether they were abundant, rare or endemic to the area.

Results and Discussion

A. Species Identification and Composition of Zingiberaceae

The study revealed 14 species of Zingiberaceae in Mt. Hamiguitan expansion site, namely, *Alpinia haenkei* C. Presl, *Alpinia* cf. *vulcanica* Elmer, *Alpinia rufa* C.Presl, *Alpinia* sp., *Curcuma zedoaria* (Christm.) Rosc., *Curcuma longa* L., *Etilingera dalican* (Elmer) A.D.Poulsen, *Etilingera hamiguitanensis* Naive, *Etilingera* sp., *Geocharis fusiformis* (Ridl.) R.M.Sm., *Globba campsophylla* K.Schum., *Hornstedtia conoidea* Ridl., *Hornstedtia microcheila* Ridl., and *Meistera muricarpa* (Elmer) Škorničk. & M.F.Newman (Fig. 2).

The species mostly belong to the subfamily Alpinioideae and tribe Alpineae, except for the species of *G. campsophylla*, *C. zedoaria*, and *C. longa*, belonging to the subfamily Zingiberoideae under tribe Globbeae and Zingibereae, respectively. This study documented 47% of the total genera and 14% of the total species of Zingiberaceae in the Philippines.



Figure 2. Zingiberaceae species of Mt. Hamiguitan expansion site. A) *Alpinia haenkei*, B) *Alpinia cf. vulcanica*, C) *Alpinia rufa*, D) *Curcuma zedoaria*, E) *Curcuma longa*, F) *Etlingera dalican*, G) *Etlingera hamiguitanensis*, H) *Geocharis fusiformis*, I) *Globba campsophylla*, J) *Hornstedtia conoidea*, K) *Hornstedtia microcheila*, and L) *Meistera muricarpa*.

1. *Alpinia haenkei* C.Presl, Symb. 1 (1832) 66

Terrestrial herb, 1-2 m tall. Rhizome creeping, 8-10 mm in diameter, cream brown. Ligule bifid, 0.8-1 cm long and petiole 4-6 cm long. Leaf blade broad-lanceolate, margin entire with fine hairs, 33-45 x 9-10 cm. Leaf base oblique, apex broadly acuminate, leaf texture adaxially pubescent, glaucous-glossy

abaxially. Inflorescence terminal, originates on the leafy shoots, raceme. Bracts, bracteoles, calyx, corolla white, labellum red inside at centre with striate marks and white in margin. Fruit globose, pubescent with fine hairs, red when mature. The specimen of this species was recorded at an elevation of 250 m a.s.l. at a shady area associated with grasses and trees (CMUH 00010981).

2. *Alpinia cf. vulcanica* Elmer, LPB 8 (1915) 2971

Terrestrial herb, 3-5 m tall. Rhizome and roots raised and exposed. Ligule notched with fine hairs, 1-1.5 mm in diameter. Petiole 4-5 cm long. Leaf blade broad, lanceolate, margin entire, base oblique, apex acuminate, glabrous abaxially, 45-65 x 10-12 cm. Inflorescence terminal, raceme. Bracts and bracteoles spatulate, white to pale green. Fruits globose, yellowish, glabrous to glaucous. Seeds black. The specimens of this species were collected near *Pandanus* sp. and recorded at elevations of 536, 548, 550 and 565 m a.s.l. (CMUH 00010982).

3. *Alpinia rufa* C.Presl, Rel. Haenk. 1 (1827) 114

Terrestrial herb, 1-2 m tall. Rhizome creeping, brown, 10-15 mm in diameter. Ligule entire, 0.8-1 cm long. Leaf blade lanceolate, sessile, margin entire to ciliate, base attenuate, apex acuminate, pubescent abaxially and adaxially, 18-27 x 6-7 cm. Inflorescence terminal in the leafy shoots, umbel. Fruit globose, pubescent, green when young, red when mature. Seeds numerous. Specimens of this species were recorded at an elevation of 436 m a.s.l. near forest trail. It has been reported to be associated with shrubs, vines and rattans (see Acma & Mendez, 2018).

4. *Alpinia* sp.

Terrestrial herb, 1-2 m tall. Rhizome creeping, fleshy to pinkish, 11-15 mm in diameter. Ligule notched, yellowish to maroon, 0.2-4 cm long. Leaves sessile, lanceolate, margin entire to sinuate, base oblique, apex acuminate to cuspidate, glabrous abaxially, 16-17 x 4-5 cm. Inflorescence terminal. The specimen of this species was recorded at an elevation of 604 m a.s.l. and associated with falcata trees, grasses and shrubs.

5. *Curcuma zedoaria* (Christm.) Rosc., Monandr. Pl. (1828) t. 109

Terrestrial herb, 1-1.5 m tall. Rhizome creeping, branched, fleshy, often with tuber-bearing roots, 10-15 mm in diameter. Petiole 10-16 cm long. Leaf blade lanceolate, base cuneate, apex acuminate, glabrous rarely narrowly linear, with purple band along the center, 20-36 x 5-8 cm. Inflorescence arising on a

separate side shoots in conic-spike cylindrical form. Coma bracts pink to white. The specimens of this species were recorded at elevations of 124 and 463 m a.s.l. Introduced or cultivated mainly by local people and were associated with *Cocos nucifera* L. (coconut), trees and grasses (CMUH 00010988).

6. *Curcuma longa* L., Sp. Pl. (1753) 2

Terrestrial herb, 1 m tall. Rhizomes creeping, branched, fleshy roots bearing tubers, 9-13 mm in diameter. Petiole 9-14 cm long. Leaf blade lanceolate, margin entire, base cuneate, apex acuminate, glabrous, 12-23 x 7-10 cm. Inflorescence terminally arising on pseudostems in a conic-spike cylindrical form. Coma bracts white and green. The specimen of this species was recorded at an elevation of 115 m a.s.l. Introduced or cultivated in the Philippines by local people (CMUH 00010992).

7. *Etilingera dalican* (Elmer) A.D.Poulsen, Blumea 48 (2003) 524

Terrestrial herb, 1-1.5 m tall. Rhizome creeping, fleshy pinkish to reddish, 5-7 mm in diameter. Ligule entire, 0.8-1 cm long. Leaf blade sessile, margin entire to sinuate, base cuneate, apex acuminate, glabrous on surface, broadly lanceolate, 16-35 x 6-10 cm. Inflorescence arises from the rhizome, obconic/truncate at the top. Bracts yellowish towards the top, pale green towards the base, oblong. Bracteoles tubular, cream brown, sepals 3-tipped, pinkish to whitish, yellow tip and whitish base, oblanceolate. Labellum faint yellow, lip and filament fused into a tube. Stigma bright red. The specimen of this species was recorded at an elevation of 364 m a.s.l. It has been reported to be associated with vines and grasses (see Acma & Mendez, 2018) (CMUH 00010991).

8. *Etilingera hamiguitanensis* Naive, Taiwania 62 (2017) 341

Terrestrial herb, 2 m tall. Rhizome creeping covered with fleshy purple or red bracts, 17-20 mm in diameter. Ligule entire, apex dark purple, 0.8-1 cm long. Petiole 1-2 cm long. Leaf blade broad lanceolate, margin entire to sinuate, base round, apex acuminate, glabrous abaxially and adaxially, 36-38 x 7-10 cm. Inflorescence emerges on rhizome, surrounded by several sterile coloured bracts appearing at soil level. Bracts and bracteoles red towards the top, white towards the base. Calyx pinkish, light red corolla. Labellum bilobed, curved which made it different from *E. philippinensis* having a distal part of the lip in curved. Specimens of this species were recorded at elevations of 486, 489 and 491 m a.s.l. and associated with *Bambusa* sp. and grasses (CMUH 00010987).

9. *Etilingera* sp.

Terrestrial herb, 1-2 m tall. Rhizome creeping, 12-15 mm in diameter, reddish to pinkish. Ligule entire, 0.5-0.8 cm long. Leaves sessile, broad lanceolate, margin entire to sinuate, base cuneate, apex acuminate, glabrous. 20-27 x 6-8 cm. Inflorescence arising on rhizomes, obconic. Bracts and bracteoles red towards the top, pinkish towards the base. Fruit globose, creamy pink. Specimens of this species were recorded at elevations of 386, 389 and 395 m a.s.l. in shady areas near creeks (CMUH 00010984).

10. *Geocharis fusiformis* (Ridl.) R.M.Sm., Notes Roy. Bot. Gard. Edinburgh 43 (1986) 458

Terrestrial herb, 2-3 m tall. Rhizome creeping, brownish, 18-25 mm in diameter. Ligule entire, 0.7-1 cm. Petiole 1-2 cm long. Leaf blade broad to ovate lanceolate, margin entire, base rounded, apex acuminate to cuspidate, glabrous, upper surface green, whitish on lower, 29-43 x 5-10 cm. Whitish linear streak laterally present in the leaf sheath. Inflorescence arises on rhizomes in lax spike, prostrate or erect on ground. Bracts and bracteoles light red, calyx light pink, corolla lobe long yellow with edges. Labellum bilobed, yellow. Stigma and anther bright red. Specimens of this species were recorded at elevations of 401-600 m a.s.l. in shady areas relatively open with few shrubs, falcata and mahogany trees (CMUH 00010983).

11. *Globba campophylla* K.Schum. in Engl., Pflanzenreich 20 (1904) 145

Terrestrial herb, relatively short, 0.65-0.77 m tall. Rhizome creeping, short, white with fleshy roots, 1-1.5 mm in diameter. Ligule entire, 0.8-1cm long. Leaf blade sessile, lanceolate, base oblique, apex acuminate, glabrous, 33-36 x 5-7 cm. Inflorescence terminal, lax principally, white in colour. Long curved filament present and the reflexed, yellow streaked white labellum partially fused to floral tube. Lateral staminodes are attached below. Specimens of this species were recorded at an elevation of 263 m a.s.l. It has been reported in the shady dipterocarp forest associated with Araceae species and grasses (see Acma & Mendez, 2018) (CMUH 00010985).

12. *Hornstedtia conoidea* Ridl. in Elmer, LPB 2 (1909) 605; PJS 4 c (1909) Bot. 175

Terrestrial herb, 1-2 meters tall. Rhizome creeping, 8-12 mm in diameter, reddish. Ligule entire, 0.3-0.9 cm long with purple to black margin. Petiole 1-2 cm long. Leaf blade broadly lanceolate, margin entire to sinuate, base cuneate, apex acuminate to cuspidate, glabrous with reddish purple colour along its edge, 32-47 x 7-8 cm. Inflorescence arises on rhizome, spindle. Bracts

red with white base, broadly ovate, sharp apex. Specimens of this species were recorded at elevations of 396 and 404 m a.s.l. in shady and stony substrate area (CMUH 00010990).

13. *Hornstedtia microcheila* Ridl., LPB 2 (1909) 606; PJS 4 c (1909) Bot. 176
Terrestrial herb, 2-3 m tall. Rhizome creeping, reddish to faint pink, 13-15 mm in diameter. Ligule entire, 0.8-1 cm long, blacken apex, light green base with fine hairs. Petiole 1-2 cm long. Leaf blade lanceolate, margin entire, base cuneate, apex acuminate to cuspidate, glabrous abaxially and adaxially, 29-36 x 6-7 cm. Inflorescence arises on rhizome. Bracts and bracteoles pinkish. Calyx and corolla transparent, white to yellowish. Labellum broad curved spatulate with straight marks at the centre in faint yellow. The specimen of this species was recorded near a creek area at an elevation of 511 m a.s.l. (CMUH 00010986).

14. *Meistera muricarpa* (Elmer) Škorničk. & M.F.Newman, Taxon 67 (2018)
26

Terrestrial herb, 1-2 m tall. Rhizome creeping, robust, 8-10 mm in diameter. Ligule entire, 0.4-0.8 cm long. Petiole 1-1.5 cm long. Leaf blade lanceolate, margin entire to sinuate, base cuneate, apex acuminate to cuspidate, glabrous abaxially and adaxially, 29-30 x 5-7 cm wide. Purplish lines along pseudostems in adjacent area. Inflorescence arises from rhizome, obconic. Bracts and bracteoles pinkish. Calyx light green to pinkish. Corolla yellowish towards base. Labellum brownish at centre with straight marks, yellow at sides. Infructescence have branched spines, rambutan-like. Capsule red, globose or ellipsoid. The specimen of this species was recorded at an elevation of 371 m a.s.l. in sandy soil substrate (CMUH 00010989).

This study revealed that *C. zedoaria* and *C. longa* are the only introduced species and are cultivated by a specific community known as “Rizalian group” in the area, and they process these into a food drink. According to Smith et al. (1998), the classification of Zingiberaceae had been recognized widely based on morphological characters and molecular phylogeny. As for this study, morphological characters were used for plant identification. The members of Zingiberaceae have distichous phyllotaxy with simple leaves (Sirirugsa, 1999), and the attachments of the leaves vary from petiolate to sessile. *Alpinia rufa*, *Alpinia* sp., *E. dalican*, and *Etingera* sp. are sessile while the rest are petiolate.

Leaf base varies from cuneate, oblique, attenuate and rounded. Most of the species exhibit oblique base, such as *G. campsophylla*, *A. haenkei*, *A. cf. vulcanica*, and *Alpinia* sp. *Alpinia rufa* possess attenuate base, while cuneate base in the case of *M. muricarpa*. However, *C. longa*, *C. zedoaria*, *E. hamiguitanensis*, *E. dalican*, *Etingera* sp., *H. conoidea*, *H. microcheila*, and *G. fusiformis* have a rounded base.

Shapes of ligules among the species varied from entire, notched and bifid. *Alpinia haenkei* and *A. rufa* had bifid ligule with fine hairs, while *A. cf. vulcanica* and *Alpinia* sp. possess a notched ligule. *Alpinia* sp. had yellowish to maroon ligule colour, while *H. microcheila* had also ligule which are blacken at edge or tip and green towards the base having entire shape. The rest of the species, namely, *E. hamiguitanensis*, *E. dalican*, *Etingera* sp., *G. campsophylla*, *G. fusiformis*, *M. muricarpa*, *H. conoidea*, and *H. microcheila* had entire ligule shape.

Variations on inflorescence and infructescence of the species were also observed. The inflorescence of each species is important since it is the main characteristic in distinguishing which genera they belong to. Based on their reproductive parts, inflorescence and infructescence emerge terminally on leafy shoots or on pseudostems or arise from the rhizome. Noteworthy in this paper was *G. fusiformis*, which is supposed to bear inflorescence arising from the rhizome; however, the inflorescence was also observed at the terminal of the leafy shoot. Thus, this study supported Larsen et al. (1999) which reported that terminal inflorescence on the leafy shoots of this species is rare. Labellum shapes of the Zingiberaceae species were also differentiated such as bilobe on *E. hamiguitanensis* and broad spatulate on *H. microcheila*. Other species exhibit a curved labellum with straight marks along the centre and colour varies from species. In addition, floral characters which comprise stamen, corolla, calyx, and bracts are also significant for their taxonomic delineation. However, using these characters as key in identifying the species level is quite tough since flowers are ephemeral, which means it would last for only a short period of time, blooming for a day, or even just for a few hours (Larsen et al., 1999).

B. Cluster Analysis

Bray-Curtis Cluster analysis revealed affinities of the species (Fig. 3). The different clusters generated revealed that the same genus belong to the same cluster which implies that the morphological descriptions support the present taxonomic placements of the species. The Bray-Curtis Cluster analysis revealed seven clusters, which are cluster I with *G. fusiformis*, cluster II with *H. conoidea* and *H. microcheila*, cluster III with *M. muricarpa*, cluster IV with *Etlingera* sp., *E. dalican* and *E. hamiguitanensis*, cluster V with *G. campsohylla*, cluster VI with *C. longa* and *C. zedoaria*, and cluster VII with *A. rufa*, *Alpinia* cf. *vulcanica*, *A. haenkei*, and *Alpinia* sp. The dendrogram generated from the cluster analysis implies that the identification based on the morphological descriptions is supported by numerical analysis, implying that species identification in this study is reliable.

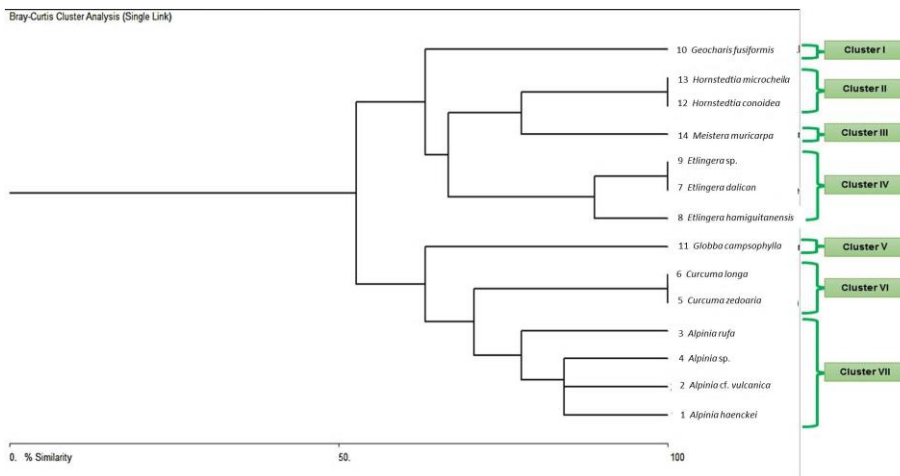


Figure 3. Dendrogram generated from Bray-Curtis Cluster Analysis.

C. Altitudinal Distribution

The distribution map revealed that the species were observed in different elevations (Fig. 4). For *C. longa*, it was recorded at an elevation of 115 m a.s.l., while *C. zedoaria* at an elevation of 124 m a.s.l. Both *Curcuma* species were abundant in their specific elevations. *Globba campsohylla* was the only recorded species at an elevation of 263 m a.s.l. *E. dalican*, on the other hand, was the only observed species recorded at an elevation of 364 m a.s.l., and nearer to it was *M. muricarpa* at an elevation of 371 m a.s.l. *Etlingera* sp.

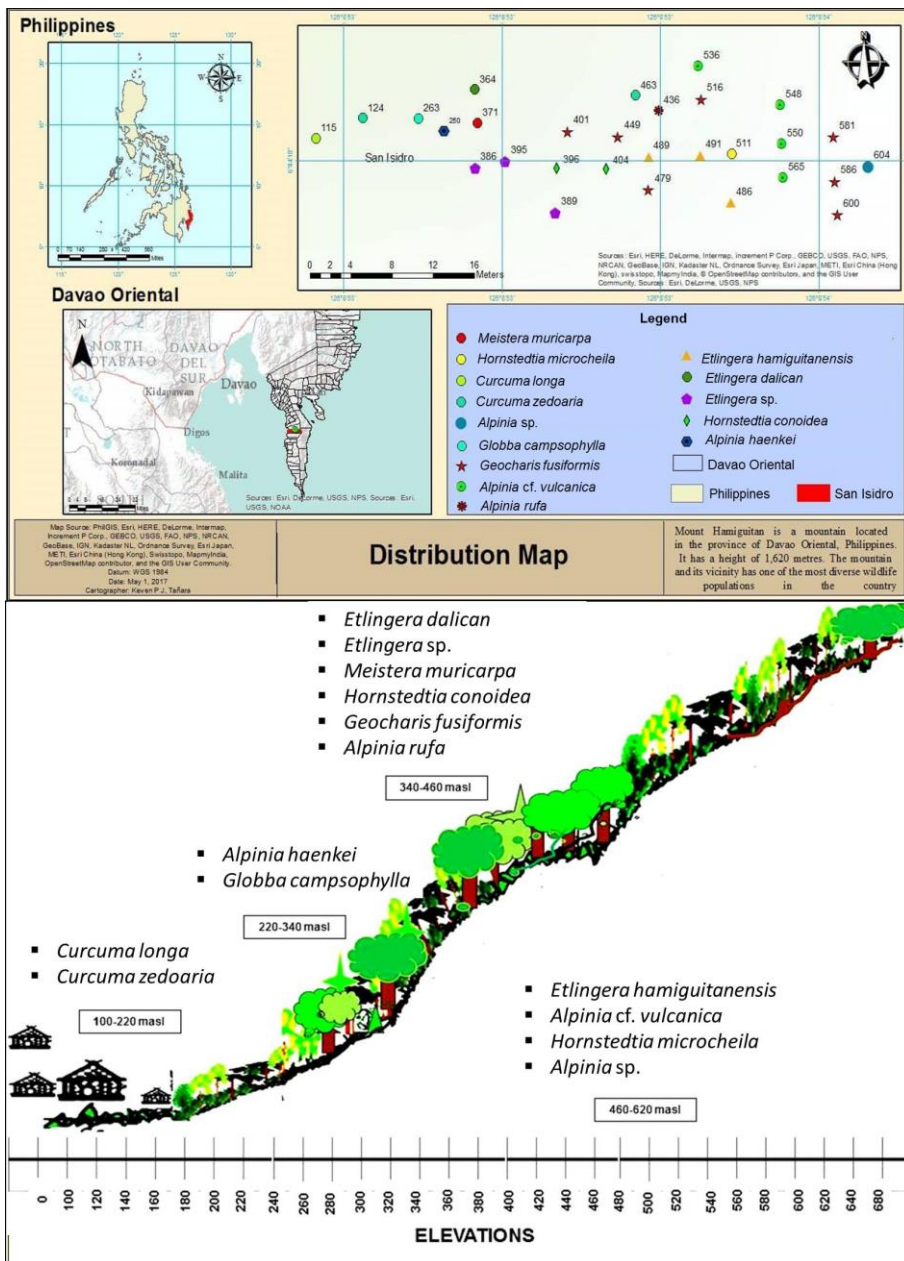


Figure 4. Map of Mt. Hamiguitan expansion site showing the distribution and elevation of Zingiberaceae species.

which is considered to be a possible new species is abundant at elevations of 386, 389, and 395 m a.s.l., while *H. conoidea* was abundant at 396 and 404 m a.s.l., and *G. fusiformis* at elevations of 401, 449, 479, 516, 581, 586 and 600 m a.s.l. With an elevation of 436 m a.s.l., *A. rufa* was the only recorded species, while from elevations of 486, 489 and 491 m a.s.l., *E. hamiguitanensis* was well observed, and in 511 m a.s.l. was *H. microcheila*. *Alpinia* cf. *vulcanica* was also diverse at elevations of 536, 548, 550 and 565 m a.s.l. Further, *Alpinia* sp. was only located at an elevation of 604 m a.s.l. which was the highest elevation recorded among the species.

D. Endemicity and Abundance of Species

Among the collected species, 10 are endemic to the Philippines, namely, *A. haenkei*, *A. cf. vulcanica*, *A. rufa*, *E. dalican*, *E. hamiguitanensis*, *G. fusiformis*, *G. campophylla*, *H. conoidea*, *H. microcheila*, and *M. muricarpa*. Of these, *G. fusiformis* was the most abundant species in the area. Noteworthy also in this study is the *Alpinia* sp. which is the only recorded species found in the highest elevation which may be new to science together with *Etlingera* sp.

Conclusions and Recommendations

This study concluded that there are 14 species of Zingiberaceae in the expansion site of Mt. Hamiguitan. Of these, 10 species are endemic to the Philippines, two species are introduced and cultivated by local people, and two are still unidentified to the species level. The distribution of the Zingiberaceae species revealed that the species are generally scattered and dwell at elevations between 115-604 m a.s.l. *Geocharis fusiformis* was the most abundant species recorded in the area. Floral morphology including the inflorescence shape and origin/emergence and also their infructescence were found to be of taxonomic significant characters for identification of the species. Moreover, this study revealed that *Alpinia* sp. and *Etlingera* sp. are possibly new to science. The present data represents 47% of the total genera and 14% of the total species of Zingiberaceae in the Philippines. Further, the high endemicity of ginger species in this area is also noteworthy and adds a feature to the MHRWS as a UNESCO World Heritage Site and ASEAN Heritage Park.

Acknowledgments

The authors would like to thank the following: Central Mindanao University for the logistics support, Mt. Hamiguitan research funded by the DENR from

October 2016 to March 2017; Hon. Romero Gamoza (Brgy. Captain of La Union), Hon. Justina MB Yu (Municipal Mayor of San Isidro), and Ruel D. Colong (PASu of Mt. Hamiguitan) for allowing the authors to conduct this study at the Mt. Hamiguitan expansion site; Jun Limbaga, Edgar, and the staff of the DENR Region XI of the MHRWS for the warm welcome; and Keven Tanara for generating the distribution map.

References

- Acma FM. 2010. Biosystematics of the genus *Amomum* Roxb. (Family Zingiberaceae) in the Philippines. Dissertation University of the Philippines, Los Baños, College, Laguna.
- Acma FM, Mendez NP. 2018. Noteworthy records of Philippine endemic gingers (Zingiberaceae) in the buffer zone of Mt. Hamiguitan Range Wildlife Sanctuary, Davao Oriental, Philippines. *Environmental and Experimental Biology* 16(2): 111-115. doi: 10.22364/eeb.16.10.
- Amoroso VB, Aspiras RA. 2010. Hamiguitan Range: a sanctuary for native flora. *Saudi Journal of Biological Sciences* 18: 7-15.
- Amoroso VB, Coritico FP, Fritsch PW. 2016. Species Richness and Conservation Status of Ferns and Lycophytes in Mt. Hamiguitan Range Wildlife Sanctuary, Davao Oriental, Philippines. *Philippine Journal of Science* 145(2): 127-137.
- Amoroso, VB, Acma FM, Coritico FP, Gorme FS, Lagunday NE, Salolog MCS, Colong RD. 2019. Floral diversity assessment of the buffer zones and vicinity of the Mt. Hamiguitan Range Wildlife Sanctuary (MHRWS), Davao Oriental: basis for inclusion to protected area zone. *Philippine Journal of Systematic Biology* 12(2): 36-51.
- Gronemeyer T, Suarez W, Nuytemans H, Calaramo M, Witsuba A, Mey FSm, Amoroso VB. 2016. Two New *Nepenthes* Species from the Philippines and an Emended Description of *Nepenthes ramos*. *Plants* 5: 1-15. doi: 10.3390/plants5020023.
- Kress WJ, Prince LM, Williams KJ. 2002. The Phylogeny and a new classification of the Gingers (Zingiberaceae): Evidence from the molecular data. *American Journal of Botany* 89(11): 1682-1696.
- Lamb, A, Gobilik J, Ardiyani M, Poulsen AD. 2013. A Guide to Gingers of Borneo. Natural History Publications (Borneo).
- Larsen K, Larsen SS. 2006. Gingers of Thailand. Queen Sirikit Botanic Garden. The Botanical Garden Organization. Ministry of Natural Resources and Environment. Maerim, Chiang Mai, Thailand.
- Larsen K, Ibrahim H, Khaw SH, Saw IG. 1999. Gingers of Peninsular, Malaysia and Singapore. National History Publications (Borneo) Kota kinabalu, Malaysia.

- Larsen K. 1980. Annotated key to the genera of Zingiberaceae of Thailand. *Natural History Bulletin - Siam Society* 28: 151-169.
- Leong-Škorničková J., Newman M. 2015. Gingers in Cambodia, Vietnam and Laos. *Journal of Singapore Botanic Gardens*.
- Madulid DA. 1996. The family Zingiberaceae and the flora of the Philippines project in T, -L. Wu, Q-G, & Z.Y. Chen (Eds.), Proceedings of the second symposium on the family Zingiberaceae, South China Institute of Botany, Guangzhou, People's Republic of China.
- Merrill ED. 1924. An Enumeration of Philippine Flowering Plants, Bureau of Printing, Manila. 228-246 pp.
- Pelser PB, Barcelona JF, Nickrent DL (eds.). 2011 onwards. Co's Digital Flora of the Philippines. www.philippineplants.org.
- Sirirugsa P. 1999. Thai Zingiberaceae: Species Diversity and Their Uses, *Natural History Bulletin of the Siam Society* 40: 67-90.
- Smith RM. 1988. A Review of Bornean Zingiberaceae: IV. (Globbeae). *Notes from the Royal Botanic Garden Edinburgh* 45(1): 1-19.
- Steiner ML. 1959. A New and Illustrated Flora of Manila. Zingiberaceae 88(1):1-40.
- Wu TL, Larsen K. 2000. Family Zingiberaceae. In Z-G. Wu and P. Raven (eds.). *Flora of China* 24: 322-377. Science Press, Beijing, China, and Missouri Botanical Gardens Press, St. Louis, Missouri, USA.