

Zingiberaceae of Marilog Forest Reserve, Southern Philippines: Its Richness and Endemism

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ABSTRACT

Numerous studies on Zingiberaceae were carried out in the Philippines since 2010, and have reported several new species, new records, and recollections. This paper documented 27 species of gingers belonging to 10 genera in four tribes and two subfamilies, from the five sampling sites in Marilog Forest Reserve, Southern Philippines from February 2018 to November 2019. Data revealed that Zingiberaceae species in these sites constitute *ca.* 23% of the total number of Philippine Zingiberaceae, and 56% of the collected species are endemic to the Philippines. *Wurfbainia hedyosma* (I.M.Turner) Škorničk. & A.D.Poulsen and *W. mindanaensis* (Elmer) Škorničk. & A.D.Poulsen were recollected after a lapse of 100 years. *Hedychium philippinense* K.Schum. is a CITES-listed species and one of the five threatened ginger species, while *H. coronarium* Koenig is the only invasive alien species documented. Furthermore, this paper bears significance due to the highest number of Zingiberaceae species collected in a certain geographical area in the country as of to date. Since Marilog Forest Reserve is not a protected area and is under severe threats from various

anthropogenic activities that endanger these wild species, there is, therefore, an urgent call for *in situ* conservation efforts by the local people and stakeholders in the area.

Keywords: Endangered, *Hedychium philippinense*, Philippine endemic, *Wurfbainia hedyosma*, *Wurfbainia mindanaensis*

INTRODUCTION

Marilog Forest Reserve is ca. 53 km from the center city of Davao on the southern side of Mindanao, Philippines (Delima-Baron et al., 2019). It is recognized as one of the priority areas for biodiversity conservation by the Conservation International (Escarlos et al., 2019). However, small rampant scale logging activities, conversion of the forest land into agricultural use, proliferation of residential to mountain resorts, over-harvesting of ornamental plants, and observable population increase, as well as the abundance of invasive alien species, such as *Piper aduncum* L. in denuded mountains, have reduced the biodiversity in the area. It has been observed that trading of several species of ornamental plants from the wild along the road in Marilog District is rampant, which implies that bioprospecting and trade on biodiversity in the said area has not been monitored and regulated.

There is scanty literature regarding the flora of Marilog Forest Reserve (e.g., Amoroso et al., 1996; Acma, 2010; Amoroso et al., 2018; Acma et al., 2019). Recent botanical fieldworks in 2018 and 2019 conducted by the authors have led to the discoveries of *Mitrastemon yamamotoi* Makino (Mitrastemonaceae) and *Plagiostachys albiflora* Ridl. (Zingiberaceae) which were recorded in the Philippines for the first time (Amoroso et al., 2018; Acma et al., 2019). These findings imply that further field expeditions in these areas would yield more new records or discoveries of additional vascular flora in Marilog Forest Reserve, which has still intact forest areas and with cool breezy atmosphere situated in relatively high elevation, which is over 1,000 m asl.

Zingiberaceae, with at least 1,500 species, are widely distributed in the tropical and subtropical regions of the world (Delin & Larsen, 2000; Kantayos & Paisooksantivatana, 2012; Lamb et al., 2013). In the Philippines, Zingiberaceae is represented with 119 species distributed in 17 genera (Pelser et al., 2011 onwards). Floristic studies on Zingiberaceae in the Philippines were only conducted by Acma (2014), Naive (2017), Acero et al. (2019), Jayme et

al. (2020), and these studies were done in the mountains of Mindanao Island. Thus, this study on species richness and assessment of conservation status and endemism of Zingiberaceae in Marilog Forest Reserve was undertaken to add information on the poorly studied Philippine Zingiberaceae.

OBJECTIVES OF THE STUDY

This study was conducted to inventory the Zingiberaceae species found in Marilog District, Davao City, Philippines, and determine the endemism of the recorded species.

MATERIALS AND METHODS

Permit Statement

The inventory of Zingiberaceae was carried out in five sampling sites under the three Barangays of Marilog District, Davao City, Philippines, after necessary permits were obtained from respective agencies, such as Barangay resolutions; Prior Informed Consents (PICs) from Barangay Baganihan, Barangay Datu Salumay and Marahan Proper; Memorandum of Agreement (MOA) from Matigsalug-Manobo Tribal People Council of Elders Davao, Inc. (MAMATRIPCEDI); and Gratuitous Permit (GP) from the Department of Environment and Natural Resources (DENR).

Study Sites and Description

Site 1 comprises the forest patches in Purok-5, Sitio New Calinan and Sitio Maharlika in Brgy. Baganihan; Site 2 in Mt. Malambo, Brgy. Datu Salumay; Site 3 in Sitio Epol, Brgy. Baganihan; Site 4 in Mt. Ulahingan, Sitio Tagumpay, Barangay Datu Salumay; and Site 5 in Sitio Matigsalug, Marahan Proper (Fig. 1). This study was carried out from February 2018 to November 2019. The forest sites in Marilog District were classified as agro-ecosystem to mixed dipterocarp forest, with steep to rolling plains (10–46°), dominated by *Lithocarpus* spp. (Fagaceae), *Canarium* spp. (Burseraceae), *Palaquium philippense* (Perr.) C.B.Rob. (Sapotaceae), *Ficus* spp. (Moraceae), *Syzygium* spp. (Myrtaceae), *Astronia ferruginea* Elmer (Melastomataceae), *Cinnamomum* spp. (Lauraceae), and Rubiaceae.

The five established sites in Marilog Forest Reserve were located in the upper montane. Site 4 (Mt. Ulahingan) was the highest among the five sites, while Site 5 (Sitio Matigsalug) was found in the lowest elevation. Among the five sites, Site 1 had the highest number of plots since this site consists of two adjacent sitios: New Calinan and Maharlika (Table 1). Of these sites, Site 2 (Mt. Malambo) had the highest number of gingers collected with 18 species. However, as previously reported by Amoroso et al. (2018), many species in Mt Malambo were under several threats posed by anthropogenic activities, such as intensive grazing, tourism activities, soil erosion, landslides, shifting cultivation, and forest fire which are the main reasons of habitat destruction of wild species.

Table 1

Forest Characteristics in Marilog Forest Reserve where sampling and collection of Zingiberaceae were conducted.

Study Site	Elevation (masl)	Number of plots (20x20 m)
Site 1: Sitio New Calinan and Sitio Maharlika	1220–1240	24
Site 2: Mt. Malambo	1197–1345	21
Site 3: Sitio Epol	1151–1178	20
Site 4: Mt. Ulahingan	1280–1320	20
Site 5: Sitio Matigsalug	1,000–1,200	20
		Total: 105

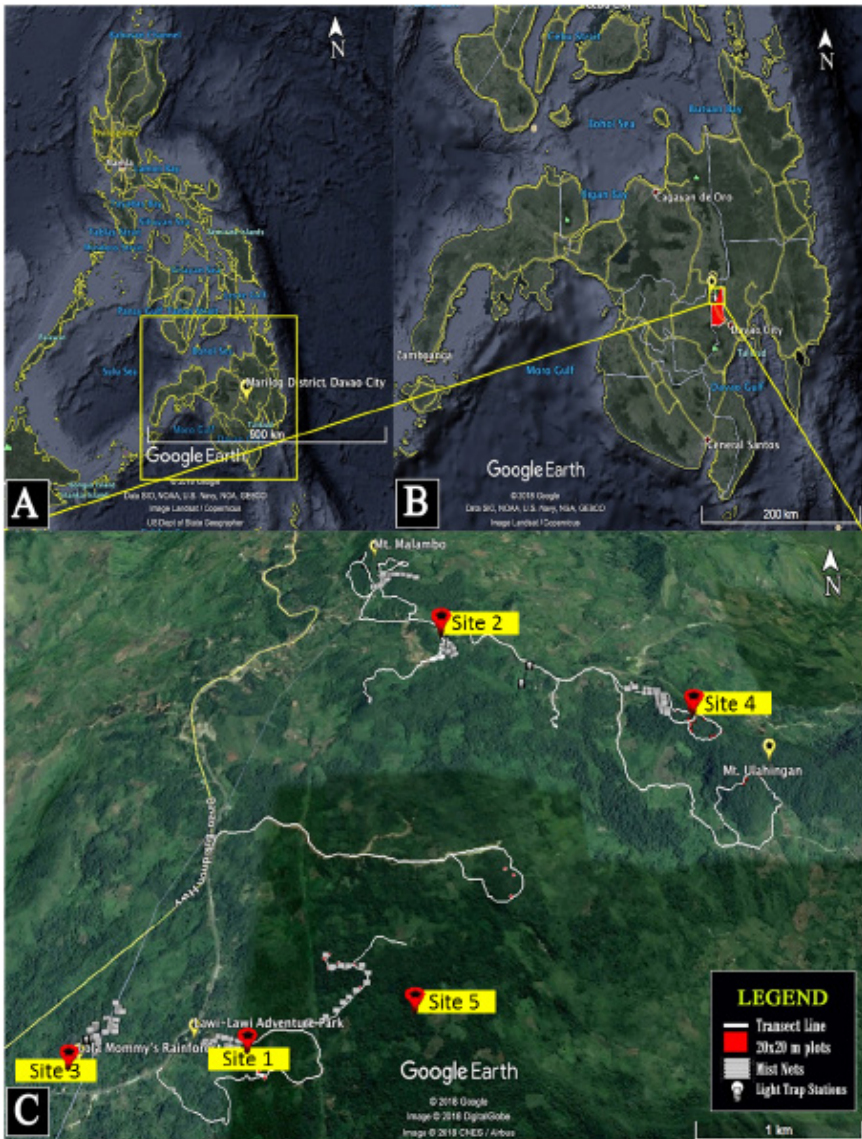


Figure 1. Map of the study site. A) Map of the Philippines, B) Map of the Mindanao Island, C) Marilog forest patches explored by the present study (©2018 Google, image ©2018 CNES/Airbus).

Establishment of Sampling Plots

Floristic surveys were carried out in Marilog District to inventory the Zingiberaceae species. These were done by establishing 105 20x20 m plots, repeated transect walks, and opportunistic sampling in five sampling sites of Marilog District, Davao.

Collection, Processing, and Identification of Specimens

Voucher specimens were processed following the wet method, dried using a mechanical dryer, and deposited at the Central Mindanao University Herbarium (CMUH). Herbarium specimens were limited to three pieces of plant parts per species per site as stipulated in the GP. Field guides, online database (e.g., JSTOR), online e-Flora (e.g., Co's Digital Flora of the Philippines by Pelsner et al., 2011 onwards), Communication, Education and Public Awareness (CEPA) materials, protologues (Ridley, 1909; Elmer, 1915; Elmer, 1919), and published literature were used to identify the collected specimens.

Assessment of Endemism and Conservation Status

The assessment of endemism of Zingiberaceae was based on Pelsner et al. (2011 onwards), while the conservation status was based on DAO 2017-11. CITES (2018) and IUCN (2018) were also used for the assessment of the species.

RESULTS AND DISCUSSION

Species Richness and Composition

The study revealed a total of 27 species of Zingiberaceae belonging to two subfamilies, four tribes, and 11 genera (Table 2). The collected species are higher than that of Naive (2017), Acero et al. (2019), and Jayme et al. (2020), with 12 species, 14 species, and 11 species, respectively. The works of Naive (2017) at Kalatungan Mountain Range in Bukidnon, Acero et al. (2019) at the expansion site of Mt. Hamiguitan Range Wildlife Sanctuary (MHRWS) in Davao Oriental, and Jayme et al. (2020) at Cinchona Forest Reserve, Lantapan, Bukidnon were the only published papers dealing on the floristic studies of wild Zingiberaceae species in the Philippines.

Table 2

Subfamilies, tribes and genera of the collected Zingiberaceae species

No.	Subfamily	Tribe	Genus	No. of Species
1	Alpinoideae	Alpinieae	<i>Adelmeria</i>	1
2			<i>Alpinia</i>	4
3			<i>Amomum</i>	1
4			<i>Etilingera</i>	7
5			<i>Hornstedtia</i>	3
6			<i>Meistera</i>	1
7			<i>Plagiostachys</i>	3
8			<i>Wurfbainia</i>	2
9	Zingiberoideae	Globbeae	<i>Globba</i>	1
10		Hedychieae	<i>Hedychium</i>	2
11		Zingibereae	<i>Zingiber</i>	2
Total:				27

The collected species in this study include *Adelmeria alpina* Elmer, *A. haenkei* C.Presl, *A. rufa* C.Presl, *Alpinia* sp. 1, *Alpinia* sp. 2, *Amomum dealbatum* Roxb., *Etilingera coccinea* (Blume) S.Sakai & Nagam., *Etilingera elatior* (Jack.) R.M.Sm., *E. fimbriobracteata* (K.Schum.) R.M.Sm., *E. philippinensis* (Ridl.) R.M.Sm., *E. pubimarginata* (Elmer) A.D.Poulsen, *Etilingera* sp. 1, *Etilingera* sp. 2, *Globba campophylla* K.Schum., *Hedychium coronarium* Koenig, *H. philippinense* K.Schum., *Hornstedtia conoidea* Ridl., *H. lophophora* Ridl., *H. microcheila* Ridl., *Meistera muricarpa* (Elmer) Škorničk. & M.F.Newman, *Plagiostachys albiflora* Ridl., *P. escritorii* Elmer, *Plagiostachys* sp., *Wurfbainia hedyosma* (I.M.Turner) Škorničk. & A.D.Poulsen, *W. mindanaensis* (Elmer) Škorničk. & A.D.Poulsen, *Zingiber banahaense* Mood & Theilade, and *Z. spectabile* Griffith (Table 3; Fig. 2).

Table 3

Checklist of Zingiberaceae in Marilog Forest Reserve with their conservation and endemism.

No.	Species	Conservation Status	Endemism	Study Site				
				1	2	3	4	5
1	<i>Adelmeria alpina</i> Elmer		PE	/	/	/	/	/
2	<i>Alpinia haenkei</i> C.Presl		PE	/				
3	<i>Alpinia rufa</i> C.Presl		PE					/
4	<i>Alpinia</i> sp. 1			/			/	
5	<i>Alpinia</i> sp. 2					/		
6	<i>Amomum dealbatum</i> Roxb.			/				
7	<i>Etilingera coccinea</i> (Blume) S.Sakai & Nagam.					/		
8	<i>Etilingera elatior</i> (Jack.) R.M.Sm.					/		
9	<i>Etilingera fimbriobracteata</i> (K.Schum.) R.M.Sm.				/	/	/	/
10	<i>Etilingera philippinensis</i> (Ridl.) R.M.Sm.		PE	/	/	/	/	/
11	<i>Etilingera pubimarginata</i> (Elmer) A.D.Poulsen		PE	/	/	/		/
12	<i>Etilingera</i> sp. 1			/	/	/	/	
13	<i>Etilingera</i> sp. 2					/		
14	<i>Globba campsophylla</i> K.Schum.		PE	/				
15	<i>Hedychium coronarium</i> Koenig				/			
16	<i>Hedychium philippinense</i> K.Schum.	EN	PE	/	/	/	/	/
17	<i>Hornstedtia conoidea</i> Ridl.		PE	/	/	/		
18	<i>Hornstedtia lophophora</i> Ridl.		PE	/	/			
19	<i>Hornstedtia microcheila</i> Ridl.		PE				/	
20	<i>Meistera muricarpa</i> (Elmer) Škorničk. & M.F.Newman		PE					/

Table 3 continued.

No.	Species	Conservation Status	Endemism	Study Site				
				1	2	3	4	5
21	<i>Plagiostachys albiflora</i> Ridl.			/	/			/
22	<i>Plagiostachys escriptorii</i> Elmer		PE	/	/	/		
23	<i>Plagiostachys</i> sp.			/				
24	<i>Wurfbainia hedyosma</i> (I.M.Turner) Škorničk. & A.D.Poulsen		PE	/				
25	<i>Wurfbainia mindanaensis</i> (Elmer) Škorničk. & A.D.Poulsen		PE	/	/	/		/
26	<i>Zingiber banahaoense</i> Mood & Theilade		PE	/	/			/
27	<i>Zingiber spectabile</i> Griffith				/			

Legend: EN – endangered; PE – Philippine Endemic; 1 – Sitio New Calinan; 2 – Mt. Malambo; 3 – Sitio Epol; 4 – Mt. Ulahingan; 5 – Sitio Matigsalug.

The genus *Etilingera* constitutes the highest number of collected species with seven species, followed by *Alpinia* with four species, *Hornstedtia* and *Plagiostachys* with three species, *Wurfbainia*, *Hedychium*, and *Zingiber* with two species, and least by *Adelmeria*, *Amomum*, *Globba*, and *Meistera* with only one species for each genus. Based from the list of Philippine Zingiberaceae by Pelsner et al. (2011 onwards), the collected species constitute ca. 25% of the total number of Philippine Zingiberaceae.

New distribution localities of some of the collected species were recently reported by some researchers. One of which is *E. coccinea*, which was reported by Naive (2018a) to occur in the Philippines, specifically in Claveria in Misamis Oriental, Mt. Hamiguitan in Davao Oriental, and Malaybalay City in Bukidnon. A few months after, *H. microcheila* was recollected after a lapse of more than 100 years by Naive (2018b) in Mt. Mandalagan Range in Negros Occidental and by Acero et al. (2019) in Mt. Hamiguitan. On the other hand, the presence of *A. rufa* and *G. campsophylla* in Mt. Hamiguitan was also recently reported by Acma and Mendez (2018).

The study also revealed that there are five undescribed species, viz., *Alpinia* sp. 1, *Alpinia* sp. 2, *Etilingera* sp. 1, *Etilingera* sp. 2, and *Plagiostachys* sp. These

species did not fit the descriptions in the protologues of Philippine Zingiberaceae species. These could be due to the incomplete materials, such as the absence of flowers for *Alpinia* sp. 1 and *Alpinia* sp. 2 (only fruits were collected) and absence of fruits for *Plagiostachys* sp. (only flowers were collected). However, the two *Etilingera* species have a complete set of materials and yet cannot be identified to the species level. These species might be new to science or hold new records in the Philippines, which will be dealt with later publications.

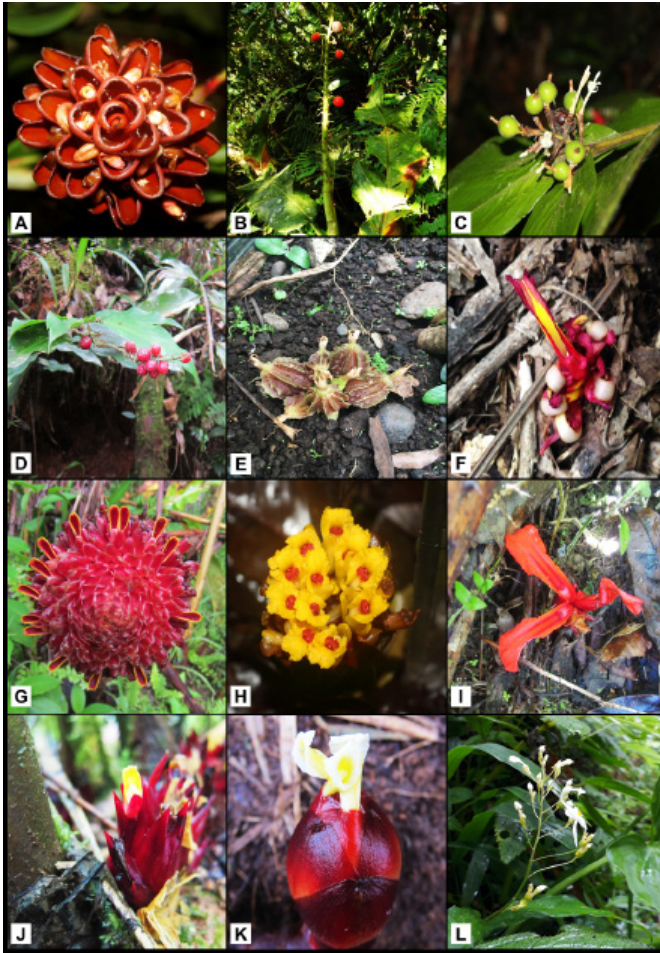


Figure 2a. Zingiberaceae species in Marilog Forest Reserve. A) *Adelmeria alpina* Elmer, B) *Alpinia haenkei* C.Presl, C) *Alpinia rufa* C.Presl, D) *Alpinia* sp. 1, E) *Amomum dealbatum* Roxb., F) *Etilingera coccinea* (Blume) S.Sakai. & Nagam.,

G) *Etilingera elatior* (Jack.) R.M.Sm., H) *Etilingera fimbriobracteata* (K.Schum.) R.M.Sm., I) *Etilingera philippinensis* (Ridl.) R.M.Sm., J) *Etilingera pubimarginata* (Elmer) A.D.Poulsen, K) *Etilingera* sp. 1, L) *Globba campsophylla* K.Schum.



Figure 2b. Zingiberaceae species in Marilog Forest Reserve. M) *Hedychium coronarium* Koenig, N) *Hedychium philippinense* K.Schum., O) *Hornstedtia conoidea* Ridl., P) *Hornstedtia lophophora* Ridl., Q) *Hornstedtia microcheila* Ridl., R) *Meistera muricarpa* (Elmer) Škorničk. & M.F.Newman, S) *Plagiostachys albiflora* Ridl., T) *Plagiostachys escritorii* Elmer, U) *Wurfbainia hedyosma* (I.M.Turner) Škorničk. & A.D.Poulsen, V) *Wurfbainia mindanaensis* (Elmer) Škorničk. & A.D.Poulsen, W) *Zingiber banahaoense* Mood & Theilade, X) *Zingiber spectabile* Griffith.

Notes on Conservation Status and Endemism

Among the collected species, only *H. philippinense* is Endangered (EN) based on DAO (2017-11) and IUCN (2018), and it is also a CITES-listed species. This species is epiphytic on tree trunks and can be seen along the forest trails in all sampling sites. Noteworthy in this paper is the percentage endemism of the collected species. This is the highest number of Zingiberaceae collected in a certain geographical area. Of the 27 collected species, 14 species are endemic to the Philippines, viz., *A. alpina*, *A. haenkei*, *E. philippinensis*, *E. pubimarginata*, *G. campophylla*, *H. philippinense*, *H. conoidea*, *H. lophophora*, *H. microcheila*, *M. muricarpa*, *P. escritorii*, *Wurfbainia hedyosma*, *W. mindanaensis*, *Z. banahaoense*. These endemic species constitute 56% endemism in the total collected species of Zingiberaceae.

CONCLUSIONS

The 27 collected species constitute ca. 23% of the total number of Philippine Zingiberaceae and 56% of which are endemic to the Philippines. It is noteworthy that *W. hedyosma* and *W. mindanaensis* were recollected after a lapse of 100 years. *H. philippinense*, one of the five threatened and CITES-listed ginger species, and *H. coronarium*, the only invasive alien species in this family, were documented. Furthermore, this paper bears significance due to the highest number of Zingiberaceae species collected in a certain geographical area in the country as of to date.

RECOMMENDATIONS

It is recommended that further studies in other mountains in the Philippines should be carried out to understand clearly the diversity of gingers. It is also recommended that Marilog Forest Reserve should be protected by the local people and stakeholders since the area holds various endemic and threatened flora. *In situ* and *ex situ* conservation efforts are also recommended to be undertaken, and the propagated plantlets to be re-introduced back to the forests. More fieldworks in these areas are recommended to collect the lacking reproductive materials of these undescribed species because these might be new to science.

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