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Diversity and Endemism of *Ficus* L. (Moraceae) in Selected Mountains in Mindanao, Philippines

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ABSTRACT

Ficus species are keystone components of tropical ecosystems, playing a vital role in sustaining biodiversity and ecological processes. The year-round fruit production supports a wide range of frugivores, aiding in seed dispersal and forest regeneration, thereby maintaining ecosystem s tability. Despite their ecological importance, research on the diversity and status of *Ficus* in the Philippines remains limited. Thus, this study provides baseline data on the species composition of *Ficus* in selected forest patches across Mindanao, Philippines. Fig species were documented through opportunistic sampling along forest trails, with identification based on morphological features and verified by a taxonomist. A total of 23 *Ficus* species were recorded, with the highest number found in Talangisog, Eureka, Gingoog City, Misamis Oriental (20 species), while Lilingayon and Kalabugao in Bukidnon each harbored 13 species. Notably, three species, *Ficus multistipularis, F. cataupi* (Endangered), and *F. cassidyanna* (Near Threatened), are listed as threatened under IUCN 3.1 criteria, and 16 species are categorized as Least Concern. Five species are confirmed Philippine endemics while all recorded species are native to the Philippines. The presence of threatened and endemic species emphasizes the ecological value and conservation importance of these sites. However, observed threats such as habitat loss, land-use change, and the narrow distribution of some species highlight the urgent need for targeted conservation efforts. This study not only fills a critical knowledge gap but also establishes a foundation for future ecological research and conservation planning for *Ficus* species in Mindanao's forests.

Keywords: abundance, conservation, threatened species, forest types

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INTRODUCTION

Ficus L. is a versatile, pantropical genus of woody plants recognized as a keystone resource for both human populations and wildlife (Sawadogo *et al*., 2024). With an estimated 900 species worldwide, it is considered as one of the largest plant genera (Pancho, 1983). In the Philippines, *Ficus* is well-represented, with over 100 species, many of which are native, and some endemic and 75 species of this genus can be found in Mindanao Island (Pelser *et al*., 2011).

These plants are distinguished by their unusual inflorescence and unique pollination syndrome, which involves wasps from the family Agaonidae (Castro-Cárdenas *et al*., 2024; Rasplus, 1996). This extraordinary mechanism profoundly impacts tropical forest ecosystems because when the pollinator wasps depart, *Ficus* fruits ripen fast, providing essential food resources for a variety of animals and birds (Jauharlina *et al*., 2012; Shanahan *et al*., 2001). Additionally, the year-round fruiting pattern, driven by the wasps' brief adult lifespan, makes *Ficus* a critical food source during periods of scarcity (Mawa *et al*., 2013; Wiebes, 1994). Thus, *Ficus* species play a vital functional role in tropical forest ecosystems, deserving a comprehensive study of their biology.

However, limited ecological research and diverse data on *Ficus* as a keystone species create significant knowledge gaps, hindering effective conservation strategies. These gaps are rooted in the limitations in sampling procedures that fail to account for the diverse growth habits of these taxa. Furthermore, unresolved taxonomic issues, particularly in species-level morphological descriptions, complicate efforts to distinguish ecological variation from genetic differences, challenging its classification.

To address these challenges and the broader need to document biodiversity amidst increasing extinction risks, this study was conducted to focus on documenting the *Ficus* species present in three different mountains in Mindanao, Philippines specifically the forest patches of Sitio Tandacol in Lilingayon, Valencia City, and Kalabugao in Impasug-ong, both located in the province of Bukidnon, as well as the forest patches of Talangisog in Eureka, Gingoog City, Misamis Oriental.

This study generally aimed to document the species composition of *Ficus* species collected during these fieldworks while expanding research to previously unexplored sites. It also evaluated the ecological and conservation status of *Ficus* in these areas, hypothesizing that these forests continue to support a diverse array of *Ficus* species. By filling critical gaps in data, this research sought to contribute to the effective conservation and understanding of *Ficus* as a keystone genus in tropical ecosystems.

MATERIALS AND METHODS

Entry Protocol and Ethical Considerations

Prior Informed Consents (PIC) were obtained from the office of the Barangay Captain and the Office of the Mayor of each locality of the study sites in selected mountains in Mindanao, Philippines as requirements for the issuance of Wildlife Gratuitous Permit (WGP) No. R10-2025-40 and R10-2024-25. The legal and authorized collection of voucher specimens adhered to the guidelines specified in the WGP, which was issued by DENR Region 10, Cagayan de Oro City, following its application.

Before field sampling, a ritual was first offered to honor local traditions and seek permission from the spirits of the land, as is customary in many indigenous communities. This process involved offerings, prayers, or ceremonies conducted by community elders or spiritual leaders, emphasizing the researchers' commitment to ethical and culturally sensitive scientific practices.

Study Sites and Descriptions

The study was conducted in the forest patches of Sitio Tandacol in Lilingayon, Valencia City, and Kalabugao in Impasug-ong, both located in the province of Bukidnon, as well as the forest patches of Talangisog in Eureka, Gingoog City, Misamis Oriental (Figure 1). These forests maintained an intact forest environment conducive to the growth of various tree species, including *Ficus*. Fig plants thrived in consistently warm and humid climates, making the sampling sites ideal due to their physical characteristics, where sunlight and humidity were optimal for *Ficus* growth. Aside from this, the criteria for the selection of these sites included their accessibility, ecological diversity, and representation of different *Ficus* habitats. The study was conducted between January and May 2025, with sampling commencing after the issuance of the WGP by DENR Region 10. Moreover, *Ficus* plants produced syconia most abundantly during the wet season, making sampling easier during this period. The presence of syconia served as a key identifying feature in the field, facilitating more efficient species identification.

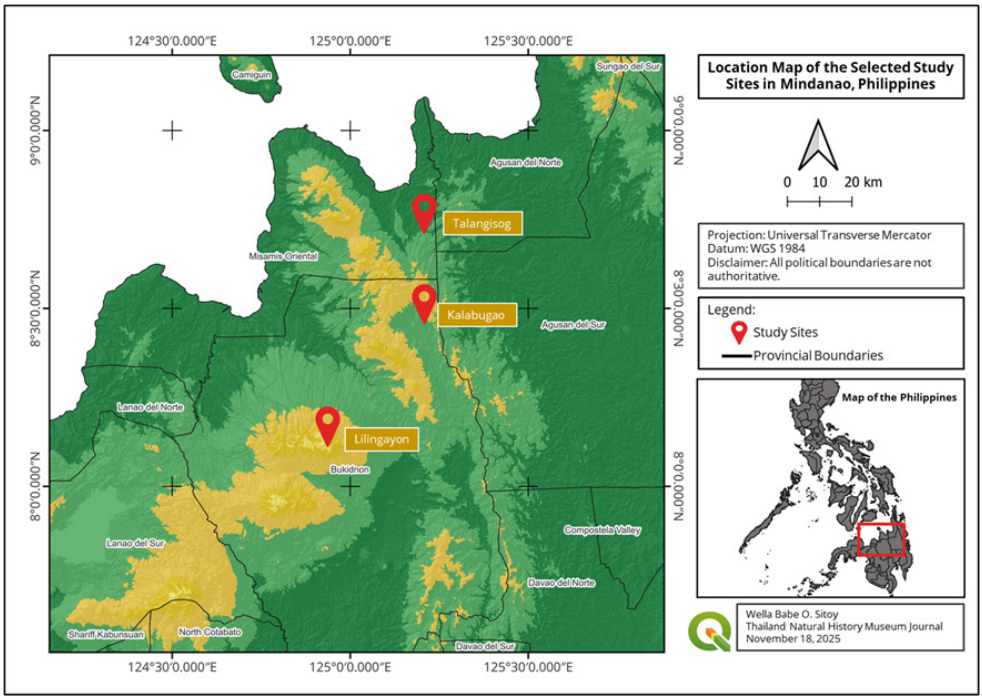

Figure 1. Location map of the study sites in Mindanao, Philippines.

Sampling Procedure

Floristics surveys were carried out in the established forest trails in the forest patches of Sitio Tandacol, Kalabugao, and Talangisog. Repeated transect walks were conducted along established forest trails within the study sites to explore and document the *Ficus* species present.

Collection, Processing, and Identification of Specimens

All *Ficus* species encountered along the trails were collected, investigated, and recorded. Voucher plant specimens were collected and preserved following the method described by

Morse (2000). Using pruning shears, three to five representative specimens bearing syconia and/or mature leaves were clipped from the individual plant during collection. The collected specimens were placed in clean containers or plastic bags to prevent damage and dehydration. The characteristics of each specimen, including coordinates, elevation, seasonal traits, and other data were recorded on a field data sheet.

After collecting specimens were processed in Central Mindanao University Natural Science Research Center. These plant samples were then dried in a forced-air plant dryer at temperatures approaching 100°C. After drying, the voucher specimens were mounted on herbarium sheets with appropriate labeling.

For the collected syconia samples, spirit collection was used for preservation. Very fleshy or delicate structures like syconia were placed in airtight jars and fully immersed in denatured alcohol. The jars were labeled accordingly and were deposited in the Botany Section of the CMU Herbarium.

The identification of *Ficus* species was based on their vegetative characteristics such as their twigs, stipules, leaves, and the overall plant habit. Identification also includes the color and size of the syconia. Initial identification was made by comparing their morphological descriptions with different sources, including the classification and description provided by Berg et al. (2005), Co's Digital Flora of the Philippines (Pelser *et al*., 2011), the JSTOR Global Plants Initiative website, and other available sources and further verified.

Assessment of Conservation and Endemism

To assess conservation status of the *Ficus* plants, the standard International Union for Conservation of Nature (IUCN) Red List of Threatened Species (Version 2023-1) was used. The conservation status of the species was also assessed to determine whether it was Data Deficient (DD), Least Concern (LC), Near Threatened (NT), Vulnerable (VU), Endangered (EN), Critically Endangered (CR), Extinct in the Wild (EW), or Extinct (EX). Additionally, other references were based on DENR Administrative Order No. 11, series of 2017, known as the Updated List of Threatened Philippine Plants and Their Categories, and data from Co's Digital Flora of the Philippines (Pelser *et al*., 2011).

RESULTS

Species Composition

A total of twenty-three species of *Ficus* were identified and recorded across the three (3) selected mountains in Mindanao, Philippines. This number represented the five out of six subgenera of *Ficus,* namely *Ficus* (Figure 2), *Sycidium* (Figure 3), *Sycomorus* (Figure 4), *Synoecia* (Figure 5), and *Urostigma* (Figure 6), excluding the genus *Pharmacosycea* without representative species collected. Furthermore, these species are further classified into eleven sections and seven subsections (Table 1).

The finding accounts for 22% of the known *Ficus* species in the Philippines and around 29% of the *Ficus* found in Mindanao Island based on the list in the Philippines by Pelser *et al*. (2011). This study revealed that among the five genera of *Ficus,* the subgenus *Sycomorus* constitutes the highest number of collected and identified species with a total of eleven species. Among these, one species is classified under section *Sycomorus*, subsection *Neomorphe*; one under section *Bosscheria*; and one under section *Dammaropsis*. The remaining eight species belong to section *Sycocarpus,* with four species categorized under subsection *Sycocarpus (Axillares)*, and another four species under subsection *Sycocarpus (Cauliflorae).* Following this, the subgenus *Urostigma* comprises four species, all are classified under section

Table 1. Checklist of *Ficus* species collected from the selected sampling sites in Mindanao, Philippines.

No.	Species	Subgenus	Section	Subsection	Local Name
1	*Ficus oleifolia* King	*Ficus*	*Ficus*	*Frutescentiae*	None
2	*F. pustulata* Elmer	*Ficus*	*Ficus*	*Frutescentiae*	None
3	*F. ruficaulis* Merr.	*Ficus*	*Eriosycea*	*Eriosycea*	None
4	*F. ampelos* Burm.f.	*Sycidium*	*Sycidium*	none	Upli/Uplas
5	*F. heteropleura* Blume	*Sycidium*	*Paleomorphe*	none	Is-is
6	*F. scaberrima* Blume	*Sycidium*	*Paleomorphe*	none	None
7	*F. variegata* Blume	*Sycomorus*	*Sycomorus*	*Neomorphe*	Amison
8	*F. minahassae* (Teijsm. & de Vriese) Miq.	*Sycomorus*	*Bosscheria*	none	Logimit
9	*F. pseudopalma* Blanco	*Sycomorus*	*Dammaropsis*	none	Lubi-lubi
10	*F. benguetensis* Merr.	*Sycomorus*	*Sycocarpus*	*Sycocarpus* (Axillares)	Tambog
11	*F. lepicarpa* Blume	*Sycomorus*	*Sycocarpus*	*Sycocarpus* (Axillares)	None
12	*F. multistipularis* Merr.	*Sycomorus*	*Sycocarpus*	*Sycocarpus* (Axillares)	Payahan
13	*F. septica* Burm.f.	*Sycomorus*	*Sycocarpus*	*Sycocarpus* (Axillares)	Lagnob
14	*F. botryocarpa* Miq.	*Sycomorus*	*Sycocarpus*	*Sycocarpus* (Cauliflorae)	None
15	*F. cassidyana* Elmer	*Sycomorus*	*Sycocarpus*	*Sycocarpus* (Cauliflorae)	None
16	*F. nota* (Blanco) Merr.	*Sycomorus*	*Sycocarpus*	*Sycocarpus* (Cauliflorae)	Tibig
17	*F. satterthwaitei* Elmer	*Sycomorus*	*Sycocarpus*	*Sycocarpus* (Cauliflorae)	Tibig
18	*F. cataupi* Elmer	*Synoecia*	*Kissosycea*	None	None
19	*F. villosa* Blume	*Synoecia*	*Rhizocladus*	*Punctulifoliae*	None
20	*F. benjamina* L.	*Urostigma*	*Urostigma*	*Conosycea*	Dakit
21	*F. callophylla* Blume	*Urostigma*	*Urostigma*	*Conosycea*	None
22	*F. cucurbitina* King	*Urostigma*	*Urostigma*	*Conosycea*	None
23	*F. stricta* (Miq.) Miq.	*Urostigma*	*Urostigma*	*Conosycea*	None
Total	23	5	11	7	

Figure 2. Representative species of subgenus *Ficus*. A, *Ficus oleifolia* King.; B, *F. pustulata* Elmer; C, *F. ruficaulis* Merr.

Figure 3. Representative species of subgenus *Sycidium*. A, *Ficus ampelos* Burm.f.; B, *F. heteropleura* Blume; C, *F. scaberrima* Blume.

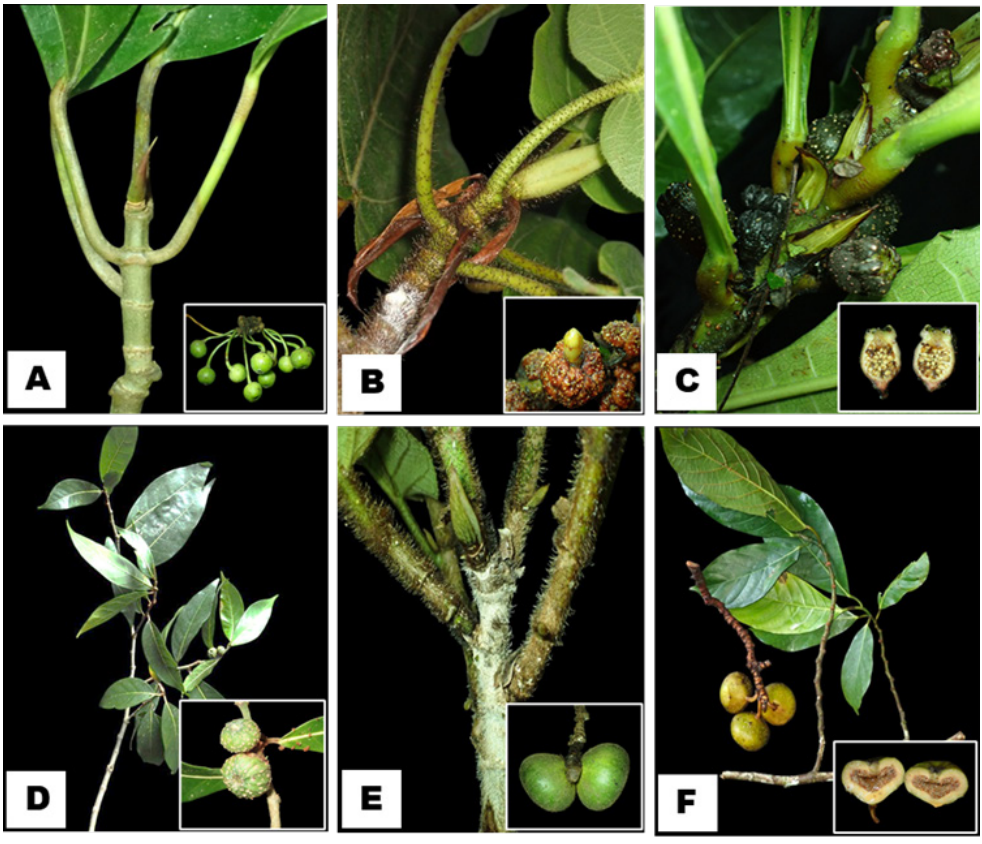

Figure 4. Representative species of subgenus *Sycomorus*. A, *Ficus variegata* Blume.; B, *F. minahassae* (Teijsm. & de Vriese) Miq.; C, *F. pseudopalma* Blanco.; D, *F. septica* Burm.f.; E, *F. cassidyana* Elmer.; F, *F. nota* (Blanco) Merr.

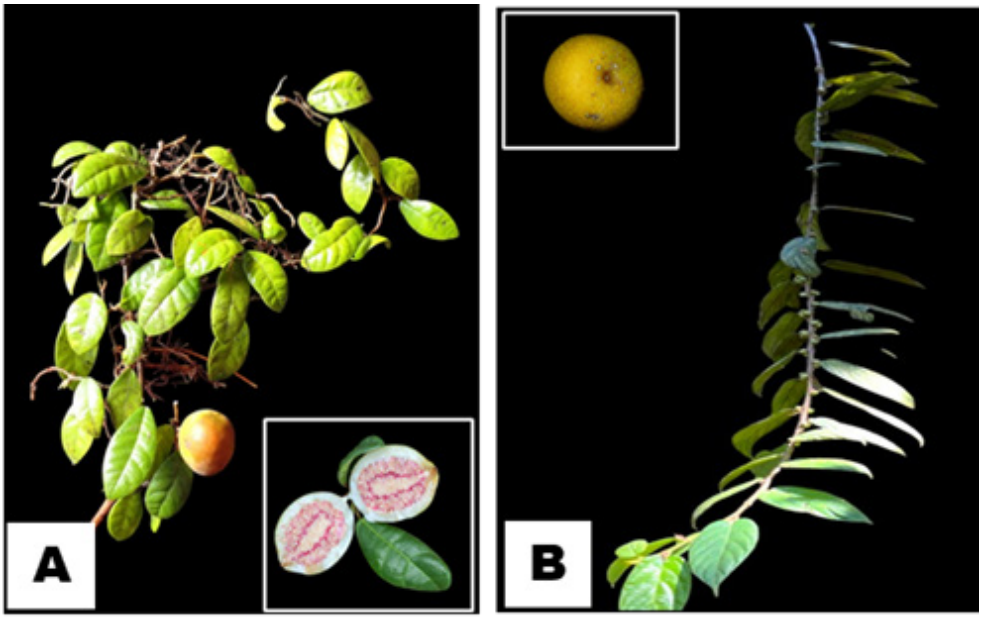

Figure 5. Representative species of subgenus *Synoecia*. A, *Ficus cataupi* Elmer; B, *F. villosa* Blume.

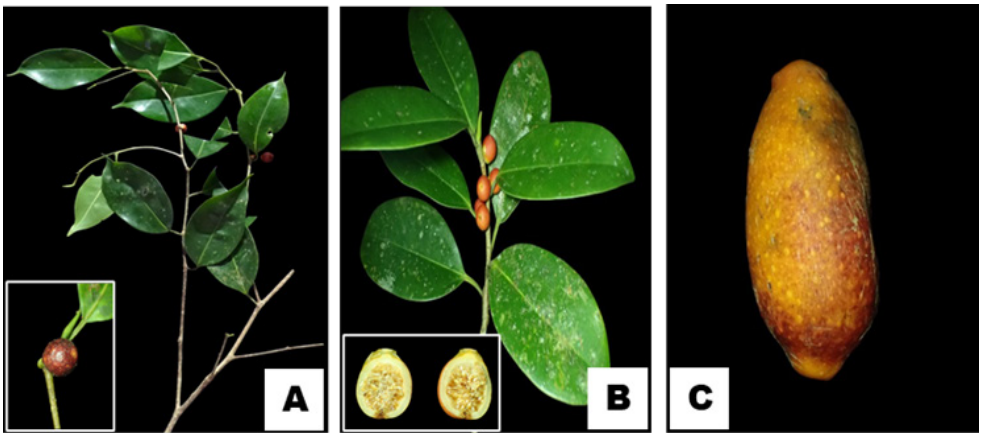

Figure 6. Representative species of subgenus *Urostigma.* A, *F. benjamina* L.; B, *F. callophylla* Blume.; C, *F. cucurbitina* King.

Urostigma, subsection *Conosycea.* This number is also followed by the two subgenera, *Ficus* and *Sycidium*, with three species each. Two species of subgenus *Ficus* are further classified under section *Ficus*, subsection *Frutescentiae,* while only one species that falls under section *Eriosycea*, subsection *Eriosycea*. Meanwhile, subgenus *Sycidium* has one species under section *Sycidium* and two species classified under section *Paleomorphe*. Lastly, subgenus *Synoecia* is represented by two species, one under section *Kissosycea*, and another one species under section *Rhizocladus*, subsection *Punctulifoliae*.

Distribution of *Ficus* Species in the Selected Sites

Based on the results of the study, 20 out of the 23 species collected from the selected mountains in Mindanao, Philippines were recorded in Talangisog, Eureka, Misamis Oriental. Meanwhile, 13 different species were also recorded across the two sites in Bukidnon, Sitio Lilingayon in Valencia City and Kalabugao in Impasug-ong (Table 2).

Table 2. Occurrence of *Ficus* species in different mountains in Mindanao, Philippines.

Species	Distribution		
	Sitio Lilingayon, Valencia City, Bukidnon	Talangisog, Eureka, Gingoog City, Misamis Oriental	Kalabugao, Impasug-Ong, Bukidnon
Ficus oleifolia King	+	+	+
F. pustulata Elmer		+	
F. ruficaulis Merr.	+		+
F. ampelos Burm.f.	+	+	
F. heteropleura Blume	+	+	+
F. scaberrima Blume		+	+
F. variegata Blume	+	+	
F. minahassae (Teijsm. & de Vriese) Miq.		+	+
F. pseudopalma Blanco	+	+	
F. benguetensis Merr.	+	+	+
F. lepicarpa Blume			+
F. multistipularis Merr.		+	+
F. septica Burm.f.	+	+	+
F. botryocarpa Miq.		+	
F. cassidyana Elmer	+	+	
F. nota (Blanco) Merr.	+	+	+
F. satterthwaitei Elmer	+		+
F. cataupi Elmer	+	+	+
F. villosa Blume	+	+	+
F. benjamina L.		+	
F. callophylla Blume		+	
F. cucurbitina King		+	
F. stricta (Miq.) Miq.		+	
Total	13	20	13

Conservation Status and Endemicity

Among the 23 species of *Ficus* documented from the three study sites in Mindanao, Philippines, three are assessed as threatened species based on the IUCN 3.1: *Ficus multistipularis* and *F. cataupi* are categorized as Endangered, and *F. cassidyanna* is listed as Near Threatened. As observed in the sites, these species face varying degrees of risk due to habitat loss, land-use change, and limited distribution ranges. Furthermore, of the total collection of *Ficus* in these sites, 16 species are currently listed as Least Concern by the IUCN, indicating that they are relatively abundant and not presently at immediate risk of extinction.

However, while some populations remain stable, others may be experiencing declines that need closer monitoring. Importantly, all *Ficus* species documented in this study are native to the Philippines, emphasizing their ecological role as keystone species in tropical rainforests. Notably, five are confirmed as Philippine endemics namely, *F. pustulata, F. pseudopalma, F. multistipularis, F. cassidyanna,* and *F. cataupi.* Their restricted distribution emphasizes both their evolutionary and biogeographic significance, as well as the urgent need for targeted conservation efforts to preserve these important components of the Philippine flora (Table 3).

Table 3. Conservation status and endemism of *Ficus* species from different mountains in Mindanao.

Species	Conservation Status (IUCN 3.1)	Endemicity
Ficus oleifolia King	Least Concern	Native
F. pustulata Elmer	Least Concern	Philippine Endemic; Native
F. ruficaulis Merr.	Least Concern	Native
F. ampelos Burm.f.	Least Concern	Native
F. heteropleura Blume	Not assessed	Native
F. scaberrima Blume	Least Concern	Native
F. variegata Blume	Least Concern	Native
F. minahassae (Teijsm. & de Vriese) Miq.	Least Concern	Native
F. pseudopalma Blanco	Not assessed	Philippine Endemic; Native
F. benguetensis Merr.	Least Concern	Native
F. lepicarpa Blume	Least Concern	Native
F. multistipularis Merr.	Endangered	Philippine Endemic; Native
F. septica Burm.f.	Least Concern	Native
F. botryocarpa Miq.	Least Concern	Native
F. cassidyana Elmer	Near Threatened	Philippine Endemic; Native
F. nota (Blanco) Merr.	Least Concern	Native
F. satterthwaitei Elmer	Not assessed	Native
F. cataupi Elmer	Endangered	Philippine Endemic; Native
F. villosa Blume	Not assessed	Native
F. benjamina L.	Least Concern	Native
F. callophylla Blume	Least Concern	Native
F. cucurbitina King	Least Concern	Native
F. stricta (Miq.) Miq.	Least Concern	Native

DISCUSSION

The present study recorded a lower number of *Ficus* species compared to previous floristic assessments conducted in various parts of the Philippines. Notably, 26 species were documented from Mt. Malindang in Misamis Occidental (Amoroso *et al*., 2006; Alaman *et al*., 2020; Arances *et al*., 2004; Gomez-Roxas, 2005). Meanwhile, this number is higher when compared to the study of Paz-Alberto *et al*. (2016) wherein they reported ten *Ficus* species as the most abundant taxa in Bataan Natural Park. In a comprehensive survey by Medecilo and Lagat (2017), 19 species of *Ficus* were identified in Mts. Palay-Palay–Mataas na Gulod National Park and a total of ten species of *Ficus* were recorded in Mt. Agad-Agad in the

studies of Medecilo-Guiang *et al*. (2021) and Amoroso *et al*. (2022). These variations in species richness may be attributed to differences in habitat types, elevation gradients, forest heterogeneity, and sampling intensity across study sites. The broader geographic scope of the present investigation, encompassing multiple localities across the Mindanao Island in the Philippines, may have contributed to the comparatively higher species count compared to the two studies of Paz-Alberto *et al*. (2016), Medecilo and Lagat (2017), Medecilo-Guiang *et al*. (2021), and Amoroso *et al*. (2022). Furthermore, studies from other Malesian countries, such as Malaysia, also reported lower species composition, with Moulana *et al*. (2020) documenting 13 species, whereas studies from Northern Thailand recorded a higher species composition of 33 monoecious and dioecious fig species (Pothasin *et al*., 2014). However, when viewed in the context of the number of surveyed sites, the total number of recorded *Ficus* species in this study remains relatively low. This suggests the possibility of overlooked species, either due to limited sampling in certain habitats or the presence of morphologically cryptic taxa. Nonetheless, this study constitutes the first coordinated taxonomic inventory of *Ficus* species across selected forests in Mindanao, Philippines serving as a critical foundation for future biodiversity assessments.

The data on the distribution of *Ficus* species collected from the three sampling sites suggest that the forest patches of Talangisog exhibit characteristics more favourable for the growth of *Ficus* species compared to the other two forests. Talangisog in Gingoog City, Misamis Oriental comprises the significant number of collected and identified *Ficus* species with 20 species. The variation in elevation and the presence of intact forest structure at these sites create numerous ecological niches ideal for supporting *Ficus*. Although detailed studies on the forests of Talangisog remain limited, its geographic proximity and ecological similarity to Mount Balatukan which is characterized by upper montane forests, exhibits high humidity, cooler temperatures, and diverse microhabitats, which together foster rich plant diversity (Pescuela *et al*., 2024), also likely *Ficus* taxa, and this suggests comparable environmental conditions favourable for *Ficus* growth; notably, this site features well-preserved lowland evergreen and montane forests. The two sampling sites namely, Lilingayon and Kalabugao in Bukidnon, Philippines, both harbour 13 species each. The mountainous regions of Bukidnon, particularly the Kitanglad and Kalatungan mountain ranges where these forest patches are situated, offer an ideal environment for the abundant growth of *Ficus* species and the evolution of these unique, endemic taxa. These areas feature diverse forest types, including montane rainforests and mossy forests, which support a wide range of plant species. The canopy is dominated by large, buttressed trees, including *Shorea* and *Ficus*, with *Agathis* replacing *Shorea* at higher elevations. The rich biodiversity is influenced by elevation gradients, varied microhabitats, and favourable climatic conditions. Notably, species like *Ficus* thrives at altitudes of up to 1,800 meters, emphasizing the suitability of Bukidnon's mountainous environments for *Ficus* growth (Aribal *et al.*, 2015; Coritico *et al*., 2020; Suminguit *et al*., 2002). Nonetheless, this result in the number of *Ficus* recorded from each site, may also be attributed to the sampling effort during the study period, as more days were spent in Talangisog compared to the other two sites due to time constraint. This allowed for a broader coverage of forest areas of Talangisog to be sampled. Therefore, it is recommended to conduct more sampling efforts in the area where species composition of *Ficus* is low.

The result of the study also shows that some of the *Ficus* species in these areas are threatened species based on IUCN data. These plants face several threats, primarily habitat loss due to deforestation, agricultural expansion, and urbanization, which reduce suitable environments and disrupt ecological interactions (Araza *et al*., 2021; Gabriel, 2023). Overexploitation for timber and other uses further pressures some species (Agduma *et al*.,

2023). Additionally, the spread of invasive *Ficus* species in non-native regions and the impacts of climate change, which alter growth conditions and affect pollinators and dispersers, pose significant risks to their survival (van Kolfschoten *et al*., 2022).

Furthermore, the presence of five confirmed Philippine endemics namely, *F. pustulata, F. pseudopalma, F. multistipularis, F. cassidyanna*, and *F. cataupi* suggest that the selected study sites serve as important habitats for the conservation of endemic *Ficus* species and highlight their ecological significance in supporting localized biodiversity. Also, this number is also higher than the Philippine endemic *Ficus* collected in Mt. Malindang in combined studies of Amoroso *et al*. (2006), Gomez-Roxas (2005), Arances *et al*. (2004), and Alaman *et al*. (2020).

CONCLUSIONS

The present study provides a foundational assessment of *Ficus* diversity across selected forests in Mindanao, Philippines, recording a total of 23 species. Talangisog in Gingoog City, Misamis Oriental, emerged as the most species-rich study site with 20 species, likely due to its intact forest structure, elevation gradient, and ecological similarity to Mount Balatukan. The two Bukidnon sites, Lilingayon and Kalabugao, each recorded 13 species, reaffirming the ecological importance of the Bukidnon highlands. The study also documented three threatened species based on the IUCN 3.1: *Ficus multistipularis* and *F. cataupi* are categorized as Endangered, and *F. cassidyanna* is listed as Near Threatened. Sixteen species are currently listed as Least Concern and lastly, five confirmed Philippine endemics—*Ficus pustulata, F. pseudopalma, F. multistipularis, F. cassidyanna, and F. cataupi*, highlighting the conservation value of the surveyed sites. Despite the relatively low overall species count, potential under sampling and the presence of cryptic species suggest that *Ficus* diversity in these areas may be underestimated and need of further sampling of the area. Additionally, the detection of threatened species emphasizes the vulnerability of *Ficus* populations to habitat loss, deforestation, agricultural expansion, overexploitation, invasive species, and climate change. This study therefore not only fills a significant gap in the taxonomic inventory of *Ficus* in Mindanao but also establishes a critical baseline for future biodiversity monitoring and conservation efforts.

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