PRELIMINARY CHECKLIST OF ENSIFERA (ORTHOPTERA) SPECIES FROM MT. MALINDANG RANGE NATURAL PARK, MINDANAO, PHILIPPINES

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Abstract

Mt. Malindang Range Natural Park (MMRNP) is a key biodiversity area that serves as a crucial habitat for Ensifera species. This study provides the first preliminary checklist of Ensifera species in Mt. Malindang. The study was conducted through a purposive sampling via hand catching across 14 selected sites in MMRNP from January to November 2024 and from March to April 2025 respectively. Results showed a total of 36 species from six families, 11 subfamilies, and 28 genera of Ensifera were recorded with 25% endemic to Mindanao Island. Paranisitra flavofacia Baroga-Barbecho, Yap, Tan & Robillard, 2019 was the most dominant species recorded in the area. Interestingly, Anthracites zebra Hebard, 1922, was noted to have color variations, from which each species was collected at different sites. Additionally, two new species were identified in this study such Itara mindanao Tan, Bahoy, Grumo & Gono, 2024 and Scytocera musa Tan & Rivera, 2025. The study highlights the underappreciated status of Ensiferans in Mt. Malindang, evidenced by the numerous new locality records and the identification of two previously unknown species. These results underscore the importance of ongoing and thorough exploration of Ensifera species in the area, building on sampling efforts that have been ongoing since 1959. Nonetheless, the lack of molecular data limits a complete understanding of their genetic composition and evolutionary connections, hindering efforts to accurately resolve phylogenetic relationships, assess cryptic diversity, and implement informed conservation strategies.

Keywords: *Ensiferan cheklist, Mt. Malindang, Species, Taxonomy*

INTRODUCTION

The Philippines is one of the megadiverse countries worldwide, characterized by complex and rich biodiversity hotspots (Koh et al., 2019). With more than 7,000 islands, many

of which are considered species-rich and are left unexplored (Heads, 2013), the country harbors a remarkable diversity of insects, including orthopterans (crickets, grasshoppers, and katydids), which play a vital role in ecological processes. Orthopterans, with more than 2,000 known species across Southeast Asia (Tan et al., 2017a), contribute to nutrient cycling, soil aeration, and trophic interactions as both herbivores and prey for higher taxa (Tan et al., 2013). However, due to the archipelagic nature and vast ecological gradients of the Philippine islands, many habitats remain insufficiently surveyed, leaving numerous orthopteran species undiscovered (Conservation International Philippines, 2025; Robillard & Yap, 2015).

The order Orthoptera is classified into two major suborders: Caelifera, which includes short-horned grasshoppers, and Ensifera, which comprises long-horned grasshoppers, crickets, and katydids (Shin et al., 2024). The last comprehensive survey of the orthopteran checklist in the Philippines was compiled by Bruner over a century ago (Bruner, 1915). The compilation of a catalogue from this work highlighted the documentation of various species of grasshoppers, crickets, and katydids, which served as a foundational reference for subsequent studies on Philippine Orthoptera. Moreover, since its publication, the archipelago's orthopteran diversity has been further explored, leading to the discovery and description of new species (Tan et al., 2017). For instance, a 2019 survey on Siargao Island (Tan et al., 2019) discovered 37 species and 34 genera emphasizes the rich orthopteran biodiversity in understudied areas. Tan et al. (2024) discovered a new genus and species Fartmanntettix undulatus, Tan & Tummbrinck, 2024 under subfamily Cladonotinae (Orthoptera: Tetrigidae) from Mindanao Island, tentatively classified under the tribe Trusmaditetrigini Storozhenko, 2023. This newly identified genus is distinguished from other members of the tribe by its undulating and elevated curinae on the pronotum and femora. Patano et al. (2021) described Tegotettix derijei (Orthoptera: Tetrigidae), a newly identified pygmy grasshopper species from Mindanao. Previously known only from historical descriptions and illustrations, this species had not been documented for over a century. Meanwhile, Ensifera –a notable group of orthoptera are

recognized for their unique and diverse communication strategies such as acoustic signaling that is crucial for their mating and territorial behaviors (Walker & Rentz, 2020). This group of insects occupy a variety of microhabitats from forest canopies, leaf litters, and beneath the ground and serve as essential components of food webs both as herbivores and prey for larger animals (Guido & Gianelle, 2001). A recent expedition on Ensifera species in the Philippines, particularly in Mindanao, resulted in a taxonomic review of the genus Paranisitra and Lebinthus. This study led to the description of new species and new locality records of Ensifera from the different regions of Mindanao, highlighting the ongoing need for taxonomic revisions and biodiversity assessments in the region (Baroga-Barbecho et al., 2019; 2020). Additionally, Tan et al. (2023) conducted a bioacoustics study on the little-known Grylloidae crickets from various areas in Mindanao which led to the discovery of four previously undocumented species such as Mistshenkoana lunotan, Mistshenkoana higaonon. and Ectatoderus dubius from Misamis Oriental; and Phaloria (Phaloria) rotundata from Agusan del Sur, Philippines respectively. Further, Bahoy et al. (2024) discovered new species, Falcerminthus hisipidus of subtribe Lebinthina (Grylloidea, Eneopterinae, Lebebinthini) from Zamboanga del Norte and a new locality record of Lebinthus luae in Lake Sebu, Cotabato City in Mindanao, Philippines.

The Mt. Malindang Range Natural Park (MMRNP) is an ASEAN heritage park situated in the province of Misamis Occidental, Philippines. The park extends a total of 53,262 hectares of forest lands with covering grasslands to mossy-montane forest measuring at about 34,000 hectares that straddle the provinces of Misamis Occidental and Zamboanga Peninsula (DENR-BMB, 2016). The unique structure of Mt. Malindang is crucial as it is designated as one of the major terrestrial key biodiversity areas (KBA) in the country which provides environmental habitats for orthoptera specifically, Ensifera – a key indicator for maintaining ecological balance (Calago et al., 2019). The first attempt to sample the Ensifera species in the area was carried out by Tan et al., (2024) and discovered new species (Itara mindanao) from the subgenus Itara (Orthoptera: Grylloidea: Itarinae). The recent discovery was a first record of

the subgenus in the Philippines and in Mindanao Island, offering more insights on ensiferan biodiversity in the mountain range (Tan et al., 2024). This suggests that despite their presence, Ensifera species are often overlooked and largely unexplored. Given the ecological and economic significance of MMRNP as a major hub for economic activities and a designated key biodiversity area (Conservation International Philippines et al., 2006), documenting the Ensifera species and their distribution is essential for understanding and conserving the park's biodiversity.

This study presents the first preliminary checklist of Ensifera species recorded in Mt. Malindang Range Natural Park (MMRNP), accompanied by taxonomic notes. Additionally, it provides distribution data and potential biogeographic patterns for each species, along with detailed illustrations to aid in accurate species identification.

MATERIALS AND METHOD

The study was conducted across 14 selected sites, encompassing 14 barangays within two cities and six municipalities in Misamis Occidental, all within the protected landscapes of MMRNP which exhibit a distinctive geographical configuration characterized by bushy to mossy forest, dipterocarp forest, grasslands, and agricultural areas. The study took place from January to November 2024 and from March to April 2025 respectively. The northern portion of MMRNP comprises higher elevation (colder region) extending from 1600 to 2,400 m.a.s.l. The area is also characterized by a crater lake, waterfalls (Municipality of Don Victoriano) and hot springs (Oroquiety City) that paved a way for microhabitat composition for various species of Ensifera. The southern portion of MMRNP comprises areas with lower elevations and are characterized by riparian systems, vegetation covers, and crops.

Prior to sampling, the researcher secured a Wildlife Gratuitous Permit (GWP No. R10-2024-17) from the Department of Environment and Natural Resources – Region 10 (DENR-10). In addition, local permits were obtained from the relevant local government units (LGUs), barangays, and Indigenous Peoples through the Free, Prior, and Informed Consent (FPIC) process, ensuring the legal and ethical compliance of data collection.

Ensiferan specimens were collected using opportunistic sampling methods, including hand-catching and sweep-netting, conducted during both daytime (0600–1000 hours) and nighttime (1730–2230 hours) across multiple visits (at least three per site) from January to November 2024. Manual collection of adult Ensifera was carried out using wide-mouthed plastic vials, with most specimens located and captured during nighttime calling activity, although early morning collections were also made.

Specimens were preserved in 70% ethanol for later analysis. Acoustic recordings of calling songs were obtained by placing individuals in mesh cages and recording with a Zoom H1n recorder set at a 120 Hz sampling frequency. Recordings were saved in 24-bit, BWF-compliant WAV format. In situ photographs of the Ensiferan specimens were taken using iPhone XR and iPhone 15 smartphones.

The terminology and analytical procedures for acoustic data followed Tan et al. (2023). Temporal parameters, such as call durations and intervals, were measured manually using Raven Lite 2.0.0. Peak frequency was analyzed using the *'spectro_analysis'* function from the R package warbleR (Araya-Salas & Smith-Vidaurre, 2017) in R version 4.4.2.

Sampling Sites

The study was conducted in Mt. Malindang Range Natural Park in Misamis Occidental, Philippines. The MMRNP is a vast stretch of landscape that serves as host to endemic species of the Philippines. It extends up to 34,000 ha allowing various species to inhabit. To date, the range experiences an overwhelming development as because of rapid urban expansion, agriculture, and eco-tourism. Although, the MMRNP offers vast areas for different species, studies about the taxonomy of Ensifera have never been conducted. In fact, the last comprehensive assessment of flora and fauna studies ever conducted in the area was way back 2006 through a project funded by SEARCA (Garcia et al. 2006). On that research expedition, Ensifera studies were not included, hence, there is a great call for establishing the taxonomic profile of Ensifera species in the MMRNP. The study sites are shown in the map below generated from Quantum Geographical Information System (QGIS v. 3.41)

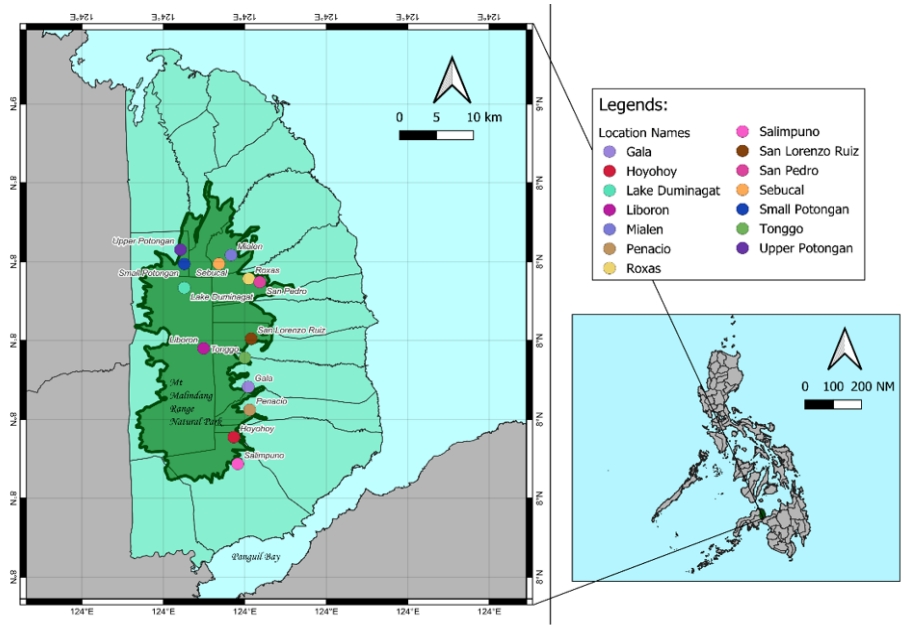

FIGURE 1. Geographic Locations of the 14 Selected Sites in MMRNP using QGIS v. 3.41

Sites

Table 1. Sampling Sites in Mt. Malindang Range Natural Park with Corresponding GPS Coordinates

Site Municipality/City	Barangay Sites Around MMRNP	GPS Coordinates
1. Don Victoriano	Lake Duminagat	N8.27811, E123.59756
	Liboron	N8.29335, E123.5931
2. Oroquieta City	Sebucal	N8.4119, E123.6625
	Mialen	N8.4105, E123.6852
3. Conception	Small Potongan	N8.4013, E123.6145
	Upper Potongan	N8.4179, E123.6138
4. Aloran	Roxas	N8.3835, E123.7298
	San Pedro	N8.3853, E123.7422
5. Sinacaban	San Lorenzo Ruiz	N8.2856, E123.6998
6. Tudela	Gala	N8.2292, E123.6801
	Tonggo	N8.2791, E123.7003
7. Clarin	Penacio	N8.2125, E123.7047
8. Tangub City	Hoyohoy	N8.1559, E123.7009
	Salimpuno	N8.1353, E123.7026

Specimen Preservation and Analysis

The preservation process entailed immersing the specimens in absolute analytical-grade ethanol to ensure optimal conditions for subsequent analysis. Following this, the specimens were carefully pinned and subjected to dry preservation. Additionally, a single hind leg from each specimen was meticulously preserved in absolute analytical-grade ethanol to facilitate potential future molecular investigations. This meticulous curation and preservation approach was designed to maintain the integrity of the specimens, ensuring their suitability for both morphological and molecular analyses.

Specimen Identification

Whenever possible, species-level taxonomic identification was performed, with male genitalia dissected to facilitate comparisons within and between species for validation. Specimens were identified using relevant published keys, and descriptions and descriptions of voucher specimens provided by Robillard (2014), Salvador et al. (2024), Tan et al. (2024), Gorochov (1996; 2015; 2023), Beroga-Barbecho et al. (2019), Ingrisch, 2015, Bahoy et al. (2024), Gorochov, 2021 and available database descriptions from orthoptera species file (OSF). For confirmation of the taxonomic identifications, the researcher sought the expert validation from Ming Kai Tan at the Faculty of Science, Lee Kong Chian Natural History Museum, National University of Singapore, Singapore. Classification and nomenclature of species was based on the OSF (Cigliano et al., 2025).

Photographic Documentation and Analysis of Morphological Features

The pinned specimens were imaged using a Canon EOS 6D digital SLR camera attached to a Visionary Digital Passport system. Close-up images of morphological features, a macro photo lens MP-E 65 mm f/2.8 USM (1–5×) (with Tamron SP AF Tele-Converter 14OF-CA 1.4× for titillators) was used. Image stacking was done using Zerene Stacker version 1.04 or Helicon Remote version 9.3.1, and Helicon Focus version 6.8.0. Alternatively, close-up images were also obtained using Leica M205C Encoded stereomicroscope. Image stacking was performed using the Leica Focus Stacking Imaging System, which is operated with-

in the Leica Application Suite X. Image editing was accomplished using Adobe Photoshop 2025 (Adobe Systems Incorporated, San Jose, CA, USA). Measurements of dry, pinned specimens were made from images using ImageJ 1.54g (Wayne Rasband, Research Services Branch, National Institute of Mental Health, Bethesda, MD, USA).

Analysis on Relative Abundance

Relative Abundance=Nni

Where:

- nin_ini = Number of individuals of species i
- NNN = Total number of individuals of all species

To express it as a percentage:

Relative Abundance (%)=(ni/N)×100

Depositories

The specimens were deposited in:

PNM Philippine National Museum,Manila, Philippines

MMRNPM Mt.Malindang Range Natural Park Museum, Oroquieta City, Misamis Occidental

MSU-IIT Mindanao State University-Iligan Institute of Technology Natural Museum, Iligan,Philippines

ZRC Zoological Reference Collection, Lee Kong Chian Natural History Museum, National University of Singapore, Singapore

RESULTS

Family Composition and Richness of Ensifera in Mt. Malindang Range Natural Park (MMRNP)

Species of Ensifera were collected via purposive sampling through hand catching and sweep-netting in different selected sites in Mt. Malindang. Below is a family- and subfamily-level breakdown of the 36 Ensiferan species recorded, followed by a comprehensive discussion of what these numbers tell us about orthopteran diversity, ecology, and biogeography in your study area.

Table 2. Summary of the Coverage of *Ensifera* families and subfamilies that were represented in the collection in Mt. Malindang, Misamis Occidental.

1.	**Order**	**Orthoptera**	**Species Richness**
1.1	Suborder	Ensifera	
1.1.1	Family	Tettigoniidae	
1.1.1.1	Subfamily	Conocephalinae	7
1.1.1.2	Subfamily	Mecopodinae	4
1.1.1.3	Subfamily	Phaneropterinae	2
1.1.1.4	Subfamily	Pseudophyliinae	2
1.1.2	Family	Gryllacrididae	
1.1.2.1	Subfamily	Gryllacridinae	7
1.1.3	Family	Gryllidae	
1.1.3.1	Subfamily	Eneopterinae	2
1.1.3.2	Subfamily	Gryllinae	5
1.1.3.3	Subfamily	Itarinae	1
1.1.4	Family	Gryllotalpidae	
1.1.4.1	Subfamily	Gryllotalpinae	1
1.1.5	Family	Oecanthidae	
1.1.5.1	Subfamily	Podoscirtinae	4
1.1.6	Family	Rhaphidophoridae	
1.1.6.1	Subfamily	Rhaphidophorinae	1
Total			**36**

The table above shows the species composition and richness of Ensifera in Mt. Malindang, comprising six families and 11 subfamilies. Family Tettigoniidae obtained the highest number of subfamilies (4 subfamilies) with 15 species accounting to 42% of the total species composition. This indicates that this group is considered ecologically versatile with species adapted to a wide range of microhabitats including grasslands, understory, shrubs, and forest canopy (Rentz, 1996; Mugleston et al., 2018). These are conditions where katydids typically thrive due to their foliage specialization, acoustic communication, and nocturnal activity patterns (Heller et al., 2014). Meanwhile, two families obtained with only one subfamily composition such as family Gryllotalpidae (Subfamily Gryllotalpinae) and family Rhaphidophoridae (Subfamily Rhaphidophirinae). This limited subfamily representation is not unexpected, as these families typically exhibit narrow

ecological niches and specialized life history traits that constrain their diversity and distribution (Gorochov, 2001; Heads, 2010). Gryllotalpidae, commonly referred to as mole crickets, are fossorial insects adapted to subterranean environments, characterized by morphological traits such as enlarged forelegs for digging and reduced wings in some species (Rentz, 1996). Their subterranean lifestyle and strong site fidelity often result in under-sampling during conventional surface collection methods, such as sweep netting or light trapping (Nickle & Castner, 1995). Consequently, their detection in faunal surveys is limited, and their representation in the species pool is typically low unless targeted pitfall or soil-excavation methods are appropriately employed.

On the other hand, Rhaphidophoridae, or camel crickets, are primarily troglophilic or cave-dwelling insects that inhabit dark, moist environments such as forest litter, rock crevices, or caves (Naskrecki, 2000). Their ecological specialization and cryptic behavior often result in low encounter rates unless surveys are conducted in microhabitats specifically suited to their niche. The presence of only one subfamily (Rhaphidophorinae) in the dataset suggests a limited availability of suitable microhabitats or a sampling bias toward more open or above-ground habitats.

Relative abundance of each Ensifera species found in the different sites of Mt. Malindang

In the present study, a total of 37 Ensiferan species distributed across six families were recorded. The species among these families were collected across the 14 sampling sites in Mt. Malindang. The data is visualized through a pie chart below.

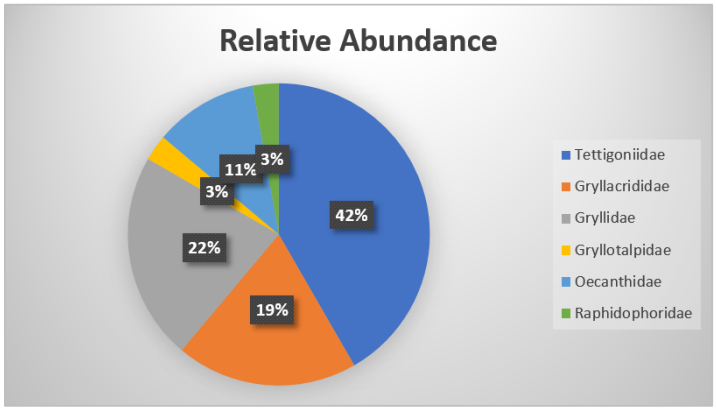

FIGURE 1. Relative abundance of Ensifera families found in Mt. Malindang

The data above showed a disproportionate distribution of species richness relative abundance the families. **Tettigoniidae,** the family of katydids, emerged as the most species-rich group, contributing **42**% of the total species. This is followed by **Gryllidae (22%)** and **Gryllacrididae (19%),** which also showed considerable species diversity. The remaining families—**Oecanthidae (11%), Gryllotalpidae (3%),** and **Rhaphidophoridae (3%)**—were represented by fewer species. This uneven distribution highlights the ecological dominance of Tettigoniidae and reflects their high adaptability to various vegetation strata and microhabitats, as well as their diversified acoustic communication systems (Mugleston et al., 2018). In contrast, the relatively low species representation in Gryllotalpidae and Rhaphidophoridae may be attributed to their specialized lifestyles, such as fossorial or cave-dwelling behavior, which may limit their detectability during surface-level sampling efforts (Naskrecki, 2000; Nickle & Castner, 1995).

Table 3. List of Species from the collection in Mt. Malindang, Misamis Occidental, Mindanao, Philippines along with the distribution data for each species. Only species with genera confidently identified species were included here.

Taxon	Type Locality	Type Dep.	Bruner (1915)	OSF 2025	Notes
Family Tettigoniidae Krauss, 1902 Subfamily Conocephalinae Kirby & Spence, 1826					
1. *Anthracites zebra* Hebard, 1902	PHILIPPINES; Mindanao, Mt. Apo, North Cotabato, Mt. Malindang, Misamis Occidental	ANSP	+	+	With various color variations among species from the holotype (Sensu Bahoy, Sensu Ingrisch)
2. *Anthracites sineaureus* Tan, Rivera & Daguplo, 2025	----------		-	-	
3. *Scytocera musa* **sp. nov**. Tan & Rivera, 2025	PHILIPPINES; Mindanao, Misamis Occidental; Hoyohoy Tangub City	PNM; ZRC	-	-	New Species recorded from Mt. Malindang
4. *Euconocephalus* sp.	----------				
5. *Xestophrys* sp.	----------				Usually found on dead plant leaves
6. *Pseudorhynchus* sp.	----------				Rarely found in the sites
7. *Conocephalus (Anisoptera) longipennis* Haan,1843	India, Java, Malay Peninsula, New Guinea, Sumatra, outside Southeast Asia and the Philippines (Bruner, 1915); Mindanao, Mt. Malindang, Misamis Occidental	NHML	+	+	Very common in Cogon grass
Subfamily Mecopodinae Walker, 1871 Tribe Mecopodini Walker, 1871					
8. *Mecopoda elongata* Linnaeus, 1758	BRUNEI; NEPAL; MALAYSIA; INDONESIA; MYANMAR; THAILAND; SINGAPORE; VIETNAM; PHILIPPINES	LSL; MNHN; NHML	+	+	New Record in the Philippines
9. *Mecopoda tenebrosa* Walker, 1869	KOREA; PHILIPPINES, Mindoro, Mindanao, Mt. Malindang, Misamis Occidental	BMNH	+	+	Widely distributed in low-land areas
10. *Segestes* sp.	----------				
11. *Rectimarginalis* sp.	----------				
Subfamily Phaneropterinae Burmeister, 1838					

12. *Ducetia laniae,* Salvador, Tan, Nuñeza, & Robillard, 2023	PHILIPPINES; Mindanao, Agusan del Sur; Mt. Malindang, Misamis Occidental	PNM; ZRC; MNHN	_	_	New locality record in MMRNP
13. *Phaneroptera (Phaneroptera) neglecta* Karny, 1926	PHILIPPINES; Mindanao, Siargao	PNM	_	+	Endemic to Mindanao
Subfamily Pseudophyliinae					
Tribe Pseudophyllini Burmeister, 1838					
14. Cymatomerini sp.	----------				
15. *Phyllominus* sp.	----------				
Family Gryllacrididae Blanchard, 1845					
Subfamily Gryllacridinae Blanchard, 1845					
16. *Eugryllacris* sp.1	----------				
17. *Eugryllacrus* sp. 2	----------				
18. Gryllacrididae sp.1	----------				
19. *Phlebogryllacris cyanipes* Karny, 1926c	PHILIPPINES; Samar, Mindanao, Mt. Malindanag, Misamis Occidental	NHMW	_	_	Endemic to the Philippines; New record in Mindanao
20. *Phlebogryllacris* sp.					
21. Gryllacrididae sp. 2	----------				
22. Gryllacrididae sp. 3	----------				
Family Gryllidae Laicharting, 1781					
Subfamily Eneopterinae Saussure, 1874					
23. *Cardiodactylus* sp.	----------				
24. *Paranisitra flavofacia* Baroga-Barbecho, Yap, Tan & Robillard, 2019	INDIA; PHILIPPINES, Mindoro, Luzon, Palawan, Leyte, Siargao, Zamboanga, Misamis Oriental, Misamis Occidental	PNM; MNHM;	-	+	New locality record and the most abundant species in the area.
Subfamily Gryllinae					
25. *Mirolotmia?dinocephala* Gorochov, 2021	PAPUA NEW GUINEA PHILIPPINES, Mindanao, Mt. Malindang, Misamis Occidental	ZIRAS	_	_	First record in the Philippines
26. *Mitius* sp.	----------				
27. *Teleogryllus* sp.	----------				
28. *Loxoblemmus* sp.	----------				
29. *Duolandrevus (Bejorama) balabacus* Gorochov, 2016	PHILIPPINES; Luzon, Palawan Group of Island	ZIRAS	_	_	New locality record in Mindanao
Subfamily Itarinae					
30. *Itara mindanao* **sp. nov.** Tan, Bahoy, Grumo, & Gono, 2024	PHILIPPINES; Mindanao, Misamis Occidental	PNM; ZRC	_	_	Endemic to Mt. Malindang.
Family Gryllotalpidae					
Subfamily Gryllotalpinae					Found only in Upper Potongan
31. *Gryllotalpa* sp.	----------				
Family Oecanthidae Blanchard, 1845					
Subfamily Podoscirtinae Saussure, 1878					
32. *Varitrella (Cantotrella) fuscoirorata* Chopard, 1925	Endemic to the PHILIPPINES; Mindanao, Lanao del Norte, Iligan City; Misamis Oriental, Gingoog City; Mt. Malindang, Misamis Occidental	PHN; ZRC	_	_	Endemic to the Philippines. New distribution record
33. *Varicella* sp.	----------				
34. Aponoidini sp.	----------				
35. Phalorini sp.	----------				
Family Rhaphidophoridae Walker, 1869					
36. *Rhaphidophoridae* sp.	----------				

Legend:

PNM – Philippine National Museum

ZRC – Zoological Reference Collection, Lee Kong Chian Natural History Museum, national University of Singapore, Singapore

Table 4. Species Composition of Ensifera in each sampling site from Mt. Malindang

Taxa	Sites														Total Number of Individuals
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	
Family Tettigoniidae															
Subfamily Conocephalinae															
Anthracites zebra *	35	38	1		2						1	1	53		**131**
Anthracites sineaureus **sp. nov.***								5							**5**
Scytocera musa **sp. nov**.*													6		**6**
Euconocephalus sp.			2	3		4									**9**
Xestophrys sp.						3									**3**
Pseudorhynchus sp.								1							**1**
Conocephalus (Anisoptera) sp.			7	13	11	3		2				25	11	14	**86**
Subfamily Mecopodinae															
Tribe Mecopodini															
Mecopoda elongata							3								**3**
Mecopoda tenebrosa **			2	4		5	2	2	3			3		3	**24**
Segestes sp.							2				1		1		**4**
Rectimarginalis sp.								1							**1**
*Ducetia laniae,**				6	3	2							7	1	**19**
*Phaneroptera (Phaneroptera) neglecta**			3	4					1				8		**16**
Subfamily Pseudophyliinae															
Tribe Pseudophyllini															
Cymatomerini sp.			3												**3**
Phyllominus sp.			2												**2**
Family Gryllacrididae															
Subfamily Gryllacridinae															
Eugryllacris sp.1			3				3		4				8		**18**
Eugryllacrus sp. 2				2			3		2				4		**11**
Gryllacrididae sp.1		1													**1**
Phlebogryllacris cyanipes Karny, 1926c **												2			**2**
Phlebogryllacris sp.					2				1						**1**
Gyllacrididae sp. 2													1		
Gryllacrididae sp. 3													1		**1**
Family Gryllidae															
Subfamily Eneopterinae															
Cardiodactylus sp.		3					1						2		**2**
Paranisitra flavofacia *			38	59	52	38	19	13	28	38	18	19	189	9	**520**
Subfamily Gryllinae															
Mirolotmia?dinocephala *						5									**5**
Mitius sp.				18				12					4		**34**
Teleogryllus sp.										2			4		**6**
Loxoblemmus sp.													1		**1**
Duolandrevus (Bejorama) balabacus **													1		**1**
Subfamily Itarinae															
Itara mindanao **sp. nov.***	2	2													**4**
Family Gryllotalpidae															
Subfamily Gryllotalpinae															
Gryllotalpa sp.						1									**1**
Family Oecanthidae															
Subfamily Podoscirtinae															
Varitrella (Cantotrella) fuscoirorata *									2	2	5		5		**14**
Varicella sp.											2				**2**
Aponoidini sp.														1	**1**
Phalorini sp.									1		3				**4**
Family Rhaphidophoridae															
Rhaphidophoridae sp.													2		**2**
Total															**930**

A total of 930 individual Ensifera specimens (table 4) were recorded from 14 sampling sites in the designated field area, reflecting a relatively high level of Ensiferan biodiversity and population density within the studied habitat. The most dominant species identified was Paranisitra flavofascia Baroga – Barbecho, Yap, Tan & Robillard, 2019, which

comprised 520 individuals, accounting for approximately 41.9% of the total samples. This high relative abundance suggests that P. flavofascia is a numerically dominant species in the sampled environment. Environmental heterogeneity across the 14 study sites may also have influenced the observed distribution patterns. Several studies have demonstrated that species richness and abundance in Ensifera are closely linked to elevational gradients, vegetation complexity, and anthropogenic disturbance (Ingrisch & Rentz, 2009; Naskrecki, 2000). In contrast, collection of only a single specimen each from the following Ensiferan genera and species—Pseudorhynchus sp., Rectimarginalis sp., Phlebogryllacris sp., Gryllacrididae sp. 3, Loxoblemmus sp., Duolandrevus (Bejorama) balabacus Gorochov, 2016, and Aponoidini sp.—indicates a low relative abundance and potentially limited distribution within the sampled sites. This singleton - species condition is common to insect surveys, especially in diverse tropical habitats, and this can be attributed to cryptic behavior, seasonality and phenology, acoustics specificity and low calling activity and microhabitat specialization (Tan et al., 2015; Robillard & Desutter-Grandcolas, 2004; Cadena-Castañeda, 2015). Moreover, out of 36 species compositions in the area, 26% are endemic to Mindanao. This endemism rate carries significant ecological implications, suggesting that Ensifera species in the region are a biogeographic hotspot due to their unique faunal assemblages (Baroga-Barbecho et al., 2019; Bahoy et al., 2024). Endemic Ensifera species often have restricted ranges, specialized habitat needs, and low dispersal capacity. With deforestation, habitat fragmentation, and climate change accelerating in Mindanao, endemic Ensifera are at high risk of extinction (Tan et al., 2023). The 25% endemism rate may be an underestimation due to incomplete sampling in the areas. Recent surveys (Tan et al., 2023; Bahoy et al., 2024) indicate that new Ensifera species continue to be discovered with each focused expedition in unexplored habitats.

Discussion

In a recent Ensifera faunal survey conducted in the Mt. Malindang Range Natural Park (MMRNP), the study recorded six families, 11 subfamilies, 28 genera, and 36 species. The distribution of Ensifera species recorded in Mt. Malindang is emphasized in table 1. Generally, the species were collected at varying elevational concentrations ranging from 275 masl – 1632 masl. The lowest

point of collection was in Brgy. Roxas, Aloran (275.6 masl) while the highest point was in Brgy. Lake Duminagat, Don Victoriano (1632 masl). Itara mindanao (Tan et al., 2024) was the first new Ensifera species (Fig. 31) ever recorded in Mt. Malindang and fairly, the first attempt to have conducted fieldworks in the area. It was highly noted during the fieldworks that specific Ensifera species occupy specific elevational gradient. For instance, Mecopoda elongata (Linneaus, 1758), Mecopoda tenebrosa (Walker 1869), Ducetia laniae, (Salvador et al., 2023), and Varitrella (Cantotrella) fuscoirorata (Chopard, 1925; Tan et al., 2023) were found at lower elevations ranging from 275 masl to 500 masl. Habitats in these sites were generally slashed and occupied with households with only few vegetations available. Meanwhile, the species recorded at the highest elevation where most habitat types are characterized by montane forests and canopy covers were the Anthracites zebra (Hebard, 1902), Cardiodactylus sp., and Itara mindanao (Tan et al., 2024) which were found at 1632 masl. Sammeta et al. (2020) documented Orthopteran diversity from Himalayas (including Ensifera) and found that certain Ensiferan taxa are elevation-restricted, while others show wide and complex elevational ranges due to physiological and ecological adaptability. Paranisitra flavofacia (Baroga – Barbecho et al. 2019) was recorded to dominate (Fig. 25) in various elevations ranging from <200 masl - <700 m.a.s.l. with a total of 520 recorded individuals. P. flavofacia, like other members of the genus, are believed to inhabit tropical montane forests, particularly in areas with dense vegetation and high canopy cover as to better perform their camouflage characteristics. This species was also considered as the most abundant in terms of population density in Mt. Malindang due to the high environmental and ecological conditions of the areas. It was also considered as the widely distributed species across all sampling sites which was present in 12 out of 14 selected sites within Mt. Malindang. Apparently, Anthracites zebra (Hebard, 1922) (black species) found in Brgy. Hoyohoy was the second most abundant taxa (Fig. 3D) which was recorded only in this Brgy. This species was first discovered by Hebard (1922) in Mt. Apo, North Cotabato and was studied by Ingrisch in 2015 from the rivers of Clarin in Misamis Occidental and was found by Bahoy et al. (2024) in Brgy. Lake Duminagat, Don Victoriano, thus, this distribution pattern suggests that the species is highly adaptive to its surrounding environments.

Interestingly, *A. zebra* exhibited notable intraspecific color variation across sites and elevations, which may be adaptive in nature. Specimens from Brgy. Lake Duminagat (1632 masl) and Brgy. Liboron (1558.7 masl) showed light coloration (*A. zebra sensu* Bahoy et al., 2024), while those from Brgy. Penacio, Clarin (856.9 masl) displayed a combination of red brown and black (*A. zebra sensu* Ingrisch, 2015). Two darker forms were recorded from Brgy. Small Potongan (845.1 masl) and Brgy. Hoyohoy (778.7 masl), respectively, with the latter exhibiting an orange body with a darker overlay. These color morphs may reflect phenotypic adaptations to local microclimatic or predation pressures and may relate to **thermoregulation, camouflage,** or **sexual selection** in different habitats. Another unique distribution characteristic observed among different Ensirferan species from Mt. Malindang were the *Scytocera musa* **sp. nov.** (Tan & Rivera, 2025) and the *Mirolotmia? dinocephala* (Gorochov, 2021) due to their presence in only one specific sampling site. S. musa was recorded exclusively in Brgy. Hoyohoy, Tangub City which is located at the south peak areas of Mt. Malindang. This new species represents a new member of Scytocera which are endemic to Mindanao Island. The genus Scytocera is widely distributed in Mindanao regions including Zamboanga del Sur *(Scytocera zamboangae* Hebard, 1922), Jolo, Sulu (*Scytocera niger* Redtenbacher, 1891) and in Mindanao region *(Scytocera (Scytocera) longicornis* Redtenbacher, 1891). Meanwhile, M? *denocephala* was found exclusively in Brgy. Upper Potongan, Conception which uniquely burrows under the clay soil near Mt. Balabag in the western portion of Mt. Malindang. This species was the first taxon to be described under genus *Mirolotmia* originally discovered by Gorochov (2021) from *West* Papua and now considered as first record in the Philippines and first outside New Guinea. Its discovery in Mt. Malindang has significant biogeographic implications, possibly hinting at historical dispersal events or relict populations.

CONCLUSION AND RECOMMENDATION

This pioneering survey of Ensifera species in Mt. Malindang has revealed a rich and ecologically structured assemblage, emphasizing the park's importance as a conservation area and a reservoir of endemic biodiversity. The results highlight not only the diversity and elevational specialization of Ensiferan fauna but also the existence of previously unrecorded and potentially

endemic taxa. The pronounced elevational partitioning, abundance of dominant species like *Paranisitra flavofacia,* and the discovery of new or geographically significant species (Anthracites sineaureus sp. nov. and *Scytocera musa* **sp. nov.**) reinforce the need for continued research and protection of Mt. Malindang's montane ecosystems.

The study highlights the underappreciated status of Ensifera in Mt. Malindang, evidenced by the numerous new locality records and the identification of two previously unknown species. These results emphasize the need for continued and thorough exploration of Ensifera species in the area, expanding on sampling efforts that have been ongoing since 1959. It is suggested that more fieldwork expeditions be conducted around Mt. Malindang, especially in areas not covered by this study to potentially uncover new species of Ensifera, thereby, adding to the existing body of science.

Continued efforts of collaborations among local indigenous communities (Subanen) and the protected area management board (PAMB) is seen as a vital strategy in safeguarding endemic Ensifera species in Mindanao, particularly in biologically rich yet ecologically vulnerable areas such as the Mount Malindang Range Natural Park. Nonetheless, the lack of molecular data limits a full understanding of their genetic composition and evolutionary connections hindering efforts to accurately resolve phylogenetic relationships, assess cryptic diversity, and implement informed conservation strategies. This will in turn help broader our understanding on Ensifera taxonomy and its importance in our ecosystem.

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