

Diversity of Weevils (Coleoptera) in Marahan, Marilog Forest Reserve, Southern Mindanao, Philippines

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Article history:

Submission May 2020

Revised July 2020

Accepted September 2020

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ABSTRACT

Fieldworks were conducted last January to March, 2019 to collect and record species of weevils at Sitio Matigsalug, Marahan, Marilog Forest Reserve, Marilog District, Mindanao, Philippines. Standard sampling techniques such as belt transect and opportunistic sampling were conducted in the established 2 kilometers transect to survey the agroforest and montane ecosystems with elevations of 800-950 masl and 1,000-1,300 masl, respectively. A total of 228 individuals belonging to 2 families and 22 species of weevils were recorded, all of which are only known from forest and mountain ecosystems of Mindanao. *Metapocyrtus* is the most encountered genus with 12 species. The montane forest had higher species richness with 15 species but with lower species abundance of 34 individuals compared to the agroforest ecosystem with 13 species and 194 individuals. Seven (7) species are common in both sites. Plant associates and behavior of the observed weevils were also noted which include 22 species of ferns and flowering plants. Other than perching behavior, species are also observed copulating, feeding and mostly hiding in abaxial part of leaves. As flightless beetles with high vulnerability for predation by other insectivorous species, the observations gathered will help in understanding their behaviors for survival. Despite of high species richness and abundance, anthropogenic disturbances such as agricultural activities are on-going which extend towards the montane forest in the area. Conservation initiatives must be implemented to protect the remaining endemic and rare species of flora and fauna.

Keywords: Endemic, Marilog District, *Metapocyrtus*, Montane forest, *Pachyrhynchus*

Introduction

The Philippines is considered one of the mega diverse tropical countries due to its very high endemism and richness of flora and fauna [1]. Some of which are the interesting group of insects called weevils. They are group of beetles with an estimated endemism of more than 90% and with a Philippine centered distribution [2, 3]. Currently, there are more than 51,000 species of weevils in 4,600 genera in which Philippines contributes more than 400 species [4]. Discoveries on new species of Philippine weevils was prominently conducted by taxonomists from other countries [5, 6, 7, 8, 9] but recently more dis-

coveries were published by Filipino taxonomists and systematists specifically from the genera *Pachyrhynchus* and *Metapocyrtus* [9, 10, 11].

At present, over 100 species of weevils from the genus *Pachyrhynchus* Germar and over 200 from the genus *Metapocyrtus* Heller were recorded in the Philippines [6, 13]. Inventory and diversity studies of weevils were conducted in some parts of Mindanao [13, 14, 15]. These studies showcased different endemic and rare species of weevils. These studies implied that weevils are highly restricted in a specific area which supports their high endemism. Ecological aspects of these

How to cite:

Mohagan AB, Patano Jr. RR, Melencion MG et al. (2020) Diversity of Weevils (Coleoptera) in Marahan, Marilog Forest Reserve, Southern Mindanao, Philippines. Journal of Tropical Life Science 10 (3): 259 – 270. doi: 10.11594/jtls.10.03.10.

species are still poorly understood. Plant associates of Mindanao weevils were first studied by Ballentes *et al.* (2006) but the behaviors of those were not elaborated. Although studies had been already conducted when it comes to their diversity and distribution, there are still remote and inaccessible areas including Sitio Matigsalug that houses undocumented species.

Thus, this study was done to provide the species composition, diversity, plant associates and common behaviors of weevils in Sitio Matigsalug, Marahan, Marilog Forest Reserve, Marilog District, Southern Philippines.

Material and Methods

Sampling sites

Sitio Matigsalug, Marilog District was surveyed from January to March 2019, primarily its agroforest and montane forest ecosystems (Figure 1). This area was surveyed due to its intact forest and vegetation. There are no recent published data in these unexplored areas because of its inaccessibility. Disturbances in the area were observed such as agricultural activities and clearing of land area for housing purposes. Sitio Matigsalug is at the eastern side of Marilog District

which is about 8-10 kilometers away from the main road (7°26'13.22"N, 125°15'50.42"E). The area is composed of 7 distinct ridges which are considered as montane forest surrounded by agroforest ecosystem due to shifting cultivation of farm crops such as *Sechium edule* L., *Basella alba* (Jacq.) Swartz and *Zea mays* L. by the indigenous people.

The area is dominated by tall trees of *Lithocarpus* spp. and the invasive shrub *Piper aduncum* L. The understory plants are primarily dominated by ferns such as *Dicranopteris linearis* (Burm.f.) Underw. and aroids such as *Alocasia* spp. Leaf litter was not so thick. The area surveyed has an altitudinal range of 800-1,300 m.a.s.l (Figure 2).

Collection of weevils

The standard belt-transect sampling method [16] with combination of random and opportunistic sampling was employed in the study. The collection of weevils was conducted along the transect covering 10 meters (5 meters on both sides). Specimens were collected through handpicked whenever encountered during the diurnal (0700-1500) and nocturnal (1700-2200) searches and

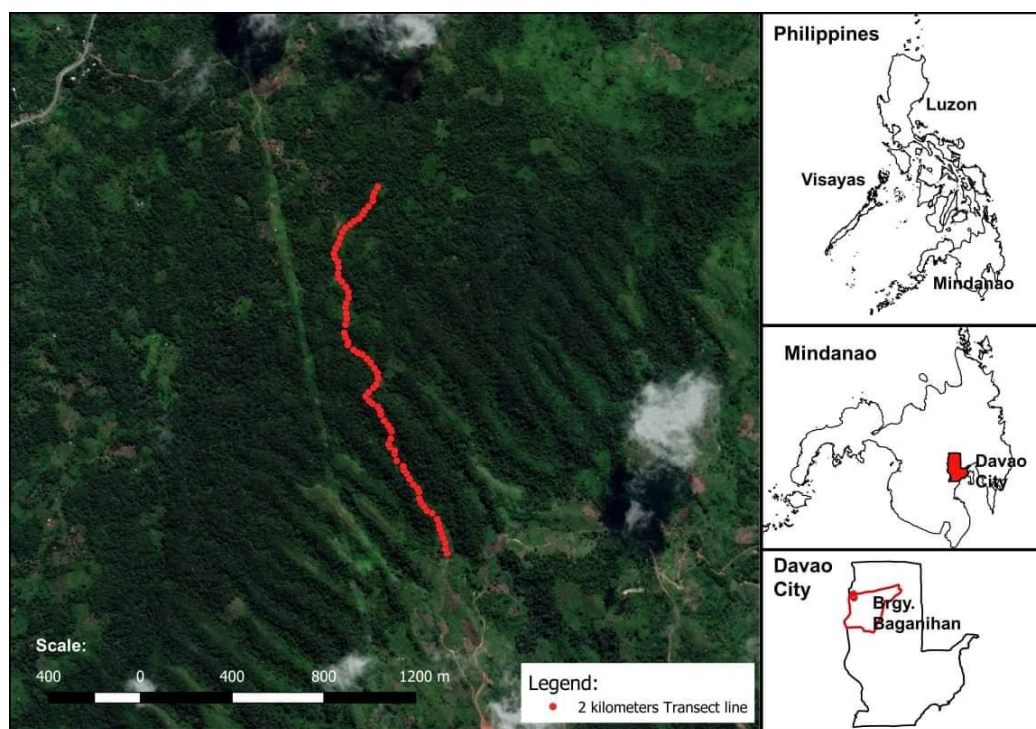


Figure 1. Map of the Philippines, Mindanao and Davao City showing the location of the study site and the 2 kilometers transect (red points) in Sitio Matigsalug, Marahan, Marilog Forest Reserve, Marilog District (7°26'13.22"N, 125°15'50.42"E, 800-1,300 m.a.s.l.)

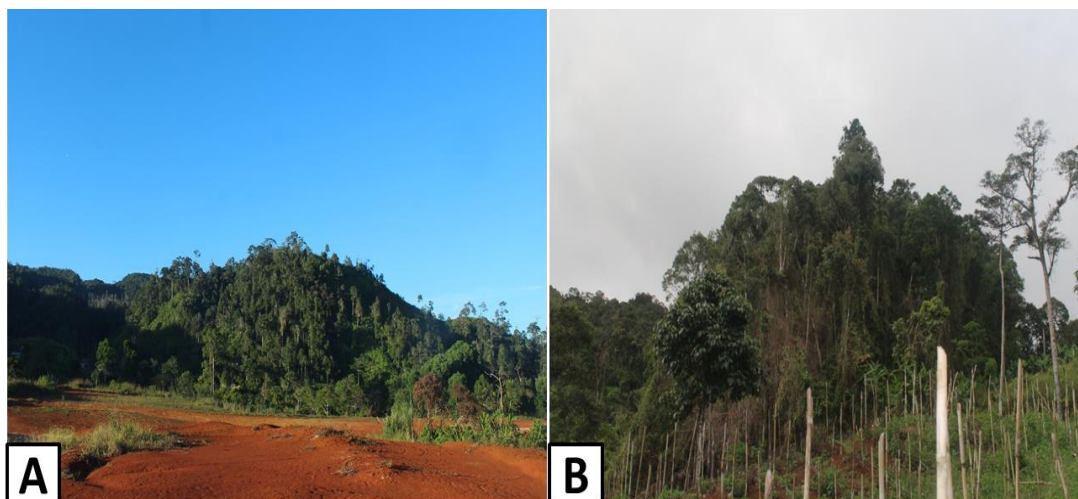


Figure 2. Forest patches in Sitio Matigsalug, Marahan Proper, Marilog District, Davao City (A and B)

placed in modified jars with ethyl acetate. Collected specimens were then preserved in 95% ethyl alcohol and brought to the laboratory, air-dried and photographed under a stereomicroscope. A maximum of 3 individuals per species was collected in accordance to the Gratuitous Permit issued by the DENR.

Composition, relative abundance, plant associates and ecological notes

Other important data such as relative abundance and plant associates of weevil species were recorded. Relative abundance of each species is presented as percentage. The values were taken by dividing the number of individuals per species to the total number of individuals observed for all species then multiplied by 100. Plant associates of each species were photographed and identified by a plant taxonomist (FPC; one of the authors). Notable behaviors and activities of each species were also observed and noted.

Identification and Diversity analysis

Published articles, taxonomic keys and monographs of Schultze (1923), Yoshitake (2012b) and Rukmane and Barsevskis (2016) were used for the identification of the collected and observed specimens. Bio Pro software version 2.0 was used in producing Shannon-weiner diversity indices of the agroforest and montane forest ecosystems.

Results and Discussions

Species Richness and Abundance

The faunistic inventory of weevils revealed a

total of 228 observed and collected individuals comprising 22 species and six (6) genera from the agroforest and montane forest of Sitio Matigsalug, Marilog Forest Reserve. Three (3) species belong to the genus *Pachyrhynchus*, twelve (12) species of *Metapocyrtus*, four (4) species belongs to the genus *Alcidodes* and one (1) species from each genera *Desmidophorus*, *Peribleptus* and *Polycatus*. All of the species belong to the family Curculionidae except for the species *Desmidophorus* sp. from the family Brachyceridae (Table 1 and 2).

The genus *Metapocyrtus* Heller had the highest species abundance comprising 185 individuals followed by genus *Alcidodes* Marshall with 12 individuals, genus *Polycatus* Heller with 18 individuals, genus *Pachyrhynchus* Germar with six individuals, genus *Desmidophorus* Dejean with four individuals and lastly, the genus *Peribleptus* Schoenherr with only three individuals. Species richness revealed that the montane forest had the higher number of species (15 spp.) compared to agroforest ecosystem (13 spp.) which is mostly dominated by the genus *Metapocyrtus* while the species abundance revealed that the agroforest ecosystem had the higher number of individuals (194) compared to montane forest (34 individuals) (Figure 3). Genus *Alcidodes* comprising four morpho-species are just observed in montane forest with a total of 12 individuals in which *Alcidodes* sp.3 is the most common species with five (5) individuals. These species can be considered as specific on its habitat as this are recorded only in montane forest. *Desmidophorus* sp. is the only one species from the family Brachyceridae which

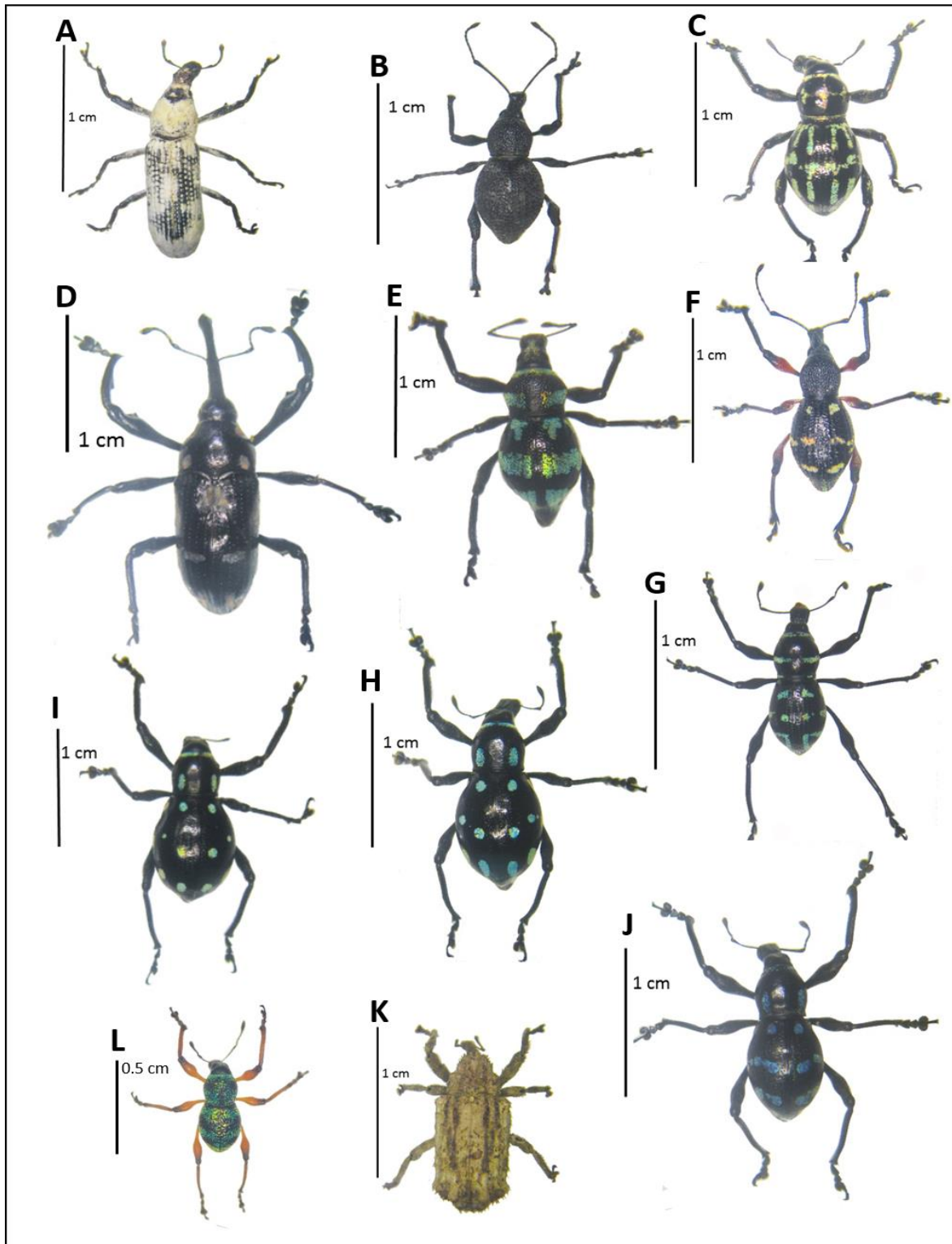


Figure 3. Collected specimens in Sitio Matigsalug, Marahan, Marilog Forest Reserve, Marilog District, Davao City, Mindanao, Philippines. A. *Peribleptus* sp.; B. *Polycatus* sp.; C. *Metapocyrtus kitangladensis*; D. *Alcidodes* sp.4; E. *Metapocyrtus* sp.3; F. *Metapocyrtus* sp.4; G. *Metapocyrtus* sp.5; H. *Metapocyrtus* sp.6; I. *Metapocyrtus* sp.7; J. *Metapocyrtus* sp.8; K. *Desmidophorus* sp. and L. *Metapocyrtus apoensis*

are morphologically unique due to its oval shape body almost covered with scales with geniculate antennae [19]. Four individuals of this species are only observed in agroforest.

Metapocyrtus is the most common genus both in agroforest and montane ecosystem with a total of twelve species in which 8 are morpho-species. All known *Metapocyrtus* species are endemic in the Philippines. Eleven species are observed in agroforest ecosystem while only 7 species are observed in montane forest ecosystem. According to Cabras *et al.* (2017), *Metapocyrtus* species have high adaptability to environmental changes and with no specific food preference which enable these species to survive to wide ranges of habitat types especially in lower elevation. This explains why more *Metapocyrtus* species are recorded in agroforest compared to montane forest ecosystem.

There are only 3 *Pachyrhynchus* species observed in the study all from montane forest ecosystem as these species are observed only in specific habitat with higher elevation. There are 2 known species namely, *P. miltoni* and *P. erichsoni*, and only 1 morpho-species recorded which reflects to the rarity of the species belonging to the genus. There are more than a hundred of described species of *Pachyrhynchus* endemic to the Philippines as there are recently described new species endemic in Mindanao.

Polycatus sp. is another common species observed only in agroforest ecosystem with a total of 18 observed and collected individuals. Lastly, the genus *Peribleptus* which was observed only in montane forest with only 3 individuals. These genera formulated and described by Heller (1922) are those undocumented and not well studied species in the archipelago. Thus, the present study provides new locality record of these genera.

In comparison to the number of species belonging to family Curculionidae documented from the neighboring mountain and forest ecosystems, the present study provides higher species richness compared to Mt. Kiamo (20) but with a lower number of species compared to its nearby forest ecosystem in Baganihan (23) with 2 shared species (*P. miltoni* and *M. apoensis*) and Mt. Malindang (31). However, the study had same number of species with Mt. Apo (21) in which 2 same species (*P. erichsoni* and *M. apo-*

ensis) is also recorded in the area.

Diversity

Species accumulation curve showed that only agroforest ecosystem reached asymptote which indicates that all of the species are well represented and there are still species that were not documented in the montane forest ecosystem. Diversity assessment revealed that montane forest had higher diversity index with $H = 1.12$ compared to agroforest ecosystem (Table 2). This is more likely due to availability food and microhabitat present in the montane forest, while anthropogenic disturbances are very common in agroforest ecosystem. The small difference in the indices across sites might due to *Metapocyrtus* spp. enables to dwell to the wide range of environments and also to the availability of food in the agroforest ecosystem. Nine (9) unique species are just recorded in montane forest ecosystem. This implies that these species inhabits montane forest, more likely primary or secondary montane forest, and won't able to survive in an agroforest ecosystem.

New records

The new recorded species in Marilog Forest Reserve Species include *Pachyrhynchus erichsoni* G.R. Waterhouse, *M. geniculatus* G.R. Waterhouse, *M. kitangladensis* Cabras et al. and *M. ruficollis* G.R. Waterhouse. *Pachyrhynchus miltoni* Cabras and Rukmane was recently discovered and recorded from the nearby localities which reflect the site endemism of the species [16]. Ballentes et al. (2006) reported two species of *Alcidodes* spp. from the montane forest of Mt. Malindang which are unique morphologically to the four morpho-species recorded in this study. The present study documented 16 morpho-species which are unique in comparison to the species recorded from nearby locality [16]. These species are potential new to science. If proven, it could add to the hundred described species of *Pachyrhynchus*, *Metapocyrtus*, *Desmidophorus*, *Polycatus* and *Peribleptus* that are endemic in the archipelago.

Plant Associates and Behavior

A total of 22 species of plant associates are recorded. These include seven (7) species of ferns and 15 species of flowering plants (Table

Table 1. Species richness and abundance of Weevils in Sitio Matigsalug, Marahan, Marilog Forest Reserve, Marilog District, Davao City, Mindanao, Philippines

No.	Species	Agroforest Ecosystem	Montane Forest Ecosystem
1	<i>Alcidodes</i> sp.1		3
2	<i>Alcidodes</i> sp.2		2
3	<i>Alcidodes</i> sp.3		5
4	<i>Alcidodes</i> sp.4		2
5	<i>Desmidophorus</i> sp.	4	
6	<i>Metapocrytus apoensis</i> Schultze, 1925	18	
7	<i>Metapocrytus geniculatus</i> G.R. Waterhouse, 1842	22	3
8	<i>Metapocrytus kitangladensis</i> Cabras et al. 2019		4
9	<i>Metapocrytus ruficollis</i> G.R. Waterhouse 1842	17	
10	<i>Metapocrytus</i> sp. 1	15	
11	<i>Metapocrytus</i> sp. 2	13	1
12	<i>Metapocrytus</i> sp. 3	28	
13	<i>Metapocrytus</i> sp. 4	21	1
14	<i>Metapocrytus</i> sp. 5	5	1
15	<i>Metapocrytus</i> sp. 6	8	2
16	<i>Metapocrytus</i> sp. 7	15	1
17	<i>Metapocrytus</i> sp. 8	10	
18	<i>Pachyrhynchus erichsoni</i> G.R. Waterhouse 1842		3
19	<i>Pachyrhynchus miltoni</i> Cabras & Rukmane, 2016		2
20	<i>Pachyrhynchus</i> sp.1		1
21	<i>Peribleptus</i> sp.		3
22	<i>Polycatus</i> sp.	18	

Table 2. Diversity indices of agroforest and montane forest ecosystem in Sitio Matigsalug, Marahan, Marilog Forest Reserve, Marilog District, Davao City, Mindanao, Philippines

Indices	Agroforest Ecosystem	Montane Forest Ecosystem
Species abundance	194	34
Species Richness	13	15
Number of endemic species	13	15
Shannon-weiner diversity index	1.07	1.12

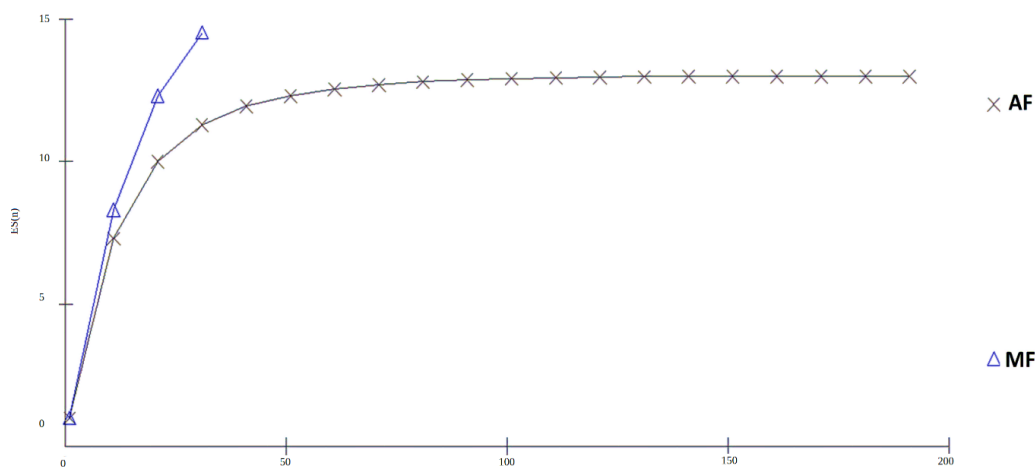


Figure 4. Species Accumulation Curve for agroforest (AF) and montane (MF) forests in Sitio Matigsalug, Marahan, Marilog District, Davao City, Mindanao

3). *Piper aduncum* L. or locally known as *Buyo-buyo*, an invasive alien species, is the most common plant associate. Eleven (11) species of weevils, all from genus *Metapocyrtus*, are observed in the plant which is mostly observed hiding in abaxial part of leaves (Figure 5 and 6). Reports have already proven that species belong to the genus are abundant especially in the lower elevation with intruding agricultural and invasive alien species such as *Lantana camara* L. and *Impatiens balsamina* Elm. Most of them are found feeding on these plants [15].

Some species of weevils in the agroforest are observed in the cultivated crop plants (e.g., *Secchium edule* (Jacq.) Swartz and *Basella alba* L.) of

the local people. These include 7 species of *Metapocyrtus* and *Polycatus* sp. Findings have already reported that some *Metapocyrtus* species are pest to some crops and ornamental plants especially in lowland ecosystems [9]. Species mostly from the genus *Metapocyrtus* observed feeding on agricultural crops in lower elevations as these areas are used to be an intact forest converted to agricultural lands.

Nine (9) species of weevils are perching on ferns mostly on *Dicranopteris linearis* (Burm.f.) Underw., locally known as *Agsam*, which is common in the area widely used for handicraft making by the indigenous people. Most of the species observed are on top of leaves and some

Table 3. Associated plants and observed activities of weevils from Sitio Matigsalug, Marahan, Marilog Forest Reserve, Marilog District, Davao City, Mindanao, Philippines

Species	Relative Abundance (%)	Associated Plants	Activities
<i>Alcidodes</i> sp.1	1.32	<i>Christella parasitica</i> (L.) H. Lev. <i>Cyclosorus</i> sp.	Atop frond, Perched on leaf axil, possibly feeding, partially hidden between fronds, atop stipe, atop twig of dried plant
<i>Alcidodes</i> sp.2	0.88	<i>Christella parasitica</i> (L.) H. Lev.	Atop frond, atop stipe
<i>Alcidodes</i> sp.3	2.19	<i>Medinilla</i> sp. <i>Begonia</i> sp.	Atop leaf
<i>Alcidodes</i> sp.4	0.88	<i>Medinilla</i> sp.	Atop leaf
<i>Desmidophorus</i> sp.	1.75	<i>Sphaerostephanos</i> sp.	Atop frond
<i>Metapocyrtus apoensis</i> Schultze, 1925	7.89	<i>Mangifera</i> sp. <i>Piper aduncum</i> L. Zingiberaceae <i>Costus</i> sp.	Partially hidden on abaxial part of the leaf, atop frond and copulating
<i>Metapocyrtus geniculatus</i> G.R.Waterhouse, 1842	10.96	<i>Piper aduncum</i> L. <i>Christella parasitica</i> (L.) H. Lev.	Atop leaf, atop frond and copulating
<i>Metapocyrtus kitangladensis</i> Cabras et al. 2019	1.75	<i>Piper aduncum</i> L. <i>Impatiens balsamina</i> Elm. Zingiberaceae	Atop leaf
<i>Metapocyrtus ruficollis</i> G.R.Waterhouse 1842	7.46	<i>Dicranopteris linearis</i> (Burm.f.) Underw. <i>Piper aduncum</i> L. <i>Bambusa</i> sp.	Atop frond and copulating
<i>Metapocrytus</i> sp. 1	6.58	<i>Piper aduncum</i> L. <i>Bambusa</i> sp. <i>Alocasia</i> sp. <i>Musa paradisiaca</i> L.	Atop leaf

Continue...

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Species	Relative Abundance (%)	Associated Plants	Activities
		<i>Sechium edule</i> (Jacq.) Swartz	
<i>Metapocrytus</i> sp. 2	6.14	<i>Piper aduncum</i> L. <i>Impatiens balsamina</i> Elm. <i>Basella alba</i> L.	Atop leaf, atop frond and copulating
<i>Metapocrytus</i> sp. 3	12.28	<i>Piper aduncum</i> L. <i>Medinilla</i> spp. <i>Schefflera</i> sp. <i>Sechium edule</i> (Jacq.) Swartz	Partially hidden on abaxial part of the leaf
<i>Metapocrytus</i> sp. 4	9.65	<i>Piper aduncum</i> L. <i>Impatiens balsamina</i> Elm.	Atop twig of dried plant, atop leaf
<i>Metapocrytus</i> sp. 5	2.63	<i>Piper aduncum</i> L. <i>Nephrolepis bisserata</i> (Sw.) Schott <i>Sechium edule</i> (Jacq.) Swartz	Atop leaf
<i>Metapocrytus</i> sp. 6	4.38	<i>Piper aduncum</i> L. <i>Rubus</i> sp. <i>Amyema</i> sp.	Atop frond and copulating
<i>Metapocrytus</i> sp. 7	7.02	<i>Piper aduncum</i> L. Zingiberaceae <i>Dicranopteris linearis</i> (Burm.f.) Underw. <i>Sechium edule</i> (Jacq.) Swartz	Atop leaf
<i>Metapocrytus</i> sp. 8	4.39	<i>Piper aduncum</i> L. <i>Angiopteris</i> sp. <i>Tridax procumbens</i> <i>Sechium edule</i> (Jacq.) Swartz	Partially hidden on abaxial part of the leaf
<i>Pachyrhynchus erichsoni</i> G.R. Waterhouse 1842	1.32	Shrub	Atop leaf
<i>Pachyrhynchus miltoni</i> Cabras & Rukmane, 2016	0.88	<i>Dicranopteris linearis</i> (Burm.f.) Underw.	Atop stipe
<i>Pachyrhynchus</i> sp.1	0.44	<i>Asplenium nidus</i> L.	Atop leaf with a fungus attached on its hind tarsus
<i>Peribleptus</i> sp.	1.32	Poaceae <i>Artocarpus</i> sp.	Perching on a branch and some on top of leaves
<i>Polycatus</i> sp.	7.89	Shrub <i>Basella alba</i> L.	Partially hidden on abaxial part of the leaf

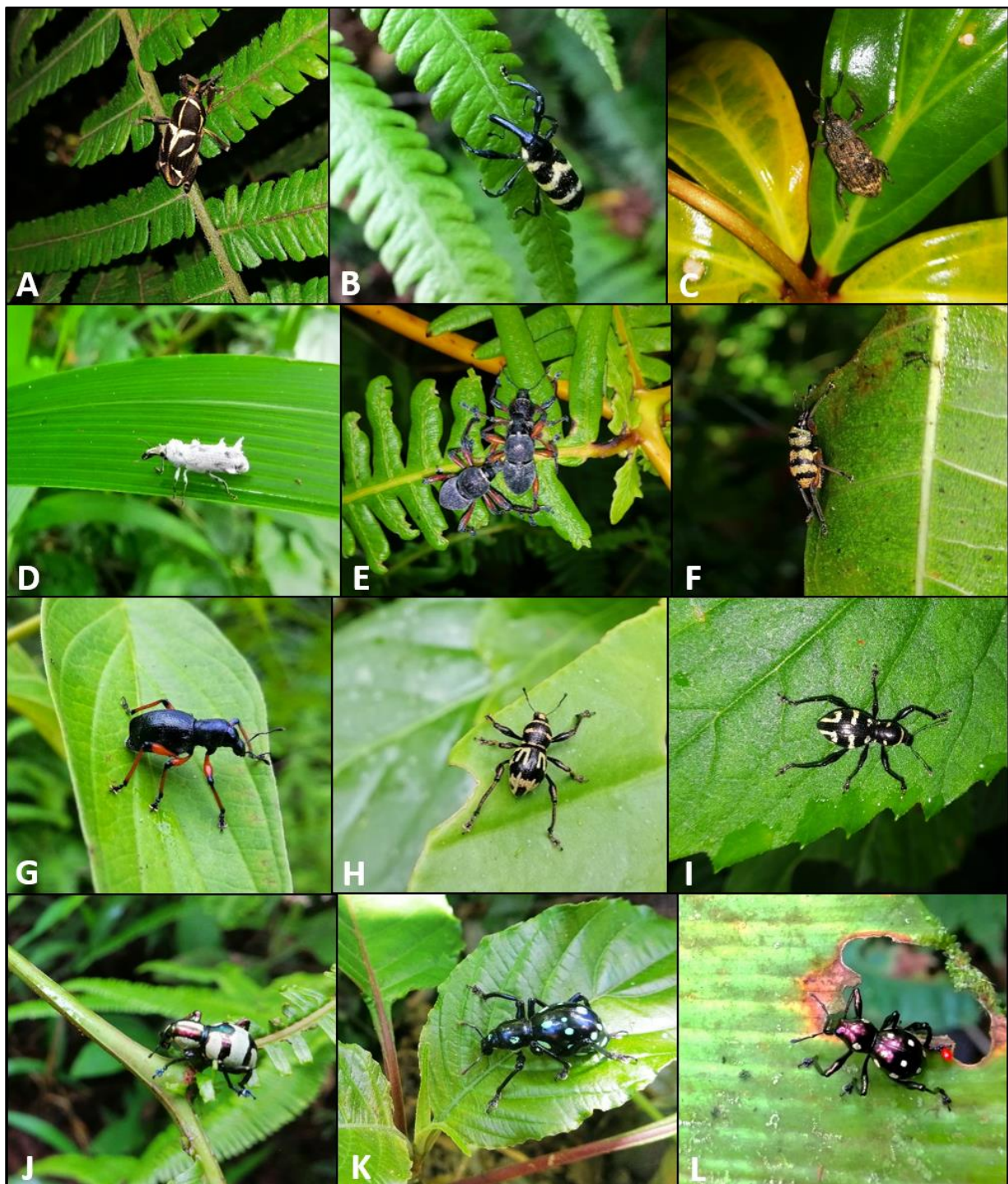


Figure 5. Some species of weevils in Sitio Matigsalug, Marilog Forest Reserve, Marilog District, Davao City, Mindanao, Philippines. A. *Alcidodes* sp. 1; B. *Alcidodes* sp. 2; C. *Alcidodes* sp. 3; D. *Peribleptus* sp.; E. *Metapocyrtus ruficollis*; F. *Metapocyrtus apoensis*; G. *Metapocyrtus geniculatus*; H. *Metapocyrtus* sp.1; I. *Metapocyrtus* sp.2; J. *Pachyrhynchus miltoni*; K. *Pachyrhynchus erichsoni* and L. *Pachyrhynchus* sp.

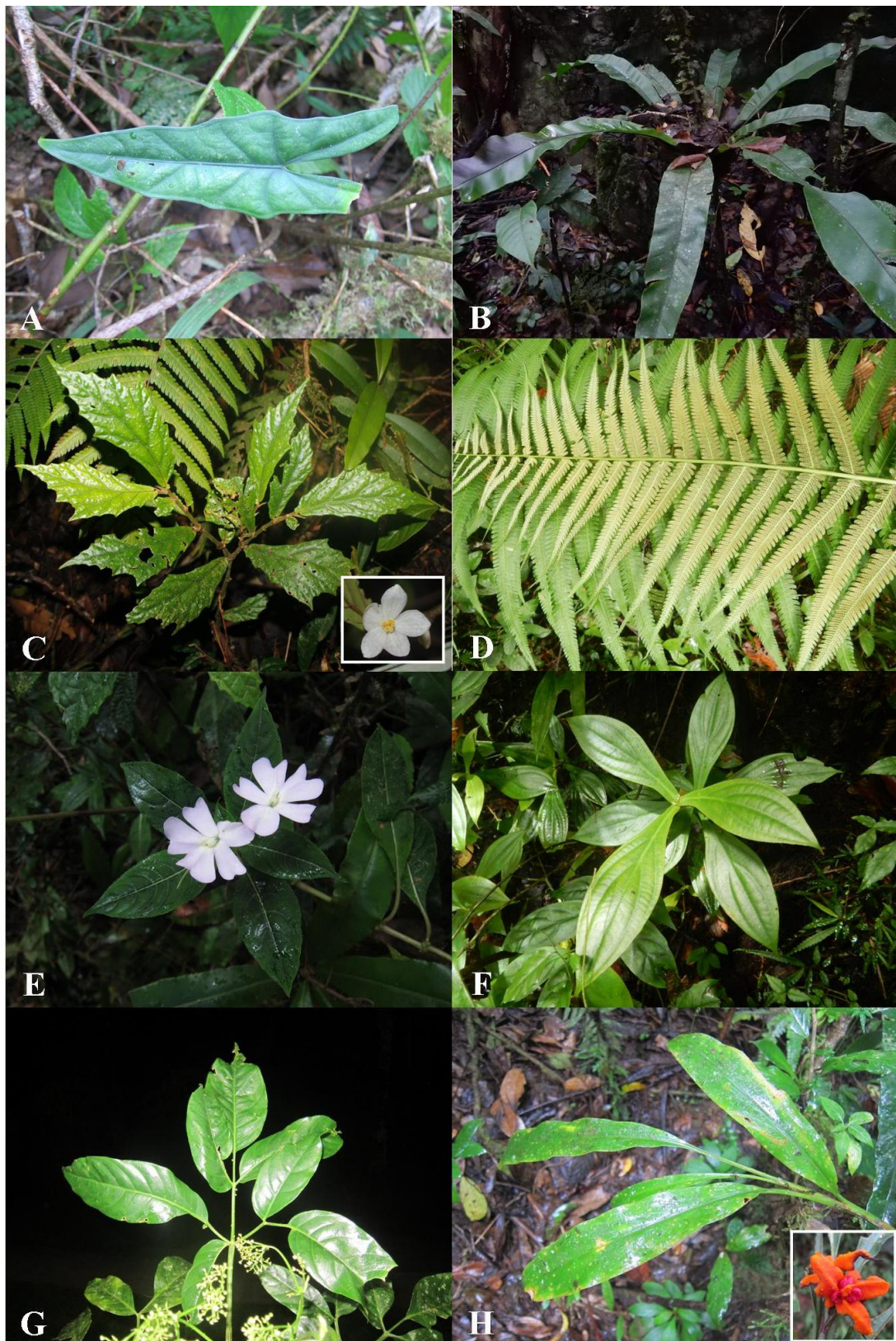


Figure 6. Some plant associates of weevils from Sitio Matigsalug, Marahan, Marilog Forest Reserve, Marilog District, Davao City, Mindanao, Philippines. A. *Alocasia* sp.; B. *Asplenium nidus* L.; C. *Begonia* sp.; D. *Cyclosorus* sp.; E. *Impatiens balsamina* Elm.; F. *Medinilla* sp.; G. *Schefflera* sp. and H. *Zingiberaceae*.

are partially on the abaxial while others are on the branch. Although *Pachyrhynchus* species are not observed in agroforest ecosystem, there are reports shows that they are infesting fruit trees [18]. There are 5 species observed copulating mostly on top of leaves. All of which are from genus *Metapocyrtus* which observed mostly in agroforest ecosystem. This observation explains the big difference in species abundance of the genus between the agroforest and montane forest ecosystems.

Conclusion

Study revealed high species abundance and richness both in agroforest and montane forest of Sitio Matigsalug, Marahan with a total of 228 individuals distributed to 22 species and six genera. *Alcidodes*, *Pachyrhynchus*, *Peribleptus* and some *Metapocyrtus* preferred montane forest habitat while *Desmidophorus*, *Polycatus* and most of *Metapocyrtus* explored the agroforest ecosystem. Most of the species are also unique which implies the site endemicity and restricted distribution in the area. Weevils also vary when it comes to their plant associates with a total of 22 species. Most of the observed weevils were hiding in leaves while some are observed copulating and possibly feeding. These species of plants and vegetation as a whole has a vital role in the survival of not just weevils but also other group of fauna in the area. Anthropogenic disturbances specifically agricultural activities and clearing of forest area must be minimized. Protection and conservation initiatives are highly recommended to save the remaining flora and fauna in Sitio Matigsalug, Marahan, Marilog District.

Acknowledgment

The authors would like express gratitude to the DARE TO (Discovery-Applied Research and Extension for Trans/Interdisciplinary Opportunities) program entitled Saving Terrestrial Biodiversity: inventory, Assessment, Conservation and Capability Building in Marilog Forest Reserve, Southern Mindanao, Philippines of the Commission on Higher Education (CHED) for funding this research; to the MAMATRIPCEDI (Matigsalug-Manobo Tribal People Council of Elders Davao Inc.) and to the local researchers of Marilog District, Davao City, Southern Mindanao. The Department of Environment and Natural Re-

sources Region XI for the Gratuitous Permit (GP). We would like also to thank our University President Dr. Jesus Antonio G. Derije for his help in implementing our research project.

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