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Diversity and Assessment of Butterflies in Marilog District, Davao City, Philippines

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ABSTRACT

Butterflies are important biological and ecological indicators of a healthy environment. They also play a vital role in the pollination of many economically important farm crops and forest trees. The study provided a checklist of butterflies in Marilog District, its diversity and ecological and local status. A combination of belt transect and opportunistic sampling were employed in four different sites of Marilog District, which includes two forest ecosystems and two mountain ecosystems from the months of March 2018 to November 2018. A total of 61 species of butterflies belonging to five families and 39 genera with a total of 497 individuals were recorded. Species diversity across four sites revealed that site one (H'=1.47) had the highest species diversity, followed by site two (H'=1.35), site four (H'=1.254), and site three (H'=0.932), which had the lowest value. For endemism, site one had the highest number of endemic species (17) followed by site four (10 species), site two (nine species) and site three (five species). This data is important as it is a benchmark information on the diversity of butterflies in the area that documented endemic and rare species as a good basis for the protection and conservation of the remaining forested areas in Marilog District.

Keywords: Biodiversity, Lepidoptera, ecological status, local status, species richness

INTRODUCTION

Butterflies, taxonomically known from order Lepidoptera, are important arthropods due to their significant role as pollinators and biological indicators (Mihoci et al., 2011; and Bonebrake et al., 2010). They have ecological functions as biomass indicator and agent in controlling weeds (Mohagan et al., 2011; Treadaway, 1995). They are also considered as good genetic sources for gene diversity or indicator component of a natural environment or rich forest ecosystem (Cheng, 1993). They are sensitive or easily affected by environmental disturbances or stresses and depend primarily in forest ecosystems for survival (Simberloff, 1998; Hamer et al., 2003; Humpden & Nathan, 2010; Mohagan et al., 2011).

Marilog District is one of the priority areas on biodiversity conservation by the Conservation International. It has a total land area of 63,800.22 hectares, in which 11,102 hectares (17.4%) are forest patches. The decrease of the forest land

was due to the development of the resorts, road construction, and agricultural activities. Anthropogenic disturbances in the area lead to forest degradation in the area which is more likely to have effects to the diversity and richness of butterflies in the area (Thomas, 1991). The present study focused on the comparison of diversity of butterflies from four different forested areas in Marilog District; two forest reserve ecosystems (Lawi-lawi forest reserve and Lola Mommys rainforest) in Brgy. Baganihan and two mountain ecosystems (Mt. Malambo and Mt. Ulaguingan) in Brgy. Datu Salumay, which differ from their elevation, presence of water systems, presence of various host and food plants, and vegetation types.

Although studies were already been conducted in the different forest and mountain ecosystems in Mindanao for the diversity and occurrences that primarily aimed to conserve the species of butterflies in the area (Gapud, 2005; Mohagan et al., 2011), there are still scanty of information on the species composition and diversity in some remote areas in Southern part of Mindanao. Conservation efforts must be considered as these areas are being threatened by disturbances such as mining, loggings and deforestation to convert the land area for agricultural use, and resorts for tourism purposes.

OBJECTIVES OF THE STUDY

This study was conducted to: a) determine the diversity; b) assess the ecological and local status; and c) determine the species richness of butterflies in Marilog District, Davao City, Philippines.

MATERIALS AND METHODS

Study Sites

The study was conducted in four different sites of Marilog District, Davao City, Philippines, which includes two forest ecosystems namely, Lawi-lawi Forest Reserve, Sitio Maharlika and Sitio Calinan (07°27'13.74"N, 125°15'1.12"E) (1220 to 1240 masl) (site one) and Lola Mommys Rainforest, Sitio Epol (07°27'19.73"N, 125°14'33.37"E) (1,197 to 1,345 masl) (site three) in Brgy. Baganihan, and two mountain ecosystems namely, Mt. Malambo (07°29'87"N, 125°15'22.23"E) (1,151 to 1,178 masl) (site two), and Mt. Ulaguingan (07°28'29.89"N, 125°16'36.77"E) (1,280 to 1,320 masl) (site four), Sitio Tagumpay in Brgy. Datu Salumay (Figure 1). The study was conducted from the months of March 2018 to November 2018.

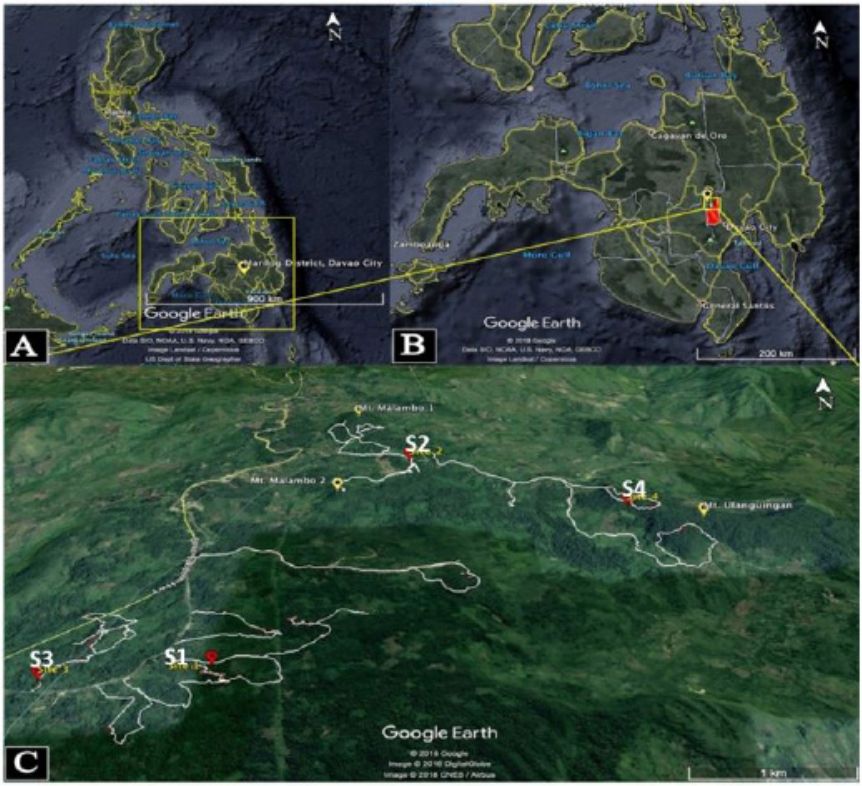

Figure 1. Map of the Philippines (A) and Mindanao (B) showing the Marilog District (C) and the location of the 4 study sites (red balloons (site 1-S1, site 2-S2, site 3-S3 and site 4-S4).

All study sites are characterized as secondary montane forests (Figure 2). Abundant food plants were observed in all sites such as vines, ferns, aroids (e.g., *Aglaonema* cf. *densinervium* Engl., *Alocasia heterophylla* (C. Presl) Merr., *Arisaema polyphyllum* (Blanco), *Begonia* spp., *Impatiens platypetala* Lindl., *Cyrtandra* spp., *Elatostema* sp., Zingiberaceae (e.g., *Alpinia* spp., *Amomum* sp., *Etlingera* spp., *Globba* sp., *Hornstedtia* spp., *Plagiostachys* spp., *Wurfbainia mindanaoensis* (Elmer) Skornick & A.D. Poulsen and *Zingiber negrosense* Elmer) *Medinilla clementis* Merr. and *Macaranga* sp. Native and introduced species of food plants such as *Crotalaria* spp., *Tridax procumbens* L., *Mimosa pudica* L., *Chromolaena odorata* L., *Lantana camara* L., and other ornamental plants were also observed in all sites and were most abundant in site 1, which is vital as these are the primary food plants of butterflies (Alarape et al., 2015). Water systems were also observed

in all sites such as creeks, canals, rivers, and swamps but mostly observed in site 1.

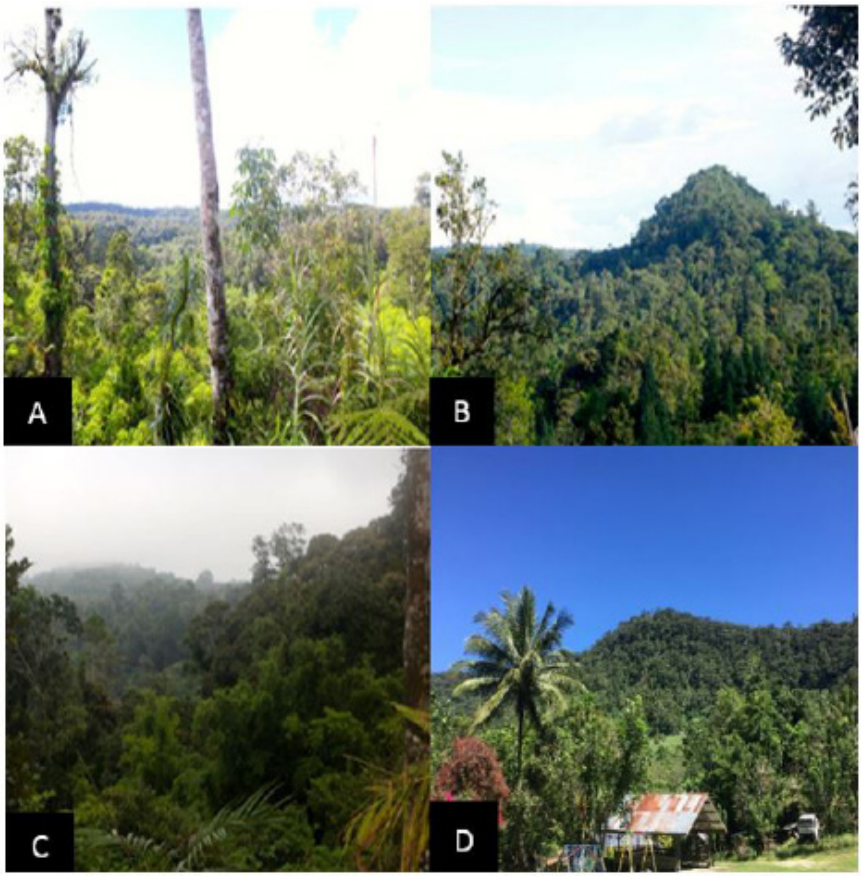

Figure 2. Study site 1 in New Calinan and Sitio Maharlika in Lawi-lawi, Brgy. Baganihan (A). Study site 2 in Mt. Malambo in Brgy. Datu Salumay (B). Study site 3 in Sitio Epol, Brgy. Baganihan (C). Study site 4 in Sitio Tagumpay, Mt. Ulahingan, Brgy. Datu Salumay, Marilog District, Davao City, Philippines (D).

Entry Protocol and Research Ethics

Prior to the conduct of the study, the research was presented to the stakeholders and the Protected Area Management Board (PAMB) of Marilog District, Davao City, Southern Mindanao, Philippines, to obtain prior inform consent. An approved Gratuitous Permit (GP) from the Department of Environment and Natural Resources was then issued in compliance with RA 9147. Institutional

Animal Care and Use Committee (IACUC) Permit was also obtained after being examined by the College of Veterinary Medicine commitee, Central Mindanao University, Musuan, Bukidnon, Philippines.

Sampling Stations and Sampling Techniques

The study was conducted within the four forested patches in Marilog District mentioned above. Transect belt sampling was conducted using a natural trail where species of butterflies were collected. Catching nets and butterfly traps were used as sampling techniques. Captured and observed individuals of butterflies were recorded as part of the computations for the analysis of the results.

Identification and Assessments of the Collected Specimens

Books, journals, and photographs were used for the identification of the collected specimens. The checklist of Treadaway (1995) were used a basis in determining the ecological status of the butterflies collected. Moreover, the assessment of the local status was based on the work of Mohagan and Treadaway (2010) using the following ranges; Very rare 1-3 individuals, Rare 4-10 individuals, Common 11-20 individuals, Very common 21 above (Mohagan and Treadaway, 2010).

Species Richness and Diversity of Butterflies

Shannon-Weiner diversity index was computed using Bio Pro software version 2.0. Values were categorized as low level (0.1-1.49) and fair level (1.5 – 3.0). Cluster analysis (Bray-Curtis) was used to determine the similarity index of butterfly composition across four sampling sites.

Preservation and Mounting of the Collected Specimen

Three specimens per species were collected using killing jars filled with ethyl acetate solution. Collected individuals were then stored in a triangular wax paper with mothballs to preserve. Specimens were then mounted for photography.

RESULTS AND DISCUSSION

Species Composition of Butterflies

A total of 61 butterfly species referable to 5 families and 39 genera were documented across four sampling sites. The highest species abundance of butterflies was observed in site 1 with 201 individuals from 40 species, followed by site 2 with 145 individuals from 31 species, site 4 with 104 individuals from 26 species, and site 3 with 47 individuals from 11 species which has the lowest number of individuals recorded with a total 497 individuals (Table 1). It reveals lower species composition and richness compared to recent studies on the inventory of butterflies in some areas in the archipelago (Toledo & Mohagan, 2011; Ramirez & Mohagan, 2012; Gestiada et al., 2014; Mohagan et al., 2014). This is correlated to the ongoing conversion of the land area, which disturbed species of butterflies in the area.

Table 1

Checklist of Butterflies in 4 sites in Marilog District, Davao City, Philippines

Family		Species	Ecological Status	Site 1	Site 2	Site 3	Site 4	Total # of Individuals
1. Hesperiidae	1	*Ancistroides nigrita fumatus* Mabille, 1876	NE	/	/			4
	2	*Cephrenes acalle chrysozona* Plotz, 1883	NE	/		/	/	16
	3	*Notocrypta feisthameli alinkara* Frushtorfer, 1911	NE	/	/		/	3
	4	*Tagiades gana elegans* Moore, 1865	PE	/			/	17
2. Lycaenidae	5	*Catochrysops strabo luzonensis* Fabricius, 1793	NE	/				1
	6	*Jamides alecto manilana* Toxopeus, 1930	PE	/	/			11
	7	*Jamides bochus pulchrion* Stoll, 1782	NE	/	/			7
	8	*Jamides cleodus trichonis* Frushtorfer, 1916	NE		/			1
	9	*Lampides boeticus* Linnaeus, 1767	NE				/	1
	10	*Nacaduba berenice leei* Herrich-Schäffer, 1869	NE	/				11
	11	*Prosotas nora semperi* Frushtorfer, 1916	NE		/		/	3
	12	*Zizina otis oriens* Butler, 1883	NE	/		/		4

Table 1 continued.

Family		Species	Ecological Status	Site 1	Site 2	Site 3	Site 4	Total # of Individuals
3. Nymphalidae	13	*Acrophtalmia albofasciata* Moore, 1877	NE	/		/		5
	14	*Acrophtalmia leto ochine* Semper, 1886	ME	/				2
	15	*Athyma kasa gordia* C.& R.Felder, 1863	ME	/				1
	16	*Athyma maenas semperi* Moore, 1896	NE	/	/			12
	17	*Centhosia luzonica magindanica* Semper, 1888	NE	/	/			14
	18	*Charaxes amycus carolus* Rothschild, 1900	NE		/		/	4
	19	*Charaxes antonius antonius* Semper, 1878	ME		/			11
	20	*Danaos melanippus edmondii* Bougainville, 1837	NE	/				12
	21	*Danaos melanippus melanipus* Crame, 1777	NE		/			1
	22	*Elymnias beza beza* Frushtorfer, 1907	NE		/			1
	23	*Euploea eunice eunice* Godart, 1819	NE		/			1
	24	*Euthalia lubentina philippenensis* Frushtorfer, 1899	PE	/				1
	25	*Faunis phaon leucis* Felder & Felder, 1861	NE	/	/	/		35
	26	*Hestinales waterstradti borealis* Tsukada, 1991	PE	/	/		/	13
	27	*Hypolimnas anomala anomala* Wallace, 1869	NE	/	/			21
	28	*Ideo electra electra* Semper, 1878	PE	/	/	/	/	11
	29	*Ideo leuconoe obscura* Staudinger, 1889	NE	/		/	/	9
	30	*Ideopsis juventa manillana* Moore, 1883	NE	/	/			3
	31	*Junonia hedonia ida* Cramer, 1775	NE	/	/	/	/	41
	32	*Lexias panopus miscus* Fruhstorfer, 1913	NE	/	/			24
	33	*Melanitis ieda idea* Linnaeus, 1758	NE	/	/			14
	34	*Moduza pintuyana gahiti* M.& T. Okano, 1989	PE	/				4
	35	*Mycalesis felderi felderi* Butler, 1868	PE	/				1
		Mycalesis ita imeldae						

Table 1 continued.

Family		Species	Ecological Status	Site 1	Site 2	Site 3	Site 4	Total # of Individuals
	36	*Mycalesis ita imeldae* C. & R. Felder	NE	/				2
	37	*Mycalesis janardana micromede* Frushtofer, 1900	PE	/		/		4
	38	*Mycalesis mineus philippina* Moore, 1892	NE	/			/	13
	39	*Mycalesis tagala semirasa* Frushtorfer, 1911	NE				/	1
	40	*Neptis mindorana pseudosoma* Moore, 1899	NE				/	12
	41	*Orsotriaena medus medus* Fabricius, 1775	NE		/		/	2
	42	*Polyura athamas acuta* Rothschild, 1899	NE		/			4
	43	*Ptychandra lorquinii platini* C. Felder & R. Felder, 1861	PE	/				9
	44	*Symbrenthia lilaea* Staudinger, 1885	NE		/		/	2
	45	*Symbrenthia lilea semperi* Hewitson, 1864	NE		/		/	3
	46	*Tacola magindana* Semper, 1878	PE	/	/			8
	47	*Tanaecia leucotaenia aquamarina* Fruhstorfer 1912	NE	/				13
	48	*Ypthima kasa gordia* C.& R.Felder, 1863	NE				/	1
	49	*Ypthima sempera chaburos*	PE	/	/		/	14
	50	*Ypthima stellera stellera* Eschscoltz, 1812	PE		/		/	11
4. Papilionidae	51	*Graphium sarpedon sarpedon* Linnaeus, 1758	NE	/				2
	52	*Menelaides helenus hystaspes* C&R Felder, 1862	PE	/		/	/	5
	53	*Menelaides deiphobus rumanzovia* Eschscholtz, 1821	PE	/	/	/	/	11
	54	*Menelaides polytes ledebouria* Eschscholtz, 1821	PE		/			5
	55	*Menelaides helenus hystaspes* C. & R. Felder, 1862	PE	/			/	2

Table 1 continued.

Family		Species	Ecological Status	Site 1	Site 2	Site 3	Site 4	Total # of Individuals
5. Pieridae	56	*Dellias diaphana diaphana* Semper, 1878	PE	/		/		10
	57	*Dellias henningia saturnina* Eschscholtz, 1821	NE	/				5
	58	*Eurema alitha alitha* C. & R. Felder, 1862	ME				/	11
	59	*Eurema hecabe tamiathis* Fruhstorfer, 1910	NE		/		/	22
	60	*Eurema sarilata sarilata* Semper, 1891	PE				/	1
	61	*Eurema simulatrix simulatrix* Staudinger, 1891	NE				/	4
		Total						**497**

PE-Philippine Endemic, ME-Mindanao Endemic, NE-Non-Endemic, /-Present

Diversity of Butterflies

Species diversity revealed that site 1 (H'=1.47) had the highest value, followed by site 2 (H'=1.35), site 4 (H'=1.25), and site 3 (H'=0.932), which had the lowest diversity value (Table 1 and Figure 3). A low level of species diversity was obtained in all sites. These results are more likely due to some anthropogenic disturbances observed across four different sites. In comparison, Site 1 had the highest diversity index, which can be correlated to the various food plants' availability needed for their survival and development as it is a critical factor of a typical butterfly habitat and species diversity (Dennis et al., 2006; Koh & Sodhi, 2004). The presence of several water systems and less disturbances observed in site 1 compared to the other three sites is more likely contributes to the high species of site one forest ecosystem (Ballentes et al., 2005; Mohagan & Treadaway, 2010).

In comparison to some studies in the archipelago (Gestiada et al., 2014; Mohagan et al., 2013), the present result has a lower diversity index which can be correlated to the effects of anthropogenic disturbances such as logging, conversion of the land, road constructions and agricultural activities. In addition, the present result revealed a higher species diversity compared to the study of Sumagaysay and Sumagaysay (2011), with 49 species of butterflies documented in the Vicinity of Mountain View College, Mt. Nebo, Valencia City.

Some species of butterflies were also observed to be occurring in a specific range of elevation as some species were just observed or unique in mountain ecosystems such as in site two and site 4 (Mohagan et al., 2011).

Table 2

Species Composition, Richness and Diversity of Butterflies in Marilog District, Davao City, Philippines

Sites	Number of Species	Number of Individuals	Diversity Indices
1	40	201	1.47
2	31	145	1.35
3	11	47	0.93
4	26	104	1.25

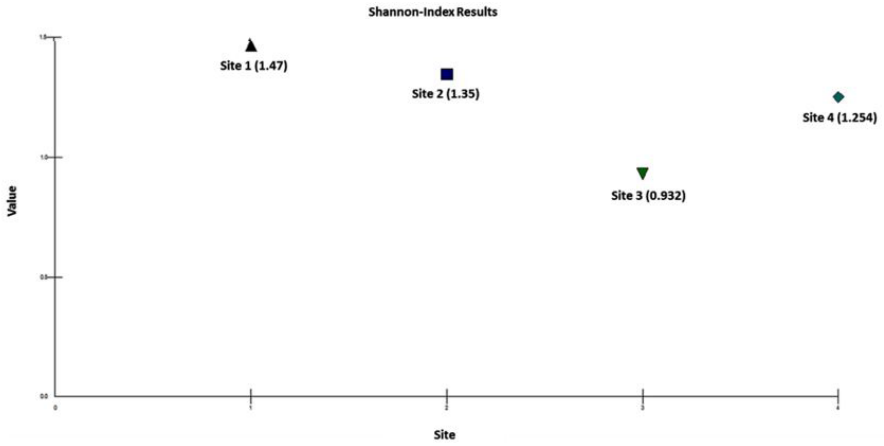

Figure 3. Shannon-Weiner Index plot for Butterflies in 4 sites in Marilog District, Davao City, Mindanao, Philippines.

The Species accumulation curve showed that not all species were represented (Figure 4). All sites have not reached asymptote, which may indicate that there

are still species of butterflies that have not been recorded by the present study (Mohagan et al., 2014). This is more likely due to the different frequency of sampling across the different sites.

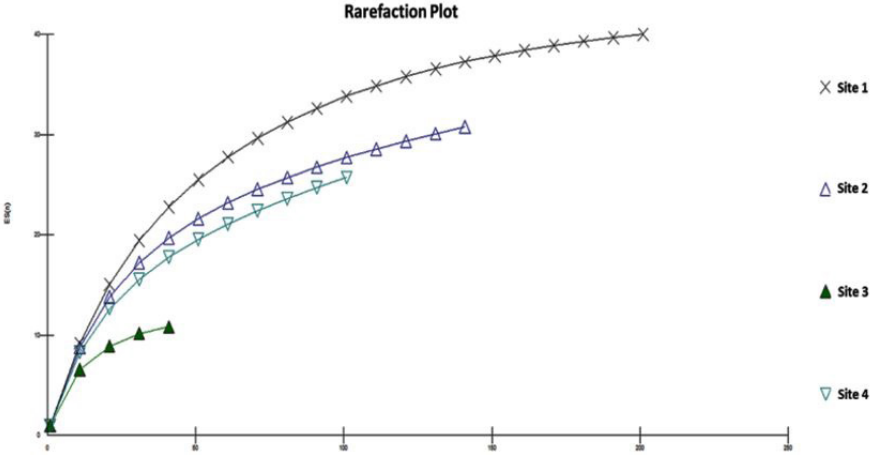

Figure 4. Species Accumulation Curve for Butterflies in 4 sites in Marilog District, Davao City, Mindanao, Philippines.

Bray-Cluster analysis across four sites in Marilog District revealed three discernible clusters (Figure 5). Site 1 and site 2 were clumped together with 44.51% similarity since they have the same vegetation types and presence of food plants. The extent of anthropogenic disturbances causing unfavorable habitat and depletion of food plants for butterflies in site 3 and site 4 (33.73% similarity) and site 3 with site 1 and site 2 (35.48% similarity) is more likely also the other factor that these sites were clustered together.

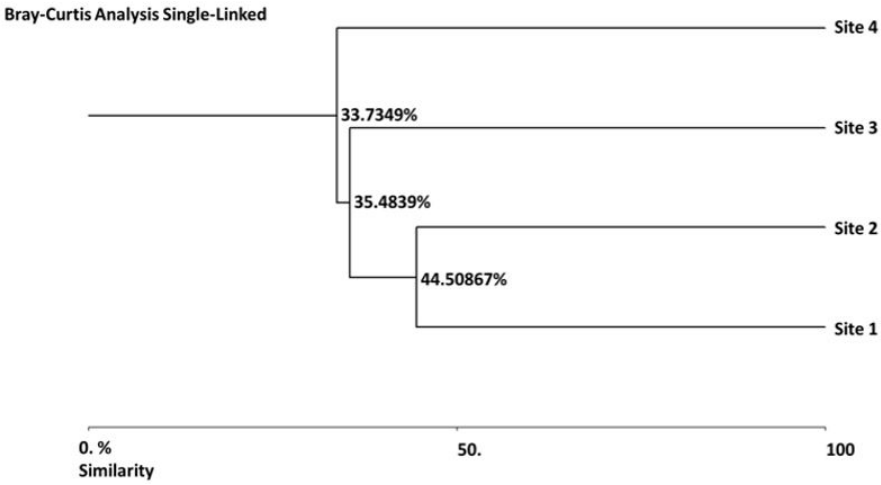

Figure 5. Dendrogram for species composition of 4 sites in Marilog District, Davao City, Mindanao, Philippines.

Ecological and Local Status of Butterflies

From the total of 61 species of butterflies documented across four sampling sites in Marilog District, 18 (29.51%) were endemic (Figure 6 & Table 3). Site 1 had the highest number of endemic species with 17 species or 42.5% of its total number of species, followed by site 4 with ten species or 38.46% of its total number of species, site 2 with nine species or 29.03% of its total number of species and site 3 with five endemic species or 45.45% of its total number of species. The local status of each species documented was also assessed per site and revealed 20 very rare species, 12 rare species and eight common species in site 1, site 2 with 15 very rare species, 12 rare species and four common species, site 3 with three very rare species, two rare species and seven common species and lastly, site 4 with 13 very rare species, nine rare species, and four common species.

Figure 6. Some endemic and rare species of butterflies collected from 4 sites of Marilog District, Davao City. (A) *Notocrypta feisthameli alinkara* Frushtorfer, 1911 (B) *Eurema sarilata sarilata* Semper, 1891, (C) *Jamides alecto manilana* Toxopeus, 1930, (D) *Euthalia lubentina philippensis* Frushtorfer, 1899, (E) *Menelaides helenus hystaspes* C. & R. Felder, 1862, (F) *Menelaides deiphobus rumanzovia* Eschscholtz, 1821, and (G) *Mycalesis janardana micromede* Frushtofer, 1900.

Unique species were mostly recorded in site 1 with 13 disconcordant species, followed by site 2 with nine disconcordant species and site 4 with seven disconcordant species (Table 3). Site 3 recorded concordant species across the three other sites. Site 1 had the highest number of rare, endemic, and unique species, which correlates to the vegetation type and abundant food plants such as *Crotalaria* spp., *Lantana camara* L., and *Mimosa pudica* L. in the area. These food plants primarily grow with enough light in an open canopy, which is observed in site 1 (Emmel & Emmel, 1963). Vegetation types, the presence of food plants, and fewer disturbances are some of the characters of a typical habitat of butterflies (Vu & Vu, 2009). Site 3 had the least rare and endemic species with no unique species recorded, which is more likely due to the anthropogenic disturbances in the area as it was observed that some parts of the forest patch were converted to agricultural land areas (Thomas, 1991). This implies that the undisturbed ecosystems are a very important sanctuary of endemic and rare species of butterflies. Availability of food plants, vegetation types, and extent of anthropogenic disturbances played a vital role in the production and survival of

the endemic and rare species of butterflies.

Table 3

Status of Butterflies in 4 sites in Marilog District, Davao City, Mindanao, Philippines

Status Assessment Category	Site 1 Lawi-lawi Forest Reserve, Brgy. Baganihan	Site 2 Mt. Malambo I and II, Brgy. Datu Salumay	Site 3 Lola Mommys Rainforest, Brgy. Baganihan	Site 4 Mt. Ulaguingan, Brgy. Datu Salumay
Endemism (%)	17/40 (42.5%)	9/31 (29.03%)	5/11 (45.45%)	10/26 (38.46%)
Very Rare Species	20	15	3	13
Rare Species	12	12	2	9
Common Species	8	4	7	4
Very Common Species	0	0	0	0
Disconcordant Species	13	9	0	7

CONCLUSIONS

The study provided the diversity, ecological and local status, endemism, and richness of butterflies in Marilog District. A total of 61 species of butterflies belonging to five families and 39 genera were recorded with a total of 497 individuals. Species diversity across four sites revealed that site 1 had the highest value compared to the other three sites all categorized as having a low level of diversity which correlates to vegetation, abundance of food plants, presence of water systems, and extent of anthropogenic disturbances. Endemic and rare species were recorded in all sites in which site 1 had the highest number of endemic species compared to the other three sites. This data is important as it is benchmark information on the diversity and species composition of butterflies in the area with records of endemic and rare species, which is a good basis for the protection and conservation of the remaining forest patches in Marilog District.

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