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Relationship of Adult Butterfly (Lepidoptera: Rhopalocera) Diversity with Plant Species Diversity in Selected Areas of Mt. Magdiwata, San Francisco, Agusan Del Sur, Philippines

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ABSTRACT

Studies on butterfly diversity and their relationship to plant diversity are scarce and their importance are sometimes overlooked. Thus, a study in order to determine their relationship was conducted across three selected habitats (Agro-forest, Grassland and Secondary growth forest) of Mt. Magdiwata, San Francisco, Agusan del Sur using opportunistic sampling along 2-km transect lines. Fifty-two species of butterflies were collected (46 species in agro-forest, 37 species in the grassland, and 39 species in secondary dipterocarp) with Nymphalidae as the most species-rich family (58%). *Ypthima sempera chaboras* had the most number of individuals (N=81) accounting to 10.60% of the recorded butterflies. The overall diversity of butterflies was high (H'= 3.476). Local status showed that 64.74% of the species were very rare. In terms of plant species composition, a total of 1460 individuals from 33 species were recorded. Notes on plant diversity was also high in flowering plants (H'= 3.235) and adult nectar plants (H'= 3.099) possibly contributing to the high butterfly diversity in the area. Results of the correlation analysis showed that there was a strong, significant relationship between the butterfly diversity to nectar plant diversity (rs = .997 p = .047). Furthermore, linear regression analysis showed that the abundance of nectar plants explained 72.34% of the variation in the butterflies recorded in the area. Nectar plants is a highly important factor governing and supporting butterfly species population. Thus, the protection and conservation of herbaceous plants will equate to the conservation of not only butterfly species but of all the plant-dependent species in the area.

Keywords: *Lepidoptera, Plant Diversity, Habitat types, Correlation Analysis*

1 Introduction

There are about 28,000 butterfly species described worldwide (Frias et al. 2010) which comprise 9% of the world's order (Heppner 2008). In the Philippines, there are 1,615 butterfly species recorded with 44% being endemic to the island (Baltazar 1991) with Mindanao hosting 247 butterfly species (Mohagan et al. 2011).

Butterflies are universally treasured because of their bright and colorful patterns. They play a very important role, as their presence and diversity are considered to be a sign of the upright condition of any terrestrial biotope. Butterflies are also ideal subjects for the environmental condition of landscape and are also very receptive to climatic change. Most of the butterflies have a preference to a particular type of habitat (Thomas and Malorie 1985; Kunte 1997; Aluri and Rao 2002; Raman 2010; Gupta 2018).

Butterflies are often dependent on specific host plants. A cue signal for the butterfly to be familiar with and distinguish among rewarding plants is the floral scent (Mali et al. 2014), as they are also careful in their choice of flowers and plants they visit. Butterflies and plants have an intimate association (Uniyal and Mehra 1996; Amala et al. 2011). They are often considered as opportunistic searchers that visit a wide variety of available flowers. The plants acquired the provision of pollinators to transport pollen from one flower to another (Protocture and Lake 1996; Mali et al. 2014). They feed on nectar from sugars for their energy and minerals for their reproduction (Parasharya and Jani 2007; Mali et al. 2014). However, studies also showed that many butterfly species depended on two or more host plants while some depended only on one plant species for its larval host (Agudilla 2012). Studies showed a significant positive correlation between the diversity of plants and butterflies which served as a good basis for habitat restoration and conservation (Mukherjee et al. 2019).

Mt. Magdiwata is one of the important mountains in the Philippines and contains a diversity of plant and animals species that are rare (Department of Tourism 2011). Seeing the importance of Lepidopterans in the ecosystem, a study that aims to examine the relationship between Lepidopteran species diversity and their plant host species diversity on Mt. Magdiwata was conducted. Biodiversity assessments and continuous monitoring schemes are important and generally recognize prerequisites to operatively address the ongoing biodiversity crises.

2 Materials and Methods

Study Area and Establishment of Sampling Stations

Mt. Magdiwata is located in the municipality of San Francisco, province of Agusan del Sur, Caraga Region, Philippines, with an area cover of 1, 658 hectares and has an elevation of 633 meters high (Figure 1). Mt. Magdiwata is a forest reserved based on the Presidential Proclamation 282, dated August 15, 1993. It is located 8˚28'40.1" N and 125˚59'13.7" E. Its vegetation consists of 55% natural/secondary growth forest, 31% cultivated areas, 15% open grassland, and reforested/agro-forest area. The mountain is the major source of potable water supply in the province of Agusan del Sur (Figure 1).

Three habitat types were chosen as study sites within the area: grassland, agro-forest and secondary dipterocarp forest. A two km straight transect line with a width of ten m (five m at each side) was laid in the different vegetation. CENRO-

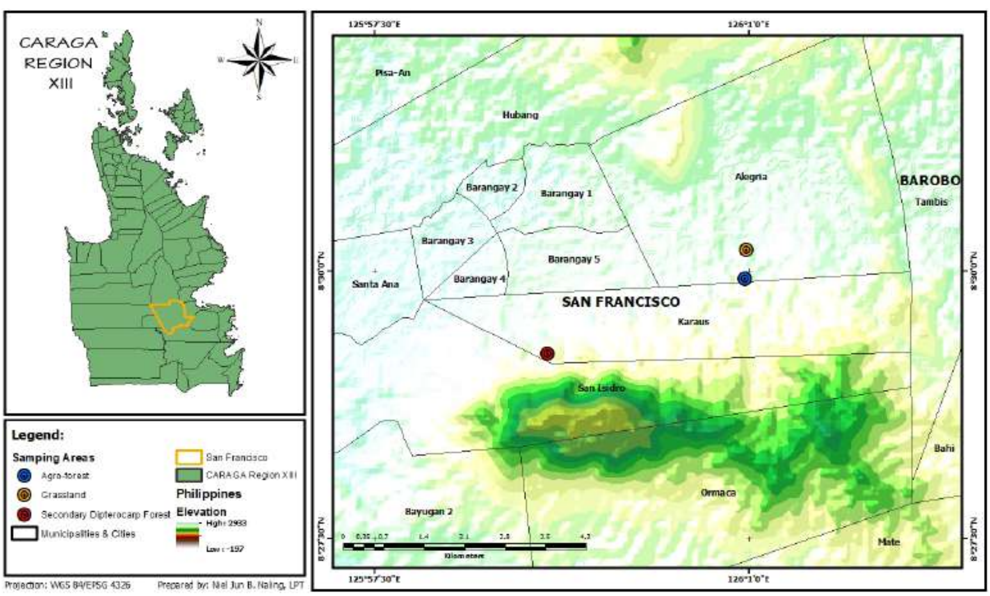

Figure 1. Map of the sampling stations at Mt. Magdiwata, San Francisco, Agusan del Sur. Inset left: Map of Caraga Region highlighting Agusan del Sur, Philippines.

DENR and Barangay permits were acquired prior to sampling.

Agro-forest

Agro-forest habitat is located in Barangay Alegria with geographic coordinates of 8˚29'56" N and 126˚0'58" E. The slopes were a bit hilly with sandy soil. The area was dominated by Palm oil trees (*Elaeis guineensis*), which can be observed as the main tree component. They were planted with some Coconut trees (*Cocos nucifera*), Marang (*Artocarpus odoratissimus*), Ibanag (*Melastoma malabathricum*), and Coffee (*Coffea canephora*).

Secondary Dipterocarp Forest

The secondary dipterocarp forest type is located 8˚29'14" N and 125˚59'7" E. The slopes are rolling hills and its soil is characterized as sandy loam. This habitat type was situated in Barangay Karaos where Lapag reservoir is also situated. Trees belonging to family dipterocarpaceae including Almon (*Shorea almon*), Apitong (*Dipterocarpus grandiflorus*), Bagtikan (*Parashorea malaanonan*), Gisok (*Shorea guiso*), Hagikhik (*Dipterocarpus validus*), Narig (*Vatica mangachapoi*), Red Lauan (*Shorea negrosensis*), Tanguile (*Shorea polysperma*), White Lauan (*Shorea contorta*), and Yakal (*Shorea astylosa*). Flowering plants such as ground orchid and wild santan were also observed in the area. The study stations has early secondary and advanced secondary dipterocarp growth where the canopy layer consisted of epiphytic ferns.

Grassland

The grassland habitat is located 8˚30'12" N and 126˚0'59" E. This habitat type was plain with sandy loam soil, and was found in Barangay Alegria, where rice fields and streams were also present. Yellow dots (*Sphagneticola trilobata*) can be observed as the main flowering plants in the area. Various plants such as Bush passion fruit (*Passiflora foetida*) and Hagonoy (*Chromolaena odorata*) and grasses such as Carabao grass (*Paspalum conjugatum*) and ferns were also observed in the area.

Identification of Flowering Plants and Adult Nectar Plants

All flowering plants in each transect were recorded before the butterfly survey. The common and scientific names of plants and their taxonomic classification were identified. Sample species were collected or photographed for those species in which field identification were not certain and brought to the experts that can facilitate the proper identification using the reference collections (Tantiado 2012). Flowering plants include all herbaceous plants, shrubs, and trees.

Butterfly Survey and Collection

Transect walk and opportunistic sampling techniques were employed for the butterfly survey. Each transect line was surveyed six times with four field workers. The collection started at t 8:00 – 11:00 am and between 2:00 – 5:00 pm. Butterflies were captured using aerial nets, sacrificed in a killing jar and papered in a small triangular envelope.

Classification, Identification and Status of Butterfly Species

Classification and identification of butterflies were based on Mukherjee et al. (2015) and internet sites such as Philippine Butterflies by Hardy and Lawrence (http://pbh-butterflies.yolasite.com). Dr. Peter Hardy confirmed the identification.

To evaluate the status of butterflies in each habitat, occurrence scale by Mohagan and Treadaway (2010) were used: very rare – (1-3 occurrences), rare (4-10 occurrences), common – (11-20 occurrences), very common – (21-above occurrences).

Observation of Flower Preference by Adult Butterfly

Species of butterflies visiting flowers were observed. A thirty min visual survey along each transect line was conducted, moving slowly across the habitats. Two observations were made each day. Nectar plants visited by butterflies were identified (Rusman et al. 2016).

Diversity index

The biodiversity indices of butterflies and plants (richness, abundance, diversity, evenness, and dominance) were computed using Paleontological Statistics Software (PAST) Software version 2.17b. The Bray-Curtis similarity index was used to calculate the percentage of similarities of butterflies among the three sites.

Statistical Analysis

Descriptive statistics such as count, percentage, and total species abundance were computed. The overall significant relationship between adult butterflies' diversity to plant species diversity was analyzed using the Spearman's rho correlation test. Linear regression analysis was also done. Using SPSS Software, where H_o = There is no significant relationship between butterfly diversity and flowering plant diversity and butterfly diversity and nectar plant diversity.

3 Results and Discussion

Butterfly Species Composition and Distribution

A total of 764 individuals of butterflies from 52 species belonging to five families were recorded and collected in three sampling sites: Agro-forest, Grassland, and Secondary Dipterocarp in Mt. Magdiwata, San Francisco, Agusan del Sur (Table 1 and Figure 3). The family Nymphalidae had the highest number of individuals with thirty species (Figure 2A).

Figure 2B shows the abundance of butterfly families throughout the sampling area. The grassland had the highest number of butterflies with 409 individuals (54%), while the secondary dipterocarp had the least with 124 individuals (16%) recorded during the sampling period. Most adult butterflies were seen in open sunny places, just like in the grasslands compared to the shady places of the dipterocarp forest. These observations adhere to the study of Pivnick and McNeil (1987) and Kitahara (2004). Sparks et al. (1996) also reported that the amount of sunlight affects the community structure and abundance of adult butterflies.

The most abundant Rhopalocera species throughout the sampling period on Mt. Magdiwata was *Ypthima sempera chaboras* with a total of 81 individuals (10.60%), followed by *Ypthima baldus* with 65 individuals (8.51%), and *Junonia almana* with 51 individuals (6.68%).

Ypthima sempera chaboras or the common three-ring from the family Nymphalidae that was very common in grassland and agro-forest often rested in leaves or obtained nectar from the flowering plants *Sphagneticola trilobata* (Trailing daisy) of the family Asteraceae which was also the most abundant in the grassland area. This observation coincide with Koneri et al. (2020) wherein most butterflies surveyed frequently visited plants of family Asteraceae. Individuals of *Ypthima sempera chaboras* were also seen resting on leaves of the Carabao grass, *Paspalum conjugatum*. Flower abundance and probable nutrient levels are factors influencing butterflies in the grassland area. Hansel et al. (2006) agreed that the availability of food plants and host plants affects the occurrence of butterflies. Studies also suggests that the abundance of butterflies depend upon the diversity of nectar resources in the area (Pryke and Samways 2003; Pywell et al. 2004). According to Koneri et al. (2020) butterflies were also influenced by the habit of their host plants, types of inflorescence, flower morphology (color and shape of corolla tube), and volume and sugar content of nectar.

The secondary dipterocarp forest had the highest number of very rare species (N=39). Most butterflies in this area were hard to capture, flying high beyond the access of aerial nets. Another factor was the steep mountain of Mt. Magdiwata and other plant species that could hinder in capturing the butterflies observed. The presence of very rare species also signifies the need to protect the herbaceous nectar resources, which is essential in conserving the butterfly species community (Kitahara et al. 2008).

In comparison to other areas in the Philippines, the study conducted at Mt. Banahaw de Majayjay yielded 81 butterfly species (Gestiada et al. 2014), 35 species were recorded across habitat types of

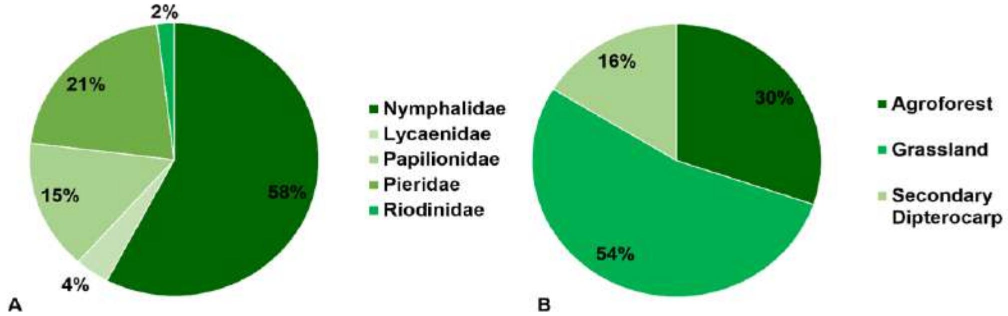

Figure 2. A. Family composition butterflies in three sampling sites and B. Abundance of Butterflies in each site.

Table 1. Checklist and Counts of Adult Butterflies recorded in all Sampling sites: AF- Agro-forest, G- Grassland, and SD- Secondary dipterocarp in Mt. Magdiwata.

Species	Counts	Sampling Sites		
		AF	G	SD
Abisara m. mindanaensis	1	/		
Acnillides palinorus daedalus	4	/		/
Acrophtalmia leto ochine	5			/
Amathusia phidippus policaris	6	/		/
Appias olferna ♀	20	/	/	
Appias olferna ♂	19		/	
Athyma maenas semperi	4	/	/	
Catopsilia pomona pomona ♀	7	/	/	
Catopsilia pomona pomona ♂	8	/	/	/
Catopsilia p. pyranthe	11	/	/	/
Cirrochroa menones	12	/	/	/
Cirrochroa tyche tyche	9	/	/	
Cyllogenes janetae janetae	5	/		/
Danaus melanippus edmondii	4	/		/
Delias hyparete mindanaensis	9	/	/	/
Discophora philippina	1			/
Elymnias casiphonides	1			/
Elymnias beza	3			/
Eooxylides meduana	5	/	/	/
Euploea mulciber mindanaensis ♀	3	/		/
Euploea mulciber mindanensis ♂	6		/	/
Eurema alitha	23	/	/	
Eurema andersoni	39	/	/	/
Everes lacturnus syntala	14	/	/	/
Faunis phaon leucis	16	/		/
Graphium a. agamemnon	8	/	/	/
Graphium doson axionides	1			/
Hypolimnas bolina philippensis ♀	13	/	/	/
Hypolimnas bolina philippensis ♂	12	/	/	/
Junonia almana almana	51	/	/	
Junonia atlites atlites	28	/	/	
Junonia iphita iphita	21	/	/	/
Lassipa pata semperi	9	/	/	/
Leptosia nina	49	/	/	
Lethe chandica flanona	1			/
Lexias panopus miscus	6	/		/
Melanitis leda leda	25	/	/	
Menelaides ledebouria polytes ♀	9	/	/	/
Menelaides ledebouria polytes ♂	14	/	/	/
Moduza pintuyana gahiti	1		/	
Mycalesis mineus	35	/	/	/
Nepthis hylas	8	/	/	
Pachliopta phlegon phlegon	16	/	/	/
Papilio demoleus libanus	23	/	/	/

Species	Counts	Sampling Sites		
		AF	G	SD
Papilio alcmenor alcmenor ♀	9	/	/	/
Pareronia boebera trinobantes ♀	9	/	/	/
Pareronia boebera trinobantes ♂	7	/	/	/
Ragadia crito	4	/	/	/
Tarratia cosmia cosmia	22	/	/	/
Ypthima sempera chaboras	81	/	/	/
Ypthima baldus	65	/	/	/
Xeuxidia sp.	2			/

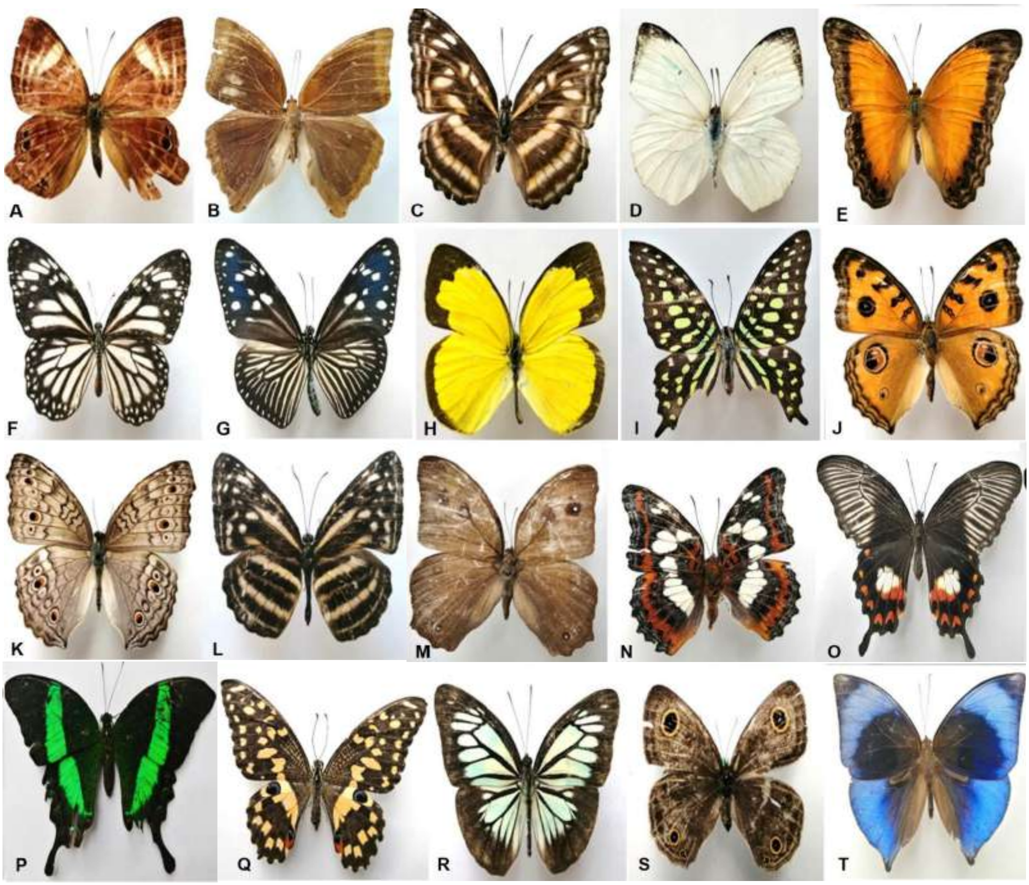

Figure 3. Some Butterflies of Mt. Magdiwata, San Francisco, Agusan del Sur: (A) *Abisara echerius paionea*, (B) *Amathusia phidippus pollicaris*, (C) *Athyma kanwa phorkys*, (D) *Catopsilia pyranthe pyranthe* ♂, (E) *Cirrochroa menones*, (F) *Ideopsis juventa*, (G) *Euploea mulciber mindanaensis* ♀, (H) *Eurema blanda vallivolans*, (I) *Graphium agamemnon agamemnon* ♀, (J) *Junonia almana almana*, (K) *Junonia atlites atlites*, (L) *Neptis clinia susruta*, (M) *Melanitis leda leda*, (N) *Moduza procris procris*, (O) *Papilio polytes romulos* ♀, (P) *Papilio buddha*, (Q) *Papilio demoleus demoleus*, (R) *Pareronia hippie* ♂, (S) *Ypthima newara newara*, and (T) *Zeuxidia aibulana*

PC Hills, Leyte (Igano et al. 2021), 45 butterfly species at Davao City urban area (Salaga et al. 2018), 29 species from the lowland forests of Central Surigao del Sur (Gracia et al. 2021), 62 butterfly species were recorded from the study of Guadalquiver et al. (2019) from Mimbilisan

Protected Landscape, and 104 species of butterflies from Maitum Village, Tandag, Surigao del Sur (Ramirez and Mogahan 2012).

Biodiversity Indices of Adult Butterfly

The agro-forest has a greater number of species (S=42; Table 2) due to being a transition zone between the open grassland and shady secondary dipterocarp forest. This finding is parallel to Salmony (2010) where the agroecosystems had higher species richness than in secondary dipterocarp forests and grassland areas. The diversity of plants and microclimate could have offer a unique habitat to butterfly species.

Species diversity was highest in the secondary dipterocarp forest followed by agro-forest. Even though the grassland area had the most number of individuals. Generally, secondary dipterocarp forest had the highest diversity than in agroecosystems and grasslands according to Ballentes et al. (2006), Igano et al. (2021) and Ramirez and Mogahan, (2012). The taxonomic patterns and plants structure mainly affect the community diversity (Southwood et al. 1979). Several butterfly species such as *Acrophtalmia leto ochine, Discophora sondaica zal, Elymnias beza, Elymnias casiphonides, Graphium doson axionides, Lethe chandica flanona,* and *Xeuxidia* sp. were recorded only in secondary dipterocarp forest and not in other habitats proving their probable affinity to the trees, resources and shelters provided by this habitat. Furthermore, the secondary growth forest in the area was slightly disturbed. According to Brown (1996) species diversity is highest among moderately disturbed and lowest in urbanized and intensive agriculture areas and endemic species are common among undisturbed.

Similarity index of butterflies

The Bray Curtis cluster analysis of adult butterflies across stations (Figure 4) show two groups, in which the first group is composed of secondary dipterocarp forest species alone and has a unique species composition with only 40% similarity to the other sampling stations. This suggests that only 40% of the species were concordant, and the remaining 60% were disconcordant. The second group was composed of butterflies from the grassland and agro-forest area with 60% similarity. The remaining 40% disconcordant species may be due to the disturbance (Ramirez and Mohagan 2012) and the manifestation of host and nectarine plants that made a good habitat for the adult butterflies to survive (Nacua et al. 2017). The grassland area was more similar to the agroforest area due to the concordance of some species to the different vegetation types as observed in the study of Toledo and Mohagan (2011). This can also be attributed to the similarity in light penetration that subsequently affects temperature as stated by Ramirez and Mohagan (2011).

Plant Species Composition and Distribution

A total of 1460 individuals of flowering plants belonging to 33 species and 22 families were recorded in all sampling stations. More butterflies were seen visiting flowers in grasslands (n=242) followed by the agro-forest (n=147) and secondary dipterocarp forest (n=8). Butterflies resting on leaves were also recorded (Figure 5).

The grassland area was an open space where butterflies can have sunlight and there were streams near the area where some butterflies frequently visit water. Butterflies prefer marshes, swamps and riversides harmonize in the study of Klass and Dirig (1992) and Uniyal and Mehra (1996).

Table 3 shows the most abundant flowering plant species in the sampling stations was *Sphagneticola trilobata* (10.89%) followed by *Melastoma malabathricum* (7.26%) and *Stachytarpheta cayennensis* (6.23%). Out of all 33 species of flowering plants recorded in this study, 23 plant species were visited by butterflies in the grassland habitat, 22 plant species in the agro-forest, and seven plant species in the secondary dipterocarp forest.

Table 2. Biodiversity indices of Adult butterflies in three sampling stations on Mt. Magdiwata.

Sampling sites	Species richness (S)	Abundance (N)	Species diversity (H’)	Dominance (D)	Evenness (E)
Agro-forest	42	231	3.19	0.07	0.58
Grassland	37	409	3.16	0.06	0.64
Dipterocarp	39	124	3.48	0.04	0.83
Total	**52**	**764**	**3.48**	**0.04**	**0.62**

Biodiversity indices of Flowering plants and Adult nectar plants

The data showed that the agro-forest area had the most diverse flowering plants (H'= 3.07; Table 4) and adult nectar plants (H'= 2.91; Table 5). This observation might explain the high butterfly species richness in this area. Furthermore, the secondary growth forest had the lowest flowering plant diversity (H'= 2.60) and adult nectar plants (H'= 1.80), but it harbours the highest butterfly diversity

Table 3. Counts and Relative Abundance of Flowering Plants and Checklist of Nectar Plants in all Sampling Sites: AF- Agro-forest, G- Grassland, and SD- Secondary dipterocarp in Mt. Magdiwata.

Species	Counts	Relative Abundance (%)	Sampling Sites		
			AF	G	SD
Abelmoschus manihot	10	0.68		/	
Acmella sp.	25	1.71		/	
Amischotolype hispida	7	0.48	/		
Brachiaria sp.	61	4.18			
Chromolaena odorata	75	5.14	/	/	
Cleome rutidosperma	68	4.68	/	/	
Cordia dichotoma	1	0.07		/	
Crassocephalum crepidiodes	23	1.58	/	/	
Cuphea hyssopifolia	59	4.04	/	/	
Desmodium sp.	32	2.19		/	
Eclipta prostrata	39	2.67	/	/	
Elephantopus mollis	58	3.97	/	/	/
Ficus odorata	8	0.55			/
Ficus spinose	29	1.99			
Heliconia sp.	16	1.10	/		
Heliotropium indicum	39	2.67		/	
Hippobroma longiflora	49	3.36	/	/	
Homalomena philippinensis	9	0.62			/
Lepidium sativum	28	1.92	/		
Ludwigia alternifolia	32	2.19	/	/	
Melastoma malabathricum	106	7.26	/	/	/
Melochia corchorifolia	55	3.77	/	/	
Mimosa pudica	75	5.14	/	/	
Passiflora foetida	52	3.56	/	/	
Phrynium interruptum	22	1.51	/		/
Rhynchoglossum sumsum	10	0.68			/
Solanum torvum	17	1.16		/	/
Scirpus sylvaticus	48	3.29	/	/	
Stachytarpheta cayennensis	91	6.23	/	/	
Stachytarpheta jamaicencis	78	5.34	/	/	
Urena lobate	49	3.36	/	/	
Sphagneticola trilobata	159	10.18	/	/	
Xiphidium ceruleum	30	2.05	/		

Table 4. Biodiversity indices of flowering plants in three sampling stations on Mt. Magdiwata.

Sampling sites	Species richness (S)	Abundance (N)	Species diversity (H')	Dominance (D)	Evenness (E)
Agro-forest	24	501	3.07	0.05	0.89
Grassland	25	835	3.00	0.06	0.81
Dipterocarp	16	124	2.59	0.09	0.83
Total	**33**	**1455**	**3.24**	**0.05**	**0.77**

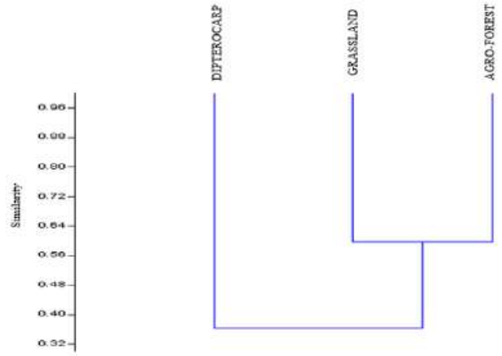

Figure 4. Dendogram using using Bray-Curtis cluster analysis of adult butterflies across three sampling stations on Mt. Magdiwata during the study period.

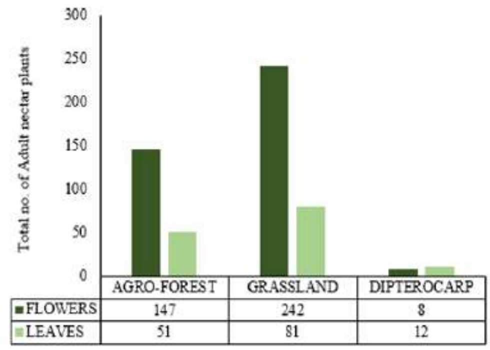

Figure 5. The number of species of the adult nectar plants visited by adult butterflies in all sampling stations during the study period.

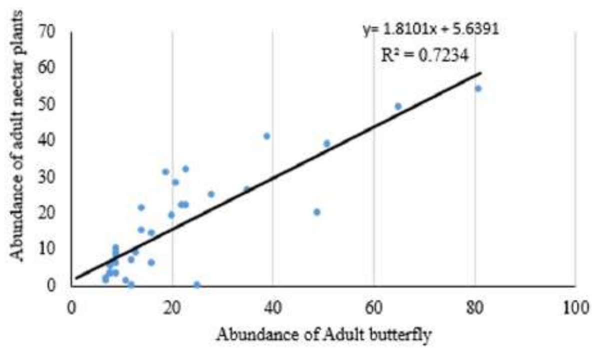

Figure 6. Linear relationship between the total number of adult butterflies and total number of adult nectar plants.

Table 5. Biodiversity indices of adult nectar plants in three sampling stations on Mt. Magdiwata.

Sampling sites	Species richness (S)	Abundance (N)	Species diversity (H')	Dominance (D)	Evenness (E)
Agro-forest	22	197	2.91	0.06	0.84
Grassland	23	323	2.90	0.06	0.79
Dipterocarp	7	20	1.79	0.19	0.86
Total	**31**	**540**	**3.10**	**0.05**	**0.72**

Table 6. Significant Relationship between adult butterfly's diversity and flowering and nectar plants diversity.

		Correlation Coefficient[a]	p-value	Remarks
Butterfly Diversity	Flowering Plant Diversity	0.98	3.17	Fail to reject Ho
	Nectar Plant Diversity	1.00	3.16	Fail to reject Ho at α=0.05 Strong and direct relationship

Legend: [a] tested using Spearman's rho correlation test.

(H'= 3.48). Overall flowering plant diversity and adult nectar plant diversity was high.

Relationship of butterfly species diversity and flowering and nectar plants species diversity

The diversity of butterflies and flowering and nectar plant diversity were strikingly different within sampling areas.

Table 6 shows the significant relationship between diversity of adult butterflies and diversity of flowering and nectar plants. As shown, there is a significant and strong relationship between diversity of adult butterfly and diversity of nectar plants at α=0.05. Furthermore, populations of the flowering plant *Xiphidium ceruleum* and nectar plant *Phrynium iterruptum* had a strong, direct relationship to adult butterflies (a= 0.05). The result of the study suggest that diversity of nectar plant species was the significant factor influencing the diversity of adult butterfly species at each sampling site. This observation is parallel to the study of Kitahara et al. (2008), Nacua et al. (2014) and influencing the diversity of by Mukherjee et al. (2019). The number of butterflies population influence the accessibility of nectar plant resources in the dispersal arrangement than the existence of larval host plants (Hardy and Dennis 1999). Our study showed that diversity butterfly species was strongly correlated with the herbaceous nectar plant species diversity, especially the perennial plants, but not in the woody nectar plant species (Kitahara et al. 2008). The study of Gestiada et al. (2014) at Mt. Banahaw de Majayjay also showed a diverse record of butterfly species significantly related to vegetation patterns while the study of Manalo et al. (2017) at Halang Lipa, Batangas using QGIS also showed that butterflies were attracted to specific host plants and nectarine plants for survival.

Figure 6 shows the linear relationship of the abundance of adult butterfly and adult nectar plants. The R^2 value (72.34%) indicates a strong relationship between abundance of adult butterflies and adult nectar plant each sampling area. The abundance of nectar plants is a highly important factor governing and supporting its adult butterfly species richness (Kitahara et al. 2008). Furthermore, temperature, elevation, and slope of habitats (Gestiada et al. 2014) and plant compounds (Fujita et al. 2017) are also some other factors contributing to the pattern of butterfly-host plant diversity in an area.

4 Conclusion and Recommendations

Butterflies are good indicators of the environment, capable of supplying information on changes in the ambient features of any ecosystem, and are economically important. Mt. Magdiwata has high diversity of butterfly species as well as flowering and nectar plants. The results revealed that butterfly species diversity was significantly dependent on nectar plant diversity. This study will add to the importance of conserving vegetation and nectar plants for the survival of butterfly species. Seasonal assessment of butterflies is recommended. Sex identification of butterflies should also be considered so that the male to female ratio can also be distinguished. Recording flower morphology, proboscis length of butterflies, and environmental factors are also highly recommended to determine the preference of butterflies to flowering plants.

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Statement of Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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