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DIVERSITY AND STATUS OF BUTTERFLIES IN AWASIAN WATER FOREST RESERVE, MT. HILONG-HILONG, PHILIPPINES

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ABSTRACT

Butterflies are deemed as an essential faunal group in the ecosystem due to their ecological services. However, continuous habitat loss leads to the decline of its population. Thus, this study was conducted to assess its diversity and status in one of the Watersheds of Mt. Hilong-hilong. Sweep netting (336 man-hours) and butterfly trapping (200 trap days) were carried out to document the species. Fifty-seven species of butterflies were recorded with the family Nymphalidae as the most represented group (n = 30). Species diversity (H') was relatively higher in Dipterocarp (H' = 1.49) forest than Agroecosystem (H' = 1.39), a result primarily influenced by favorable ecological support like food availability. Endemicity was 31%, which comprised mostly of rare species. Noteworthy findings are the listing of globally and nationally rare species but locally assessed as common. Based on the results, the area harbors an array of butterfly species and various rare species that requires an effective management plan to conserve the organisms.

Keywords: butterflies, diversity, lepidoptera, mt. hilong-hilong, richness

INTRODUCTION

Lepidoptera is one of the largest families in the insects' realm, where butterflies well represent most of the species. Its occurrence and diversity are considered good indicators for any terrestrial biotopes (Kunte 2000; Aluri & Rao 2002; Thomas 2005; Arya & Dayakrishna 2014), which also denote environmental quality changes and served a vital role in agricultural landscapes (Munyuli 2012; Nacua *et al.* 2015a). Lepidoptera are excellent pollinators that ensure the reproduction and survival of plants used by other organisms as sources of food, reproductive areas, and medicine (Mohagan & Treadaway 2010).

Despite the high diversity, sociological and ecological functions of butterflies, the taxa are still not spared from gradual extinction due to overexploitation, illegal trading, and habitat loss which are the manifestations of uncontrollable anthropogenic activities (Myers *et al.* 2000; Brook *et al.* 2008; Serengil *et al.* 2010; Parria *et al.* 2017). Owing to habitat destruction for developmental activities in an urban environment and unscientific management of natural resources, most of our native butterflies are fast disappearing. At present, their survival is under threat (Nair *et al.* 2014) and these threats are highly observable in the Philippines, making the country one of the hottest hotspots (Bisson *et al.* 2003). Hence, determining the diversity, level of endemism, and distribution of species is necessary for it serves as bases and guidelines for the formulation of conservation measures (Ehrlich & Hanski 2004; Pyke & Ehrlich 2010).

Awasian Water Forest Reserve is one of the watersheds of Mt. Hilong-hilong, a Key

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Biodiversity Area (KBA) in the Philippines located in the Northeastern Mindanao. Mt. Hilong-hilong itself has been considered as an ideal abode for various forms of flora and fauna (PEF 2008). However, ecological information is observed to be fragmented and limited, with scientific studies mainly focused on vertebrates and the western part of the ecosystem (Agusan Provinces). In contrast, invertebrates, especially butterflies and the eastern part (Surigao Provinces), are relatively poorly known, with only one accessible data set on butterflies from the study of Ramirez and Mohagan (2012).

The area is also considered a vulnerable habitat under the criterion of Very High due to highly observed anthropogenic pressures (BirdLife International 2020), especially on the aspect of the rapid growth of human population in the uplands, mining, agricultural expansion, and road expansion and development (Haribon 2017). For these reasons, the study was conducted to address the scarcity of ecological information on butterflies in the area and provide information that can be utilized for effective environmental management planning. The study generally aimed to assess the diversity through the determination of species composition and richness of butterflies across habitat types, as well as the evaluation of its status in comparison with the global and national assessments.

MATERIALS AND METHODS

Duration and Description of the Study Area

The study was conducted at Awasian Water Forest Reserve, Mt. Hilong-hilong in Tandag City Surigao del Sur, Philippines located at 9.07579 N and 126.14006 E (Fig. 1). The study was carried out on 1 - 9 October 2017, covering nine days of sampling. The site's topography is generally plain, rolling, and gently sloping. The area can be reached for approximately two hours by walking from the nearest human settlements. The climatic condition in the area falls under the Type II climate condition of the Philippines. It has rainfall distributed throughout the year, with a negligible short dry season (MPDO 2004). The area has two vegetations, the Agroecosystem and Dipterocarp Forests.

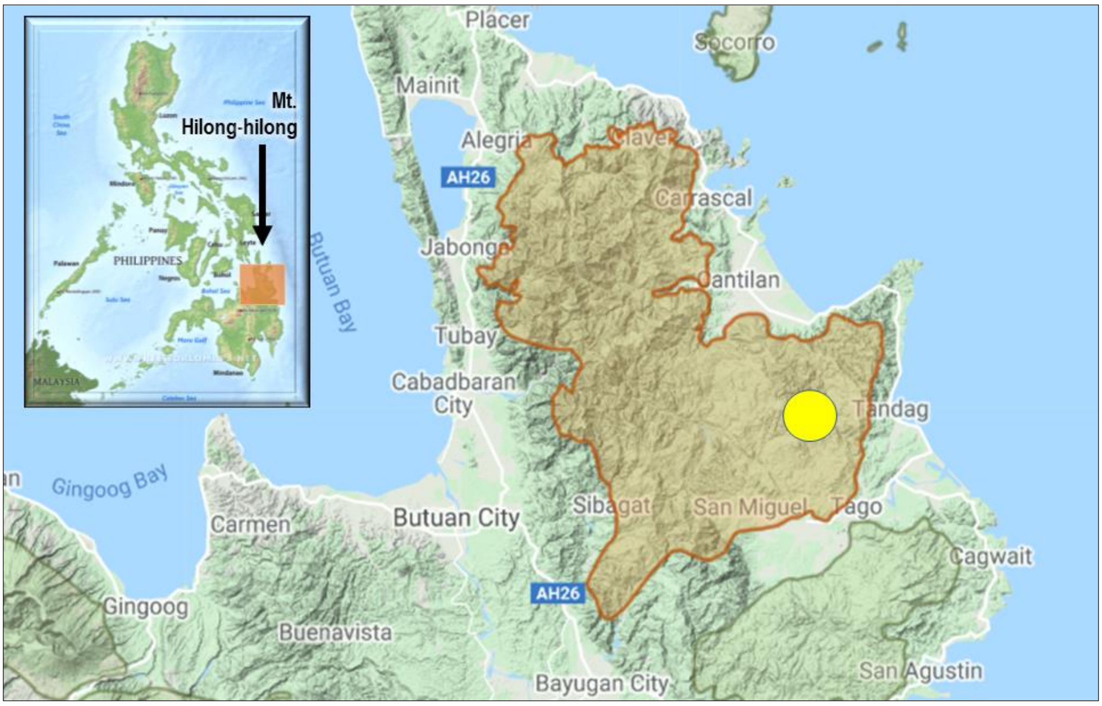

Figure 1 Location and spot map of the study site (BirdLife International 2020)

Establishment of Study Stations and Habitat Assessment

Two transect lines with a length of 1,000 m were established in the study area with an aerial distance of 200 m from each transect. The reason for such aerial distance is to avoid or lessen possible bias in documenting the species. The first transect line was laid across the human trail in the Agroecosystem and labeled as Transect 1 (T1), while the second transect line was laid across the Dipterocarp Forest and labeled as Transect 2 (T2). Habitat assessment was carried out through the documentation of the plant community and composition, canopy cover, nearness of water bodies, distance from the nearest human settlements, and temperature.

Sampling Techniques

Collection and capturing the butterflies was carried out primarily through sweep netting. The activity was actively performed from 9:00 AM to 3:00 PM, for these are the hours the butterflies are highly active. A total of 336 man-hours of sampling effort was spent for the entire duration of the study. Wherein 168 man-hours were spent per transect or habitat. As for this technique, the researchers wore brightly colored clothes to attract butterflies. Also, 25 pieces of classical butterfly traps containing muscovado sugar solutions were deployed along the first 500 m of the transect lines. Each trap was placed with a 20 m interval from each other. The traps were hung in the place which was convenient for butterflies feeding like open fields.

Identification, Preservation, and Data Analysis

Preliminary identification of butterflies was carried out using taxonomic keys. Other references, such as books, journals, and photographs (Mohagan & Treadways 2010; Treadway 2012; Ramirez & Mohagan 2012) of the previously identified specimens, were also used. After the initial identification, the samples were sent to the Zoological Section of the University Museum of Central Mindanao University (CMU), a state-governed research university for verification. The collected species of butterflies were pinned and preserved using naphthalene balls and powder. Data analyses that include the computation of species rarefaction and diversity indices were analyzed using Biodiversity Professional (BioPro) software version 2.0 (McAleece 1997). The butterfly's global status assessment was based on the International Union Conservation for Nature (IUCN 2020), while the established national and local assessments by Treadaway (1995) as well as Mohagan and Treadaway (2010) were adopted.

RESULTS AND DISCUSSION

Taxonomic Composition and Overall Richness

Fifty-seven (57) species of butterflies were recorded in the study area. These species were classified into 43 genera belonging to 5 families. Among the five families, family Hesperiidae was the least represented with three species observed, followed by family Papilionidae (n = 5), Pieridae (n = 8), Lycaenidae (n = 11), and Nymphalidae (n = 30) (Table 1). The low representation of species under Hesperiidae was attributed to a generally thicker canopy in the area. The thick canopy makes the habitat shadier, which is not favorable for the Hesperiidae, which species used to inhabit an open place and near the shrubs (Braby 2016). Hesperiids also prefer to feed on various weedy plants, including pigweeds and lamb's quarter (Hilty 2013), which is not present in any vegetation types of the current sampling area.

Table 1 Species list, endemicity, and status of observed butterflies in Awasian Water Forest Reserve, Mt. Hilong-hilong

	Taxon	Assessment			Endemism
		Local	National	Global	
Family Hesperiidae					
1	*Hasora moestissima moestissima*	R	C	-	NE
2	*Tagiades japetus titus*	R	C	C	NE
3	*Tagiades trebellius martinus*	R	C	C	PE
Family Lycaenidae					
4	*Allotinus pallax apsecus*	C	C	-	NE
5	*Arhopala abseus abseus*	C	C	-	NE
6	*Caleta angola angola*	R	C	-	NE
7	*Cheritra orpheus orpheus*	R	C	-	PE
8	*Eooxylides neduna neduna*	C	-	-	-
9	*Hypolycaena sipylus tharrytas*	C	C	-	NE
10	*Jamides alecto manillana*	C	R	-	PE
11	*Jamides celeno lydanus*	C	R	R	NE
12	*Jamides philatu osias*	C	R		NE
13	*Nacaduba borenice leei*	C	-	-	-
14	*Prosotas nora semperi*	R	C		NE
Family Nymphalidae					
15	*Acrophtalmia albofasciata*	R	R	-	ME
16	*Acrophtalmia leto ochine*	C	C	-	NE
18	*Amathusia phidippus pollicaris*	R	C	C	NE
19	*Cirrochroa tyche tyche*	C	C	-	NE
20	*Cyrestis maenalis*	C	C	-	NE
21	*Danaus melanippus*	C	C	-	NE
22	*Elymnias beza beza*	R	C	-	ME
23	*Euploea amulciber mindanensis*	C	C	-	NE
24	*Euploea euniceleucogaris*	R	-	-	-
25	*Faunis phaon leuces*	C	C	-	NE
26	*Junonia hedonia ida*	C	C	C	NE
27	*Lassipa pata semperi*	R	R	-	NE
28	*Lexias panopus miscus*	R	C	-	NE
29	*Milanitis boisduvalia*	R	R	-	PE
30	*Mycalesis micromede micromede*	C	R	-	NE
31	*Mycalesis federi federi*	R	R	-	PE
32	*Mycalesis mineus philippina*	C	C	R	NE
33	*Mycalesis tagala semiraza*	C	R	-	NE
34	*Neptis mindorana pseudosoma*	C	-	-	PE
35	*Neptis pampanga boholica*	R	R	C	NE
36	*Pantaporia dama commixta*	C	C	C	PE
37	*Pantoporia cyrilla cyrilla*	R	C	-	PE
17	*Pantoporia* sp.	R	-	-	-
38	*Phaedyma columella messogai*	C	C	-	NE
39	*Phalantha phalantha phalantha*	C	C	-	NE
40	*Ptychandra schadenbergi*	R	R	-	PE
41	*Ragadia melindena mindeninse*	C	R	-	PE
42	*Tanaecia leucotaenia acquamarina*	R	C	-	NE
43	*Tarattia cosmia cosmia*	C	-	-	PE
44	*Ypthima sempera chaboras*	R	R	-	PE
Family Papilionidae					
45	*Atrophaneura semperi*	R	R	R	PE
46	*Graphium argamemnon argamemnon*	R	C	-	NE
47	*Melenaides deiphobus rumanzovia*	R	C	-	NE
48	*Melenaides helenus hystaspes*	C	C	C	ME
49	*Pachliopta mariae mariae*	C	C	-	PE
Family Pieridae					
50	*Appias nepheleelis*	R	R	-	NE
51	*Cepora aspasia orantia*	R	C	-	NE
52	*Eurema blanda valli volans*	C	C	C	NE
53	*Eurema hecabeta miathis*	C	C	-	NE
54	*Eurema sarilalas arilata*	C	R	R	PE
55	*Gandaca harina mindanensis*	C	C	-	NE
56	*Leptosia nina terantia*	R	C	-	NE
57	*Pareronia boebera trinobantes*	C	C	-	NE
Total Number of Families				5	
Total Number of Genera				43	
Total Number of Species				57	

Notes: C = Common; R = Rare; NE = Non-endemic; PE = Philippine Endemic; ME = Mindanao Endemic.

The family Nymphalidae was observed to be the most represented group. This finding is attributed to the study site's general characteristics as a forest. Nymphalids are perceived to be dominant in a forested area, particularly in tropical regions (Sarkar 2011; Harsh *et al.* 2015). Its abundance is attributed to the availability of food resources from the variety of host plants and favorable microclimate conditions (Widhiono 2015). At the course of the conduct, various plants were flowering and fruiting. Among these plants are the dominant species in the area like *Shorea* spp. and other trees like *Lansium dosmesticum*, *Artocarpus odoratissimus*, and *Durio zibithenus,* which make the condition suited to the requirements of the butterfly group for their feeding behavior. This observation agrees with Opler *et al.* (2017) claim that Nymphalids' feeding behavior depends on the nectar, sap flows, and rotting fruit, wherein the food availability from one vegetation type influences the butterfly composition (Toledo & Mohagan 2011).

The total richness observed in this study is comparatively higher compared to some of the faunistic studies conducted in the Philippines. Zapanta *et al.* (2016) at Bulusan, Bulakan, only recorded 21 species, whereas the lepidopteran assessment carried out in Lipa, Batangas documented only 25 species (Nacua *et al.* 2017). The same observation was noted for the studies of Toledo and Mohagan (2011) at Mt. Hibok-hibok, Camiguin (n = 41) and Sumagaysay and Sumagaysay (2012) at Mt. Nebo, Bukidnon (n = 31). As compared to the global findings, the study surpasses the records of Arya and Dayakrishna (2014) in Naital, Uttarakhand, India (n = 27); Haroon *et al.* (2020) in Tanga, Charsadda, Khyber Pakhunkhwa, Pakistan (n = 22); Castro and Espinosa (2015) in Arenillas Ecological Reserve, Ecuador (n = 22); and Koneri *et al.* (2016) at Manembo-nembo Wildlife Reserve, North Sulawesi, Indonesia (n = 44). Findings of our study suggested that the study area is an ideal abode for butterflies due to its capability for supporting larger communities. Our study also indicated that the habitat has a better support system coming from the butterflies, especially on the aspect of pollination.

On the other note, the results of our study are comparatively lower compared with the records in Mts. Apo, Kitanglad, Musuan, and Timpoong in the Philippines with 104, 148, 114, and 79 species, respectively (Mohagan *et al.* 2011). The reports of Nacua *et al.* (2015b) at San Fernando La Union Botanical Garden, Mohagan *et al.* (2018) at Mt. Pinamantawan, Bukidnon, as well as Mohagan and Treadway (2010) at Mt. Hamiguitan, Davao Oriental, Philippines were also noted to have higher richness with 104, 118, 142 species, respectively. Even in comparison with the study results of Ramirez and Mohagan (2012) at Maitum Village, Tandag City which is an area adjacent to the sampling site of this study, recorded a total of 104 species.

The discrepancy between the results is attributed to various factors ranging from sampling effort to study duration. Unlike in different studies, the participation of a well-versed taxonomist maximizes the observation since visually observed species are added to the list, like the case of the abovementioned studies. In contrast, our study only represents the verified captured samples. The influence of sampling duration could also be another factor due to more time provided for further documenting the faunal group. The concept conforms to the elaborated observation in the faunistic study of Lepidoptera in one of the wildlife sanctuaries in Misamis Oriental (Guadaluiver *et al.* 2019) and Mt. Hamiguitan (Mohagan & Treadway 2010).

As shown in Figure 2, the species rarefaction entails that sampling effort is still unachieved. Thus, observing additional species is still feasible by doing reassessment in the field and could lead to an increase in the overall butterfly richness. Not to mention that various uncaught morphologically distinct individuals were observed during the fieldwork that could mean a different species as well.

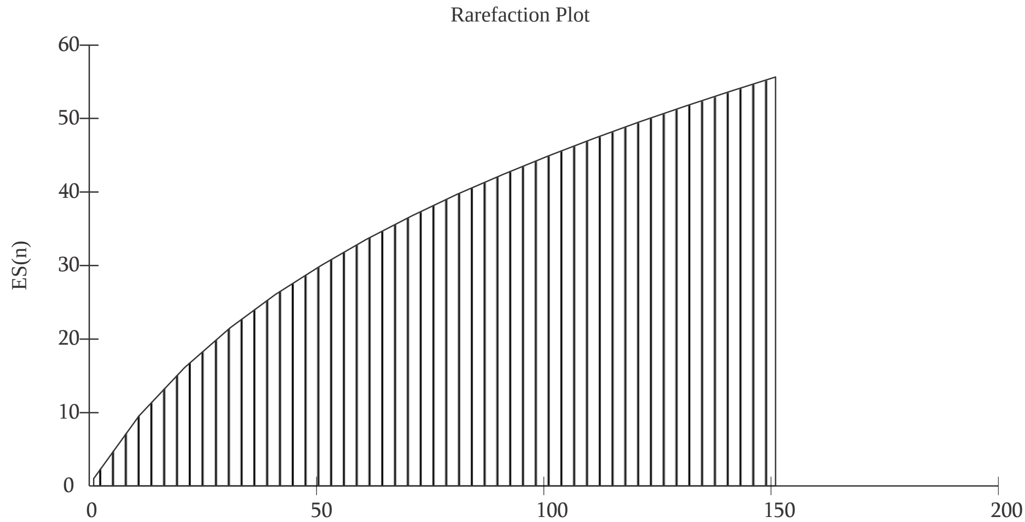

Figure 2 Butterfly species rarefaction plot in Awasian Water Forest Reserve

Ecological Profile of Butterflies across Habitats

In this study, 155 individuals of butterflies were captured. Butterfly abundance was higher in the Dipterocarp Forest, with 83 (53%) individuals than in the Agroecosystem with 72 (47%) individuals. In terms of species richness, Dipterocarp Forest had higher species-richness with 42 species while the Agroecosystem had only 34 species. Diversity index (H') and species evenness (J') were relatively higher in Dipterocarp Forest (H'=1.49; J'=0.93) compared to those in Agroecosystem (H' = 1.39; J' = 0.90) (Table 2). These consistent results suggest that the Dipterocarp Forest has better ecological support for the survival of the butterflies in the area. The Dipterocarp Forest was observed to have numerous flowering and fruiting plants during the sampling. This environmental set-up could have resulted in wider ecological support concerning food preference, unlike in the Agroecosystem, where limited resources were observed.

The result conforms with the report at Mt. Malindang (Ballentes 2006) and in the lowland forest at Maitum, Mt. Hilong-hilong (Ramirez & Mohagan 2012). The findings supported the idea that butterfly assemblage was more diverse in the Dipterocarp Forest than that in the Agroecosystem. This finding could be attributed to the diversity and abundance of butterflies which are highly correlated with the availability of food plants and assemblage of floral species in the surroundings (Kunte 2000; Stefenascu 2004; Ansari 2015). This common ground of findings is linked to the butterflies' voracious eating behavior, particularly in their larval stage, to meet the demand for nutrients in their fast development through the process of metamorphosis. Moreover, Schneider (2003) reported that the habitat characteristics and landscape structure influenced species abundance and richness, thus, supporting the variation of the result in this study.

Table 2 Ecological data of butterflies representing species richness, abundance, evenness, and diversity index in the two study areas

Habitat	Ecological Profile			
	Richness	Abundance	Shannon-Wiener Diversity Index (H’)	Evenness (J’)
• Agroecosystem	34	72	1.49	0.93
• Dipterocarp Forest	42	83	1.39	0.90
• Overall	57	155	1.58	0.90

The lesser diversity in the Agroecosystem is also attributed to the influence of human disturbance. The habitat was more vulnerable to anthropogenic activities compared to the situation in the Dipterocarp Forest since the Agroecosystem is nearer to human settlements. The butterflies are profoundly affected and endangered by land use and forest cultivation (Avigliano *et al.* 2019) because those activities affect the butterflies' continual survival by delimiting the needed resources, such as food and good habitat (Ozden *et al.* 2008). Hence, forest cultivated areas have comparatively low butterfly diversity than any other habitats (Malagrino *et al.* 2008; Laghude *et al.* 2019).

Among the documented species, *Acrophtalmia leto ochine* and *Euploea amulciber mindanensis* (Nymphalidae) and *Pachliopta mariae mariae* (Papilionidae) were the most abundant with 15, 10, and 12 individuals, respectively. Representatives of *A. leto ochine* were mostly seen in the Agroecosystem, particularly in the open fields and grasslands. In contrast, *P. mariae mariae* mainly were seen in the Dipterocarp Forest in an area with at least 50 - 70% canopy coverage and near the water systems. As for the *E. amulciber mindanensis*, samples of its population were equally observed in both habitats.

Species Assessment

Out of the 57 species recorded, only 21% (n = 12) of the butterfly species have International Union for Conservation of Nature assessment status (IUCN 2020), consisting of 5 (9%) Common Non-Endemic Species (CNES), 2 (4%) Rare Non-Endemic Species (RNES), 2 (4%) Common Philippine Endemic Species (CPES), 2 (4%) Rare Philippine Endemic Species (RPES), and 1 (2%) Common Mindanao Endemic Species (CMES). The Philippines national assessment levels were also carried out following Treadaway (1995) for 52 (91%) butterfly species. These were categorized into CNES (n = 28; 53%), RNES (n = 7; 13%), CPES (n = 5; 9%), RPES (n = 8; 15%), CMES (n = 2; 4%), and Rare Mindanao Endemic Species (RMES) (n = 1; 2%). It is noticeable that most of the species are unassessed globally and even some species nationally, thus, signifying the importance of the findings to the global and national platforms for the eventual global and national synopsis, especially on the local and national levels, because species assessment is considered important for any management planning on any forest reserves and protected areas (Haribon 2017; PEF 2008). As for the local assessment, 21 (37%) species were evaluated as CNES, 14 (25%) as RNES, 7 (12%) as CPES, 8 (14%) as RPES, 1 (2%) as CMES, and 2 (4%) as RMES (Fig. 3).

Other noteworthy findings are the observation of the rare species. Most importantly, the listing of the globally rare but observed to be locally common species such as *Jamides celeno lydanus* (Lycaenid), *Mycalesis mineus philippina* (Nymphalid), and *Eurema sarilalas arilata* (Pierid). The same pattern was observed for the following: *Jamides alecto manillana*, *Jamides philatu osias*, *J. celeno lydanus*, *Mycalesis micromede micromede*, *Mycalesis tagala semiraza*, *Ragadia melindena mindeninse*, and *Eurema sarilalas arilata*. These species were abundantly observed in the area but nationally assessed as a rare species. This observation entails that habitat has different dynamics, and it varies from one another and could support species in the various ecological spectrum. Thus, indicating every ecosystem is unique and requires different conservation measures.

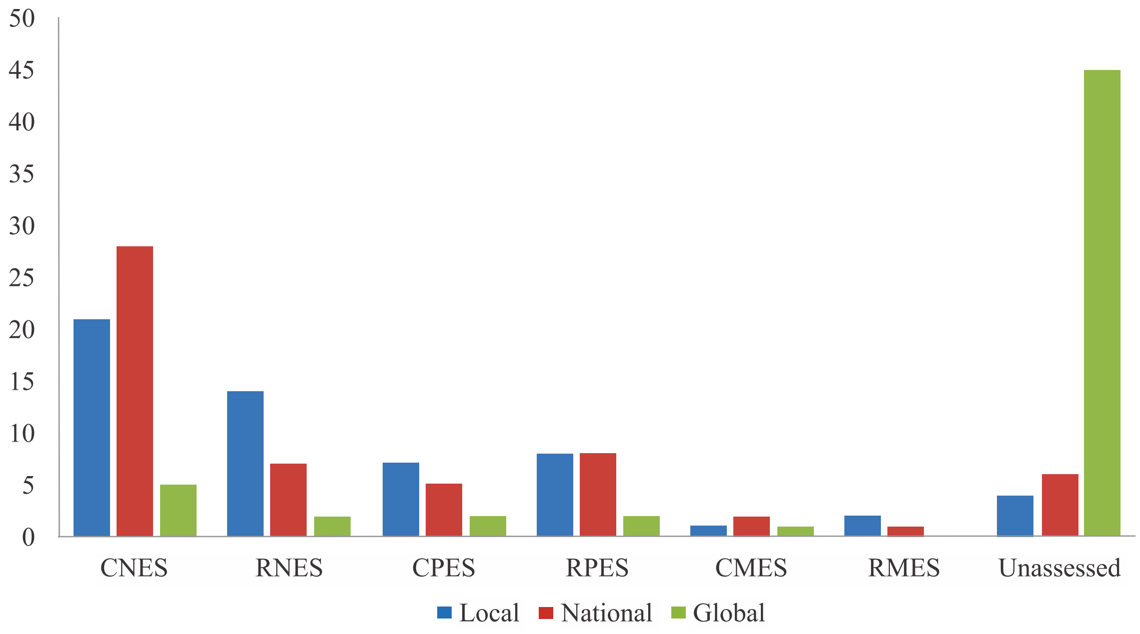

Figure 3 Distribution of butterfly status based on Global, National, and Local level of assessments
Notes: CNES = Common Non-Endemic Species; RNES = Rare Non-Endemic Species; CPES = Common Philippine Endemic Species; RPES = Rare Philippine Endemic Species; CMES = Common Mindanao Endemic Species; RMES = Rare Mindanao Endemic Species.

The overall percentage of endemism was 31%. The finding is comparatively higher compared to the records of Martinez and Mohagan (2012) at the adjacent forest of the study site with 22% endemicity. The same observation was noted compared to the findings of Nacua *et al.* (2015b) at La Union and Mohagan *et al.* (2018) at Mt. Pinamantawan with a percentage of endemism difference of 9 to 10%. As compared with the major forest reserves in the Philippines such as Mt. Malindang (Ballentes *et al.* 2006), Mt. Hamiguitan (Mohagan & Treadway 2010), and Mimbilisan Protected Landscape (Guadelquiver *et al.* 2019), the findings were observed to be closed with only 1 to 3% difference on its endemicity. This infers that the area is a relatively preferable habitat for endemic species and is comparable with other pristine environments.

CONCLUSION

Based on the findings, Awasian Water Forest Reserve is home to various butterfly species and has good ecological support. These supports span from multiple factors, especially on the perspective of plant community structure, which is vital to the survival of the organisms. Endemism was relatively high as compared with other ecosystems and showed to be comparable with other pristine habitats. In the context of rarity, the habitat houses various globally and nationally rare species that require conservation attention.

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REFERENCES

Aluri JSR, Rao SP. 2002. Psychophily and evolution consideration of *Cadaba fructicosa* (Capparaceae). J Bombay Nat Hist Soc 99(1): 59-63.

Ansari NA, Ram J, Nawab A. 2015. Structure and composition of Butterfly (Lepidoptera: Rhopalocera) fauna in Surajpur wetland, National Capital Region, India. Asian J Conserv Biol 4(1): 43-53.

Arya MK, Dayakrishna CR. 2014. Species richness and diversity of Butterflies in and around Kumaun University, Nainital, Uttarakhand, India. J Entomol Zool Stud 2(3): 153-9.

Avigliano E, Rosso JJ, Lijtmaer D, Ondarza P, Piacentini L, Izquierdo M, …, Schenone N. 2019. Biodiversity and threats in non-protected areas: A multidisciplinary and multi-taxa approach focused on the Atlantic Forest. Heliyon 5(8): e02292.

Ballentes M, Mohagan A, Gapud V, Espallardo MC, Zarcilla M. 2006. Arthropod Faunal Diversity and Relevant Interrelationships of Critical Resources in Mt. Malindang, Misamis Occidental. Manila (PH): Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA). 1-166 p.

BirdLife International. 2020. Important Bird Areas Factsheet: Mount Hilong-hilong. Downloaded from http://www.birdlife.org on 30/03/2020.

Bisson J, Guiang ES, Walpole P, Tolentino D. 2003. Better governance critical to reversing forest degradation trends in Southeast Asia. Paper presented in the XII World Forestry Congress, Quebec City, Canada. p. 21-8.

Braby M. 2016. The complete field guide to butterflies of Australia. Clayton South (AU): CSIRO Publishing. 84-5 pp.

Brook B, Navjot W, Sodhi S, Bradshaw CJJA. 2008. Synergies among extinction drivers under global change. Trends Ecol Evol 23(8): 453-60.

Castro A, Espinosa CI. 2015. Seasonal diversity of butterflies and its relationship with woody-plant resources availability in an Ecuadorian tropical dry forest. Trop Conserv Sci 8(2): 333-51.

Ehrlich PR, Hanski I. 2004. On The Wings of Checkerspots: A Model System for Population Biology. New York (US): Oxford University Press. 371 pp.

Guadalquiver DM, Nuñeza OM, Dupo AL. 2019. Species Diversity of Lepidoptera in Mimbilisan Protected Landscape, Misamis Oriental, Philippines. Entomol Appl Sci 6(3): 33-47.

Haribon. 2017. Site Profile: Mt. Hilong-hilong, Caraga Region, Philippines. Forest Governance Project: Strengthening Non-state Actor Involvement in Forest Governance in Indonesia, Malaysia, Philippines and Papua New Guinea. 1-4 pp.

Haroon YFM, Khan Z, Perveen F, Rafi MA, Shah SW, Su XH, Xing L. 2020. Biodiversity of Butterflies in Tangi Charsadda, Khyber Pakhtunkhwa, Pakistan. Pak J Zool 52(3): 835-41.

Harsh S, Jena J, Sharma T, Sarkar PK. 2015. Diversity of butterflies and their habitat association in four different habitat types in Kanha-pench corridor, Madhya Pradesh, India. IJAR 3(1): 779-85.

Hilty J. 2013. Insect visitors of Illinois wildflowers. World Wide Web electronic publication. Illinoiswildflowers.info. Version (01/2013) Verified, 2(13).

IUCN. 2020: The IUCN Red List of Threatened Species. http://www.iucnredlist.org/

Koneri R, Maabuat PV. 2016. Diversity of Butterflies (Lepidoptera) in Manembo-Nembo Wildlife Reserve, North Sulawesi, Indonesia. Pak J Biol Sci 19(5): 202-10.

Kunte KA. 2000. Butterflies of Peninsular India. Indian Academy of Sciences. Hyederabad (IN): Universities Press (India) Ltd. 254 pp.

Laghude R, Khobragade B, Irungbam JS. 2019. Species Diversity of Butterflies in Moderately Disturbed Forests and Along Forest Edges–A Case Study of Karjat, Distict Ahmednagar, Maharashtra, India. Uttar Pradesh Journal of Zoology 40(4): 214-21.

Opler PA, Lotts K, Naberhaus T. 2017. Butterflies and Moths of North America. Bozeman (MT): Big Sky Institute. http://www.butterfliesandmoths.org/

Malagrino G, Lagunas M, Rubio AO. 2008. Environmental impact reduction through ecological planning at Bahia Magdalena, Mexico. J Environ Biol 29(2): 179.

McAleece N, Gage JDG, Lambshead PJD, Paterson GLJ. 1997. BioDiversity Professional statistics analysis software. Jointly developed by the Scottish Association for Marine Science and the Natural History Museum London.

Mohagan AB, Treadaway CG. 2010. Diversity and status of butterflies across vegetation types of Mt. Hamiguitan, Davao Oriental, Philippines. Asian J Biodiv 1(1): 121-48.

Mohagan AB, Remulta SGB, Mohagan DJB, Mohagan DP, Amoroso VB, Porquis HC, Escarlos Jr, JA. 2018. Species composition and status of butterflies across vegetation types in Mt. Pinamantawan Sto. Domingo, Quezon, Bukidnon, Philippines. Asian J Biodiv 9(1): 116-35.

Mohagan DP, Tambuli AE, Mohagan AB. 2011. Diversity of butterflies in the selected key biodiversity areas of Mindanao, Philippines. Asian J Biodiv 2(1): 121-48.

Municipal Planning and Development Office (MPDO) Tandag. 2004. Executive Summary. pp 1, 5, 9.

Munyuli MBT. 2012. Butterfly diversity from farmlands of Central Uganda. Psyche: A Journal of Entomology 2012: 1-23.

Myers N, Mittermeier RA, Mittermeier CG, Da Fonseca GA, Kent J. 2000. Biodiversity hotspots for conservation priorities. Nature 403(6772): 853-8.

Nacua A, Mohagan A, Alejandro GJ. 2015a. Diversity and distribution of butterflies in the open and close canopy forests of Cadaclan, San Fernando La Union botanical garden of North Luzon, Philippines. J Biodiv Environ Stud 6(1): 169-77.

Nacua AE, Mohagan AB, Alejandro GJD. 2015b. Species composition and status of butterflies in the sunny and shady habitats of Cadaclan, San Fernando, La Union Botanical Garden of North Luzon, Philippines. IAMURE International Journal of Ecology and Conservation 13(1): 63-81.

Nacua AE, Clemente KJE, Soriano CJM, Oro ALB, Tosoc NRN, Manalo JR, Zapanta MRG, Empasis MGDC, Mendoza MJE. 2017. The species composition of butterflies (Lepidoptera: Rhopalocera) in Lipa city, Batangas, Philippines. J Entomol Zool Stud 5(2): 531-6.

Nair AV, Mitra P, Bandyopadhyay SA. 2014. Studies on the diversity and abundance of butterfly (Lepidoptera: Rhopalocera) fauna in and around Sarojini Naidu College campus, Kolkata, West Bengal, India. J Entomol Zool Stud 2(4): 129-34.

Ozden Í, Ciesla WM, Fuller WJ, Hodgson DJ. 2008. Butterfly diversity in Mediterranean Islands and in Pentadaktylos Pinusábrutia forests of Cyprus. Biodiv Conserv 17(12): 2821-32.

Paria S, Bhattacharyya M, Halder MP, Chakraborty SK. 2017. Positive impact of bio-invasive host plant on butterfly diversity: The other side of the coin. ZSI ENVIS Newslett 23(1): 5-9.

Philippine Eagle Foundation (PEF). Conservation International Philippines, Department of Environment and Natural Resources (DENR). 2008. Eastern Mindanao Biodiversity Corridor Conservation Framework, Davao City, Philippines. 1-52 pp.

Pyke GH, Ehrlich PR. 2010. Biological collections and ecological/environmental research: A review, some observations and a look to the future. Biological Reviews 85: 247-66.

Ramirez RKC, Mohagan AB. 2012. Diversity and status of butterflies in Maitum Village, Tandag, Surigao del Sur, Philippines. Asian J Biodiv 3(1): 74-112.

Sarkar VK, Sukumar DD, Balakrishnan VC, Kunte K. 2011. Validation of the reported occurrence of *Tajuria maculata*, the spotted royal butterfly (Lepidoptera: Lycaenidae), in the Western Ghats, Southwestern India, on the basis of two new records. Journal of Threatened Taxa (JoTT) 3(3): 1629-32.

Schneider C. 2003. The influence of spatial scale on quantifying insect dispersal: An analysis of butterfly data. Ecol Entomol 28(2): 252-6.

Serengil Y, Augustaitis A, Bytnerowicz A, Grulke N, Kozovitz AR, Matyssek R, ..., Paoletti. 2010. Adaptation of forest ecosystems to air pollution and climate change: A global assessment on research priorities. iForest-Biogeosciences and Forestry 4(2): 4448.

Stefanescu C, Herrando S, Páramo F. 2004. Butterfly species richness in the north‐ west Mediterranean Basin: The role of natural and human‐ induced factors. J Biogeogr 31(6): 905-15.

Storch D, Konvicka M, Benes J, Martinková J, Gaston KJ. 2003. Distribution patterns in butterflies and birds of the Czech Republic: Separating effects of habitat and geographical position. J Biogeogr 30(8): 1195-205.

Sumagaysay JB, Sumagaysay CJL. 2012. Biodiversity and status of butterflies in the vicinity of Mountain View College, Mt. Nebo, Valencia City. Asian J Biodiv 3(1): 142-55.

Thomas JA. 2005. Monitoring change in the abundance and distribution of insects using butterflies and their indicator groups. Philos Trans R Soc Lond B Biol Sci 360: 339-57.

Toledo JMS, Mohagan AB. 2011. Diversity and status of butterflies in Mt. Timpoong and Mt. Hibok-hibok, Camiguin Island, Philippines. JPAIR Multidisciplinary Journal 6: 103-16.

Treadaway CG. 1995. Checklist of the butterflies of the Philippine Islands (Lepidoptera: Rhopalocera). Nachr ent Ver Apollo 14: 7-118.

Treadaway CG. 2012. Revised checklist of the butterflies of the Philippine Islands (Lepidoptera: Rhopalocera). Nachr entomol Apollo Suppl 2012 (20): 1-64.

Widhiono I. 2015. Diversity of butterflies in four different forest types in Mount Slamet, Central Java, Indonesia. Biodiversitas 16(2): 196-204.

Zapanta MRG, Victoria JV, Del Rosario MPN, Empasis MGD, Gasat VJP, Bonoan JM, ..., Nacua AE. 2016. Diversity of butterflies (Rhopalocera) in Bulusukan (San Ildelfonso, Bulacan, Philippines). International Journal of Advanced Engineering, Management and Science (IJAEMS) 2(9): 1477-83.