SPECIES

To Cite:
Kuan J, Mohagan DP, Mohagan AB. Species composition and status of Hawkmoths (Lepidoptera: Sphingidae) in the Agroecosystem and Man-Made Mini Understory of Bayabason, Maramag, Bukidnon, Philippines. *Species* 2023; 24: e67s1570
doi: https://doi.org/10.54905/disssi.v24i74.e67s1570

Author Affiliation:
[1]Undergraduate Student, Central Mindanao University, Maramag, Bukidnon, Philippines
Email: s.kuan.jeanne@cmu.edu.ph
[2]University Museum, Central Mindanao University, Maramag, Bukidnon, Philippines
Email: Mohagand70@gmail.com
[3]Faculty of the Biology Department, Central Mindanao University, Maramag, Bukidnon, Philippines
Email: almohagan@gmail.com

Peer-Review History
Received: 10 June 2023
Reviewed & Revised: 14/June/2023 to 20/July/2023
Accepted: 24 July 2023
Published: 27 July 2023

Peer-Review Model
External peer-review was done through double-blind method.

Species
pISSN 2319–5746; eISSN 2319–5754

Species composition and status of Hawkmoths (Lepidoptera: Sphingidae) in the Agroecosystem and Man-Made Mini Understory of Bayabason, Maramag, Bukidnon, Philippines

Jeanne Kuan[1], **Dave P Mohagan**[2], **Alma B Mohagan**[2, 3]

ABSTRACT

Hawkmoths are referred to as Sphinx moths, as they belong to family Sphingidae family, they play a vital role as ecological indicators and they exhibit remarkable diversity across the globe, with the exception of Antarctica and Greenland. In Bayabason, Maramag, Bukidnon, the chosen habitat types include a semi-urban agroecosystem disturbed area and a man-made understory garden, which have not been previously studied and there are no reported studies in this area. A light trap sampling technique was employed involving the use of a 4x4 white cloth and a 500-watt bulb in two habitat types. A total of eight species from eight genera were documented, none of which were endemic to the Philippines. The findings revealed eight species classified as very rare locally, seven species categorized as common, and only one species was considered rare on a national status. This study highlights the necessity for further research and an extended duration of time for the light-trapping sampling method to capture the full diversity of these species.

Keywords: Hawkmoths, Bayabason, Light trap, Disturbed area, Man-made

1. INTRODUCTION

Hawkmoths scientifically referred to as Sphingidae or Sphinx Moths are important ecologically as they serve as indicators of a biologically rich environment, pollinators, biomass convertors and source of drugs but are naturally impacted by environmental pressures. They are found across a broad range spanning Southeast Asia (Mohagan et al., 2019). They are known for their captivating charm and wide-ranging variety, also they have received extensive global attention in scientific studies (Norbu et al., 2022). The family Sphingidae exhibits remarkable diversity, with 1700 species (Miller et al., 2022) documented under 205 genera that are distributed in the entire globe (Kitching et al., 2018) except Antarctica and Greenland (Moré et al., 2005).

DISCOVERY SCIENTIFIC SOCIETY

A total of 118 species of hawkmoths have been documented in the Philippines, with the highest number of species found on the islands of Palawan (73 species), Luzon (72 species), Mindanao, Leyte, and Negros (62 species each). The highest concentration of endemic species is observed on Luzon, accounting for 71% of the total endemic species in the Philippines, followed by Mindanao (58%), Negros (50%), and Leyte (46%). Despite having a high species count, Palawan exhibits a low percentage of endemic species (8%) due to its close relationship with the Bornean fauna (Hogenes and Treadaway, 1998).

Hawkmoths predominantly consist of species that primarily feed on nectar and display minimal selectivity, making them an incredibly significant group of pollinators (Johnson et al., 2016). Bayabason, previously known as spring, is a barangay situated within the municipality of Maramag, in the province of Bukidnon. It was originally a lowland forest with Bayog, Narra and Molave trees were very abundant at the largest DBH of 1.0-2.0 m. There was also a portion which was a Bonsai Forest dominates with guavas of different mesocarp colors. Sad to say that currently all are replaced with all domesticate plants that includes Coconut, Corn, Rice, Sugarcane, Marang, Jackfruit trees, Camote, Gabi, Sayote and other plants.

Bayabason is a dry place after deforestation because it is hilly; the rains are drain rapidly to Kulaman River in the south, Jugacob Creek in the north and Pulangi River in the east. Despite the existence of substantial research on Hawkmoth species conducted in Mindanao, it remains imperative to pursue further investigation. This is justified by the limited extent of endeavors dedicated to the preservation and conservation of Hawkmoths, both on a local and international scale.

Furthermore, majority of published articles tend to concentrate their conservation actions in naturally forested areas, this particular study takes a different approach by examining the disturbed habitat types the semi-urban agro- ecosystem, a very disturbed area and the man-made understory garden at the mini manmade forest. It is worth noting that, as of now, there are no existing records or published studies documenting the presence and status of Hawkmoths in the specific habitat type of Bayabason, Maramag, Bukidnon.

2. MATERIALS AND METHODS

Study sites

The field collection took place in two chosen habitats located in Bayabason, Maramag, Bukidnon (Figure 1). These habitats were specifically the semi-urban agroecosystem disturbed area (Figure 2) and the man-made mini understory garden (Figure 3). The collection period spanned from June 27 to June 28, 2023. The coordinates of the study area were approximately 125.0139°E, and the elevation stood at 376.3 meters or 1,234.5 feet above mean sea level. The semi-urban agro ecosystem disturbed area is characterized by the prevalence of marang trees, mango trees, banana, and various other plants. The ground is covered with carabao grass, camote, and gabi are abundant.

On the other hand, the man-made understory garden is dominated by mango trees, pomelo, avocado, guyabano trees and the ground is covered with *Philodendron spp*, *Alocasia spp*, *Caladium,* and other genera of Araceae members or gabi family. It has 3 ponds occupied with *Polypedates leucomystax*, *Kaloula* sp. and Tilapia fish, there were also chickens in the surrounding and the temperature is relatively cooler than in the agroecosystem.

Entry Protocol

To conduct this study in Barangay Bayabason, Maramag, Bukidnon, the study area chosen was a privately owned land belonging to Dr Alma B Mohagan. Prior to conducting the collection, the researchers obtained consent from the owner to ensure permission to carry out the study on the specified land.

Collection and sampling techniques

Safety precautions were observed throughout the study by wearing personal protective equipment (PPE) such as long pants, boots, jackets, gloves, and a headlamp. The sampling sites were equipped with a light trap setup, which consisted of a 4x4 meter white silk cloth and a 500-watt bulb, adapted from (Mohagan et al., 2018). Two (2) selected habitats were established in Bayabason, Maramag, Bukidnon, and one (1) night was allocated for collecting Hawkmoth species in each habitat. The collected specimens were preserved in alcohol inside the triangular glassine papers with mothballs in the surrounding medium and mounting technique that was adapted from (Mohagan et al., 2019).

Species identification and assessment of ecological and local status

The identification of the collected specimens was conducted at the Zoology section of Central Mindanao University Museum, using the checklist provided by (Hogenes and Treadaway, 1998). The identified species were then confirmed by Mr Dave P Mohagan, the

Science Aide of the University Museum. The ecological status and endemism of the Hawkmoths were determined based on the checklist of (Hogenes and Treadaway, 1998). The local status of the gathered Hawkmoths was assessed using the checklist of (Mohagan and Treadaway, 2010).

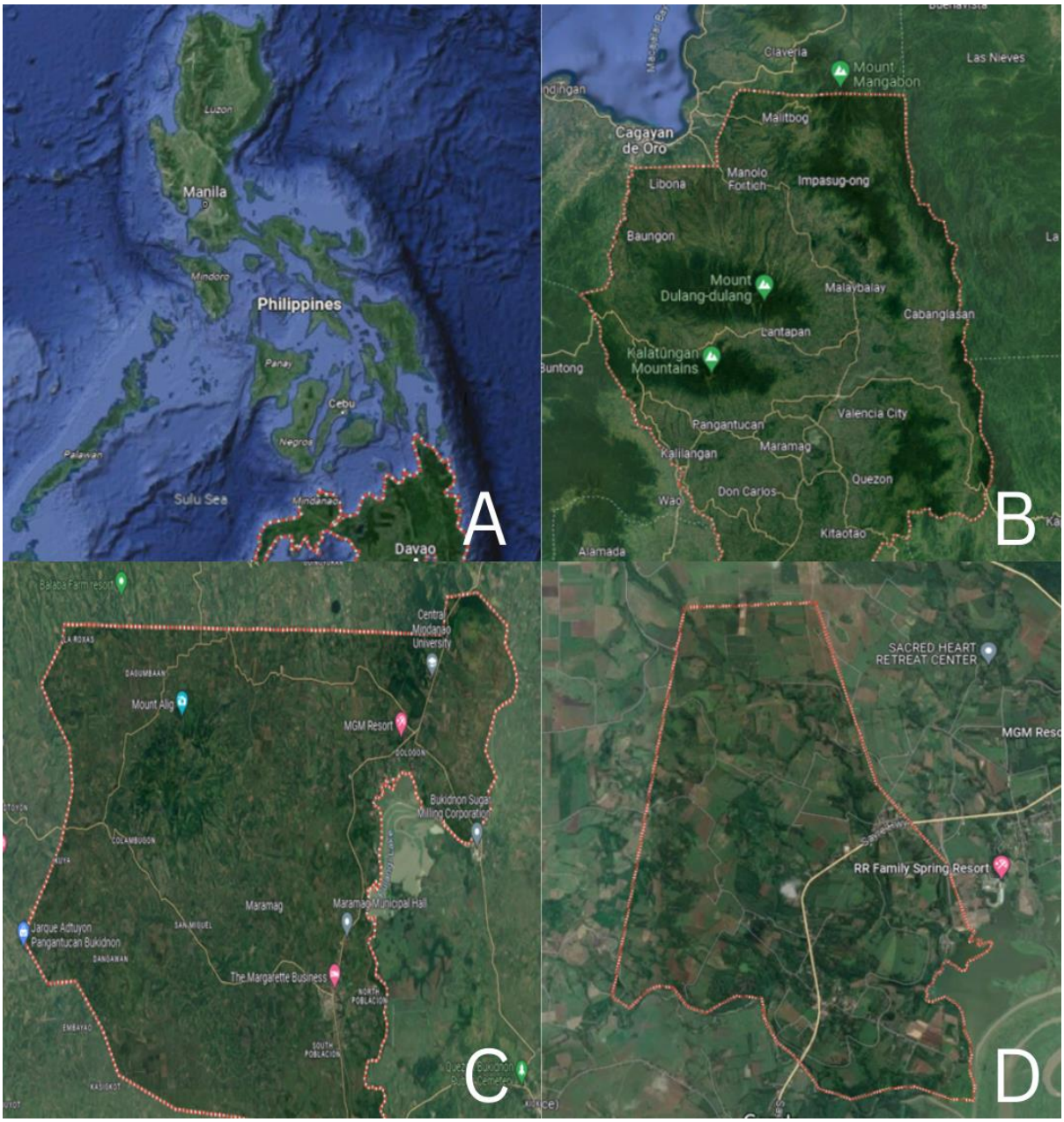

Figure 1 (A) Map of the Philippines, (B) Province of Bukidnon, (C) Municipality of Maramag and (D) Barangay Bayabason. Showing the location and grid coordinates (125.0139°E) (Photo courtesy: Google map)

Figure 2 Bayabason, Maramag, Bukidnon (Habitat 1): (A) Barangay Bayabason covered court disturbed area, (B) Light trap set-up in covered court facing the, (C) Semi-urban agro ecosystem

Figure 3 Bayabason, Maramag, Bukidnon (Habitat 2): (A) Man-made mini understory garden, (B) Light trap set up, (C) Pond inside the man-made mini understory garden

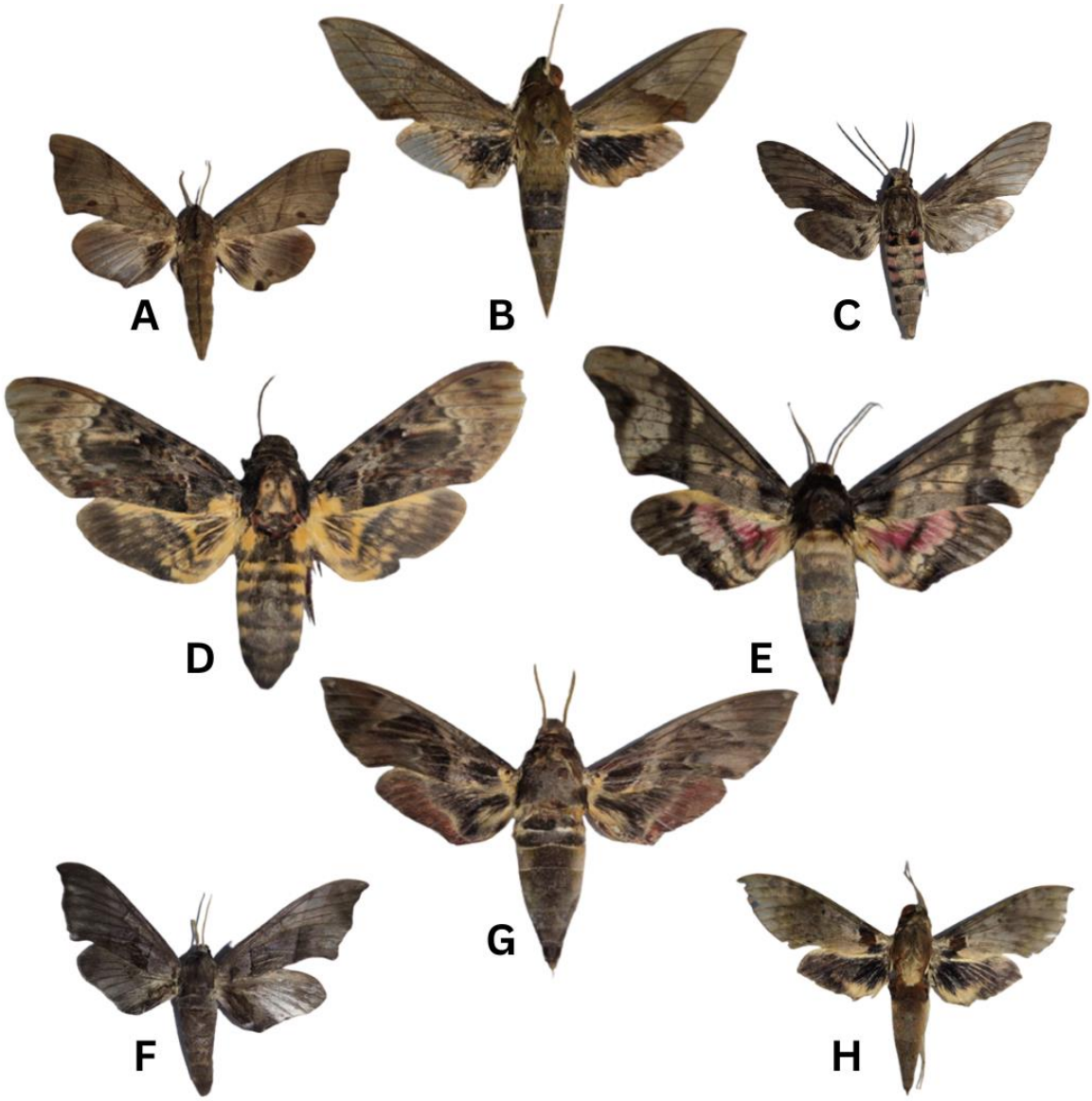

Figure 4 Hawkmoths of Semi-urban agroecosystem disturbed area (Dorsal view). (A) *Marumba amboinicus luzoni,* (B) *Theretra clotho clotho,* (C) *Agrius convolvuli,* (D) *Acherontia lachesis,* (E) *Amplypterus panopus panopus,* (F) *Polyptychus trilineatus philippinensis*, (G) *Daphnis hypothous hypothous, and* (H) *Cechenena helops helops*

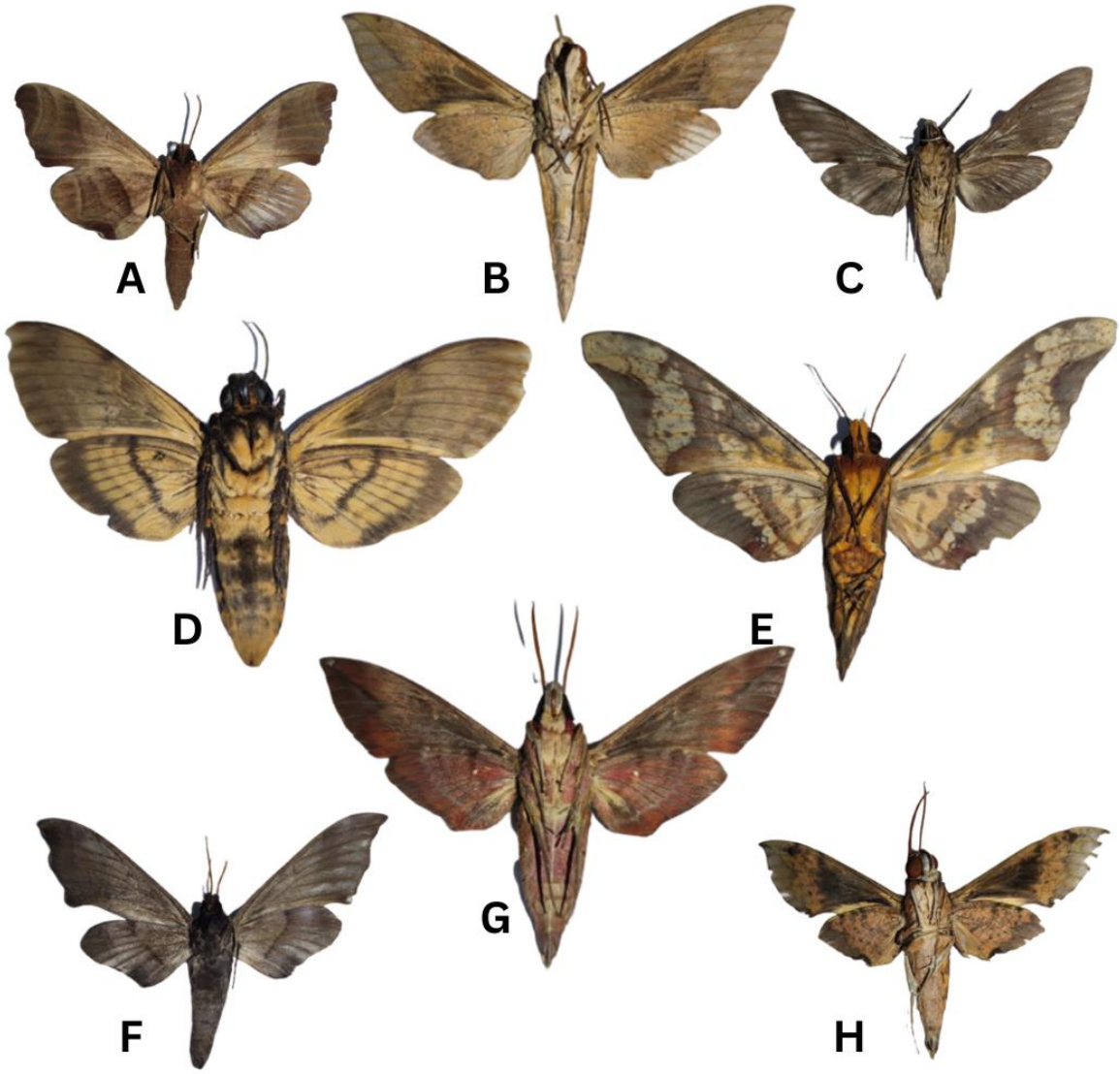

Figure 5 Hawkmoths of Semi-urban agroecosystem disturbed area (Ventral view). (A) *Marumba amboinicus luzoni,* (B) *Theretra clotho clotho,* (C) *Agrius convolvuli,* (D) *Acherontia lachesis,* (E) *Amplypterus panopus panopus,* (F) *Polyptychus trilineatus philippinensis*, (G) *Daphnis hypothous hypothous, and* (H) *Cechenena helops helops*

Figure 6 Hawkmoth larvae found in Man-made mini understory garden

3. RESULTS AND DISCUSSION

Hawkmoths species composition, ecological status, local status, and endemism

The study recorded a total of eight individuals, consisting of eight species and eight genera, in a disturbed Semi-urban agroecosystem area known as Habitat 1. These species include *Acherontia lachesis, Amplypterus panopus panopus, Cechenena helops helops, Agrius convolvuli, Daphnis hypothous hypothous, Mrumba amboinicus luzoni, Polyptychus trilineatus philippinensis, and Theretra clotho clotho.*

None of these species are endemic, and all of them are rare in the Bayabason, Maramag, Bukidnon area, with only one individual collected for each species. It appears that these recorded species, along with their host plants, prefer Habitat 1, especially within the agroecosystem area. Most of the documented species are wide range species, does do not requires a high-quality forest or pristine forest habitat in order to survive because their foodplants are just members of the Araceae family which are plenty in the farm, and many of them can be found across various Southeast Asian countries. Sphingidae, as a moth family, generally feeds on Araceae leaves (Holloway and Herbert, 1979).

There was no adult Sphingids documented in habitat 2 except for the larva. This may be due to the presence of anurans, that controls insect population in the area due to the ponds presence that makes anurans successful in the place making them the successful predators. The ponds somehow modified the ambience of the place simulating the conditions of the forest habitats. This is demonstrated also by Holloway and Herber, (1979). When they stated that variation data could be attributed to the individual response of these moths to the local environment, which is influenced by their membership in a specific ecological guild (Holloway and Herbert, 1979).

The absence of Hawkmoth species in habitat 2, which is a man-made understory garden, demonstrated a balance habitat where anurans play their role in controlling insect pest population. It could be beyond imagination if they will be very abundant in the place. Maybe the understory plants which are mainly Araceae may become bald of plants. Instead, only a few individuals of noctuid moths have been observed. The limited penetration of light in the deep areas of the understory garden might somehow affect also or it could be the brightness of nearby lights in the highways and neighboring houses.

The stronger factor to consider is that the habitat is predominantly occupied by amphibians. Amphibians hold great ecological significance in the ecosystem as insect predators, as they fulfill a crucial role in the food chain by regulating insect populations. There were so many tadpoles and adult amphibians in the ponds at the man-made understory garden. They act as natural indicators also of ecosystem's health, providing valuable insights into the overall well-being of the ecosystem (Hocking and Babbitt, 2014).

There were times in the previous years without the pond and amphibians in the said place that mosquitoes were very abundant especially in the month of July but at this present time mosquitoes were nowhere to found in the area due to amphibians and other reptiles present as the biodiversity status of animals were also enhance. Odonatas are also present in the area. The result of this study may be considered preliminary, and that seasonality might have influence too and the duration of sampling, elevation, vegetation of the sampling area, wattage of the bulb, availability of the foodplants and type of habitat. The data below may help us understand of the results we have for the area (Table 1) (Figure 7).

Table 1 Comparison of Sphingid data from different sites of Mindanao

Sampling Areas	No. of Species	Sampling Effort	Types of habitat	Dominant vegetation	Weather during sampling	Bulb wattage used	Size of light sheet
Mt. Hamiguitan Wildlife Sanctuary, Davao Oriental (Mohagan et al., 2018)	22	2 entire nights in each vegetation type	Busay garden, Eco-park, Camp 3, Black mountain	Mt. Hamiguitan Eco-park sote 1 and Busay garden	Light rain	500w	not stated
Mt. Hamiguitan Range Wildlife Sanctuary, Davao Oriental (Mohagan et al., 2019)	8	7 nights	Sitio Tagtigcup and Ecopark of Mansinagan	There were no difference between vegetation types	Tagticup – rainy and wet Mansinangan – sunny and dry	250w	3x4 m
Bacusanan, Pangantucan, Bukidnon (Suelo and Mohagan, 2021)	13	-	Agroecosystem	Agroecosystem	Foggy with starry night	500w	3x3 m
Mt. Agad-Agad, Iligan City (Mohagan et al., 2022)	6	60 light trapping hours	Upper and lower Mt. Agad-Agad	Lower elevation	Windy and rainy	500w	2x3 m
Mt. Kitanglad, Sumilao, Bukidnon (Suelo et al., 2023)	7	-	Agroecosystem and Montane Forest	Montane forest	Heavy to moderate rainfall, thick fogs, cold temperature, strong wind, full moon	500w	4x2 m
Mt. Musuan (Mohagan et al., 2023)	14	2 nights each vegetation site	Mt. Musuan base and Mt. Musuan peak	Mt. Musuan lower elevation (base)	Light rain	500w	4x4 m

This study shares a similar number of recorded species with the study conducted by Mohagan et al., (2019) in the two proposed expansion sites of Mt. Hamiguitan Range Wildlife Sanctuary in Davao Oriental. The main difference lies in the lower species count observed when using a light trap for seven nights, as compared to the collection of only 8 species in Bayabason, Maramag, Bukidnon, which was achieved on the first day of the light trap. On the other hand, a higher species composition was documented in the study by Mohagan et al., (2023) at the LTER Site of Mt. Musuan, Bukidnon, Philippines, where a total of 14 species comprising 44 individuals were recorded.

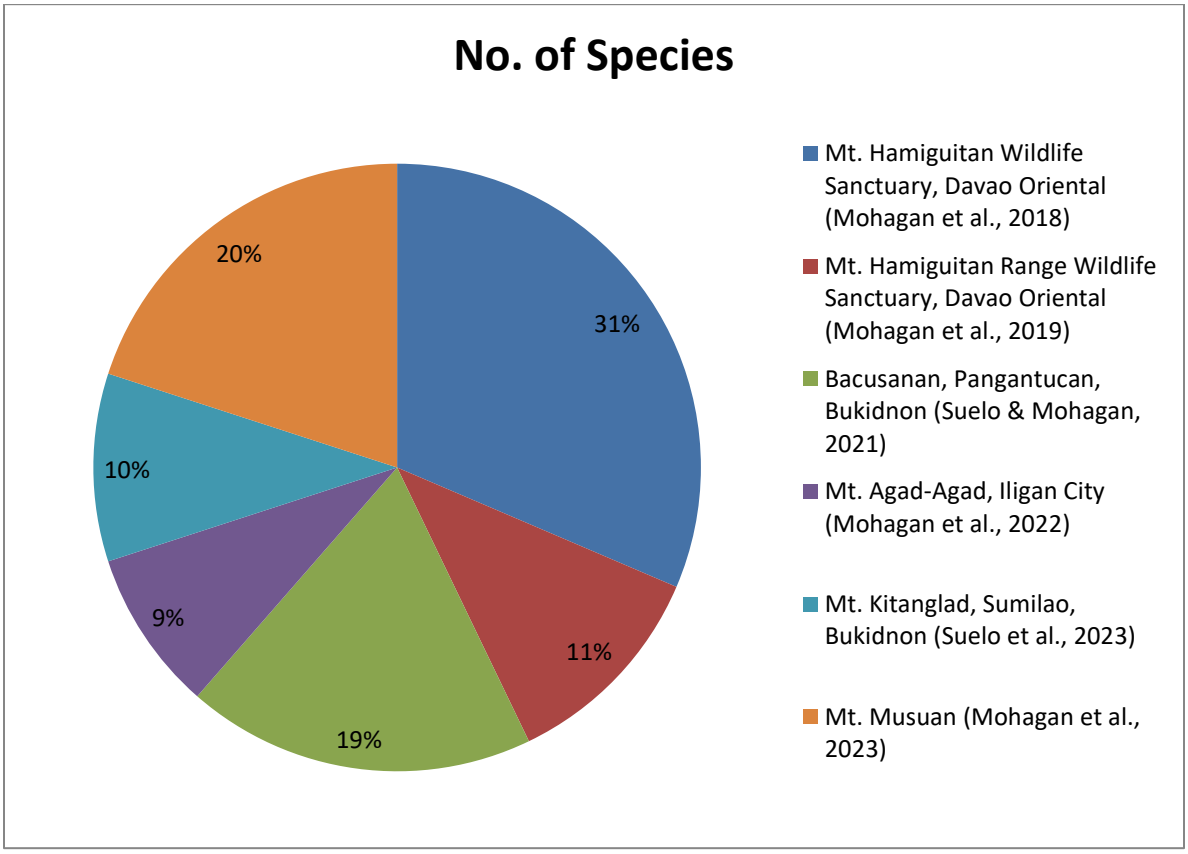

Figure 7 The richness of Sphingids in different sampling sites

Table 2 Species composition, abundance, status, endemism, and distribution of Hawkmoths in Semi-urban agroecosystem & very disturbed area and man-made understory garden, Bayabason, Maramag, Bukidnon, Philippines

S.no	Species	Site 1 (SUADA)	Site 2 (MMUG)	Local Status	National Status	Endemism	Distribution
1	*Acherontia lachesis* (FABRICIUS 1798)	1	0	Very rare	Common	-	Bal, Ceb, Ley, Luz, Mar, Mdo, Mno, Neg, Pal, Pan, Pol, Sam
2	*Amplypterus panopus panopus* (CRAMER 1779)	1	0	Very rare	Rare	-	Bon, Pal
3	*Cechenena helops helops* (WALKER 1856)	1	0	Very rare	Common	-	Bal, Din, Ley, Luz, Mar, Mdo, Mno, Neg, Pal, Pan, Sam, Siq
4	*Agrius convolvuli* (LINNAEUS 1758)	1	0	Very rare	Common	-	Bal, Boh, Cal, Ceb, CmM, Din, Jol, Ley, Luz, Mdo, Mno, Neg, Pal, Pan, Sam, Sga, Siq
5	*Daphnis hypothous hypothous* (CRAMER 1779)	1	0	Very rare	Common	-	Bal, Boh, Ceb, Hom, Jol, Ley, Luz, Mdo, Mno, Neg, Pal, Pan, Pol, Sam, Sga
6	*Mrumba amboinicus luzoni* (CLARK 1935)	1	0	Very rare	Common	-	Bab, Boh, Ceb, Din, Jol, Ley, Luz, Mar, Mdo, Mno, Neg, Pan, Sam, Sib, Siq
7	*Polyptychus trilineatus philippinensis* (ROTHSCHILD & JORDAN 1903)	1	0	Very rare	Common	-	Boh, Ceb, Ley, Luz, Mno, Neg, Pan, Siq
8	*Theretra clotho clotho* (DRURY 1773)	1	0	Very rare		-	Bal, Boh, Bon, Ceb, Dum, Jol, Ley, Luz, Mas, Mdo, Mno, Neg, Pal, Pan, Sam, Sib, Siq, Stu, Taw

Notes: SUADA = Semi-urban Agroecosystem disturbed area, MMUSG = Man-made Understory Garden

Legend: Bab – Babuyanes
Bal – Balabac
Boh – Bohol
Bon – Bongao
Cal – Calamian
Cat – Catanduanes
Ceb - Cebu
CmM – Camiguin de Mindanao
Din – Dinagat
Dum – Dumaran
Dum – Dumaran
Ley – Leyte
Luz – Luzon
Din - Dinagat
Dum – Dumanon
Mar - Marinduque
Mas – Masbate
Mdo – Mindoro
Mno – Mindanao
Neg - Negros
Pao - Panaon
Pal - Palawan
Pan - Panaywan
Pol – Polilo Island
Sam - Samar
Sga - Sarangani
Sib - Sibuyan
Siq - Siquijor
Stu - Sibutuc
Jol - Jolo
Tw – Tawi-Tawi
Tic - Ticao

(Hogenes and Treadaway, 1998).

4. CONCLUSIONS

In Bayabason, Maramag, Bukidnon, Philippines, a total of 8 species of Sphingids were documented. Out of these 8 species, only one is classified as rare in terms of its ecological status. The local assessment revealed that 8 species are considered very rare locally, namely: *Acherontia lachesis, Amplypterus panopus panopus, Cechenena helops helops, Agrius convolvuli, Daphnis hypothous hypothous, Mrumba amboinicus luzoni, Polyptychus trilineatus philippinensis, and Theretra clotho clotho.* The results suggest that a balance ecosystem will reduce harmful and pest insect population and restoration of the ecosystem near to original state is a must action.

Conflicts of interests

The authors declare that there are no conflicts of interests.

Ethical approval

In this article, as per the animal regulations in Central Mindanao University, Maramag, Bukidnon, Philippines, the authors observed Hawkmoths (Lepidoptera: Sphingidae) species composition in the Agroecosystem and Man-Made Mini Understory of Bayabason, Maramag, Bukidnon, Philippines. The Animal ethical guidelines are followed in the study for species observation, identification & experimentation.

Funding

The study has not received any external funding.

Data and materials availability

All data associated with this study are present in the paper.

REFERENCES AND NOTES

1. Hocking DJ, Babbitt KJ. Amphibian contributions to ecosystem services. Herpetol Conserv Biol 2014; 9(1):1-17.
2. Hogenes W, Treadaway CG. The Sphingidae (Lepidoptera) of the Philippines. Nachr Entomol Ver Apollo Suppl 1998; 17:17–132.
3. Holloway JD, Herbert PDN. Ecological and taxonomic trends in macrolepidopeteran host plant selection. Biol J Linn Soc 197 9; 11:229-251.
4. Johnson SD, Moré M, Amorim FW, Haber WA, Frankie GW, Stanley DA, Coccuci AA, Raguso RA. Plant-pollinator interactions from flower to landscape. The long and the short of it: A global analysis of hawkmoth pollination niches andinteraction networks. Funct Ecol 2016; 31(1):101-115.
5. Kitching I, Rougerie R, Zwick A, Hamilton C, St Laurent R, Naumann S, Ballesteros Mejia L, Kawahara A. A global checklist of the Bombycoidea (Insecta: Lepidoptera). Biodivers Data J 2018; 6:e22236. doi: 10.3897/BDJ.6.e22236
6. Miller JY, Matthews DL, Gott RJ. Three new species of Cautethia Grote (Lepidoptera: Sphingidae) from the Lucayan Archipelago and keys to West Indies species. Zenodo (CERN European Organization for Nuclear Research) 2022. doi: 10.52 81/zenodo.7167978
7. Mohagan AB, Amoraso V, Coritico F, Guiang MMM, Nuñeza OM, Anches H, Jebulan H, Maglangit E, Patano R Jr. Species Composition and Assessment of Sphingidae in Mt. AgadAgad, Iligan City, Philippines. J Trop Life Sci 2021; 12(1) :131–140. doi: 10.11594/jtls.12.01.14

8. Mohagan AB, Kuan JC, Abrea BV, Magdula M, Ondap DJ, Mohagan DP, Hongco A, Coritico F, Amoroso VB. Species composition, local status and endemism of sphingidae moths in the two vegetation types of Mt. Musuan, long-term ecological research site, bukidnon, philippines. Int J Appl Sci Res 2023; 06(02):83–92. doi: 10.56293/ijasr.2022.5509
9. Mohagan AB, Treadaway CG. Diversity and Status of Butterflies across Vegetation Types of Mt. Hamiguitan, Davao Oriental, Philippines. Asian J Biodivers 2010; 1(1). doi: 10.7828/ajob.v1i1.99
10. Mohagan AB, Tubongbanua RM Jr, Amper DO, Hongco AL, Coritico FP, Gorme FS Jr, Amoroso VB, Colong RD, Ponce RG. Species Composition, Endemism and Local Status of Hawkmoths (Heterocera: Sphingidae) in the two proposed expansion sites of Mt. Hamiguitan Range Wildlife Sanctuary, Davao Oriental, Philippines. Biol Forum 2019; 11(1):236-240.
11. Mohagan DJ, Solis E, Gorme F, Colong RM, Laraga SH, Doblas GZ, Paraguas KGS, Mohagan DP, Mohagan AB, Bergquist T. Hawkmoths (Heterocera: Sphingidae) diversity and Status on selected vegetation types of a protected natural forest (Mt. Hamiguitan Wildlife Sanctuary, San Isidro, Davao Oriental) and Ecotourist Area (Busay Garden Marilog District, Davao City) Philippines. Int J Curr Res Life Sci 2018; 7(09):2684-2690.
12. Moré M, Kitching IJ, Cocucci AA. Sphingidae: Esfingídeos de Argentina. Hawkmothsof Argentina. Buenos Aires: LOLA (Literature of Latin America) 2005; 184.
13. Norbu L, Thinley P, Jamtsho N, Dorji L, Tenzin P, Wangchuk T, Lhendup U, Dorji P, Dorji Z, Jamtsho K, Dorji T, Jamtsho T, Lodey S, Dechen U. Diversity of hawkmoths in Tashigang Forest Division, with new faunistic recordsfor Bhutan. J Animal Divers 2022; 4(3):10–22. doi: 10.52547/JAD.2022.4.3.3
14. Suelo M, Mohagan AB. Endemism of Sphinx Moth (Lepidoptera Sphingidae) in the Agroecosystem of Bacusanon, Pangantucan, Bukidnon, Philippines. Biodivers J 2021; 11(2):623–630. doi: 10.31396/biodiv.jour.2020.11.2.623.630
15. Suelo MS, Cruz RYD, Doblas GZ, Batbatan CG, Tubongbanua RM Jr, Cagas CL, Dargantes KSAT, Viernes RMP, Mohagan AB. Sphinx moths (Family Sphingidae): Species composition, local status and endemism in Mt. Kitanglad, Intavas, Sumilao, Bukidnon, Philippines. Species 2023; 24:e3s1003