Species

Sphinx moths (Family Sphingidae): Species composition, local status and endemism in Mt. Kitanglad, Intavas, Sumilao, Bukidnon, Philippines

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ABSTRACT

Family sphingidae known as sphinx moths or hakmoths plays a crucial role in the stability of terrestrial ecosystem. Philippines which is known as one of the 17 mega diverse countries comprises 118 species of sphinx moths. This study highlights the species composition, endemism and local status of sphinx moths of Mt. Kitanglad, Philippines. Three sites were employed namely agroecosystem, montane forest and dipterocarp forest. Light trapping technique was used to collect night flying moths. Twenty-two individuals which made up of even species belonging to six genera were recorded. Site 2 (montane forest) has the highest number of individuals collected (63.6%) followed by site 1 (agroecosystem- 27.2%) and site 3 (dipterocarp forest) with only 9.0%. Four species: *A socrates, C. decolor, D. hypothous* and *T. nessus* were found to be very rare while the remaining species are categorized as rare. Only one collected species namely *Ambulyx staudingeri* were found to be endemic in the Philippines.

Keywords: Sphingidae, Mt. Kitanglad, Agroecosystem, Montane Forest, Dipterocarp Forest

1. INTRODUCTION

Sphingidae is a member of the Superfamily Bombycoidea, Order Lepidoptera, Class Insecta and Phylum Arthropoda. Species of sphingidae are popularly known as hawkmoth because of sleek bodies, short wings and fast flying ability which are comparable to hawks (Stöckl & Kelber, 2019). Because they can hover around blooms and feed like hummingbirds, they are also known as hummingbird moths. On 1758, Linne' coined the term sphinx moth based on the

characteristic of larva rising up that serves as their defense position when frightened (Devi & Ramaraju, 2015; Messenger, 1997) as another name for the species of sphingidae. Hawkmoths are typically nocturnal and crepuscular and they are drawn to artificial light sources (Jonason et al., 2014). They employ their senses of smell and sight to locate and identify night blooming flowers, which are drawn to them by their potent scent and have muted hues like white or yellow (Kelber et al., 2003; Stöckl & Kelber, 2019; Messenger, 1997). Most sphingidae are very specialized, with each species designed to live in a given habitat that needs for their existence because of the presence of hostplant, as well as temperature, altitude, rainfall are other elements that also influences them in order to live (Rafi et al., 2014).

Family sphingidae are widely distributed around the world except Antarctica and Greenland which are known to have a very cold temperature (More et al., 2005; Devi & Ramaraju, 2015). Hawkmoth species exist in other countries like Brazil (31 species) (Primo et al., 2013), Taiwan (86 species) (Yen et al., 2003), Israel (21 species) (Muller et al., 2005), Pakistan (60 species) (Rafi et al., 2014), India (78 species) (Singh & Kaur, 2017), Turkey (34 species) (Akkuzu et al., 2007), Australia (65 species) (Moulds et al., 2020), South Africa (23 native species) (Johnson & Raguso, 2016) and United States (135 species) (Halloway et al., 2018). The range of hawkmoth species is impacted by geographical boundaries and climatic elements as maximum and lowest temperatures, rainfall, wind and length of season (Pittaway & Kitching, 2020). The transition between the dry and wet seasons has an effect on the cycles of host plant foliage that hawkmoth larvae may access, which in turn affects the seasonal occurrence of adults (Primo et al., 2013). Elevations may also have an impact on the species distribution of hawkmoths. According to a study by Mohagan et al., (2018), Mt. Hamiguitan's hawkmoth diversity is higher at lower elevations due to the growing gardens that may serve as their host plants.

Hawkmoth species comprises about 1,450 species (Singh & Kaur, 2017; Rougerie et al., 2014; Kawahara et al., 2009; Primo et al., 2013) all over the world with about 117 species (Hogenes & Treadaway, 1998) occurring in the Philippines plus the discovery of one new species (*Macroglossum malitum*) on the island of Palawan in Mt. Mantalingahan (Zwick & Treadaway, 2001). The island of Palawan has the most species (73), followed by Luzon (72), Mindanao, Leyte and Negros, each with 62 species. There are 24 endemic species in the Philippines and Luzon has the biggest percentage of them (71%), followed by Mindanao (58%), Negros (50%) and Leyte (46%).

Due of its well-understood taxonomy, quick reaction to environmental changes, and simple sampling method, moths are markers of a healthy environment (Hilty & Merenlender, 2000). Without them, the ecological services they provide and the other groups that rely on them in particular are impacted, which could lead to an imbalance in our environment (Mohagan et al., 2018; Young et al., 2017).

2. MATERIALS AND METHODS

Study Site

The study was conducted in Mt. Kitanglad, Intavas, Sumilao, Bukidnon (Figure 1). A gratuitous permit (No. R10 2019-14) acquired from the Department of Environment and Natural Resources (DENR) Region X as well as free and prior informed consent form was secured allowing us to collect our samples. Field collection was conducted in three vegetation types namely: Agroecosystem, montane forest and dipterocarp forest on December 3-8, 2022. Light trapping technique was used in the collection of sphinx moths on the site.

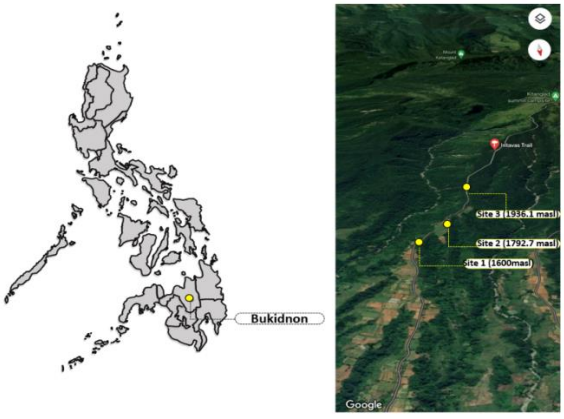

Figure 1 Study Site. A) Map of the Philippines (Bukidnon) B) Map of Mt. Kitanglad, Intavas Trail showing three sites (Site 1 Agroecosystem (8°10′12.82069″N, 124°56′10.29505″E), Site 2 Montane forest (8°10′4.48889″N, 124°55′59.70659″E) and Site 3 Dipterocarp forest (8°9′37.6146″N, 124°55′53.84557″E)

Establishment of the sampling site

Three sampling sites were selected based on increasing elevation and vegetation types. The first site (Figure 2A) were at agroecosystem (8°10′12.82069″N, 124°56′10.29505″E) with an elevation of 1748 masl. This site is surrounded with agricultural crops like sweet potato (*Ipomoea batatas*), cabbage (*Brassica sp.*) and pickles (*Capsicum annuum*). Trees like mahogany and olayan tree were also observed. Understory plants as well as several ferns were also seen. This site is prone to wind due to its open space, water source is available and the weather is humid. The second site is montane forest (8°10′4.48889″N, 124°55′59.70659″E) (Figure 2B) with an elevation of 1792.7 masl. The weather is foggy and with very cold temperature. Compared to site 1, this area is more diverse in terms of trees and other vegetations which could be a good potential host plants for sphinx moth's species. The third site is dipterocarp forest (8°9′37.6146″N, 124°55′53.84557″E) (Figure 2C) with an elevation of 1936.1 masl. Temperature at this site ranges from 13°C - 17°C. This site is foggy, windy and rainy.

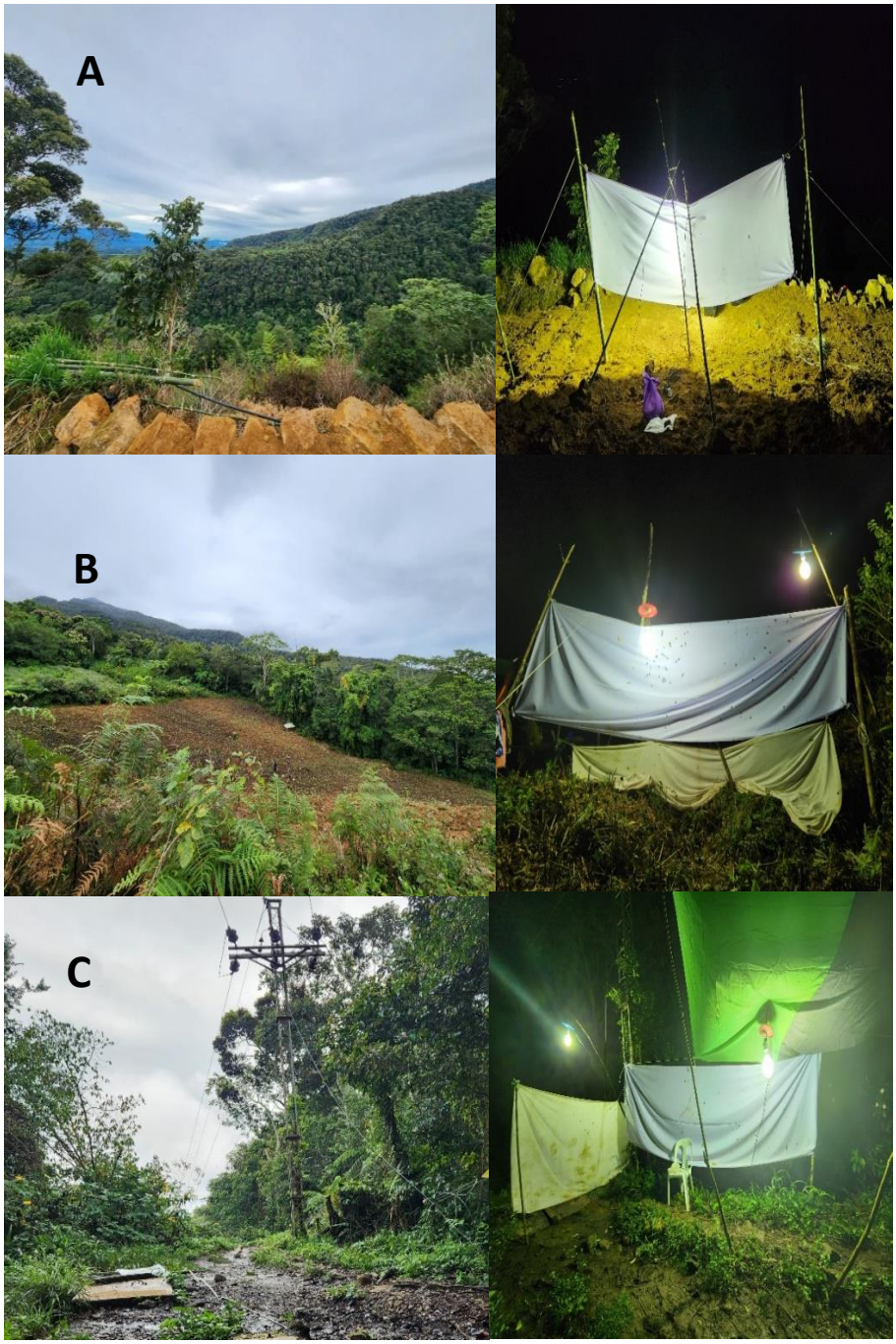

Figure 2 Sampling site and Light trapping technique A. Site 1 (Agroecosystem), B. Site 2 (Montane Forest), C. Site 3 (Dipterocarp Forest)

Sampling procedures, specimen preservation and identification

Light trapping was used as a technique to collect sphinx moth species. The set up used 4x2m white cloth, two bulbs each with 500 watts powered in a portable generator. The sampling period starts at 6:00 pm until 2:00 am in the morning. Sphinx moths were manually collected and paralyzed by pressing its thorax. Each sample was then placed inside a triangular-shaped glassine paper with its wings folded and mothballs were added to preserve the specimens. Important information was recorded in a field notebook that was taken along, including the date, site name, GPS coordinates, labels and temperature readings. The samples collected were photographed using a phone and camera. Identification of the collected hawkmoth species were based on morphological structures and using Hogenes & Treadaway, (1998) checklist at Central Mindanao University Museum Zoology Section. Classification and local status of the collected sphinx moths were based on the study of Mohagan & Treadaway, (2010), where it can be interpreted through occurences of individuals per species from 1-3 as very rare, 4-10 as rare, 11-20 as common and > 20 as very common. Endemism of the species collected were based on work of Hogenes & Treadaway, (1997). Specimens were deposited in the University Museum, Central Mindanao University.

3. RESULTS AND DISCUSSION

The study revealed a total of twenty-two individuals belonging to six genera (*Acosmeryx, Ambulyx, Cypa, Daphnis, Hippotion, Theretra*) which made up of seven species namely: *Acosmeryx socrates* (Boisduval, 1875), *Ambulyx staudingeri* (Rothschild, 1894), *Cypa decolor* (Walker, 1856), *Daphnis hypothous* (Cramer, 1779), *Hippotion brunneum* (Semper, 1896), *Theretra nessus* (Drury, 1773) and *Theretra sugii* (Cadiou, 1995). Site 2 which is the montane forest has the highest number of collected individuals of about 63.6% followed by site 1 (agroecosystem) with only 27.2% and dipterocarp forest (site 3) which has the lowest number of collected individuals with 9.0% only. Both agroecosystem and montane forest has four species collected. Three species were found rare in the area while other four species: *A. socrates, C. decolor, D. hypothous* and *T. nessus* were found very rare. Only one species collected namely *A. staudingeri* species were found to be endemic to the Philippines.

Site 2 (Montane Forest) has the highest number of individuals collected which consist of four species, two of which (*A. staudingeri* and *H. brunneum*) were also found in agroecosystem (site 1). The area was home to a variety of trees, numerous types of montane flora and some angiosperms, making it a potentially excellent source of food for adult hawkmoths, which feed on nectar or decaying fruit. Choi, (2008) asserts that one of the key elements in a moth's capacity to live and grow successfully is the availability of food plant sources. The second-highest number of captured individuals is at site 1 (agroecosystem).

During sampling period, heavy to moderate rainfall, thick fogs, cold temperature, full moon and strong wind were observed along the way. Due to this, it affects the night insects to occur during the light trap. Holyoak et al., (1997) found that daily change in weather and the presence of fogs and winds could have an impact on the quantity of moths collected in light traps. High rainfall affects which species of adult moths are present. However, increasing rainfall may also have benefits for flora, a larval food source, and the survival of early life cycle stages of constantly breeding species. Sometimes they cannot fly to where light is present because of wet wings (Intachat et al., 2001). Regional elements including wind speed, temperature, humidity and the amount of time the trap is in use also have an impact on its performance (Southwood & Henderson, 2000; Rafi et al., 2014).

Sphinx moths have 1,450 species worldwide (Singh & Kaur, 2017; Rougerie et al., 2014; Kawahara et al., 2009; Primo et al., 2013), 117 of which are found in the Philippines (Hogenes & Treadaway, 1998), plus one new species (*Macroglossum malitum*) that was discovered on the island of Palawan in Mt. Matalingahan (Zwick & Treadaway, 2001). Twenty-four species are endemic to the Philippines, according to Hogenes & Treadaway (1998), Luzon has the highest percentage of endemic species in the country with 71%, followed by Mindanao (58%), Negros (50%) and Leyte (46%). Due to its strong link with Bornean fauna, Palawan has the lowest percentage of indigenous species (8%) despite having the most species overall (Hogenes & Treadaway, 1998).

Mindanao is one of the Philippines' biggest islands. The richness of the flora and fauna inspires the bulk of scholars to perform their research. The Mt. Hamiguitan Wildlife Sanctuary in San Isidro, Davao, Oriental, has a record of 305 individuals, of which 22 species are recorded, according to recent investigations by Mohagan et al., (2018). A study by Kemal et al., (2018) also reported 49 lepidopteran taxa from the two hilly regions of Mt. Kitanglad and Caragan, belonging to 10 families, of which three species of the family Sphingidae: *Agrius convolvuli, Daphnis hypothous* and *Psilogramma menephron* were discovered. Suelo & Mohagan, (2020) documented 25 individuals of hawkmoth species in Bacusanon, Pangantucan, Bukidnon. Study in Mt. Kitanglad, Lirongan, Lantapan, Bukidnon by Suelo et al., (2020) recorded 13 species. Since hawkmoths are known for their rapid flying ability (Mohagan et al., 2018; Stöckl & Kelber, 2019), which according to Akkuzu et al., (2007), they might travel as far as 40 to 50 km to where light present that attracts their attention, there is little doubt as to why this species is widely dispersed.

Table 1 Number of individuals collected in different sites

Species		Site 1 Agroecosystem	Site 2 Montane Forest	Site 3 Dipterocarp Forest
Acosmeryx Socrates (Boisduval, 1875)		1		
Ambulyx staudingeri (Rothschild, 1894)		1	7	
Cypa decolor (Walker, 1856)			2	
Daphnis hypothous (Cramer, 1779)		1		
Hippotion brunneum (Semper, 1896)		3	2	
Theretra nessus (Drury, 1773)				1
Theretra sugii (Cadiou, 1995)			3	1
Total number of individuals	22	6	14	2
Total number of species	7			

Table 2 Species composition, local status and endemism of Sphinx moths in Mt. Kitanglad

Species	No. of Species Collected	Endemism	Distribution	Local Status
Acosmeryx socrates (Boisduval, 11875)	1	-	Balabac, Bohol, Calamian, Cebu, Leyte, Luzon, Mindoro, Mindanao, Negros, Palawan, Panay, Samar and Tawi-tawi	Very rare
Ambulyx staudingeri (Rothschild, 1894)	8	Endemic	Sulu Archipelago, especially on Jolo and Islands of the Tawi-tawi group, Mindoro, Luzon, Polillo, Marinduque, Sibuyan, Panay, Masbate, Negros, Siquijor, Cebu, Bohol, Samar, Leyte, Mindanao, Jolo, Tawitawi and SangaSanga.	Rare
Cypa decolor (Walker, 1856)	2	-	Jolo, Leyte, Luzon, Mindoro, Mindanao, Negros, Samar	Very rare
Daphnis hypothous (Cramer, 1779)	1	-	Ryukyu Islands and Taiwan, Southeast Asia, West-wards to the Middle East and from Sri Lanka, the Greater and Lesser Sunda islands, the Philippines, Sulawesi and North and South Moluccas to Tanimbar	Very rare
Hippotion brunneum (Semper, 1896)	5	-	Philippines, Sulawesi, the Moluccas and New Guinea	Rare
Theretra nessus (Drury, 1773)	1	-	Sri Lanka, India and Nepal, through Southeast Asian continent to China to Japan and Taiwan, Eastern Australia and Loyalty islands	Very rare
Theretra sugii (Cadiou, 1995)	4	-	Philippines (Mindanao)	Rare

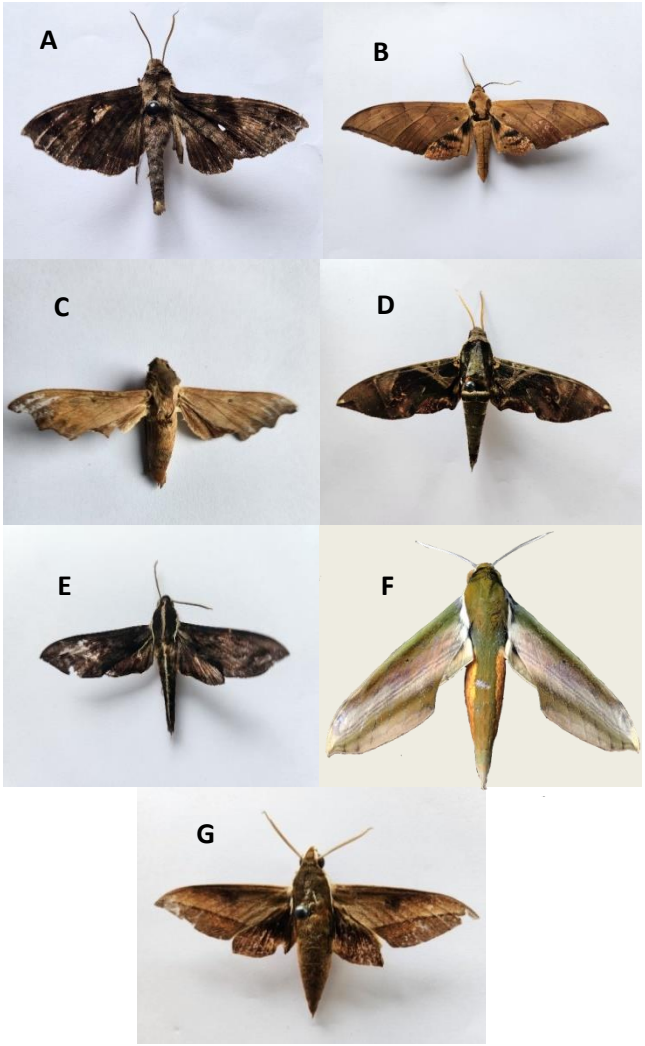

Figure 3 A) *Acosmeryx socrates* (Boisduval, 1875), B) *Ambulyx staudingeri* (Rothschild, 1894), C) *Cypa decolor* (Walker, 1856), D) *Daphnis hypothous* (Cramer, 1779), E) *Hippotion brunneum* (Semper, 1896), F) *Theretra nessus* (Drury, 1773) and G) *Theretra sugii* (Cadiou, 1995)

4. CONCLUSION

In conclusion, seven species belonging to six genera were recorded in Mt. Kitanglad, Intavas Trail, Sumilao, Bukidnon. Three species were found rare while other four species are categorized as very rare. Only one species collected namely *Ambulyx staudingeri* were found to be endemic to the Philippines. Montane forest has highest number of individual species collected followed by agroecosystem and least in dipterocarp forest. Several factors like weather, presence of moon affects the presence of hawkmoths.

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Authors contributions

All authors contributed equally.

Ethical approval

Sphinx moths (Family Sphingidae): Species was used in the study. The Animal ethical guidelines are followed in the study for species observation & identification. A gratuitous permit (No. R10 2019-14) acquired from the Department of Environment and Natural Resources (DENR) Region X as well as free and prior informed consent form was secured allowing us to collect our samples.

Informed consent

Not applicable.

Conflicts of interests

The authors declare that there are no conflicts of interests.

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Data and materials availability

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

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