

Research Article

Species Composition and Assessment of Sphingidae in Mt. Agad-Agad, Iligan City, Philippines

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ABSTRACT

Sphingidae (Hawkmoth or Sphinxmoth) is a known bioindicator that is naturally affected by environmental issues such as deforestation and pollution. Members of this family are widely distributed in Southeast Asia and play vital roles as indicators of habitat quality and biomass degradation. This study highlights the diversity and assessment of hawkmoths of Mt. Agad-Agad (Sitio Langinlanon, Barangay Puga-an) on Iligan City. Two sampling stations were established, the upper and lower Mt. Agad-Agad. Light trap sampling using 2 × 3 m² white silk cloth and 500 watts light bulb was established in selected points of the sampling stations. Six species belonging to four genera were recorded of which two species, *Acosmeryx socrates* and *Polyptychus trilineatus philippinensis*, were found very rare in the area. Station 2 (lower Mt. Agad-Agad) had the highest number of species recorded compared to Station 1 (upper Mt. Agad-Agad). However, there is no significant difference between the two ($t=0.59$, critical $t=2.2281$, $p=0.56$) sampling stations in terms of species composition. Moreover, two species from the genus *Ambulyx* are the endemic species observed, viz, *A. bakeri* and *A. wilemani*.

Keywords: *Ambulyx*, *Bioindicators*, *Hawkmoth*, *Light trap*, *Sphinx moths*

Introduction

The Family Sphingidae (hawkmoths or sphinx moths) is considered one of the species-rich families of relatively big-bodied and strong-flying moths. Hawkmoths or sphinx moths are great pollinators when adults [1] and agricultural pests during their larval stage [2, 3]. They mostly feed nocturnally and crepuscularly, while some species feed strictly diurnally [4, 5, 6]. They are considered indicators of a healthy environment. Larvae of Sphingidae have aid in controlling weeds and help in the cross-pollination of certain flowering plants. Along with butterflies, they also consume of tons of plant matter and convert them into waste materials [7]. They also serve as prey for other animals [8].

There are approximately 1,470 hawkmoth spe-

cies worldwide [9]. They are found in almost all of the continents and island groups in the world except for Antarctica, with their largest concentration observed in tropical areas [10]. Hawkmoths are widely distributed in South Asia and recorded in many Asian countries, including the Philippines [11, 12, 13]. Yakovlev et al. [14] documented 21 hawkmoth species in the Mongolian Altai. In the study of Rafi et al. [15], 60 hawkmoth species were recorded within the present-day boundaries of Pakistan. Sublett et al. [16] documented a greater number of species in Southeast Peru with 134 species. In the Philippines, on the other hand, a total of 117 species were listed, where Palawan island has the highest species count of 73 species followed by Luzon with 72 and Mindanao, along

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with Leyte and Negros with a count of 62 species [17].

In Mindanao Island, several studies explored different mountain ecosystems and discovered hawkmoth species in the respective areas. In the study of Mohagan *et al.* [18], eight hawkmoth species were listed in the two proposed expansion sites of Mt. Hamiguitan Range Wildlife Sanctuary, Davao Oriental. Another study by Mohagan *et al.* [19] recorded a higher species count in selected vegetation types of Mt. Hamiguitan Wildlife Sanctuary, San Isidro, Davao Oriental and Busay Garden, Marilog District, Davao City, with a total of 22 hawkmoth species having 16 species for each site.

Mt. Agad-Agad (08°21.530' N, 124°27.282' E) is a small mountain in Iligan City, Philippines, with a maximum elevation of 520 meters above sea level (masl). This area has no published information about the status of hawkmoths. This study presents the species composition, local status, and endemism of hawkmoths on Mt. Agad-Agad.

Material and Methods

Study sites

The study site is Mt. Agad-Agad in Sitio Langinlanon, Puga-an, Iligan City (Figure 1). Gratuitous Permit (GP) No. R10 2020-05 was acquired from the Department of Environment and Natural Resources (DENR) Region X office to collect samples in the site. Field sampling was conducted on February 21-27, 2020 after a reconnaissance survey was done to select possible sampling stations. Light trap sampling was used in the collection of hawkmoths on the site.

Establishment of the sampling stations

Two sampling stations were selected based on elevation and the type of vegetation present. The canopy epiphytes, vines, understory plants, and ground cover plants were noted. The presence of water body and type of weather was also observed.

Station 1 (N 08°21.303', E 124°27.144'), the upper part of Mt. Agad-Agad (Figure 2B), has an agro-reforested type of vegetation. It has an eleva-

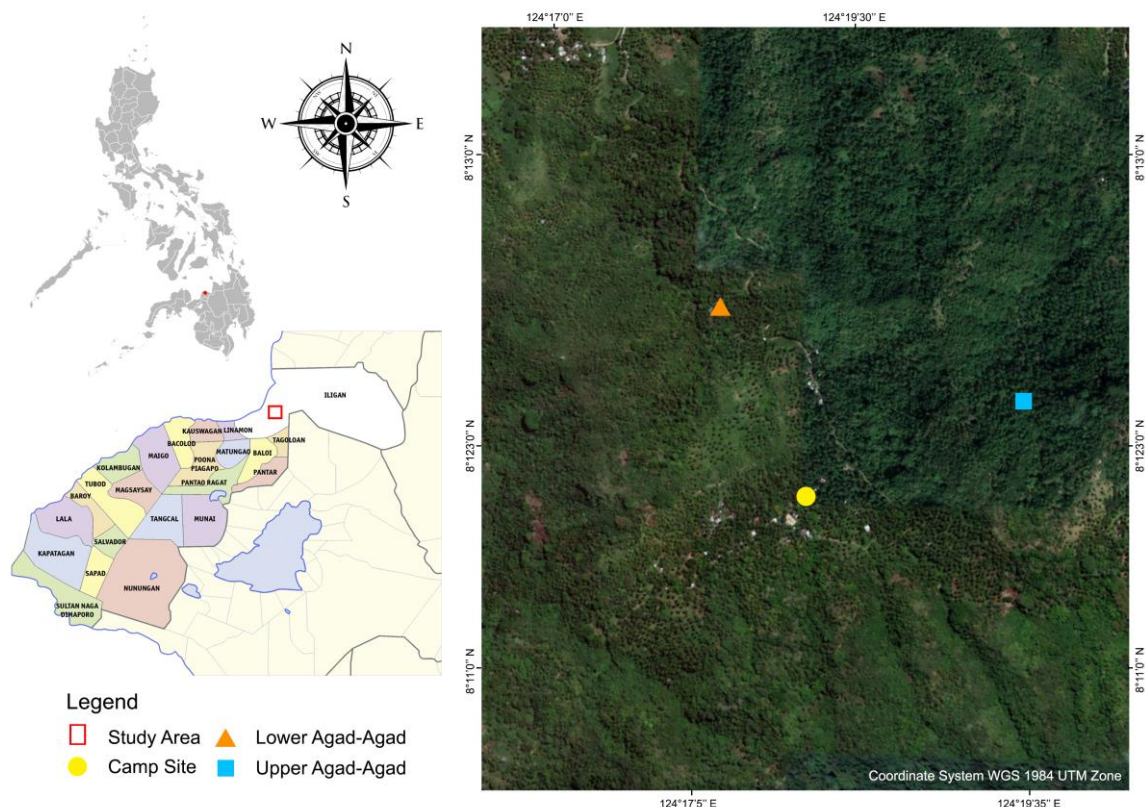


Figure 1. Map of the Philippines and Mindanao showing the location of Mount Agad-Agad, Iligan City. Colored shapes correspond to the established sampling sites in the lower and upper agro-forested site (Google Earth 2020)



Figure 2. Lower (A) and upper (B) Mt. Agad-Agad, Iligan City, Philippines (N 08°21.303', E 124°27.144')

tion of 200 – 470 masl and a total distance of two kilometers. Mahogany (*Swietenia macrophylla* King) was the most abundant tree found in this station. *Acacia mangium* Willd, *Gmelina arborea* Roxb. ex Sm., and *Eucalyptus* sp. trees were also present along with understory plants such as “makahiya” (*Mimosa pudica* L.), “hagonoy” (*Chromolaena odorata* (L.) R.M.King & H.Rob.), and ferns (*Nephrolepis* spp., *Lygodium circinnatum* (Burm.f.) Sw.). This station has no water body. The soil was dry, and the station was windy.

Fruit trees were also present in the area such as coconut (*Cocos nucifera* L.), mango (*Mangifera indica* L.), jackfruit (*Artocarpus heterophyllus* Lam.), and Soursoup or Guyabano (*Annona muricata* L.).

Station 2 (N 08°21.523', E 124°26.625') is the lower part of Mt. Agad-Agad (Figure 2A). It has an agro-secondary forest type of vegetation and an elevation of 70-200 masl with a total distance of three kilometers. Compared to Station 1, this station has a more diverse number of original trees

such as *Koordersiodendron pinnatum* (Blanco) Merr., *Pterospermum diversifolium* (Spreng.) Kuntze., *Diospyros philippinensis* A.DC, “anti-polo” (*Artocarpus blancoi* (Elmer) Merr.), *Caryota mitis* Lour., and “ilang-ilang” (*Cananga odorata* (Lam.) Hook.f. & Thomson). Several flowering and fruit trees were observed in the area. There is a presence of headwater in the area making most of the subterranean part wet. Ferns such as *Adiantum* spp., *Angiopteris* spp., *Asplenium* spp., and *Selaginella* spp. were observed. Other original plants such as *Schismatoglottis calyptata* (Roxb.) Zoll. & Moritzi, *Begonia* spp., *Epithema benthanii* C.B. Clake, and *Homalomena philippinensis* Engl. ex Engl. & K.Krause are still thriving, forming a community along the streams and at the ridge with a cooler temperature. The station was windy and rainy.

Collection, processing, and identification of samples

Light trap sampling using a 2 × 3m white silk cloth and 500 watts white light bulb powered by a portable generator was done at 1800 to 400 hours for a total of 60 light-trapping hours (Figure 3). Sphingids attracted to the light were manually collected and euthanized by exposing to 95% ethyl

acetate in the thorax following Lara-Pérez et al. [20] procedure. Each sample was positioned in a prepared triangular-shaped glassine paper with its wings folded, and then it was transferred to a rectangular microwaveable container containing naphthalene balls to prevent contamination of small insects [18]. The first author made the identification.

Local assessment, endemism, and species description of sphingidae

Classifying the local status of the hawkmoths is based on the study of Mohagan and Treadaway [21] where it can be interpreted through occurrences of individuals per species from 1-3 as very rare, 4-10 as rare, 11-20 as common, and >20 as very common. Endemism and description of hawkmoth species are based on the book of Hogenes and Treadaway [17] entitled “The Sphingidae (Lepidoptera) of the Philippines”.

Statistical Analysis

PAST version 4.13 [22] was used to determine the study's statistical test, which is the independent t-test. This test was used in determining the statistical difference between the two populations of the two sites.



Figure 3. Light trap installations in upper (A & B) and lower (C & D) Mount Agad-Agad.

Results and Discussions

Species composition, local status, and endemism of Hawkmoths

The study revealed a total of six hawkmoth species under four genera. Two species, *Acosmeryx socrates* Boisduval and *Theretra clotho clotho* Drury were only found in Station 1, the upper Mt. Agad-Agad. In contrast, three species were only found in Station 2 (lower Mt. Agad-Agad), namely: *Ambulyx bakeri* Clark, *Ambulyx wilemani* Rothschild & Jordan, and *Polyptychus trilineatus philippinensis* Rothschild & Jordan. *Theretra rhesus* Boisduval was found both in stations 1 and 2. Four species were found rare in the area, while only two species: *A. socrates* and *P. trilineatus philippinensis* were very rare. Two endemic species, *A. bakeri* and *A. wilemani*, which are both common and known in the Philippines [17] were only observed in Station 2 mainly because of the huge difference of the habitat of the two stations, Station 2 has more diverse plants compared to Station 1 (Table 1).

Hogenes and Treadaway [17] recorded 117 species of hawkmoths in the Philippines, where 62 species are found on Mindanao Island. The collected species in Mt. Agad-Agad constitute only 5.13% and 9.68% of the overall species in the Philippines and Mindanao, respectively. The collected species is higher than the collected species in Bega Watershed, Prosperidad, Agusan del Sur, the Philippines in the study of Nuñez *et al.* [23], which collected only one hawkmoth species. The reason for the low hawkmoth species count in Bega Watershed is because of the sampling method used by

the authors, where they only used sweep net instead of a light trap. Moreover, the collected species is lower than the collected species in the two proposed expansion sites of Mt. Hamiguitan Range Wildlife Sanctuary, Davao Oriental with eight species in the study of Mohagan *et al.* [18], Mt. Hamiguitan Range Wildlife Sanctuary, Davao Oriental, the Philippines with 16 species and Busay Garden, Marilog District, Davao City, Philippines with also 16 species in the study of Mohagan *et al.* [19]. This is probably because the said sites, Mt. Hamiguitan and Busay Garden, have wider areas and more diverse plants thus can house more species.

The two stations have different vegetation types and elevations. Station 1, upper Mt. Agad-Agad, with a higher elevation and agro-reforested type of vegetation, has lower species composition ($S = 3$) than Station 2, lower Mt. Agad-Agad, with a lower elevation and agro-secondary forest type of vegetation ($S = 4$). However, the difference between the two is not significant ($t = 0.59$, critical $t = 2.2281$, $p = 0.56$), as shown in Table 2. A study of Mohagan *et al.* [19] showed similar results wherein hawkmoth diversity is higher in lower elevation areas and decreases as elevation increases. This might be correlated to the presence of their food plants in the lower elevation.

The two stations have different plant compositions, with Station 2 (lower Mt. Agad-Agad) having more plants thus higher hawkmoth species which coincided with the study of Menken *et al.* [24] where he stated that hawkmoths are mega-diverse plant-eaters. Moreover, both stations were

Table 1. Species Composition, Local Status, and Endemism of Hawkmoths in Mt. Agad-Agad, Iligan City, Philippines

Species	Study Stations		Local Status	Endemism
	Station 1 (Upper Mt. Agad-Agad)	Station 2 (Lower Mt. Agad-Agad)		
<i>Ambulyx bakeri</i> Clark, 1929	0	4	R	PE
<i>Ambulyx wilemani</i> Rothschild & Jordan 1961	0	5	R	PE
<i>Acosmeryx socrates</i> Boisduval, 1875	1	0	VR	-
<i>Polyptychus trilineatus philippinensis</i> Rothschild & Jordan, 1903	0	1	VR	-
<i>Theretra clotho clotho</i> Drury, 1773	6	0	R	-
<i>Theretra rhesus</i> Boisduval, 1875	3	5	R	-

Legend: PE – Philippine Endemic; R – Rare; VR – Very Rare.

Table 2. Statistical test (independent t-test) between two sampling stations in Mt. Agad-Agad

	Station 1 (Upper Mt. Agad-Agad)	Station 2 (Lower Mt. Agad-Agad)
Mean	1.6667	2.5
Variance	5.8667	5.9
No. of samples	6	6
t value	0.59507	
Critical t value (p=0.05)	2.2281	
p-value	0.56502	

windy and rainy, but water body is only present in Station 2. However, these did not affect the composition of hawkmoths in both stations. This is because according to Mohagan et al. [18], hawkmoths are fliers and crepuscular species, meaning they have persistent wings to fly to the light source.

Species Account

1. *Acosmeryx socrates* Boisduval, 1875 (Figure 4a & b)

Description: The collected species was a female with a head color of mostly dark brown. The body length measured 44 mm and the antenna was 15mm long. The compound black eye had a diameter of 5 mm. The thorax was dominantly brown with a length of 11 mm. The wings were also brown with a yellow spot on the base of the hindwing. The forewing and hindwing measured 35 mm and 21 mm, respectively. Small orange-red spots in the ventral abdomen were observed which is said to be the unique characteristics of this species. The description is similar to the record of Hogenes and Treadaway [17].

Distribution: This species is restricted in the Philippines and Sulawesi. It is common and known in many islands in the Philippines including Palawan, Calamian, Mindoro, Luzon, Panay, Negros, Cebu, Bohol, Samar, Leyte, Mindanao, Tawitawi, and Bongao.

2. *Ambulyx bakeri* Clark, 1929 (Figure 4c & d)

Description: *A. bakeri* is characterized by its variable coloration, blackish-brown for females and light yellowish-brown in some males [17]. The collected species was a male with a dominant color of brownish-orange. The body measured 35 mm and the antenna was 10mm long. The compound black eye had a diameter of 3 mm. The thorax was dominantly brownish-orange with a

length of 11mm. The wings were brownish-orange at the base and was brown at the tip. The forewing measured 42 mm and the hindwing 22 mm.

Distribution: This species is endemic in the Philippines which is common and known from all major islands excluding Palawan. This species is common in Mindoro, Luzon, Marinduque, Panay, Negros, Siquijor, Cebu, Leyte, Samar, and Mindanao.

3. *Ambulyx wilemani* Rothschild & Jordan 1916 (Figures 6a, b, c, & d)

Description: *Ambulyx wilemani* is characterized by its prominently curved submarginal line that runs from vein M1 to the tornus [17]. The head was pale brown with a prominent brown dorsal cortex. Both male and female species were collected in the area. The female was larger with a body length of 40 mm compared to the male with a body length of 35 mm. Both antennae measured 16 mm with a compound black eye of diameter 4 mm. The thorax measured 10 mm and was pale brown in color for the female whereas was 11 mm and dark brown for the male. Both genders had the same wing size. The forewing measured 42 mm and had dark costal and sub-basal spots while the hindwing measured 22 mm.

Distribution: This species is endemic in the Philippines which is common and known in most islands including Sulu Archipelago. This species is observed in Mindoro, Luzon, Marinduque, Panay, Negros, Samar, Leyte, Mindanao, Sibutu, and Tawi-tawi.

4. *Polyptychus trilineatus philippinensis* Rothschild & Jordan 1903 (Figures 6a & b)

Description: The collected species was a male with a color of dark brown. The head was dark brown to almost black. The body length was 38 mm with an antenna measuring 15 mm with a compound black eye of diameter 3 mm. The thorax measured 12 mm and was dark brown in color. The forewing measured 43 mm and the hindwing measured 26 mm. It is similar to the observation of Hogenes and Treadaway [17] which recorded a minimum forewing length of 43 mm in males.

Distribution: This species is common in the Philippines but not known in Palawan and Sulu Archipelago. This species is recorded in most major islands including Luzon, Panay, Negros, Siquijor, Cebu, Bohol, Leyte, and Mindanao.

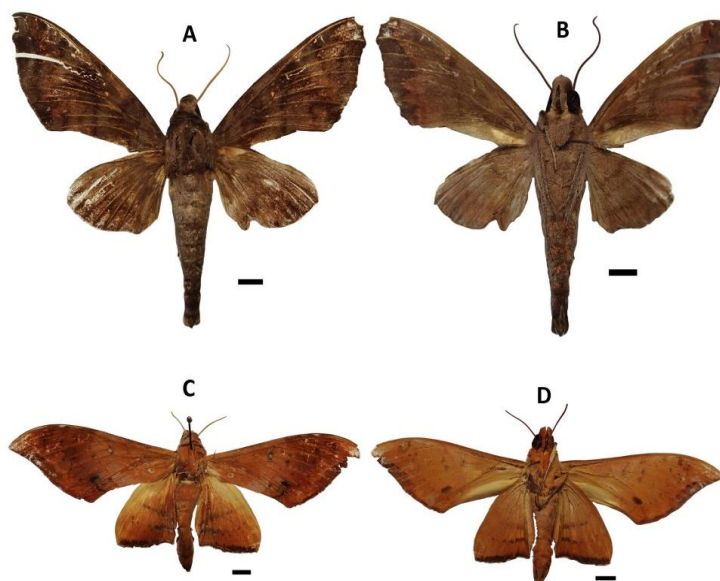


Figure 4. *Acosmeryx socrates* (A&B) and *A. bakeri* (C&D) dorsal and ventral view. Scale bars: 5 mm

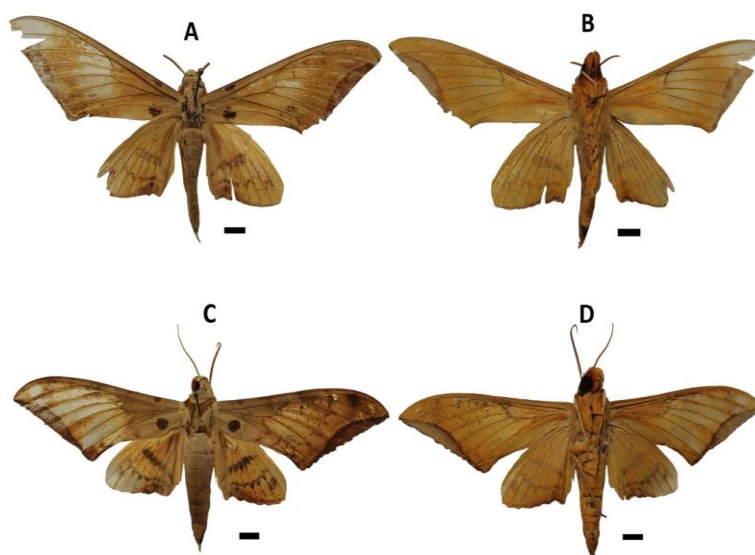


Figure 5. *Acosmeryx wilemani* male (A&B) and female (C&D) specimens. Scale bars: 5 mm

5. *Theretra clotho clotho* Drury, 1773 (Figures 6c & d)

Description: The collected species was a male *T. clotho clotho*. The head and body were pale brown covered with brownish-green hair. The body length was 48 mm, antenna length was 19 mm, and compound black eye with diameter of 5 mm. The thorax measured 13 mm and was dark brown covered with brown hair. The forewing measured 40 mm and the hindwing measured 22 mm. Hogenes and Treadaway [17] forewing measurement ranged from 35 mm-42 mm in males and the observed species was within the measurement range.

Distribution: This species is found in Sri Lanka, India, Nepal, North China, Korea, Japan, and from the Andaman Islands through the Greater Sunda Islands to Flores, Timor, Philippines, Taiwan, Sulawesi, Selayar, Moluccas, and New Guinea. In the Philippines, it is very common and known and is recorded in many islands including Balabac, Palawan, Calamian, Mindoro, Luzon, Sibuyan, Panay, Negros, Siquijor, Cebu, Bohol, Leyte, Samar, Mindanao, Jolo, Tawi-tawi, Bongao, and Sibutu.

6. *Theretra rhesus* Boisduval, 1875 (Figures 7a, b, c, & d)

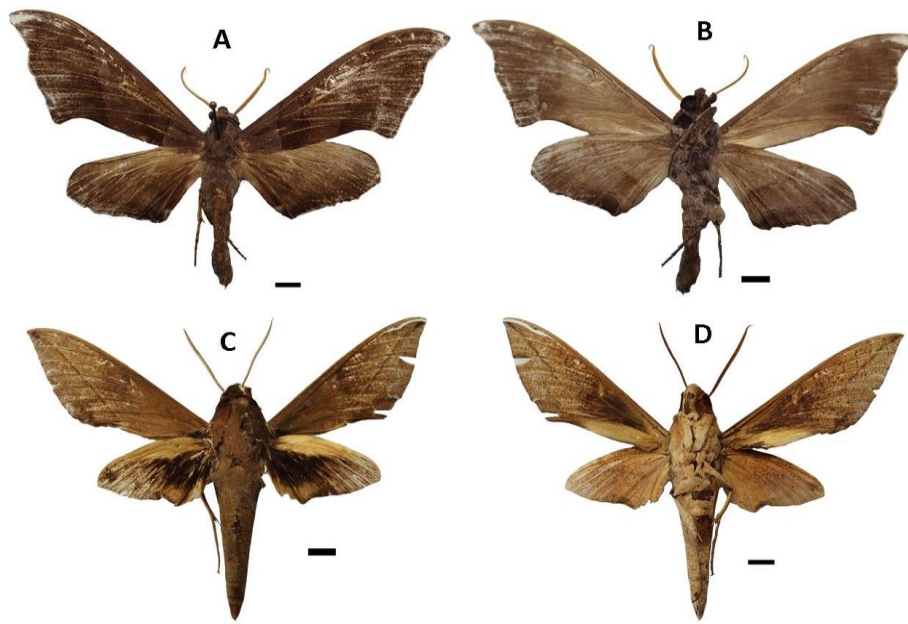


Figure 6. *Polyptychus trilineatus philippinensis* (A&B) and *Theretra clotho clotho* (C&D). Scale bars: 5 mm

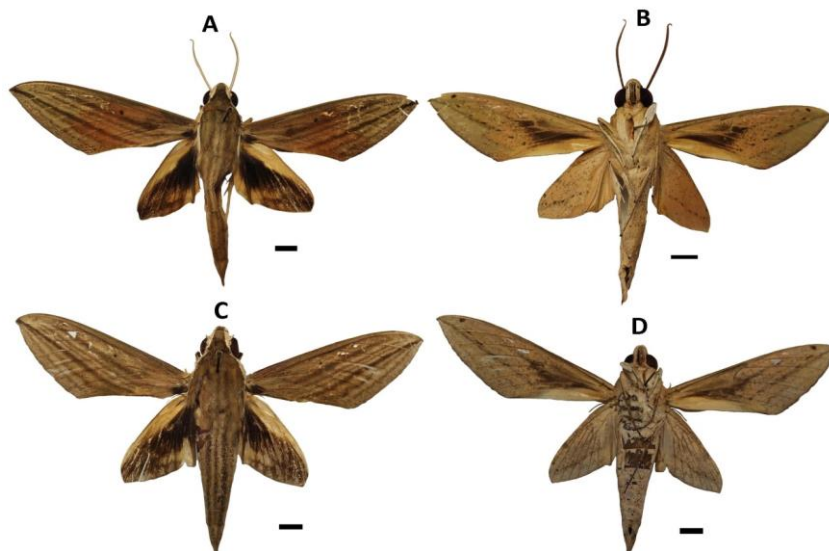


Figure 7. *Theretra rhesus* male (A&B) and female (C&D) specimens. Scale bars: 5 mm

Description: Both male and female *T. rhesus* were collected. The head was greyish brown with a prominent white marginal line that extends to the thorax. The female was larger than the male with a body length of 49 mm and 45 mm, respectively. The dorsal side of the abdomen had black vertical stripes for the female and pale black stripes for the male. The antenna of both genders measured 16 mm and compound black eye both with a diameter of 5 mm. The thorax measured 14 mm and was covered with brown hair. Both gender had the same forewing and hindwing measurement of 39 mm and 20 mm, respectively. Hogenes and Treadaway [17] forewing measurement ranged from 34-

42 mm in males and 38-47 mm in females. The observed specimens were within the measurement range.

Distribution: *T. rhesus* is recorded in Sumatra, Java, Bali, peninsular Malaysia, Borneo, Sulawesi, and the Philippines. It is common and recorded in many islands in the Philippines such as Balabac, Palawan, Mindoro, Luzon, Marinduque, Sibuyan, Panay, Negros, Siquijor, Cebu, Bohol, Leyte, Samar, Mindanao, Jolo and Bongao.

Conclusion

In conclusion, six species in four genera were recorded on Mt. Agad-Agad. Higher species rich-

ness (n = 4) was recorded in Station 2 (lower Mt. Agad-Agad) than Station 1 (upper Mt. Agad-Agad) which has three species. Four species were rare and only two were found very rare in the area. Two endemic species were observed. Elevation and type of vegetation influenced the species composition between the two stations. Higher species composition is observed in lower elevation with agro-secondary forest vegetation. Moreover, the weather and presence of the water body did not affect the hawkmoth composition between the two sites.

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