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# Checklist of Butterflies and Moths in Andanan Watershed Forest Reserve, Philippines

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ABSTRACT

The lepidopteran entomofauna plays a major role as pollinators and an essential component to food webs in terrestrial ecosystems. The present study assessed the various taxa composition of both butterflies and moths occurring in both riparian and forested systems of Andanan Watershed Forest Reserve. A one km transect was established in exploring the forest area and riparian zone of the three sampling sites. Opportunistic collection and light trapping were employed. One hundred-three individuals from 54 species were collected and recorded from the two superfamilies of butterflies (Hesperioidea and Papilionoidea) comprising 65% of the total lepidopterans, and five superfamilies of moths (Bombycoidea, Cossoidea, Geometroidea, Noctuoidea, and Pyraloidea). Among the different families, members of Nymphalidae butterflies were the most abundant, followed by Erebidae moths. Among the species recorded, the endemic birdwing butterfly *Troides rhadamantus* and the giant silkworm moth *Samia luzonica*, also endemic in the country, were the largest in size among the lepidopterans in the area. Other endemic species include *Tacola magindana, Acrophtalmia leto, Ypthima sempera,* and *Pareronia boebara*. *Eurema, Papilio*, and *Jamides* have a higher number of species among the butterflies while *Daphnis* and *Theretra* have the highest number of species for the moths, compared to other genera. The lepidopteran fauna in the area is very diverse (H'=3.69; H/Hmax=0.93) despite few anthropogenic activities in both the riparian and forested areas. The results presented here may be potentially used as basis for enhanced local conservation efforts for lepidopterans and ecosystem health monitoring of the entire Andanan Watershed Forest Reserve.

Keywords: *Andanan, Butterflies, Checklist, Lepidoptera, Moths*

## 1 Introduction

Lepidopteran fauna comprising the common groups of both butterflies and moths is one of the most prevalent terrestrial groups of entomofauna, and perform essential ecosystem services such as decomposition, nutrient cycling, pollination, and providing prey for passerine birds (Jaroensutasinee et al. 2011). Other than that, this group of insects is considered as weed controls, and provide a source of food for other animals. The abundance of butterflies is often an indication of ecosystem health, and some species also provide a natural form of pest control. Both members of this large group are more associated with flowering plants, being butterflies as diurnal pollinators, while moths are nocturnal pollinators of flowers (Gullan and Cranston 2004). These insects also play an important role as seed dispersers, herbivores, prey in various ecosystems, making them good model organisms because of their sensitivity to changes in climate conditions and other ecological alterations (Mohagan et al.

2011, and Aris et al. 2017).

Deforestation, habitat degradation, and climate change are the three most potential dangers that destroys the ecosystem's biodiversity, and this has led to the recognition of lepidopteran fauna as a bioindicator for ecosystem health. Although these threats are present in all ecosystems, tropical forests are known to possess the highest concentration of species in the world, and therefore, these equatorial ecotones require the most immediate conservation action (Didham et al. 1996). As climate change progresses, these insects are very helpful in monitoring particular areas such as in the Philippines (Mohagan et al. 2011).

The Philippines, which is a tropical and megadiverse country, has a high species diversity and endemism of butterfly and moths (Toledo and Mohagan 2011) which could be due to the country's patchwork of isolated islands, its tropical location, and its once extensive areas of rainforest (Ramos 2013). Hence, a continuous biological survey could lead to a better understanding of these important bioindicators and help in assessing the status of our forest ecosystems, since rapid destruction of the Philippine forests especially in Mindanao island, is observed as one of the major threats not only to lepidopterans but to many other entomofaunal species (Mohagan and Treadaway 2010). Unfortunately, there are only a few publications and researches on lepidopteran fauna in the Philippines available, and only a few forest reserves have still been explored, particularly in Mindanao island. The present study aims to inventory lepidopteran fauna found in Andanan Watershed Forest Reserve, Agusan del Sur, Mindanao, with notes on habitat assessment and diversity of this entomofauna in the area. This forest reserve encompasses various tributaries of the Andanan River, and covers patches of alternating lowland and mountainous area.

## 2 Materials and Methods

The study was conducted in Andanan Watershed Forest Reserve (AWFR). Three collection sites were explored in the forested and riparian area of Andanan Watershed Forest Reserve (Figure 1). The three locations were Calaitan (8.7927°N, 125.7789°E; 209.1 masl), Berseba (8.8552°N, 125.8007° E; 219.7 masl), and Santo Niño (8.8451°N, 125.7871°E; 261.7 masl), and are interconnected with various tributaries of Andanan River. In each site, a one km transect was established in exploring the forested area and near riparian zone to collect the specimens thru opportunistic sampling. The study was conducted in the months of July to September 2019, and all observations were documented in photos and videos using a digital camera, while coordinates of the location, as well as the elevation, were determined using Global Positioning System (GPS) device.

The collection sites are a combination of alternating lowland and mountainous areas, with slopes and ridges on the sides of the riparian range. Lowland forest has a dense combination of shrubs, grasses, fruit-bearing trees, flowering plants, and ferns. The mountainous area is composed of large trees having large canopy cover and has some

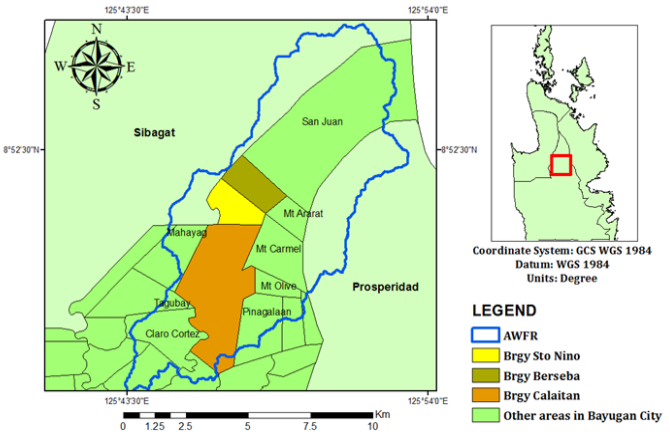


Figure 1. Map of Andanan Watershed Forest Reserve, Philippines, highlighting the three sampling stations.

grasses and shrubs. The wet ground is covered with leaf litters. Alongside the river, some parts have large to medium boulders of rocks, wherein some are covered by mosses and algae. Few plantations were also observed such as falcata tree (*Paraserianthes falcataria*), banana (*Musa paradisiaca*), and rootcrops. Some areas of the understorey were fully covered by leaf litters, fallen twigs, and few decaying logs. The river was utilized as a primary source of water in the area including activities like washing, bathing, and even fishing.

The collection of samples was done in an opportunistic method using sweep nets. Light traps were also utilized to collect specimens during night time. All specimens were stored in the laboratory and were labeled and photo-documented properly. Identification of the samples was validated by various local and international experts and lepidopterists through online communication and photo-documentation. Species diversity, richness, evenness were also generated in various tools such as Paleontological Statistics Software (PAST). For the diversity, a Shannon-Weiner (H') index was used to compare the diversity scale (0-1 = low diversity, 1-2 = moderate diversity, and >2 = high diversity). The equitability {[LN(S)] = natural log of species richness} was also determined using the data of diversity index and the maximum evenness to support the inference of the data and provides a better understanding of the occurrence and distribution of lepidopterans in the area.

## 3 Results and Discussion

### *Species Richness and Abundance*

Table 1 presents the checklist of all lepidopterans in Andanan Watershed Forest Reserve. The various taxa were composed of seven superfamilies, 13 families, 24 subfamilies, 49 genera, 54 species, and 103 individuals. Of the total number of individuals, 61% were butterflies from the superfamily Papilionoidea while Noctuoidea has the most number of species for moths, comprising 20% of the inventory. Among all the lepidopteran genera, *Daphnis, Theretra, Jamides, Papilio,* and *Eurema* have higher species richness.

Papilionoidea has the highest number of individuals consisting of four families: Lycaenidae (6); Papilionidae (7); Pieridae (10); and Nymphalidae (40). On the other hand, Noctuoidea has the highest number of families identified, in which Erebidae as the most abundant (Figure 2).

Nymphalidae is the most species-rich group with the highest percentage of species (39%) among populations, as was observed in the urban locations of Davao City (Salaga et al. 2018). This result was also supported in the study of Nuñeza et al. (2016), in which nymphalids marked the highest percentage (35.29%) of lepidopteran entomofauna in Bega Watershed, Prosperidad, Agusan del Sur. The result of the present study was also relatively higher compared to the study of Nuñeza et al. (2016) in Bega Watershed, Agusan del Sur, with 17 species recorded. However, compared to the result of Guadalquiver et al. (2019) in Mimbilisan Protected Landscape, Misamis Oriental, with 92 species of lepidopterans, Andanan Watershed Forest Reserve is relatively lower. Nonetheless, several factors may also affect the collection which include the total distance of the area explored, the time allotted for the collection, as well as the local weather during the sampling period. Furthermore, few species were collected with both female and male representatives such as *Papilio polytes*, *Hypolimnas bolina*, from butterflies, and *Ischyja marapok* in moths.

### *Occurrence and Endemicity*

*Samia luzonica* (Figure 3F), was the largest endemic species of moth collected in Andanan Watershed Forest Reserve. Similarly, the Philippine-endemic *Troides rhadamantus* (Figure 6B), was the largest butterfly observed. Aditionally, four (4) species of butterflies were endemic in the Philippines including *Ypthima sempera* (5C), *Acrophtalmia leto* (5G), *Tacola magindana* (Figure 6F) and *Pareronia boebara* (Figure 6O) (Naumann 1998, Mohagan et al. 2011, and Sebua and Nuñeza 2020). *Samia*, widely known from both tropical and temperate eastern Asian regions (Peigler and Naumann 2003), including the Philippine-endemic *S. luzonica* (Naumann 1998) is the only saturniid moth recorded in the area. *A. panopus* (Figure 3H) is generally common in the Oriental region (Schulze et al. 2000), and was reported in Mt. Hamiguitan Range Wildlife Sanctuary from Mindanao island (Mohagan et al. 2019) while *C. wilemani* (Figure 3K), was also recorded in Mt. Matutum, South Cotabato in Mindanao (Kemal et al. 2019b).

Skipper butterflies (Hesperiidae) are distributed worldwide, with its greatest richness in the Neotropical region. *T. luzonensis* (Figure 5A) was observed in Mt. Apo (Mohagan et al. 2011) while

Table 1. Inventory checklist of Lepidoptera collected in Andanan Watershed Forest Reserve, showing various species from different taxa groups.

| Superfamily | Family | Subfamily | Species | Common Name |
|---|---|---|---|---|
| Bombycoidea | Saturniidae | Saturniinae | *Samia luzonica* Watson, 1914 | Giant Silkworm; Royal Moth |
| | Sphingidae | Macroglossinae | *Daphnis hypothous* Cramer, 1780 | Jade Hawk Moth |
| | | | *Daphnis nerii* Linnaeus, 1758 | Oleander Hawk Moth |
| | | | *Eupanacra elegantulus* Herrich-Schaeffer, 1856 | Hawk Moth |
| | | | *Gnathothlibus eras* Boisduval, 1832 | Aussie White-brow Hawk Moth |
| | | | *Theretra nessus* Drury, 1773 | Yam Hawk Moth |
| | | | *Theretra rhesus* Boisduval, 1875 | Hawk Moth |
| | | Smerinthinae | *Amplypterus panopus* Cramer, 1779 | Mango Hawk Moth |
| | | Sphinginae | *Acherontia lachesis* Fabricius, 1798 | Greater Death's Head Hawk Moth; Bee Robber |
| Cossoidea | Cossidae | Zeuzerinae | *Xyleutes strix* Linnaeus, 1758 | Cossid Miller Moth |
| | | | *Zeuzera* sp. Latreille, 1804 | Cossid Miller Moth; Leopard Moth |
| Geometroidea | Geometridae | Geometrinae | *Thalassodes* sp. Guenee, 1857 | Geometer Moth |
| | | Aganainae | *Asota heliconia* Linnaeus, 1758 | Aganaid Moth; Tropical Tiger Moth |
| | | Arctiinae | *Amata* sp. Fabricius, 1807 | Tiger Moth; Wasp Moth |
| | | | *Creatonotos wilemani* Rothschild, 1933 | Tiger Moth |
| | | | *Cyana malayensis* Hampson, 1914 | Tiger Moth |
| | | Calpinae | *Arcte coerulea* Guenee, 1852 | Ramie Moth |
| Noctuoidea | Erebidae | | *Armana* sp. Swinhoe, 1890 | Erebid Moth |
| | | | *Phyllodes staudingeri* Semper, 1901 | Pink Underwing Moth |
| | | Erebinae | *Erebus clavifera* Hampson, 1913 | Underwing Moth |
| | | | *Ischyja marapok* Holloway, 2005 | Underwing Moth |
| | | | *Pterocyclophora huntei* Warren, 1903 | Underwing Moth |
| | | Lymantriinae | *Arctornis rutila* Fabricius, 1781 | Tussock Moth |
| | Noctuidae | Heliothinae | *Helicoverpa* sp. Hardwick, 1965 | Owlet Moth |
| | Nolidae | Nolinae | *Triorbis* sp. Hampson, 1894 | Tuft Moth |
| Pyraloidea | Crambidae | Spilomelinae | *Bradina* sp. Lederer, 1863 | Grass Moth |
| Hesperioidea | Hesperiidae | Hesperiinae | *Caltoris cormasa* Hewitson, 1876 | Swift; Philippine Swift |
| | | | *Taractrocera luzonensis* Staudinger, 1889 | Luzon Grass Dart |
| Papilionoidea | Lycaenidae | Lycaeninae | *Arhopala silhetensis* Hewitson, 1862 | Oakblue |
| | | | *Caleta argola* Hewitson, 1876 | Pierrot |
| | | | *Jamides schatzi* Rober, 1886 | Cerulean |
| | | | *Jamides suidas* C. & R. Felder, 1865 | Cerulean |
| | | | *Tajuria jalajala* C. & R. Felder, 1865 | Royal |
| | | Charaxinae | *Polyura athamas* Drury, 1773 | Common Nawab |
| | | Danainae | *Danaus melanippus* Cramer, 1777 | White Tiger |
| | | Limenitidinae | *Tacola magindana* Semper, 1878 | Sergeant |
| | Nymphalidae | Nymphalinae | *Hypolimnas bolina* Linnaeus, 1758 | Eggfly; Great Eggfly |
| | | | *Junonia hedonia* Linnaeus, 1764 | Brown Pansy; Brown Soldier |
| | | | *Rhinopalpa polynice* Cramer, 1779 | Wizard |
| | | Satyrinae | *Acrophtalmia leto* Semper, 1886 | Pale Ringlets |
| | | | *Elymnias parce* Staudinger, 1889 | Tawny Palmfly |
| | | | *Amathusia phidippus* Linnaeus, 1763 | Palm King |
| | | | *Faunis leucis* C. & R. Felder, 1861 | Fauns |
| | | | *Melanitis leda* Linnaeus, 1758 | Common Evening Brown |
| | | | *Mycalesis mineus* Linnaeus, 1758 | Dark Brand Bushbrown |
| | | | *Ypthima sempera* Felder, 1863 | Common Three-Ring |
| | Papilionidae | Papilioninae | *Papilio antonio* Hewitson, 1872 | Common Mormon |
| | | | *Papilio polytes* Linnaeus, 1758 | Common Mormon |
| | | | *Troides rhadamantus* Lucas, 1835 | Golden Birdwing |
| | Pieridae | Coliadinae | *Catopsilia pyranthe* Linnaeus, 1758 | Mottled Emigrant |
| | | | *Eurema alitha* C. & R. Felder, 1862 | Scalloped Grass Yellow |
| | | | *Eurema hecabe* Linnaeus, 1758 | Common Grass Yellow |
| | | Pierinae | *Leptosia nina* Fabricius, 1793 | Psyche |
| | | | *Pareronia boebara* Eschscholtz, 1821 | Wanderer |

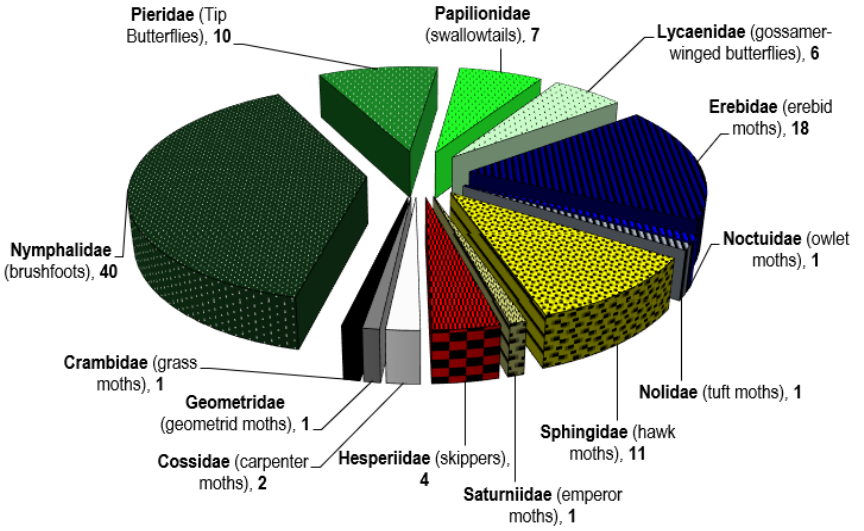


Figure 2. Relative abundance of Lepidopteran fauna in Andanan Watershed Forest Reserve.

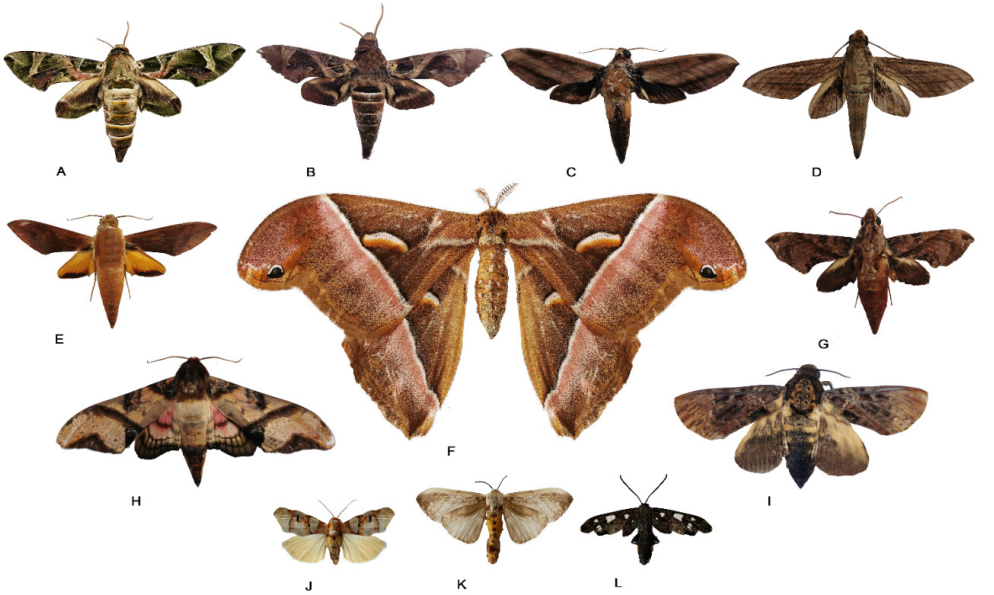


Figure 3. Moths of Andanan Watershed Forest Reserve. (A) *Daphnis nerii* Linnaeus, 1758; (B) *Daphnis hypothous* Cramer, 1780; (C) *Theretra nessus* Drury, 1773; (D) *Theretra rhesus* Boisduval, 1875; (E) *Gnathothlibus eras* Boisduval, 1832; (F) *Samia luzonica* Watson, 1914; (G) *Eupanacra elegantulus* Herrich-Schaeffer, 1856; (H) *Amplypterus panopus* Cramer, 1779; (I) *Acherontia lachesis* Fabricius, 1798; (J) *Cyana malayensis* Hampson, 1914; (K) *Creatonotos wilemani* Rothschild, 1933 and (L) *Amata* sp.

*C. cormasa* (Figure 5B) was collected from the montane forests of Mt. Timpoong in Camiguin island. The limenitidine *Tacola* is comprised of only three species that range across most of the insular regions of Southeast Asia, and among these species is *T. magindana* (Figure 6F) which is endemic in

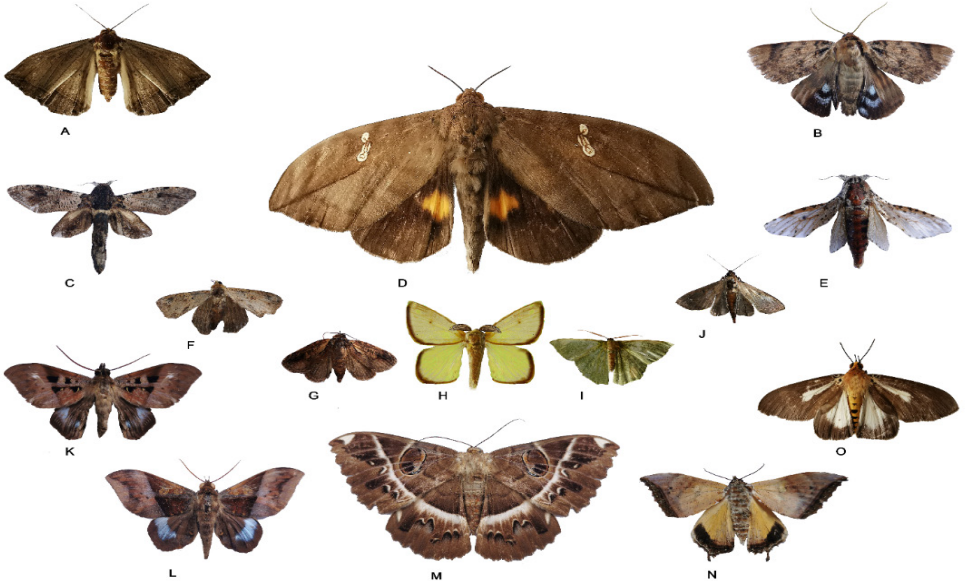


Figure 4. Moths of Andanan Watershed Forest Reserve (continued). (A) *Armana* sp.; (B) *Arcte coerulea* Guenee, 1852; (C) *Xyleutes strix* Linnaeus, 1758; (D) *Phyllodes staudingeri* Semper, 1901; (E) *Zeuzera* sp.; (F) *Helicoverpa* sp.; (G) *Triorbis* sp.; (H) *Arctornis rutila* Fabricius, 1781; (I) *Thalassodes* sp.; (J) *Bradina* sp.; (K) *Ischyja marapok* (male); (L) *I. marapok* (female); (M) *Erebus clavifera* Hampson, 1913; (N) *Pterocyclophora huntei* Warren, 1903 and (O) *Asota heliconia* Linnaeus, 1758.

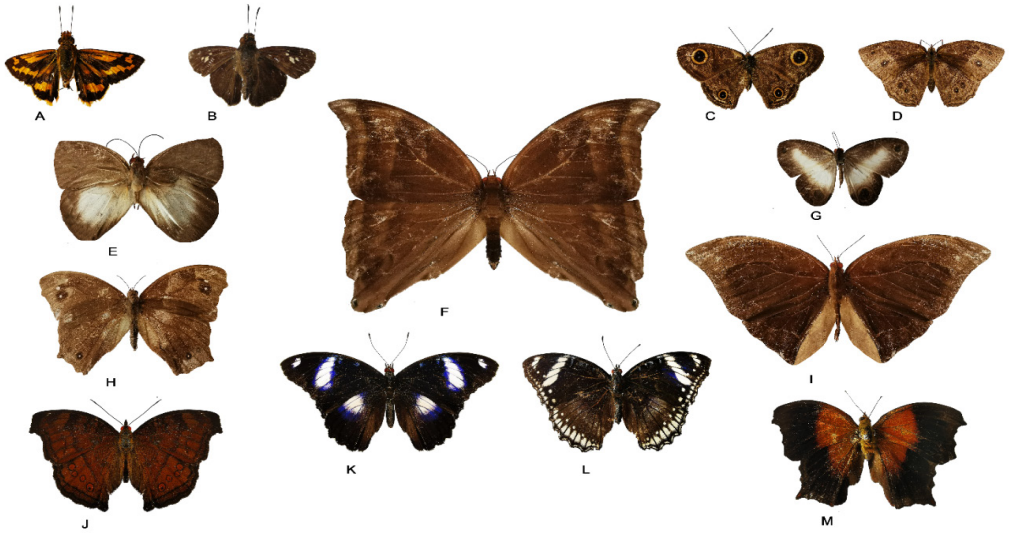


Figure 5. Butterflies of Andanan Watershed Forest Reserve. (A) *Taractrocera luzonensis* Staudinger, 1889; (B) *Caltoris cormasa* Hewitson, 1876; (C) *Ypthima sempera* Felder, 1863; (D) *Mycalesis mineus* Linnaeus, 1758; (E) *Faunis leucis* C. & R. Felder, 1861; (F) *Amathusia phidippus* Linnaeus, 1763; (G) *Acrophtalmia leto* Semper, 1886; (H) *Melanitis leda* Linnaeus, 1758; (I) *Elymnias parce* Staudinger, 1889; (J) *Junonia hedonia* Linnaeus, 1764; (K) *Hypolimnas bolina* (male) Linnaeus, 1758; (L) *H. bolina* (female) and (M) *Rhinopalpa polynice* Cramer, 1779.

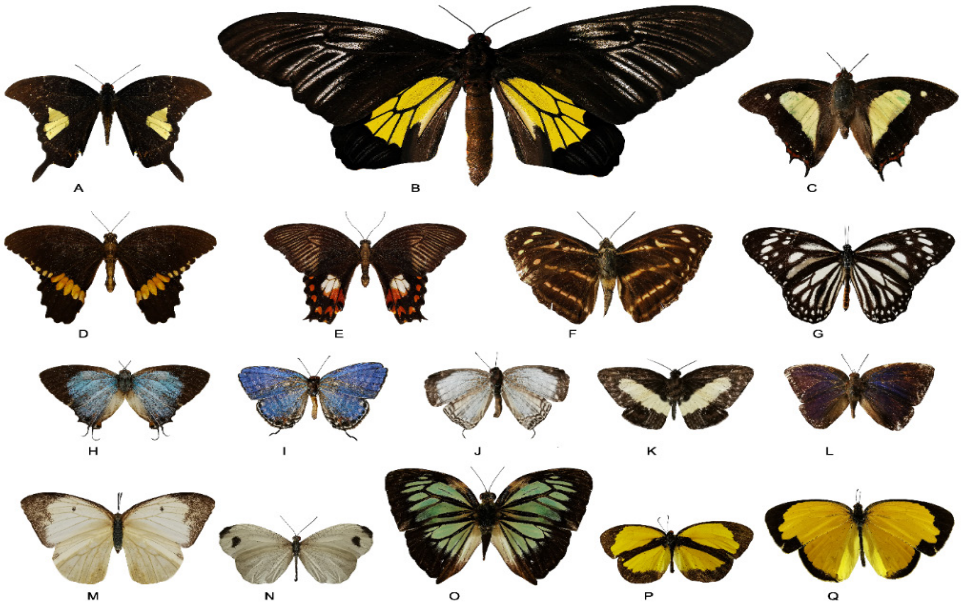


Figure 6. Butterflies of Andanan Watershed Forest Reserve (continued). (A) *Papilio antonio* Hewitson, 1872; (B) *Troides rhadamantus* Lucas, 1835; (C) *Polyura athamas* Drury, 1777; (D) *Papilio polytes* (male) Linnaeus, 1758; (E) *P. polytes* (female); (F) *Tacola magindana* Semper, 1878; (G) *Danaus melanippus* Cramer, 1777; (H) *Tajuria jalajala* C. & R. Felder, 1865; (I) *Jamides suidas* C. & R. Felder, 1865; (J) *Jamides schatzi* Rober, 1886; (K) *Caleta argola* Hewitson, 1876; (L) *Arhopala silhetensis* Hewitson, 1862; (M) *Catopsilia pyranthe* Linnaeus, 1758; (N) *Leptosia nina* Fabricius, 1793; (O) *Pareronia boebara* Eschscholtz, 1821; (P) *Eurema alitha* C. & R. Felder, 1862 and (Q) *Eurema hecabe* Linnaeus, 1758.

the Philippines particularly in Mindanao island (VaneWright and Boppre 1990, and Wolfe 2018).

The nymphaline butterflies, particularly *Hypolimnas* and *Junonia* are mainly distributed in Asia and Australia (Win et al. 2016). *J. hedonia* (Figure 5J) was also recorded in the study of Nuñeza et al. (2016) in Bega Watershed in Mindanao, and *H. bolina* (Figures 5K-L), was also recorded in the recent studies of Medina and Cabras (2018) and Manalo et al. (2017). Also, Treadaway and Schroeder (2012) listed five endemic Philippine species of *Acrophtalmia*. A species of this group – *A. leto* (Figure 5G), was also recorded in Bega Watershed (Nuñeza et al. 2016). Another species, *A. phidippus* (Figure 5F), commonly referred as the Palmking is a widely distributed species in southeast Asia (Kunte, 2016) and was also recorded in Mt. Timpoong and Mt. Hibok-hibok in Camiguin Island (Toledo and Mohagan 2011). *Ypthima* is also a diverse group in the southeastern fringe of the Palearctic to the Oriental Region (Shima and Nakanishi 2007). *Y. sempera* (Figure 5C), which is Philippine-endemic, is also recorded in the current study.

*Troides* is one of the three genera of birdwing butterflies, and *T. rhadamantus* (Figure 6B), the only species of golden birdwing collected in the area, was also previously reported in Davao City (Salaga et al. 2018), and in Mt. Hamiguitan, Davao Oriental (Mohagan and Treadaway 2010). This endemic papilionid butterfly is the largest specimen observed among the butterflies collected in the present area. Similarly, *P. boebara* (Figure 6O), an endemic Pierinae, was previously reported in other parts of Mindanao island such as Mt. Hamiguitan in Davao Oriental (Mohagan and Treadaway 2010), and Bukidnon (Mohagan et al. 2011, and Sumagaysay and Sumagaysay 2012).

***Species Diversity***

The entomofaunal diversity of both butterflies and moths in Andanan Watershed (H=3.69) indicates and index of high diversity (Table 2).

The high diversity of lepidopterans in the area

Table 2. Diversity of Lepidopteran insect fauna showing the diversity index and equitability values.

| Species Richness (S) | Total Number of Individuals (N) | Diversity Index (H) | Maximum Evenness (Hmax) | Equitability (H/Hmax) | Qualitative Inference |
|---|---|---|---|---|---|
| 54 | 103 | 3.69 | 3.97 | 0.93 | High diversity |

can be attributed to several factors. First, the species richness of these taxa may be high since different types of vegetation were observed in the area. This might be favorable to some groups of these insects since various habitats were recorded in the Andanan Watershed Forest Reserve, such as forested lands with patches of dipterocarps, riparian zone which is mostly exposed to humid areas, open grasslands and portions of agricultural lands, which have similar inferences according in the study of Nuñeza et al. (2016). Also, most parts of the riparian ecosystem are open areas with flowering plants, grasses, shrubs and canopy covers. Vu & Quang (2011) also reported that ecosystems along streams and wetlands may attract lepidopterans, and promote diversification. Similarly, the study of Highland et al. (2013) on moth diversity also showed that riparian forests are more stable and predictable communities for this group of insects since these communities have less interannual variability. The diversity of lepidopterans is also dependent on plants because caterpillars have strict dependence on specific host plants and adult on nectar plants (Anbalagan et al. 2015).

The lepidopteran diversity appeared high in the site. It may imply that both forested and riparian area are essential habitats for these insects (Nuñeza et al. 2016). Though lepidopterans may be associated in slightly disturbed habitats, but higher level of any form of disturbances may result in the decline of diversity and might cause extinction to some native and highly localized species and subspecies. Moreover, the loss of prime habitat is the major threat to all wildlife including butterflies and moths, and a variety of threats from human recreational activities, run-offs from roads and waste litter deposition are few common factors that greatly affect both butterfly and moth populations (Nair et al. 2014).

## 4 Conclusion and Recommendations

The inventory of lepidopterans in Andanan Watershed Forest Reserve shows high diversity with 54 species from 13 families which may directly correspond to the good quality of forest and vegetation. The presence of six endemic species put added premium to the importance of preserving the habitat for the lepidopteran community.

## 5 Acknowledgement

The researchers are most grateful to Dr. Peter B. Hardy, Dr. Leana Lahom-Cristobal and Dr. Romana P. Delos Reyes for the identification and series of re-validation of all the samples.

## Statement of Conflict of Interest

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

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