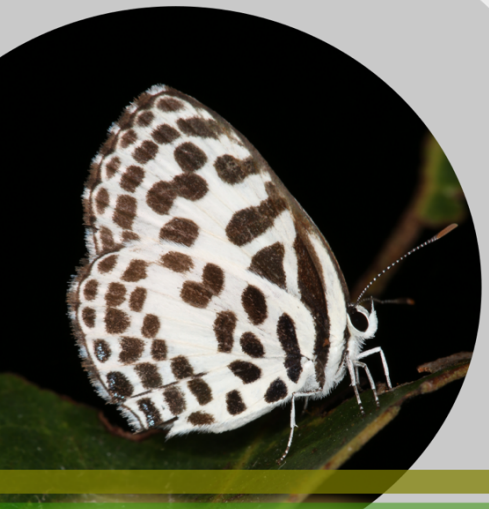
Korea Forest Service



TECHNICAL *REPORT*

Insect Baseline Survey

at Tumring REDD+ Project Study Site, Kampong Thom Cambodia

Phnom Penh, January 2022

Document prepared by Cambodian Entomology Initiatives

Cambodian Entomology Initiatives

The techincal report submitted to Project Management Unit of the Tumring REDD+ Project.

Disclaimer:

This publication aims to inventory the entomological taxa (insects) diversity at Tumring REDD+ project research sites in Kampong Thom province, Cambodia. The scientific output of the report does not imply policy position of authors nor the project implementation. The contents and knowledge of the report are supported the scientific point of view in the field of Entomology. Neither the authors nor any person acting on behalf of the authors are responsible for this document.

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Prepared by:

Sophany PHAUK, Soksan CHHORN, Sophak THOU, Saoya SEN, Sokban RUN, Gechly YOK, Bros DOEURK, Chandara KHIN and Sopha SIN

Cambodian Entomology Initiatives
Department of Biology, Faculty of Science
Royal University of Phnom Penh

Email: phauk.sophany@rupp.edu.kh

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Table of Content

List of Figures

List of Tables

Abbreviations

CCB	Climate, Community and Biodiversity
CEI	Cambodian Entomology Initiatives
CF	Community Forest
FA	Foresty Administration
GHG	Greenhouse Gases
KFS	Korea Forestry Service
MAFF	Ministry of Agriculture, Forestry and Fisheries
NGOs	Non-Governmental Organization
PFR	Permanent Forest Reserve
PLWS	Prey Lang Wildlife Sanctuary
REDD+	Reducing Emissions from Deforestation and Forest degradation
RGC	Royal Government of Cambodia
TRP	Tumring REDD+ Project
VCS	Verified Carbon Standard

Highlight

- Insect survey were employed at FOUR community forests (CFs) and ONE permanent forest reserve (PFR) from Tumring REDD+ project area: Ou Das Sko (A1-DS), Lbos Sral (A1-LS), Ou Bos Leav (A2) and Prey Kbal Ou Kror Nhak (A4) community forest and Prey Ang Ten (A3).
- A total of 1582 insect specimens were identified belonging to 283 morphs/species under 88 families and 11 orders (Blattodea, Coleoptera, Diptera, Hemiptera, Hymenoptera, Lepidoptera, Mantodea, Neuroptera, Odonata, Orthoptera and Phasmatodea) from Tumring REDD+ project area.
- The high biodiversity conservation zone at Ou Das Sko (A1-DS) and Lbos Sral (A1-LS) community forests are represented a high diversity of insect in Tumring REDD+ project. 124 and 119 morphospecies are respectively recorded and high value of Shannon diversity index (H) in both sampling sites.
- 89 morphospecies of Coleoptera (Beetles) were represented diverse species recorded in Tumring REDD+ project area due to their tough exoskeleton and adaptive to any environmental condition.
- Prey Kbal Ou Kror Nhak community forest was dominant of insect taxa from Hemipterans and Orthopterans of we compared other CFs and permanent forest preserve area.
- Indicators and rare insect species of dung beetles Copris sp., group of pollinators (Apis millifera and related species), lantern bug Zanna sp., giant stick insect (Phobaeticus sp.), were recorded in Tumring REDD+ project area.
- Entomological research at Tumring REDD+ project area should be further extended sampling to explore insect distributions, in addition of seasonal study between the wet and dry monsoon.
- Biodiversity conservation (including insect conservation) is very important to the Tumring REDD+ project area Prey Lang Wildlife Sanctuary.
- Encouragement of getting involve in support and awareness for biodiversity conservation from government sectors, NGOs, local communities and relevant sectors in TRP and PLWS.

1. Introduction

1.1. Insects and forest landscapes

The prominent concern of biodiversity was seriously sloped down of forest habitat degradation (e.g., deforestation, illegal logging and climate change) (Mauricio da Rocha et al., 2010). Based on Morante-Filho et al (2016) reported forest loss not only changed the physical condition, and climate change, but it also affected on insect diversity. Beyond, climate change is ongoing directly lead to affect dispersal, reproduction, development, and increase mortality of insect species (Morante-Filho et al., 2016). Hence, insect taxa are also sensitive to climate change and moisture that accompany such events. In Europe continent, with approximately 50% of butterfly abundance is extinct from 1990 to 2011 (European Environment Agency, 2013). Losing insect is one of the most problematic in the functional process of ecosystems. For example, about 80% of flowering plant needs insects pollinators for reproduction (Ollerton et al., 2011). The insect lost can be decreased of forest cover (Leal et al., 2016 & Wagner et al., 2021).

Insects can be found in all ecological habitat conditions (Thomas, 2005 & Ojija et al., 2016), an estimation about 97% is terrestrial insects whereas the remaining is aquatic insects. Tropical rainforest is one of the highest animal species-richness including insects (Bos et al., 2007). Insect communities in the tropical rainforest represent by herbivore insects (Basset et al., 2001), with dominantly by lepidopterans, coleopterans, and orthopterans (Novotny et al., 2006). Insect populations influenced by habitat landscapes which determined by vegetation types, and seasonal variation (Kishimoto-Yamada, 2015 & Knuff et al., 2020).

Insects are known to being either harmful and beneficial base on their ecological key roles (Balakrishnan et al., 2014). In particular, viruses-transmitter like the tree/leafhoppers, are the major pests in the agricultural and forest landscape (Klein, 2001). Insects provide factional significant role in decomposers in the forest by consuming dead woods, an example of longhorn beetles and bark beetles (Kariyanna et al., 2017). Decaying organic material consumers like larvae of scarab beetles and carrion beetles which play a significant role in the nutrient cycling (Young, 1989 & Sin et al., 2021). Insect pollinators of bees and butterflies that increase reproduction rate of plants and lead to restoring the forest cover (Ojija et al., 2016). Consequently, insects play a significant ecological role of food chain that supple to vertebrate fauna (Brown, 2013).

1.2. Tumring REDD+ Project Area

The project area of Tumring REDD+ Project (hereafter TRP) was established in 2015 and the primary activity is to reducing of carbon emission form the project area by halting deforestation and forest degradation. TRP project area is located in Kampong Thom province (Fig. 1). The project is implementing under Forestry Administration (FA) of the Ministry of Agriculture, Forestry and Fisheries (MAFF) with financial and technical support from Korea Forest Service (KFS). The project aims to contribute to the long-term greenhouse gas emission reduction from forestry sector and enhances livelihood of targeted forest-depended community in the project area through the implementation REDD+ program. There are four main drives of deforestation and forest degradation in the project area, including (1) small-scaled forest land clearing for agriculture, (2) illegal logging, (3) over collection of fuelwoods, and (4) forest fires.

Tumring REDD+ project was already certificated under Verified Carbon Standard (VCS) and Climate, Community and Biodiversity (CCB) standard (Chheng et al., 2015). To meet the project goals, the 04 specific objectives were set for the project (1) obtain forest carbon credits from the Korea-Cambodia Joint REDD+ implementation, (2) increase livelihood of forest dwellers within target Korea-Cambodia Joint REDD+ implementation site, (3) enhance capacity of key different stakeholders to effective REDD+ implementation and (4) support the Royal Government of Cambodia (RGC) on REDD+ policy formulation. TRP has been in partnership with 14 community forestry (CFs) groups, local authorities, local Forestry Administration, national

non-governmental organization (NGOs) partners, and relevance provincial departments. Those actors are clearly defined role and responsibilities in long term project implementation. This project situates in Sandan (Chheu Teal commune, Mean RIth, Sochet, Tum Ring and Tumring) and Santuk districts (Boeng Lvea commune).

1.3. Biodiversity in TRP Project Area

Buffer area of TRP project site lies on the southwestern edge of Prey Lang Wildlife Sanctuary (PLWS) and covers approximately 67,791.17 hectares in central Cambodia, to the west of the Mekong River (Work, 2017 & Freund et al., 2018). Buffer area of TRP categorized as lowland rain forest and comprise a mosaic of forest types that includes evergreen, semi-evergreen and deciduous forest types (McDonald, 2004). TRP stores carbon, whose release in the atmosphere through deforestation results in the emission of large quantities of greenhouse gases (GHG), which contribute to global climate change. Therefore, protecting the TRP forests is critical important for mitigation global climate change, biodiversity conservation and sustaining of ecosystem services to local communities.

An extension biodiversity from PLWS, TRP is important for wildlife because it is one of the last remaining lowland forest habitats left in Cambodia (Hayes et al., 215). Globally threatened large mammals present in the area, such as Asian elephant (*Elephas maximus*) and other large mammals are found in the region. Critical endangered reptile, Siamese crocodile (*Crocodylus siamensis*) and endangered species of elongated tortoise (*Indotestudo elongate*) are also recorded in PLWS (Freund et al., 2018). In addition, Prey Lang region is home to a rich and diverse wildlife of birds and smaller taxa such as amphibians and insects (Thelaide & Schmidt, 2011). However, the knowledge of wildlife diversity at the region of PLWS and the buffer zone of TRP are less documents and inventory had been studied recently.

1.4. Entomological research in Cambodia

Insects are an invertebrate animal group which determined by three general characteristics including six legs, three parts of bodies, two antennas (Borror, 1981). Insects are also well known the largest group of organisms on the planet. About 750.000 species of insect have been described worldwide (Balakrishnan et al., 2014), while million species are undescribed yet (Martin, 2012).

In Cambodia, entomological research of insect taxa is relatively low documented, comparing to other in SE Asia countries. However, some specific group of insects have been documented in the country including dragon/damselflies and butterflies from Kulen Promtep Wildlife Sanctuary (Roland et al, 2010; Kosterin & Holden, 2011; Kosterin et al., 2012 & Phauk et al., 2019), 82 morphs/species of bees were recorded (Ascher et al., 2016), 18 lantern bugs (Constant et al., 2016), aquatic insects (Sor et al., 2017; Freitag et al., 2018; Zettel et al., 2017; Chhy et al., 2019 & Chhorn et al., 2020), and a recent study of carrion beetle *Diamesus osculans* Vigors, 1825, was recorded in Prey Lang Wildlife Sanctuary (Sin et at., 2021). Additionally, we have found no research of entomo-taxa from the lowland rainforest areas, Prey Lang Wildlife Sanctuary and relatively habitats. Therefore, we want to sampling insect diversity at the buffer zone, Tumring REDD+ project area and the research outcome could be valuable for biodiversity status of TRP and PLWS.

1.5. Objectives

The principal objective of the insect sampling aims to assess and measure the values of biodiversity and scientific knowledges of entomological research at Tumring REDD+ Project area. The specific objectives of the research are:

- *to conduct a scientific survey of species diversity, abundance and richness of insects at the project sites and*
- *to identify the key species and importance of insect species at the Tuming-REDD+ project areas.*

2. Methods

2.1. Study sites

PLWS is one of the biodiversity hotspots in the lowland evergreen forest remaining in the Indo-Burma region (MacDonald, 2004; Hayes et al., 2015 & Work, 2017). Sampling and insect collection were employed at the buffer zone of PLWS, the Tumring REDD+ Project Area. Those are four community forests [Lbos Srol (A1-LS), Ou Das Sko (A1-DS), Ou Boss Leav (A2) and Prey Kbal Ou Kror Nhak (A4) and one permanant forest reserve [Prey Ang Ten (A3)], were randomly selected based on the geographical distribution (Fig. 1). Overall, the landscape of the study sites is formed in the lowland area with high proposition of semi-evergreen forests. The surrounding habitats were categorized by agricultural areas of paddy fields, cassava plantations, cashew farms, grassland and local villages as shown in Fig. 2. The survey was starting from 07 – 13 December, 2021, and 35 sub-sampling sites were randomly selected based on the accessibility and insect collecting methods. Geographical information and related habitats were detailed in the table 1.

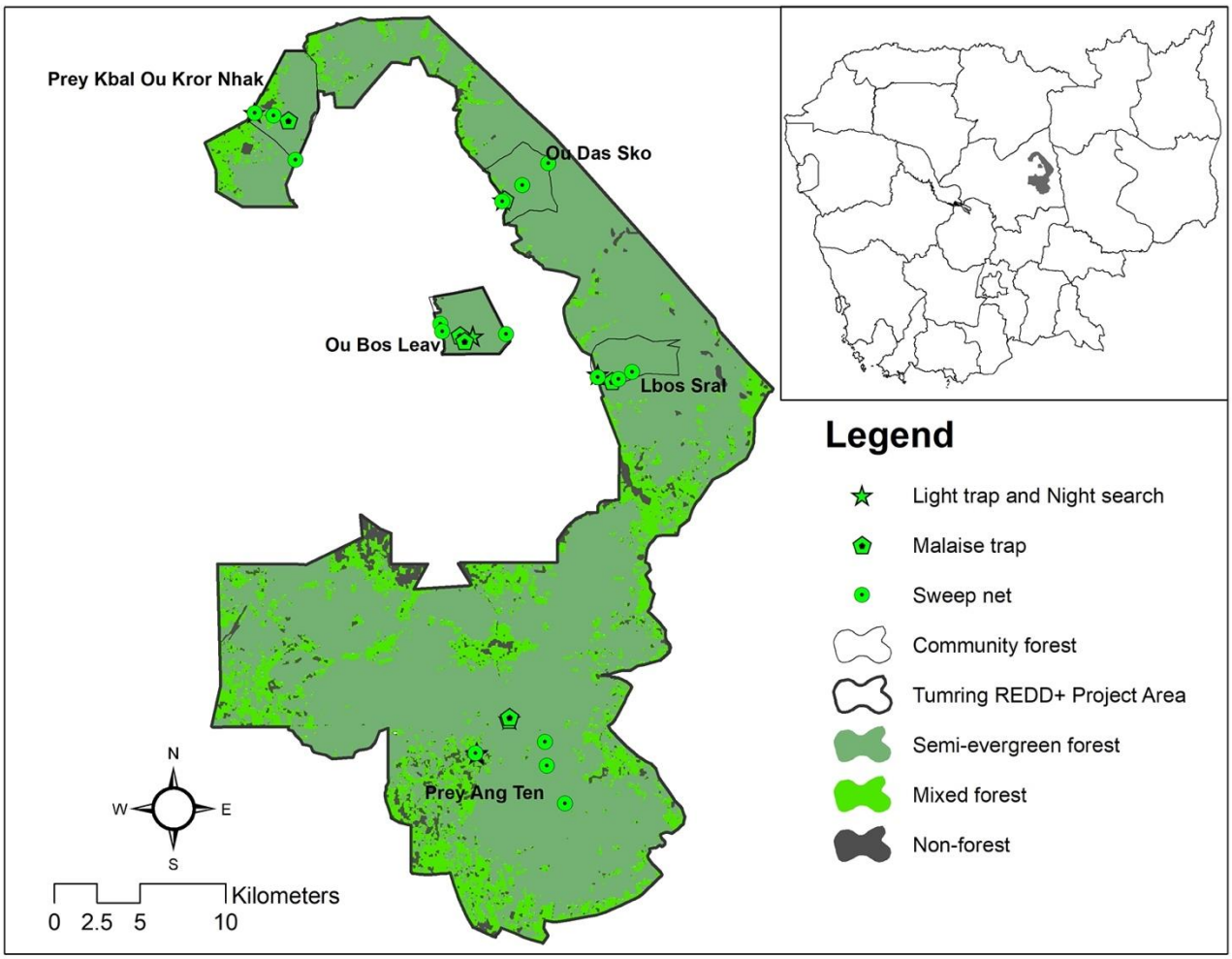

Figure 1. Map of sampling sites at Tumring REDD+ Project Area, Kampong Thom province.

Table 1. Insect sub-sampling sites at community forests (CFs) and permanent forest reserve (PFR) within habitats, sampling methods and geographical information. *Note: SN = Sweeping net, MT = Malaise trap, LT = Light trap, NS =Night search and photography*

Code site	CFs / PFR	Habitat	Method	Latitude	Longitude	Elevation	Date
A3LT1	Prey Ang Ten (PFR)	Semi-evergreen	LT	12° 46.477'N	105° 27.344'E	97	07.12.2021
A3NS1	Prey Ang Ten (PFR)	Semi-evergreen	NS	12° 46.477'N	105° 27.344'E	97	07.12.2021
A3SN1	Prey Ang Ten (PFR)	Semi-evergreen	SN	12° 45.748'N	105° 28.490'E	102	08.12.2021
A3SN2	Prey Ang Ten (PFR)	Semi-evergreen	SN	12° 43.804'N	105° 29.128'E	89	08.12.2021
A3SN3	Prey Ang Ten (PFR)	Semi-evergreen	SN	12° 44.996'N	105° 28.551'E	93	08.12.2021
A3SN4	Prey Ang Ten (PFR)	Dipterocarp	SN	12° 45.397'N	105° 26.246'E	92	08.12.2021
A2LT1	Ou Bos Leav	Semi-evergreen	LT	12° 57.372'N	105° 30.209'E	108	08.12.2021
A2NS1	Ou Bos Leav	Semi-evergreen	NS	13° 4.048'N	105° 28.629'E	108	08.12.2021
A2SN1	Ou Bos Leav	Grassland	SN	12° 57.440'N	105° 31.325'E	84	09.12.2021
A2SN2	Ou Bos Leav	Semi-evergreen	SN	12° 57.214'N	105° 30.888'E	78	09.12.2021
A2SN3	Ou Bos Leav	Semi-evergreen	SN	12° 57.281'N	105° 30.213'E	108	09.12.2021
A1SN1	Lbos Srol	Semi-evergreen	SN	13° 3.349'N	105° 27.791'E	96	09.12.2021
A1SN2	Lbos Srol	Semi-evergreen	SN	13° 2.837'N	105° 27.138'E	80	09.12.2021
A1SN3	Lbos Srol	Grassland	SN	13° 2.906'N	105° 27.215'E	67	09.12.2021
A1LT1	Lbos Srol	Shrubs&Stream	LT	13° 2.888'N	105° 27.166'E	58	09.12.2021
A1NS1	Lbos Srol	Shrubs&Stream	NS	12° 58.737'N	105° 25.191'E	58	09.12.2021
A1SN4	Ou Das Sko	Shrubs&Stream	SN	12° 58.971'N	105° 25.130'E	124	10.12.2021
A1SN5	Ou Das Sko	Grass & Shrub	SN	12° 58.644'N	105° 27.250'E	124	10.12.2021
A1SN6	Ou Das Sko	Grass & Shrub	SN	12° 58.608'N	105° 25.764'E	92	10.12.2021
A1LT2	Ou Das Sko	Cashew	LT	12° 58.585'N	105° 26.185'E	82	10.12.2021
A1NS2	Ou Das Sko	Shrub& Semi-evergreen	NS	12° 58.584'N	105° 26.185'E	82	10.12.2021
A4SN1	Prey Kbal Ou Kror Nhak	Semi-evergreen	SN	13° 4.169'N	105° 20.463'E	104	11.12.2021
A4SN2	Prey Kbal Ou Kror Nhak	Grass & Shrub	SN	13° 5.572'N	105° 19.754'E	49	11.12.2021
A4SN3	Prey Kbal Ou Kror Nhak	Grass & Shrub	SN	13° 5.655'N	105° 19.149'E	35	11.12.2021
A4LT1	Prey Kbal Ou Kror Nhak	Shrub & Stream	LT	13° 5.658'N	105° 19.135'E	35	11.12.2021
A4NS1	Prey Kbal Ou Kror Nhak	Shrub & Dipterocarp	NS	13° 5.658'N	105° 19.135'E	35	11.12.2021
A3LT2	Prey Ang Ten (PFR)	Dipterocarp	LT	12° 45.419'N	105° 26.300'E	83	12.12.2021
A3NS2	Prey Ang Ten (PFR)	Dipterocarp	NS	12° 45.387'N	105° 26.274'E	83	12.12.2021
A2MT1	Ou Bos Leav	Semi-evergreen	MT	12° 57.164'N	105° 30.675'E	115	12.12.2021
A2MT2	Ou Bos Leav	Semi-evergreen	MT	12° 57.372'N	105° 30.209'E	102	12.12.2021
A1MT1	Lbos Srol	Semi-evergreen	MT	13° 2.888'N	105° 27.166'E	98	12.12.2021
A1MT2	Ou Das Sko	Semi-evergreen	MT	12° 58.440'N	105° 25.911'E	115	12.12.2021
A4MT1	Prey Kbal Ou Kror Nhak	Semi-evergreen	MT	13° 5.424'N	105° 20.236'E	60	12.12.2021
A3MT1	Prey Ang Ten (PFR)	Semi-evergreen	MT	12° 46.456'N	105° 27.323'E	82	13.12.2021
A3MT2	Prey Ang Ten (PFR)	Semi-evergreen	MT	12° 46.535'N	105° 27.340'E	103	13.12.2021

Figure 2. Overall habitat types of research sampling sties: Semi-evergreen forest (on top), grassland, grassland mixed cassava plantation and dipterocarp forest (below).

2.2. Insect Sampling

Four insect sampling methods were used for the inventory, included of sweeping net, malaise traps, light traps, and night searching and photography in the selected study sites.

Sweeping Net

Sweep nets were employed at the three random sub-sampling sites in each CF, excepts Prey Ang Ten (PFR) with four sub-sampling sites. Sweep net is one of insect collecting tools for this survey (Figure. 3A). We used the net for sweeping on free-living insects in the grassland and vegetations along the natural trails within 60 minutes. The net is able to collects wide range of insects that are dislodge relatively easily such as leaf/treehoppers, grasshoppers, butterflies and leaf beetles (Phauk et al., 2019). Insects in the nets were then collected by using hands for large insects, and small insects were collected assisting by aspirators. Consequently, small insects were preserved with 70% of ethanol in 1.5 ml vials. However, large insects were collected by using 50 ml tubes, and preserved with Ethyl acetate ($C_4H_8O_2$) mixed wood chops. For big and fragile insect of Dragon/Damselflie, moths and butterflies were kept in prepared folding papers (Borror et al., 1981 & Phauk et al., 2019).

Malaise Traps

Malaise trap was invented by René Malaise in 1934, a tent-like structure used for trapping flying insects particularly Hymenoptera and Diptera (Malaise, 1937). Large, mesh-based interception traps that can capture high number of flying insects with good preservation and long time periods. This trap can be useful to survey rare and threatened species, and suitable for flies and wasps collecting. The trap also can be employed at the

open area in the forests and grassland. The places with water such as streams and ponds are best for using malaise traps (Phauk et al., 2019). Seven malaise traps were sampled by represented one sub-sampling site in each CF, excepted two malaise traps were placed in Ou Bos Leav (A2) and Prey Ang Ten (A3). Malaise traps were hanged and left for at most of 5 nights and keep out of sight from villagers (Fig. 3C).

Light traps

Light trap, an incandescent light bulb (light source by generator) was used to attract certain insects. Light traps were widely used to survey nocturnal moths and other insects. Variety of designs available of light that depend on attractiveness of many insects including grasshoppers, cicada, beetles, leafhoppers and moths. However, total species richness and abundance of nocturnal insects may be influenced by several factors such as night temperature, humidity and seasonal variation (Jonason et al., 2014). Six random light traps were employed for 3 hours from 19:00 to 22:00 at CFs and PFR. In particular, light source with a white sheet were used in this survey (Fig. 3B). Collecting insects can be used by aspirator or hand (Phauk et al., 2019).

Night Searching and Photography

Night searching with insect photography were conducted along the trial up to 1 km apart from the light trap sampling (Phauk et al., 2019). A gentle walking with headtorch was observed any type of leaf or bark of the tree (Fig. 3D). Less active insects were then photographed for identification by using Canon 6D Mark II profession camera with Canon EF 100mm f/2.8L macro IS USM lens and Speed lite MR-14EX II macro ring lite flash. Total of 6-nights searching (in 3 hours each) were surveyed at sampling sites as show in the Fig. 1.

Figure 3. Field work activities and insect collecting methods for insect sampling: A) Sweeping nets, B) Light trap, C) Malaise trap and D) Night search and photography.

2.3. Species Identification

Materials (insect specimens) were then deposited to Cambodian Entomology Initiatives (CEI) at the Department of Biology, Faculty of Science at the Royal University of Phnom Penh for species identification. Insect specimens were sorted and categorized into collected sampling. Stereo Microscope SZ61 and Optika Stereo Microscope were used to observe the habitus of each insect specimens (Sin et al., 2021). Individual insects were then pinned, labelled and categorized into sampling sites for further analysis. Then all specimens were determined based on their external morphology and classified into order, family, genus and morph-species (or species level if possible). Existing publications and insect identification keys, Borror et al., 1981; Ek-Amnuary, 2008 & 2012; Kosterin, & Holden, 2011 & 2012; Kosterin et al., 2012; Woo-Shin & Sungjin, 2013; Francis, 2016; Ascher et al., 2016; Constant et al., 2016; Freitag et al., 2018 & Phauk et al., 2019, were also used to identify the specimens. The interested and important insects were photographed, using the same tools in the field work.

2.4. Statistical Analysis

Shannon's diversity index (H) was used to describe the insect diversity which included species richness and abundance for each study site (community forest). We used *Shapiro wilk test* to figure out normality distributed of data. *Kruskal-Wallis test* was used to test significant difference insect composition between study sites with determine at a significant level *p-value<0.05*. Boxplots were used to visualize and describe the values variations of insect diversity (community forest) represented in each study site.

3. Results

Total of 1,582 insect specimens were identified belonging to 283 morphospecies, comprised of 88 families and 11 orders at Tumring REDD+ project area (Appendix III). The eleven insect orders were classified into group of Coleoptera, Hemiptera, Lepidoptera, Orthoptera, Hymenoptera, Diptera, Phasmatodea, Odonata, Mantodea, Blattodea and Neuroptera. Coleoptera was found the most with 89 taxa recorded in the present survey, and followed by Hemiptera with 67 taxa, Lepidoptera with 35 taxa, Orthoptera with 27 taxa, Hymenoptera with 23 taxa, Diptera with 12 taxa, Phasmatodea with 11 taxa. While the less abundance insect orders were found on Odonata with 8 taxa, Mantodea with 7 taxa, Blattodea and Neuroptera with only 2 taxa, respectively. Among 283 morphospecies, 37 insect taxa [from Lepidoptera and Coleoptera (Coccinellidae)] were identified to species level.

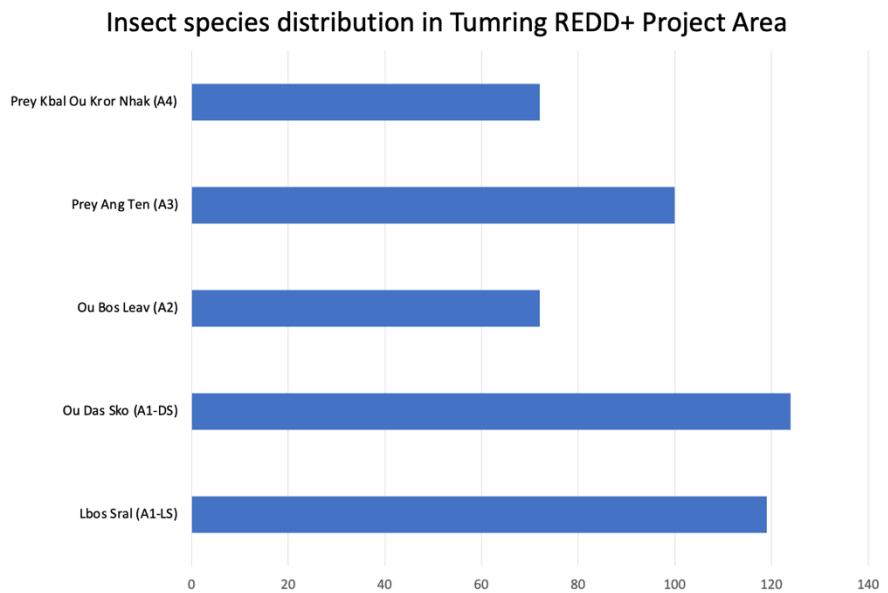

Figure 4. Insect species distribution in Tumring REDD+ Project Area: Lbos Sral, Ou Das Sko, Ou Bos Leav and Prey Kbal Ou Kror Nhak community forest and Prey Ang Ten-PFR.

3.1. Insect composition in the community forests

Ou Das Sko community forest

Ou Das Sko (A1-DS) community forest was established on 20 August 2010, with covers 1,135 hectares. This CF is located at the Eastern part and borders to PLWS (Fig. 1). Ou Das Sko is a high conservation values of large mammals such as fishing cat (*Prionailurun viverrinus*) and sunda pangolin (*Manis javanica*) (Freund et al., 2018). The community forest is dominant by semi-evergreen forest and grassland. Additional of habitats of the area at western part, agricultural landscape also has been extended nearby Ou Das Sko. The specific agriculture plants are cashews mixed of grassland and cassavas.

With 124 morphospecies, belonging to 10 orders were recorded from this study site (A1-DS). Coleoptera were found the most diverse in this site with 52 spp., followed by Lepidopteran and Hemipterans with 25 and 21 spp., respectively (Fig. 4). Other insect taxa are belonged to Orthopterans with 8 spp., Odonatans with 6 spp., Dipterans with 5 spp. and Hymenopterans with 4 spp., while Phasmatodea, Mantodea, Neuroptera with one morphospecies in these orders (Appendix III).

Lbos Srol community forest

Lbos Sral (A1-LS) community forest was established same as Ou Das Sko and covers area of 1,123 hectares. High values for biodiversity conservation due to buffer zone bordered to PLWS (Freund et al., 2018). The landscape in the area is structured by semi-evergreen forest and shrub mixed grassland. Cassava and cashew plantations are located at the western part of the CF.

Total of 119 morphospecies (Fig. 4) of 9 orders were identified from community forest (A1-LS). Hemipterans and Coleopterans were dominant insects in the site with 49 and 45 spp., respectively. The following insects were Orthoptera with 9 spp., Diptera with 6 spp., Lepidoptera with 3 spp., Phasmatodea, Blattodea and Mantodea with only 2 spp. per order. Only one species was recorded for Neuroptera in this CF (Appendix III).

Ou Bos Leav community forest

Ou Bos Leav (A2) is an isolated community forest, located in the central of TRP project area (Fig. 1). The community forest covers 1,297 hectares and became the CF for the project same date as Ou Das Sko and Lbos Sral CFs. The landscape of the area is dominant by semi-evergreen forest and grassland while surrounding by agricultural activities. The forest was highly disturbed by human activities such as cashew and cassava plantation by local community. An illegal logging and wildlife hunting (by snares) were reported during the insect collection.

This community forest was the survey site with low dominant of insect species. Only 72 morphospecies belonging to 9 orders were recorded (Fig. 4). Coleoptera were found the most in site with 31 spp., followed by Hemiptera (11 spp.) and Lepidoptera (10 spp.). The less insects were Phasmatodea (6 spp.), Orthoptera (5 spp.). Diptera and Odonata represented 3 spp. per order, Mantodea with 2 spp. and Blattodea with only one morphospecies (Appendix III).

Permanent Forest Reserve Prey Ang Ten

Prey Ang Ten (A3) is a part of permanent forest reserve in Tumring REDD+ project area where is managed by FA. The area is located in the South of the TRP area (Fig. 1). The landscape view of the area is dominant by semi-evergreen forest in the middle, and dipterocarp forest mixed grassland. The habitat surrounding is cassava and cashew plantation. Consequently, the forest was strongly disturbed by logging activities and deforestation for agricultural activities.

Total of 100 insect morphospecies of 9 orders were recorded in Prey Ang Ten (Fig. 4). Insects from Coleoptera were highly occurred with 36 spp., followed by Hymenoptera (22 spp.), Hemiptera (16 spp.), Orthoptera (9

spp.) and Diptera with 8 morphospecies. While the less common insects were Lepidoptera (4 spp.), Odonata and Mantodea with 2 taxa for each order, and Neuroptera with only one morphospecies (Appendix III).

Prey Kbal Ou Kror Nhak community forest

Prey Kbal Ou Kror Nhak (A4) is located at the Northern part of TRP area. The area covers 1,593 hectares and established on 19 November 2008 (Fig. 1). The landscape is structured by semi-evergreen forest, shrubs, cashew and cassava plantation, situated and surrounded the community forest. The forest was disturbed by human activities due to accessibility the villages and inside the community forest.

Low insect diversity of 72 morphospecies (Fig. 4) belonging to 10 orders were identified from the community forest (A4). Specifically, the order of Coleoptera were the most dominant in the site within 34 spp., and followed by Hemiptera and Orthoptera (with 16 and 10 spp. respectively). Whereas Lepidoptera was found 3 spp. and 2 spp. for Phasmatodea, Mantodea and Diptera, only one morphospecies was identified for Hymenoptera, Odonata and Neuroptera (Appendix III).

3.2. Insect Diversity at Tumring REDD+ Project Area

Based on *Kruskal-Wallis* test shown no significant difference between sites for abundance and richness. However, Shannon diversity demonstrated statically significant between A1-LS and A3 at *p-value <0.05*.

Abundance

The distribution of insect sampling at the study sites shown highest values of abundance were found in Lbos Sral community forest (A1-LS) with an average of 63.83 (Min=15-Max=155), and Ou Das Sko (A1-DS) with an average of 59.16 (20-117). Followed by Prey Ang Ten (A3) and Prey Kbal Ou Kror Nhak (A4) was 41.1 (1-150) and 38.83 (0-90), respectively. Ou Bos Leav (A2) was less abundance of 28.57 (1-45). However, based on Kruskal Wallis test revealed no significant difference between sites at *p-value > 0.05* (Fig. 5A).

Richness

Species richness of Lbos Sral (A1-LS) and Ou Das Sko (A1-DS) forest communities were the greatest average of species 25.83 (11-44) and 25.50 (9-37), respectively. Similarity of species at Ou Bos Leav (A2), Prey Kabl Ou Kror Nhak (A4) community forest and Prey Ang Ten (A3) with value of 11.71 (1-190), 15.00 (1-27) and 13.90 (5-34) respectively. However, there is no significant different amount the communities (Fig. 5B).

Shannon diversity

In term of diversity index, the sampling site (A1-LS) and (A1-DS) were the highest value of insect diversity with 2.85 (2.4-3.18) and 2.83 (1.9-3.85), respectively, and followed by A4 2.09 (0-2.85) and A3 2.08 (1-2.9). Sampling site A2 was less insect diversity with an average 1.71 (0-2.6). *Kruskal Wallis test* demonstrated statically difference between Lbos Sral (A1-LS) and Ou Bos Leav (A2) are significant different at *p-value < 0.05* as shown in Fig. 5C.

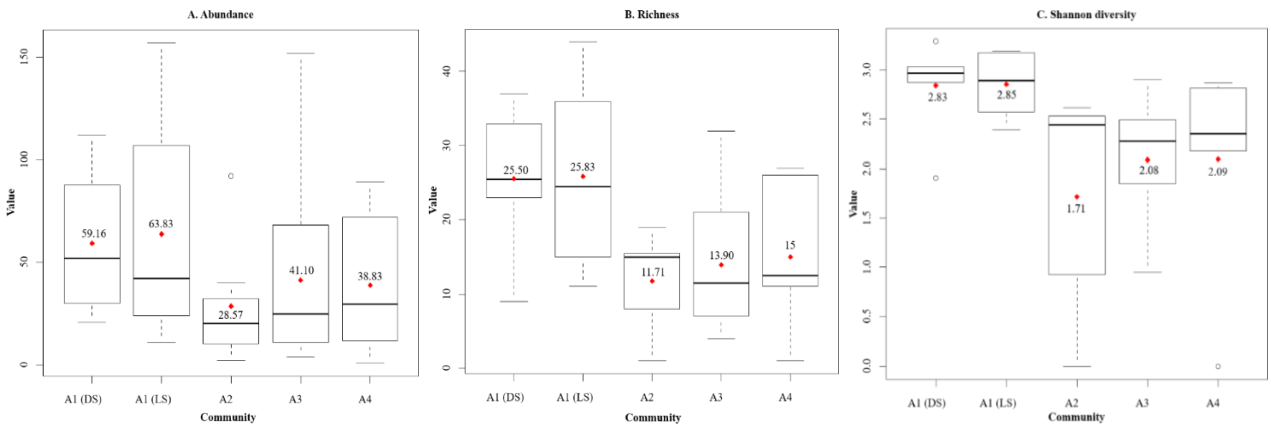

Figure 5. Boxplots- the average values (red spots) of insects recorded from 5 communities (research sampling). **A)** Abundance, **B)** Species Richness, **C)** Shannon diversity index.

4. Discussion

4.1. Species distribution at Tumring REDD+ project

The study represented the first insect inventory at Tumrng REDD+ project area. We recorded 283 morphospecies (species), comprised of 11 orders and 88 families from the five represented sampling sties. Insect distribution at Ou Das Sko (124 taxa) and Lbos Sral (119) community forests were diverse, while only 100 morphospecies were recorded in Prey Ang Ten (PFS) and 72 insect taxa were found in Prey Kbal Ou Kror Nhak and Ou Bos Leave community forests (Fig. 4). Amount 11 insect orders, Coleoptera (89 morphospecies) was diverse species recorded in Tumring REDD+ project area. Within their tough exoskeleton and adaptive to any habitat types, allow them to survive in environmental condition (Borror et al., 1981). The result is comparable to the insect survey in semi-evergreen forest in Kulen Promtep Wildlife Sanctuary (KPWS) and Northern of Thailand (Sukapanpotharam, 1979 & Phauk, et al., 2019). The diverse habitat types in the project are suitable for Hemiptera, Lepidoptera, Orthoptera, Hymenoptera, Diptera and Phasmatodea. However, Odonata, Mantodea, Blattodea and Neuroptera were less occurred in this study. This may be due to sampling effort and seasonal changing. Sampling of our survey were mostly from the semi-evergreen forest, shrubs and grassland mixed agricultural. In contrast, Schindler et al., (2003) reported all these insects prefer the humid and surrounded by water resources (pond and stream), in particular Odonata (dragonflies and damselflies).

4.2. Insect diversity and their importance of Tumring REDD+ project area

The study revealed that insect diversity in community forests of (A1-LS) and (A1-DS) comprised the highest abundance, taxonomic richness and diversity value of insects (Fig. 5). These results are consistent across the sampling sites, with both sites shown similar mean of Shannon diversity (2.85) and (2.83), respectively. The forest habitats at Ou Das Sko and Lbos Sral community forests are included diverse vegetations, semi-evergreen forest and patchy grassland where provided good conditions for shelter, foraging and avoid from predators (Jaganmohan et al., 2013). Diverse species richness of the both sampling sites can be due to high biodiversity conservation zone (Ostfeld & LoGiudice, 2003) and their located at corridor the border of PLWS (Freund et al., 2018). At Prey Ang Ten (PFR) and Prey Kbal Ou Kror Nhak (CF) were slightly high for insect diversity (Fig. 5). The fact that forest communities (habitats) were obtain disturbed activities. Therefore, changing of insect communities can be due to illegal logging, deforestation for agriculture, and increased stress by agricultural areas that have used chemical products. These impacts have also been reported in Hanski et al., (2009) and Jaganmohan et al., (2013). Nevertheless, the result suggests that Prey Kbal Ou Kror Nhak was slightly healthier comparing to Prey Ang Ten, which was highly dominated by members of Hemipterans and Orthopterans. All of which are more tolerant of pollution and as a global group (Lytle, 2015 & Tan, 2020). At Ou Bos Leav community forest was comparatively lowest insect diversity, this might be reduced amount of habitat types and disturbance activities. Changing in habitat quality (e.g., vegetation composition, streams and physical conditions) can substantially influences to their diversity (Öckinger et al., 2012; Sturm, 2018). An example from Watt et al., (1997), forest clearance has negative impact not only butterflies and termites, but also 50% of insect abundance and diversity. In addition, Ou Bos Leav (CF) is isolated without borders to other community forests where reduced corridors for insect migration (Fig. 1).

From 2010 to 2014, forest cover in Kampong Thom province was usual decreased 3.28%. While this number was higher comparing to national deforestation which was 2.66% only (Tumring REDD+, 2019). The changes lead to threaten to biodiversity in that area. However, Tumring REDD+ project is covering of semi-evergreen and evergreen forest, and 14 community forests are also involved in the project. The project aimed to reduce the deforestation and forest degradation in the communities (Freund et al., 2018). Consequently, the project is maintaining a large home-range for endangered animal species, as well as supporting insect diversity. According to this study, we found some biological indicators of insect species such as dung beetles (e.g., *Copris*

sp.) in the family Scarabaeidae, which they play essential role as a keystone species in decomposition. Honey bees (e.g., *Apis millifera*) and other species of butterflies are well known as good as pollinators (Ek-Amnuay, 2012). Members of ladybugs are biological control species and some interesting species of the group were recorded the project area. Somewhat interestingly, rare insect species such as lanternfly (*Zanna* sp.) and giant stick insect (*Phobaeticus* sp.) have been recorded from the project area (Appendix I). This such a good efficiency results through the conservation strategies of Tumring REDD+ project and all conservation collaborators including provincial authorities and local communities.

4.3. Future entomological research at TRP and PLWS

The preliminary entomological research provided a significant information to the Tumring REDD+ project area and fulfill the distribution of insect diversity for Cambodia, while many distinct ecosystems need for studying. In fact, the study of insect fauna from Prey Lang was recently proposed such as Odonata (Kosterin, 2020) and Silphidae (Sin et al., 2021). However, both studies were not represented whole region of lowland evergreen forest of Prey Lang in the country. On the other hand, lacking knowledge in entomological research and awareness in the Cambodia are an essential need to develop and improve. An example from the survey, only Lepidoptera (butterflies and moths) and Coleoptera from the family, Coccinellidae (ladybugs) were be able to identify into species level.

We could not presume the overall from this result to predict the future of insect diversity in the community forest. As mentioned above, there are many factors effected on the insect diversity in the ecosystem. This view should be considered as the driver on the present of insect in the research areas rather than focus only on forest situation. Since forest fragmentation provided positively, negatively, or neutrally effect on insect species richness among higher taxa and even within genera (Leidner et al., 2010). To conserve tropical forest, in particular forest in the study area, notably indicator taxa, including insects, should be prioritize based on their ecological role. Specifically, insect taxa were butterflies (Lepidoptera), dung beetles (Scarabiaeidae) and followed by dragonflies (Odonata) (Sutton & Collins, 1991). Butterfly community effected by enrichment of plant species, selective logging of larger trees, soil exposure or compaction, shifting agriculture, agro-forestry, formation of larger clearing. Additionally, butterflies introduced the economic plant species which happened in the neotropical forest (Brown, 1997 & Ek-Amnuary, 2012).

5. Conclusion

This preliminary study of insect diversity at Tumring REDD+ project area provides a critically awareness of insect in the protected forest area for Carbon concession in Cambodia. Within the complex of habitat types in the project area, which comprise of high proportion of semi-evergreen forest, dipterocarp forest and patchy of grassland. Interestingly, the project area is deposited on the lowland buffer zone of PLSW. All of which are highly supporting for biodiversity, in particular insect diversity. The result from this primarily survey demonstrated insect diversity was quite high, though most insect species were be able to identify to morphospecies. Some important insects including keystone species, pollinators, bioindicator and rare species were occurred from the project area. Although the sampling effort was undertaken within a short period in the early of dry season within randomly five study areas. The habitat landscape in the area was slightly dehydrated (tem 24.7 - 26.4^{o}C), this providing an insignificant time for conducting insect survey. Sampling methods should be added other tools for collecting in the wet season to capture other insect diversity in distinct ma/micro habitats. Insect communities in the project area could be disturbed by illegal logging, and human activities, including agricultural activities surrounding. All of which could be explained the number taxa recorded, it is not a specific indicating the representive taxa of the project area. This remains a large scope for further investigations on insect diversity in the area which highly encourage to conduct in other community forests. Consequently, further surveys shall collaborate with local and indigenous knowledge, as well as

international experts. This can be increased the outcomes of the survey result and describe new species to science.

Lack of available insect database and insect collection (as reference database) become a huge challenge for understanding the insect diversity in Cambodia. A milestone in the development of entomological capacity in Cambodia has been the establishment of the Cambodian Entomology Initiatives (CEI) in 2015 (Ascher et al., 2016). The goals of this multi-faceted initiative include establishment of the first national entomology collection, field expeditions to document the Cambodian entomo-fauna, training of the first generation of Cambodian entomology students and public outreach. Within support from CEI, we hope to further entomological research at project area and extension of research capacity in PLWS. We highly encourage all stakeholders (government sectors, NGOs, local community and relevant stakeholders) to participate in awareness campaigns and sensitize people to the detrimental consequences of habitat degradation upon this and other rare species as well as to prevent species extinction.

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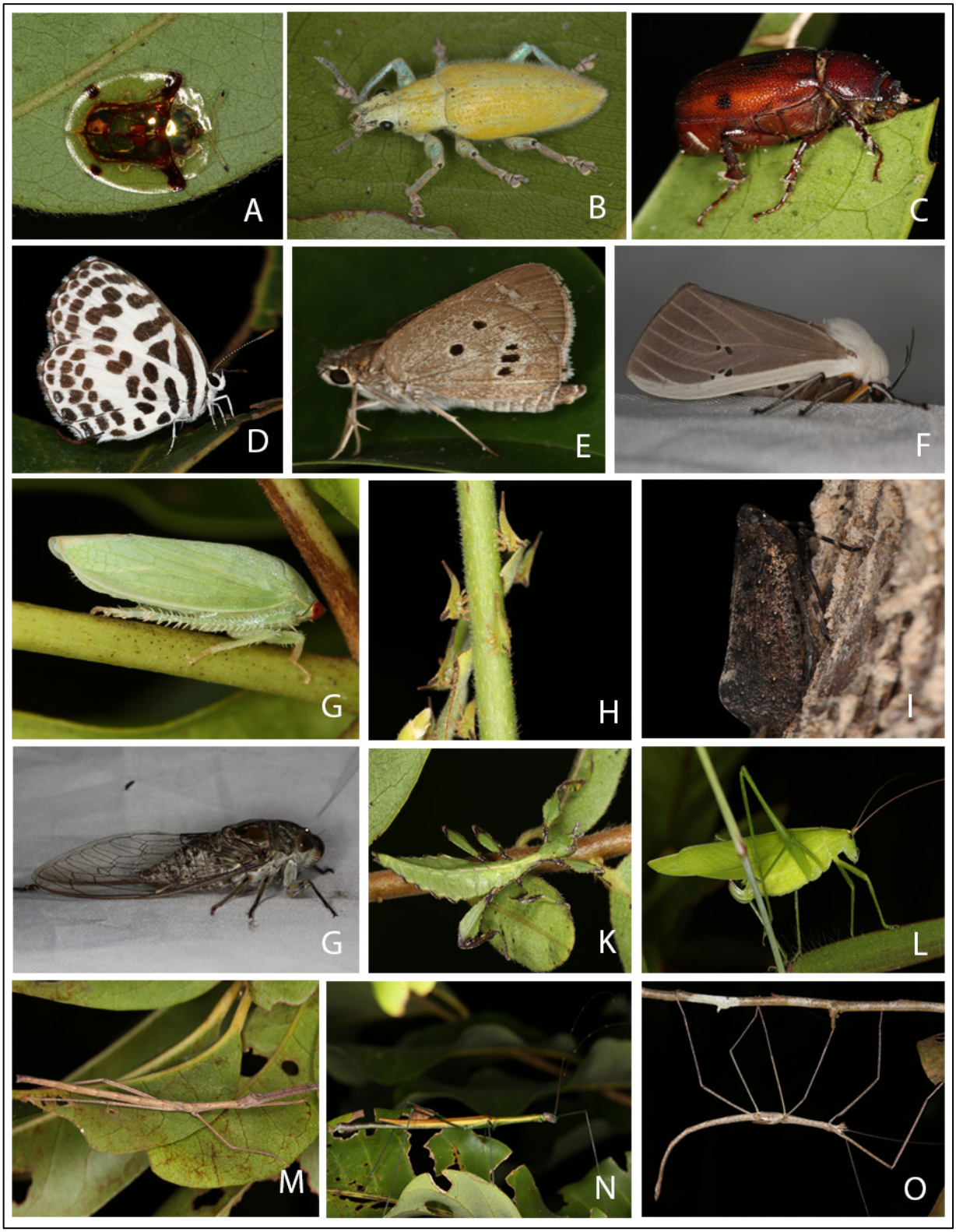
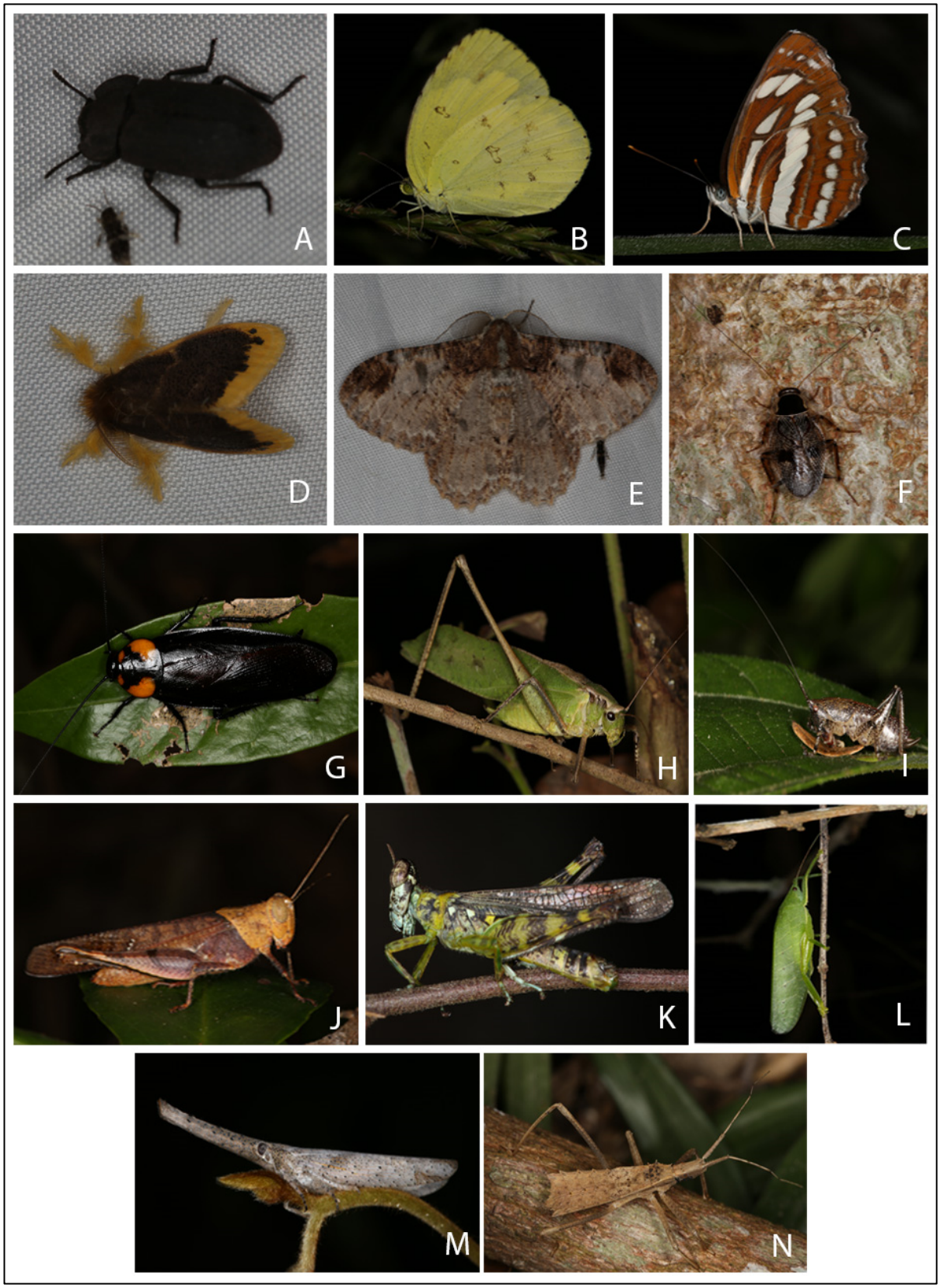
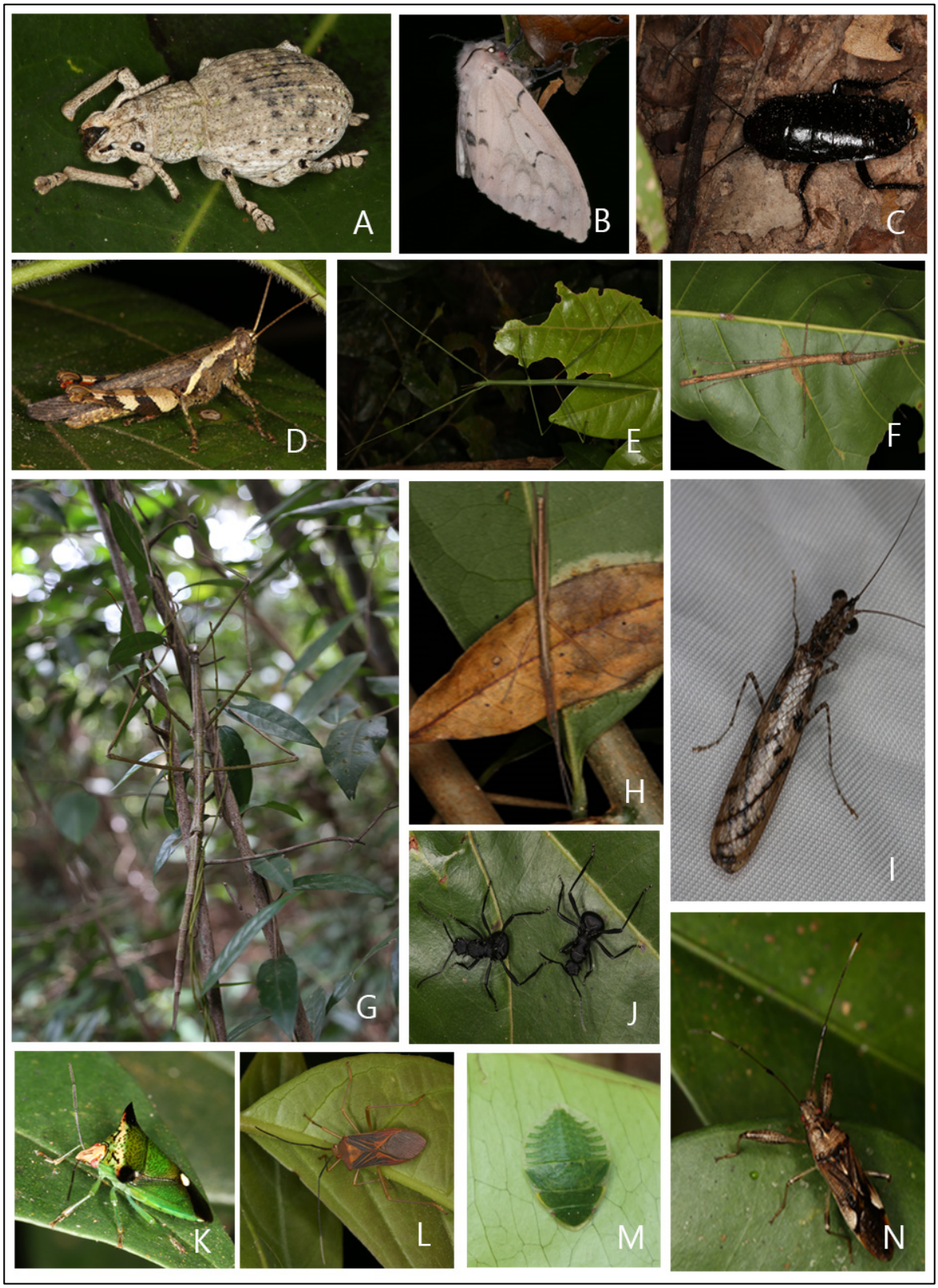
Appendix I: Insect species (morpho-species) photographed and recorded in Tumring REDD+ Project Area



Insect taxa recorded from Ou Das Sko Community Forest (A1-DS): A) Cassidinae sp, B) *Hypomeces squamosus*, C) *Anomala* sp2, D) *Castaius rosimon*, E) Hesperiidae sp, F) *Creatonotos transiens*, G) Cicadellidae sp2, H) Membracidae sp (nymph), I) *Penthicodes pulchella*, G) Cicadidae sp, K) *Cryptophyllium* sp, L) Phaneropterinae sp, M) Phasmatidae sp2, N) Pseudophasmatidae sp, O) Phasmatidae sp5.



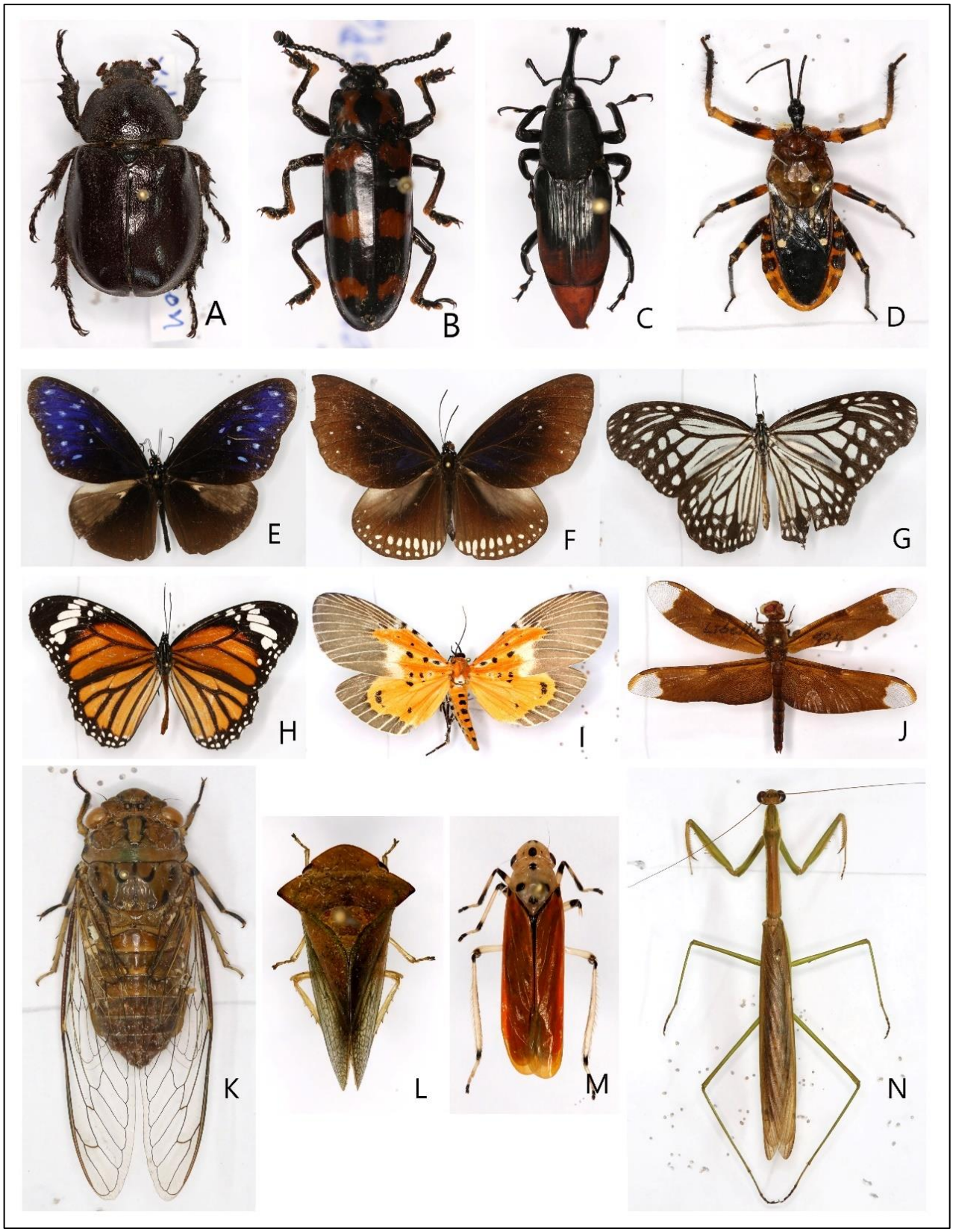
Insect taxa recorded from Lbos Sral Community Forest (A1-LS): A) Tenebrionidae sp2, B) *Eurema* sp, C) *Neptis* sp, D) Megalopygidae sp, E) Geometridae sp1, F) Blaberidae sp1, G) Blaberidae sp2, H) Phaneropterinae sp2, I) Gryllidae sp (nymph), J) Oedipodinae sp, K) Erianthinae sp, L) Pseudophyllinae sp2, M) *Zanna* sp., N) *Nabidae* sp. (nymph).



Insect taxa recorded from Ou Bos Leav Community Forest (A2): A) Curculionidae sp3, B) Erebidae sp2, C) Blaberidae sp2 (nymph), D) Acridinae sp, E) Phasmatidae sp1, F) Phasmatidae sp2, G) Phasmatidae sp4 (giant stick insect), H) Phasmatidae sp3, I) Hierodulinae sp, J) Formicidae sp, K) Pantatomidae sp1, L) Lygaeidae sp, M) *Tituria* sp (nymph), N) Alydidae sp1.

Insect taxa recorded from Permanent Forest Reserve, Prey Ang Ten (A3): A) *Copris* sp, B) *Maladera* sp, C) *Cerambycidae* sp3, D) *Curculionidae* sp4, E) Elateridae sp5, F) *Tenebrionidae* sp6, G) *Peridrome* sp2, H) *Lycaenidae* sp, I) *Tenodera sinensis*, J) *Mantidae* sp1, K) *Mantidae* sp2 (nymph), L) *Mantidae* sp3, M) *Pseudophyllinae* sp1 (nymph), N) *Bombylidae* sp, O) *Flatidae* sp1, P) *Mantidae* sp2.

Insect taxa recorded from Prey Kbal Ou Kror Nhak Community Forest (A4): A) *Popillia* sp, B) *Scarabaeidae* sp4, C) *Chrysomelidae* sp4, D) *Geometridae* sp, E) *Libelluidae* sp3, F) *Flatidae* sp3, G) *Cixiidae* sp, H) *Phasmatidae* sp1, I) *Membracidae* sp1, J) *Cicadellidae* sp12, K) *Asilidae* sp1.



Collection preparation of pinned insect reference: A) *Xylotrupes Gideon*, B) *Tenebrionidae sp*, C) *Curculionidae sp,* D) *Reduviidae sp*, E) *Euploea mulciber*, D) *E. modesta*, E) *Parantica aglea melanoides*, H) *Danaus genutia*, I) *Peridrome* sp, J) *Libellulidae sp*, K) *Cicadidae sp*, L) *Tituria* sp, M) *Bothrogonia sp*, N) *Tenoderasinensis* sp.

Appendix II: Research Sampling at Tuming REDD+ Project Area and Lab-works activities

Survey activities during insect collection and laboratory work: A-D) Insect sampling activities at Tumring REDD+ project area, E) Insects sorting and identification.

Appendix III: Check list of insect orders, families, and morpho/species recorded in study areas: *A1-LS = Lbos Srol Community Forest (CF), A1-DS = Ou Das Sko (CF), A2 = Ou Bos Leav (CF), A3 = Prey Ang Ten (PFR), A4 = Prey Kbal Ou Kror Nhak (CF); (*) presented species and (-) absent.*

Order	Family	Species/Taxa	A1-LS	A1-DS	A2	A3	A4
Coleoptera	Curculionidae	*Curculionidae sp1*	*	-	*	*	-
		Curculionidae sp2	*	*	*	-	*
		Curculionidae sp3	-	*	*	-	*
		Curculionidae sp4	*	*	-	*	-
		Curculionidae sp5	*	*	-	-	-
		Curculionidae sp6	*	-	-	-	-
		Curculionidae sp7	-	-	-	-	*
		Curculionidae sp8	-	-	-	-	*
		Hypomeces squamosus	*	*	*	*	-
		Trigonopterus sp1	*	*	-	*	*
		Trigonopterus sp2	*	-	-	-	-
		Trigonopterus sp3	*	-	-	-	*
		Trigonopterus sp4	-	*	*	-	-
		Scolytinae sp1	*	*	*	*	*
		Scolytinae sp2	-	*	-	*	*
		Scolytinae sp3	-	-	-	*	-
Coleoptera	Chrysomelidae	*Chrysomelidae sp1*	*	*	-	-	-
		Chrysomelidae sp2	*	*	-	-	*
		Chrysomelidae sp3	*	*	-	*	-
		Chrysomelidae sp4	*	*	*	-	*
		Chrysomelidae sp5	*	-	-	-	-
		Chrysomelidae sp6	*	*	*	-	*
		Chrysomelidae sp7	*	*	-	-	-
		Chrysomelidae sp8	*	-	-	-	*
		Chrysomelidae sp9	*	*	-	-	*
		Chrysomelidae sp10	-	*	-	-	*
		Cassidinae sp	-	*	*	-	-
Coleoptera	Buprestidae	*Habroloma* sp	*	*	-	-	-
		Agrilus sp1	*	*	-	-	-
		Agrilus sp2	-	-	*	-	-
		Microacmaeodera sp	-	-	*	-	-
Coleoptera	Tenebrionidae	*Tenebrionidae sp1*	*	*	*	*	*
		Tenebrionidae sp2	*	*	*	*	*
		Tenebrionidae sp3	*	-	-	*	-
		Tenebrionidae sp4	-	-	*	-	-
		Tenebrionidae sp5	-	*	-	*	-
		Tenebrionidae sp6	-	-	-	*	-
Coleoptera	Cerambycidae	*Cerambycidae sp1*	*	-	-	-	-
		Cerambycidae sp2	*	*	-	-	-
		Cerambycidae sp3	-	*	-	*	-
		Cerambycidae sp4	-	*	-	*	*
		Olenecamptus sp	-	-	*	-	-
		Gnatholea ebrurifera	-	*	-	-	-

Order	Family	Species/Taxa	A1-LS	A1-DS	A2	A3	A4
Coleoptera	Coccinellidae	*Micraspis discolor*	*	*	*	-	*
	Coccinellidae	*Cryptogonus orbiculus*	*	*	*	-	*
	Coccinellidae	*Cheilomenes sexmaculata*	-	*	*	-	*
	Coccinellidae	*Aspidimerus birmanicus*	*	-	-	-	-
	Coccinellidae	*Harmonia octomaculata*	-	*	-	-	-
	Coccinellidae	*Coccinellidae sp1*	*	-	-	-	-
	Coccinellidae	*Coccinellidae sp2*	-	*	-	-	-
	Coccinellidae	*Coccinellidae sp3*	-	-	*	-	-
Coleoptera	Dermestidae	*Dermestidae sp*	*	*	-	-	-
Coleoptera	Staphylinidae	*Pinophilus* sp	*	-	-	*	*
		Staphylinidae sp	-	*	-	*	-
Coleoptera	Phalacridae	*Phalacrus* sp1	*	*	-	-	-
		Phalacrus sp2	-	*	-	-	-
Coleoptera	Dytiscidae	*Predaceous* sp	*	-	*	*	*
		Agabus sp	*	-	*	*	*
Coleoptera	Gyrinidae	*Gyrinidae sp*	*	-	-	*	-
Coleoptera	Carabidae	*Mimocolliuris sp*	*	*	-	-	-
		Carabidae sp1	-	*	*	*	-
		Carabidae sp2	-	*	-	*	*
		Carabidae sp3	*	-	*	-	-
		Carabidae sp4	*	*	*	*	*
		Carabidae sp5	-	*	-	*	-
		Carabidae sp6	*	*	-	*	*
		Carabidae sp7	*	-	*	-	*
		Carabidae sp8	-	-	*	*	-
Coleoptera	Lycidae	*Calopteron sp*	-	*	-	*	-
Coleoptera	Attelabidae	*Attelabidae sp1*	-	*	*	-	*
		Attelabidae sp2	-	-	*	-	-
Coleoptera	Scarabaeidae	*Maladera sp*	*	*	*	*	*
		Anomala sp1	*	-	-	-	-
		Anomala sp2	-	*	-	*	*
		Copris sp	-	-	-	*	-
		Popillia sp	-	-	-	-	*
		Scarabaeidae sp1	-	*	-	-	-
		Scarabaeidae sp2	-	*	-	-	-
		Scarabaeidae sp3	-	*	-	-	-
		Scarabaeidae sp4	-	-	-	-	*
		Scarabaeidae sp5	-	*	-	-	-
		Xylotrupes gideon	-	-	-	*	*
Coleoptera	Elateridae	*Elateridae sp1*	*	*	-	*	*
		Elateridae sp2	-	-	*	*	-
		Elateridae sp3	-	*	*	-	-
		Elateridae sp4	-	-	-	*	-
		Elateridae sp5	-	-	-	*	-
Coleoptera	Nitidulidae	*Nitidulidae sp*	*	-	-	-	-
Coleoptera	Meloidae	*Hycleus cichorii*	-	-	-	*	-
Odonata	Libelluidae	*Libelluidae sp1*	-	*	*	*	-

Order	Family	Species/Taxa	A1-LS	A1-DS	A2	A3	A4
Odonata	Libelluidae	*Libelluidae sp2*	-	*	*	-	-
		Libelluidae sp3	-	*	-	-	*
		Libelluidae sp4	-	*	-	-	-
		Libelluidae sp5	-	*	-	-	-
Odonata	Coenagrionidae	*Coenagrionidae sp1*	-	-	-	*	-
		Coenagrionidae sp2	-	*	-	-	-
Odonata	Calopterygidae	*Calopterygidae sp*	-	-	*	-	-
Lepidoptera	Papilionidae	*Papilio memnon agenor*	-	*	-	-	-
		Papilio polytes romulus	-	*	-	-	-
		Graphium doson	-	-	*	-	-
Lepidoptera	Nymphalidae	*Tirumala septentrionis*	-	-	*	-	-
		Mycalesis sp	-	-	*	-	-
		Pantoporia hordonia	-	-	*	-	-
		Euploea modesta	-	*	-	-	-
		E. eyndhovii gardineri	-	*	-	-	-
		E. mulciber	-	*	-	-	-
		E. sylvesterb harrisii	-	*	-	-	-
		E. doubledayi	-	*	*	-	-
		E. orontobates	-	*	-	-	-
		Ypthima nebulosa	-	*	-	-	-
		Danaus genutia	-	*	-	-	-
		Parantica aglea melanoides	-	*	-	-	-
		Neptis sp	-	-	-	-	*
Lepidoptera	Lycaenidae	*Castaius rosimon*	-	*	-	-	-
Lepidoptera	Pieridae	*Eurema* sp	*	*	*	-	-
Lepidoptera	Geometridae	*Dysphania sagana*	-	*	-	-	-
		Dysphania sp	-	*	-	*	-
		Geometridae sp1	*	*	-	-	-
		Geometridae sp2	-	*	-	-	-
		Geometridae sp3	-	*	-	-	-
Lepidoptera	Erebidae	*Creatonotos transiens*	*	*	-	*	*
		Craetonotos gangis	-	-	-	-	*
		Nannoarctia obliguifasia	-	*	-	-	-
		Erebidae sp1	-	*	*	-	-
		Erebidae sp2	-	-	-	*	-
		Peridrome sp1	-	-	*	-	-
		Peridrome sp2	-	-	-	*	-
Lepidoptera	Limacododae	*Limacododae sp*	-	*	*	-	-
Lepidoptera	Sesiidae	*Sesiidae sp1*	-	*	-	-	-
		Sesiidae sp2	-	*	-	-	-
Lepidoptera	Hesperiidae	*Hesperiidae sp*	-	*	-	-	-
Lepidoptera	Uraniidae	*Micronia sp*	-	-	*	-	-
Phasmatodea	Pseudophasmatidae	*Pseudophasmatidae sp1*	-	*	-	-	-
		Pseudophasmatidae sp2	-	-	*	-	-
		Pseudophasma sp1	*	-	-	-	-
		Pseudophasma sp2	-	-	*	-	-
		Pseudophasma sp3	-	-	*	-	-

Order	Family	Species/Taxa	A1-LS	A1-DS	A2	A3	A4
Phasmatodea	Pseudophasmatidae	*Paraphasma sp*	*	-	-	-	-
Phasmatodea	Phasmatidae	*Phasmatidae sp1*	-	-	*	-	-
		Phasmatidae sp2	-	-	*	-	-
		Phasmatidae sp3	-	-	-	-	*
		Phasmatidae sp4	-	-	*	-	-
		Phobaeticus sp.	-	-	-	-	*
Blattodea	Blaberidae	*Blaberidae sp1*	*	-	-	-	-
		Blaberidae sp2	*	-	*	-	-
Orthoptera	Acrididae	*Phlaeoba* sp	-	-	*	*	-
		Acridinae sp	*	-	-	*	*
		Oedipodinae sp	-	-	*	*	*
		Acrididae sp1	-	*	-	-	-
		Acrididae sp2	-	*	-	-	-
		Acrididae sp3	-	*	-	-	-
		Acrididae sp4	-	*	-	-	-
		Acrididae sp5	-	-	-	*	-
		Acrididae sp6	-	-	-	*	-
		Acrididae sp7	-	-	*	-	-
Orthoptera	Gryllidae	*Gryllus sp*	*	-	-	-	*
	Gryllidae	*Gryllidae sp1*	-	*	-	-	-
	Gryllidae	*Gryllidae sp2*	*	-	-	-	-
Orthoptera	Tettigoniidae	*Sathrophyllia rugosa*	-	-	-	*	-
		Mecopoda elongata	*	-	-	-	-
		Pseudophyllinae sp	*	-	-	*	-
		Phaneropterinae sp1	*	-	-	-	-
		Phaneropterinae sp2	*	*	*	*	*
		Meconematinae sp	-	*	-	-	-
		Copiphorinae sp	-	-	*	-	-
		Conocephalinae sp	-	-	-	-	*
Orthoptera	Chorotypidae	*Erianthinae sp*	*	-	-	*	*
Orthoptera	Gryllotalpidae	*Gryllotalpidae sp*	*	-	-	-	*
Orthoptera	Tetrigidae	*Tetriginae sp*	-	-	-	-	*
Orthoptera	Trigonidiidae	*Trigonidiidae sp*	-	-	-	-	*
Orthoptera	Tridactylidae	*Tridactylidae sp*	-	-	-	-	*
Mantodea	Hymenopodidae	*Hestiasula* sp	-	*	-	-	-
		Creobroter sp	-	-	-	-	*
		Hymenopodidae sp1	-	-	*	-	-
		Hymenopodidae sp2	*	-	-	-	-
Mantodea	Mantidae	*Tenodera sinensis*	-	-	-	*	-
		Hierodulinae sp	*	-	*	-	-
		Mantidae sp	-	-	-	*	*
Hymenoptera	Apidae	*Apis millifera*	-	-	-	*	*
		Apis sp1	-	-	-	*	-
		Apis sp2	-	-	-	*	-
Hymenoptera	Chalcididae	*Brachymeria* sp	-	*	-	-	-
Hymenoptera	Vespidae	*Vespidae sp*	-	-	-	*	-

Order	Family	Species/Taxa	A1-LS	A1-DS	A2	A3	A4
Hymenoptera	Ichneumonidae	*Ichneumonidae sp1*	-	-	-	*	-
		Ichneumonidae sp2	-	-	-	*	-
		Ichneumonidae sp3	-	-	-	*	-
		Ichneumonidae sp4	-	-	-	*	-
Hymenoptera	Chrysididae	*Chrysididae sp*	-	-	-	*	-
Hymenoptera	Formicidae	*Formicidae sp1*	-	*	-	*	-
		Formicidae sp2	-	*	-	*	-
		Formicidae sp3	-	*	-	*	-
		Formicidae sp4	-	-	-	*	-
		Formicidae sp5	-	-	-	*	-
Hymenoptera	Braconidae	*Braconidae sp1*	-	-	-	*	-
		Braconidae sp2	-	-	-	*	-
Hymenoptera	Tiphiinae	*Tiphiinae sp1*	-	-	-	*	-
		Tiphiinae sp2	-	-	-	*	-
		Tiphiinae sp3	-	-	-	*	-
Hymenoptera	Sphecidae	*Sphecidae sp*	-	-	-	*	-
Hymenoptera	Dryinidae	*Dryinidae sp*	-	-	-	*	-
Hymenoptera	Trigonalidae	*Trigonalidae sp*	-	-	-	*	-
Hemiptera	Cicadidae	Cicadidae sp	*	*	*	*	*
Hemiptera	Fulgoridae	*Penthicodes pulchella*	*	*	-	*	*
		Zanna sp	*	-	-	-	-
		Fulgoridae sp	-	-	-	*	-
Hemiptera	Flatidae	*Flatidae sp1*	*	-	-	*	-
		Flatidae sp2	-	*	-	*	-
		Flatidae sp3	-	-	-	-	*
Hemiptera	Eurybrachidae	*Eurybrachidae sp*	-	-	-	*	*
Hemiptera	Pentatomidae	*Megarrhamphus sp*	*	-	*	-	-
		Pentatomidae sp1	*	*	*	*	-
		Pentatomidae sp2	*	-	*	*	-
		Pentatomidae sp3	-	*	-	*	*
Hemiptera	Reduviidae	*Reduviidae sp1*	*	*	*	*	-
		Reduviidae sp2	-	-	*	*	-
Hemiptera	Alydidae	*Alydidae sp1*	*	*	*	-	*
		Alydidae sp2	*	*	-	-	-
Hemiptera	Thyreocoridae	*Thyreocoridae sp*	*	-	-	-	-
Hemiptera	Tingidae	*Corythuca sp*	*	-	-	-	-
Hemiptera	Naucoridae	*Naucoridae sp*	*	-	-	-	-
Hemiptera	Nabidae	*Nabidae sp*	*	*	*	-	-
Hemiptera	Lygaeidae	*Lygaeidae sp*	*	-	*	-	-
Hemiptera	Coreidae	*Coreidae sp*	*	*	-	-	*
Hemiptera	Cicadellidae	*Bothrogonia* sp	*	-	-	-	-
		Deltocephalinae sp	*	*	-	-	-
		Typhlocybinae sp	-	*	*	-	-
		Tituria planata	*	-	-	-	-
		Tituria sp	*	-	-	*	-
		Ledra sp	*	-	-	-	-

Order	Family	Species/Taxa	A1-LS	A1-DS	A2	A3	A4
Hemiptera	Cicadellidae	*Deltocephalus* sp	*	-	-	-	-
		Graphocephalus sp	*	*	-	-	-
		Cicadellidae sp1	*	-	-	-	-
		Cicadellidae sp2	*	*	-	-	-
		Cicadellidae sp3	*	-	-	-	-
		Cicadellidae sp4	-	-	-	-	*
		Cicadellidae sp5	*	-	-	-	*
		Cicadellidae sp6	*	-	-	*	-
		Cicadellidae sp7	-	-	-	*	-
		Cicadellidae sp8	*	*	-	*	-
		Cicadellidae sp9	*	-	-	-	-
		Cicadellidae sp10	*	-	-	-	-
		Cicadellidae sp11	*	-	-	-	-
		Cicadellidae sp12	*	-	-	-	*
		Cofana sp	*	-	-	-	-
		Nephotettix sp	*	-	-	-	-
Hemiptera	Dictyopharidae	*Orthopagus sp*	*	-	-	-	-
		Dictyopharidae sp1	*	-	-	-	-
		Dictyopharidae sp2	-	-	-	-	*
		Dictyophara nakanonis	-	*	-	-	-
Hemiptera	Derbidae	*Derbidae sp1*	*	-	-	-	-
		Derbidae sp2	-	*	-	-	-
Hemiptera	Membracidae	*Centrotus cornutus*	*	-	-	-	*
		Leptocentrus moringae	-	*	-	-	*
		Membracidae sp1	-	-	-	-	*
		Membracidae sp2	-	*	*	-	*
		Membracidae sp3	-	-	-	*	-
Hemiptera	Cixiidae	*Cixiidae sp1*	*	-	-	-	-
		Cixiidae sp2	*	-	-	-	-
		Cixiidae sp3	*	*	-	-	-
		Cixiidae sp4	*	-	-	-	-
		Cixiidae sp5	-	*	-	-	-
Hemiptera	Delphacidae	*Metadelphax sp*	*	-	-	-	-
Hemiptera	Achilidae	*Opsiplanon sp*	*	-	-	-	-
		Synecdoche sp	*	-	-	-	-
		Achilidae sp1	*	-	-	-	-
		Achilidae sp2	*	-	-	-	-
		Achilidae sp3	-	-	-	-	*
Hemiptera	Psyllidae	Psyllidae sp	*	-	-	-	-
Diptera	Asilidae	Asilidae sp1	*	*	*	-	*
		Asilidae sp2	*	-	-	*	-
Diptera	Syrphidae	Syrphidae sp1	*	-	-	*	-
		Syrphidae sp2	*	*	-	-	-
Diptera	Sciomyzidae	*Sciomyzidae sp*	-	-	*	*	*
Diptera	Tephritidae	*Tephritidae sp*	-	-	-	*	-
Diptera	Tipulidae	*Tipulidae sp*	-	-	-	*	-
Diptera	Scathophagidae	*Scathophagidae sp*	-	*	-	*	-

Order	Family	Species/Taxa	A1-LS	A1-DS	A2	A3	A4
Diptera	Tabanidae	*Tabanidae sp*	*	*	*	*	-
Diptera	Leptogastridae	*Leptogastridae sp*	-	*	-	-	-
Diptera	Bombylidae	*Bombylidae sp*	-	-	-	*	-
Diptera	Culicidae	*Culicidae sp*	*	-	-	-	-
Neuroptera	Mymeleonidae	*Mymeleonidae sp*	*	*	-	-	*
Neuroptera	Ascalaphidae	*Ascalaphidae sp*	-	-	-	*	-