Presented at the DLSU Research Congress 2017
De La Salle University, Manila, Philippines
June 20 to 22, 2017

Lepidoptera Diversity in Grassland and Secondary Forest Using UV Light-Trap in De La Salle University – Science and Technology Complex, Biñan City, Laguna, Philippines

Anna Rose C. Zambrano[1, *], Jaryna O. Limbauan[1], Ramgie M. Bartolata[1], Maria Rejane J. Nepacina[1], Ma Monica M. Cabiles[1], Mark Louie T. Silvestre[1], Kenneth A. Bongulto[1] and Alberto T. Barrion[2]

[1]Graduate Student in Biology and [2]Visiting Lecturer, De La Salle University 2401 Taft Avenue, Manila 0922, Philippines
*Corresponding author: annarose.zambrano@gmail.com/anna_zambrano@dlsu.edu.ph

Abstract: The diversity of lepidoptera in the two adjacent ecosystems, grassland and secondary forest, behind DLSU-STC campus was determined. Species diversity of lepidoptera in both habitats is generally low – H^1=1.818 in grassland and H^1=1.850 in the secondary forest suggesting an uneven distribution of species in the area. Two families of Lepidoptera were observed to be dominating in the area; Pyralidae dominates the secondary forest due to the presence of fruit trees and Gracillariidae in the grassland due to the abundance of Napier grasses, with a relative density of 28.57% and 32.43%, respectively. The two habitats show 82.35% of taxa that are commonly shared within the area.

Key Words: UV light-trap; Lepidoptera diversity; shared taxon; grassland; secondary forest

1. INTRODUCTION

The ecology of grassland plays an important role in vegetation and agricultural products. Many species resort to get nutrients from grassland, such as grazers and insects, basically because grassland produces sustainable organic matter needed by higher organisms. In line with this, the diversity of grassland increases the species richness, particularly the animal species (Blair et al., 2014; Strömberg, 2011). On the other hand, forest owns 80% of world's terrestrial biodiversity. The ecological role of forest is to maintain the physiology of an ecosystem. The structure and function of forest is derived from different interaction of species of plants and animals, including soils and atmosphere, topography and microclimate, energy capture and biomass creation (Kimmins, 2006). Hence, the species richness, abundance and diversity correspond to the ecological health of the ecosystem.

The species diversity of grassland and secondary forest are not well understood and much less known on the diversity in the community of insects. Insects are the fundamental indicators on the species richness, diversity and of the ecosystem (Yi et al., 2012). Lepidoptera, an order of moths and butterflies that are focused in this study plays a pivotal role in the diversity of ecosystem (Beck et al., 2002; Summerville et al., 2004). Adult moths and butterflies are usually beneficial insects that feed on nectar using their siphoning proboscis. However, they are second most diverse species of pest insect. The larval stage has chewing mouthparts that are suitable for feeding on various parts of plants (e.g. leaves, stem, and fruits) (Biswas and Das, 2012).

In this study, determination on the diversity of species under order Lepidoptera (e.g. butterflies and moths) using improvised UV–light trap in grassland and secondary forest in De La Salle University – Science and Technology Complex, Biñan, Laguna. This will provide baseline information and data for reference collections of arthropods in Laguna. These data are also expected to further develop knowledge about arthropods in Laguna and will be useful in other areas of research including taxonomy, ecology, and diversity of organisms in grassland and secondary forest. Consequently, they will be helpful in conservation and management of grassland and secondary forest ecosystems.

2. METHODOLOGY

1.1 Sampling Site

The study was conducted in the botanical garden behind of De La Salle University — Science & Technology Complex (14° 26' 31" North, 121° 4' 22" East, 68 masl), located in Biñan City, Laguna, Philippines (Figure 1).

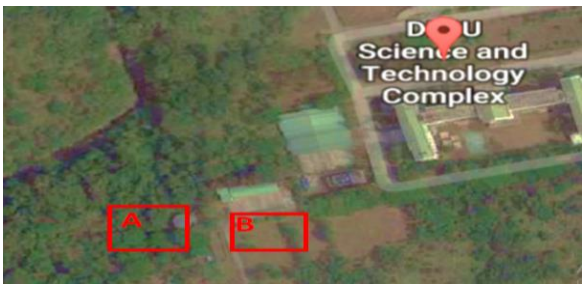

Fig. 1. Satellite image of two adjacent ecosystems: (A) Secondary Forest; and (B) Grassland.

The two sampling sites are the secondary forest and grassland. The secondary forest is dominated by woody trees, fruit trees and shrubs with few grasses, while the grassland has the abundance of Napier grasses with few shrubs and trees (Figure 2).

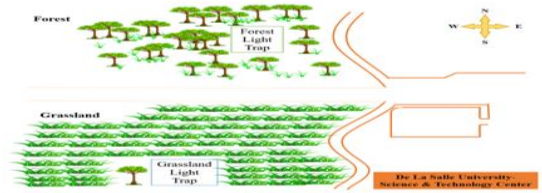

Fig. 2. The schematic diagram of the sampling site of grassland (A) and secondary forest (B) in De La Salle University – Science and Technology Complex, Sta. Rosa, Biñan City, Laguna, Philippines on July 30, 2016.

2.1 Sampling Method

One light trap was erected for each sampling site at 5pm-9pm of July 30, 2016. Each light traps contained a white cloth spread behind fluorescent UV light source. Arthropods were collected manually using jars containing cotton dipped in kerosene-based insecticide (Temox Killer) to kill the specimens after they land on the surface of light trap (Yi et al., 2012). Lepidopterans were caught by hand and pinched in the thorax to quickly stun the specimen. With lepidopterans' wings over their back, the specimens were slipped into paper triangles.

2.2 Sorting and Preservation of Samples

The arthropods in killing jar and paper triangles were all taken to the laboratory in DLSU-STC for sorting by the graduate students of DLSU. Paper triangles containing lepidopterans are stored in 21.59 cm x 27.94 cm ziplock plastic bag in freezer. Arthropods other than Lepidoptera were emptied in jar with 70% ethanol and appropriate labels (location [G vs 2˚F]).

2.3 Identification of Samples

All arthropods were identified with the use of Brownstone dissecting microscope and locally available literature (CSIRO, 1979) and arthropod identification websites as a reference for classification. These literatures were marked with asterisk in the literature cited section.

2.4 Diversity Analysis

Arthropod species diversity in secondary forest and grassland were computed using Shannon's Index of diversity (Eq. 1) and Simpson's Index of Diversity (Eq. 2). Also, species dominance was also determined using Simpson's Index of Dominance (Eq. 3). Species evenness and equitability were also determined using Shannon's Index of Evenness (Eq. 4) and Simpson's Index Equitability (Eq. 5).

$$H^1 = \sum(Pi \times LnPi) \quad \text{(Eq. 1)}$$

$$\text{SID} = 1 - \sum Pi^2 \quad \text{(Eq. 2)}$$

$$D = \sum Pi^2 \quad \text{(Eq. 3)}$$

$$J = \frac{\sum(Pi \times LnPi)}{LnS} \quad \text{(Eq. 4)}$$

$$E=\frac{1-\sum Pi2}{S} \quad \text{(Eq. 5)}$$

Where:
P = the ratio of one individual over the total no. of individuals
∑ = sum of the calculations
S = the total number of species in the community

Sorensen's Index of Similarity (IS) (Eq. 6) was used to determine the commonly shared taxa between the grassland and secondary forest ecosystem. Results were expressed in percentage (%) (Barrion et al., 2016).

$$IS = \frac{2\,(Number\ of\ shared\ species\ in\ A\ \&\ B)}{(A+B)} \text{ x } 100 \quad \text{(Eq. 6)}$$

where:

A = total species in grassland
B = total species in secondary forest

Relative abundance (RD) of Lepidoptera in two ecosystems was calculated to determine the dominant species among the collected individuals (Eq. 7).

$$RD = \frac{Number\ of\ individuals}{Total\ number\ of\ individuals} \text{ x } 100 \quad \text{(Eq. 7)}$$

2. RESULTS AND DISCUSSION

There are ninety-three specimens belonging to 10 families, namely Arctiidae, Bombycidae, Geometridae, Pyralidae, Gracillariidae, Noctuidae, Sphingidae, Gelechiidae, Yponeumotidae and an Unknown species were collected in the grassland and secondary forest of De La Salle University – Science and Technology Complex, Biñan City, Laguna, Philippines on July 30, 2016. Thirty-seven individuals were found in grassland in eight different families, and fifty-six individuals were found in the secondary forest in nine different families (Table 1). Gevaña et. Al., (2013) stated that the value of Shannon's Index of Diversity (H^1) ranges from 0-2.49 for low diversity, 2.5-2.9 as moderate and 3-4 as most highly diverse. For the Simpson's index of diversity (SID) is range from 0-1.

Table 1. Checklist of families under order Lepidoptera collected using UV light trap in the grassland (G) and secondary forest (2° F) in De La Salle University – Science and Technology Complex, Sta. Rosa, Biñan City, Laguna, Philippines on July 30, 2016.

Family	Total Individuals (No.)		Shared Taxon	Total
	G	2° F		
Arctiidae	3	1	+	4
Bombycidae	3	1	+	4
Geometridae	1	3	+	4
Pyralidae	7	16	+	23
Gracillariidae	12	10	+	22
Noctuidae	6	8	+	14
Sphingidae	0	2	-	2
Gelechidae	0	12	-	12
Yponeumotidae	4	0	-	4
Unknown1	1	3	+	4
Total	37	56	7	93

In Table 2, Shannon's Index of Diversity (H^1) both habitats falls to a range of low diversity; grassland (H^1=1.818) and secondary forest (H^1=1.850). The computed Simpson's Index of Diversity (SID) and Dominance in grassland has a value of SID=0.810; while secondary forest has SID=0.813 which falls in the lower range. However, Shannon's Index of diversity is more widely used for predicting species diversity in particular land area (Nagendra, 2002). According to Smith and Smith (2006), species having high dominance has low diversity or vice versa Shannon's index of diversity (H^1) is lower than Simpson's Index of Dominance (D) in both biomes, suggesting there are several species that dominates the soil ground in both grassland and secondary forest ecosystems.

Table 2. The diversity indices of arthropod catches in grassland (G) and secondary forest (2° F) in De La Salle University – Science and Technology Complex, Sta. Rosa, Biñan City, Laguna, Philippines on July 30, 2016 collection.

Diversity Indices	Lepidoptera	
	G	2° F
Shannon:		
Diversity (H)	1.818	1.850
Evenness (J)	0.874	0.842
Simpson:		
Dominance (D)	0.190	0.188
Diversity (SID)	0.810	0.813
Equitability (E)	0.101	0.090

The distributions of species in two biomes were measured in Shannon and Simpson's Indices of Evenness (J) and Simpson's Equitability (E). Species evenness (J) and equitability (E) ranges from zero to one, with zero signifying no evenness and one, a complete evenness (Ballasiw, 2015) and species with higher diversity increases the evenness and equitability (Gevaña, et. al, 2013). However, the species diversity of grassland and secondary forest is low suggesting that the distribution of species in two biomes is uneven or unequal.

To furtherly understand the low diversity of Lepidoptera in grassland and secondary forest; we computed the relative density of the collected species each of the two biomes. The family Gracillaridae ranks the highest in the collected Lepidoptera from light trapping in grassland and family Pyralidae in secondary forest, having a relative density of 32.43% and 28.57%, respectively (Figure 3).

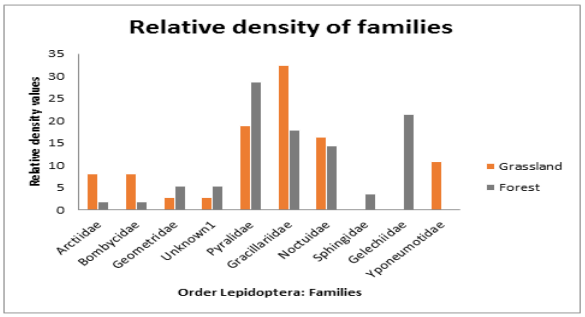

Fig. 3. Relative density of the ten families under order Lepidopter in grassland and secondary ecosystem using UV light trap technique.

One factor affecting the low diversity of Lepidoptera is the low number of species collected. Only 10 families were collected in both habitats, 8 families were collected in the grassland and 9 families were collected in the secondary forest. Both habitats show similarity in the distribution of species. To understand the similarities shared between two habitats, Sorensen's Index of Similarity (IS) was calculated. The Sorensen's Index of Similarity (IS) indicated a high 82.35% (7 species) of taxa commonly shared between the grassland and secondary forest probably because the two habitats are adjacent to each other. Of the 7 species present in both habitats, the top 4 most dominant species are represented by Pyralidae (23 individuals) > Gracillariidae (22) > Noctuidae (14) > Gelechiidae (12) (Table 1). Pyralidae is a family of micro-moths within the order Lepidoptera that includes a number of species of economic importance and one of the most potentially damaging lepidopteran species (CSIRO, 1991). It basically damages grass by feeding at the base of the plants (Curry, 1994). However, the result suggests that Pyralidae is more dominant in the secondary forest compared to the grassland. According to Nair (2007), Pyralidae feed on seeds and fruits. The secondary forest has several fruit trees that were present in the surrounding area, suggesting that, the high dominance of Pyralidae in the secondary forest is due to the presence of fruit trees. On the other hand, family Gracillariidae is dominating species in grassland ecosystem, basically because it feeds on the leaves, specifically on its larvae form (Szocks et al., 2015).

3. CONCLUSION

Insects are able to see UV radation. Nocturnal flying insect often attracted to light sources that emits UV radiation basically because most insects has a compound eye that typically contains photoreceptor cells with spectral sensitivities peaking in UV, green and blue wavelength regions. Hence, in this activity, improvised UV light trapping technique proved effective in collecting Lepidoptera in the two adjacent sampling sites. The importance of understanding the distribution of lepidopterans is to assess the ecological health of grassland and secondary forest ecosystem in De La Salle University – Science and Technology Complex, Sta. Rosa, Biñan City, Laguna, since the abundance of Lepidoptera species is a threat for pest outbreak. A total of 93 individual species of lepidopterans -- 37 individuals from the grassland in belonging to 8 different families, and 56 individuals under 9 different families were found in the secondary forest. The species diversity of lepidopterans in both habitats is relatively low, suggesting that there is an uneven distribution of species in the area. Another reason for the low diversity is the presence of a dominating species in both habitats. Lepidopterans under the families Pyralidae are dominating the secondary forest and Gracillariidae in grassland. Seven families are commonly shared in both habitats basically because the two ecosystems are adjacent to each other. However, the data we gathered in two different habitats is not enough to conclude the overall distribution of these lepidopterans due to small sampling size. Initially, we can say that the grassland and

secondary forest behind DLSU-STC campus are ecologically healthy. We recommend more intense light trapping for a longer time frame. These will provide a more vivid diversity picture of the two habitats.

4. REFERENCES

Barrion, A., Zhu, P., Zheng, X., Chen, G., Mei, Z., & Lu, Z. (2016). Diversity and functional Guild Composition of Rice Leaffolder [Cnaphalocrocis medinalis (Guenee), Lepidoptera:Pyralidae] Natural enemies in Irrigated Super Hybrid Rice and Non-rice Habitats in China. *Asia Life Sciences*, *25*(2), 547-563.

Beck, J., Schulze, C., Linsenmair, K., & Fiedler, K. (2002). From forest to farmland: diversity of geometrid moths along two habitat gradients on Borneo. *Journal Of Tropical Ecology*, *18*(01), 33-51. http://dx.doi.org/10.1017/s026646740200202x

Biswas, G., & Das, G. (2012). Insect and mite pests diversity in the oilseed crops ecosystems in Bangladesh. *Bangladesh Journal Of Zoology*, *39*(2). http://dx.doi.org/10.3329/bjz.v39i2.10594

Blair, J., Nipper, J., & Briggs, J. (2014). Grassland Ecology. Ecology and Environment. *The Plant Science*, *8*(398-432).

Commonwealth Scientific and Industrial Research Organization (CSIRO). (1979). *The Insects of Australia: A Textbook for Students and Research Workers. Australia* (p. 1131PP). Melbourne Press.

Commonwealth Scientific and Industrial Research Organization (CSIRO). (1991). *The insects of Australia : a textbook for students and research workers.* (2nd ed., p. 1137). Carlton, Victoria: Melbourne University Press.

Curry, J. (1994). *Grassland invertebrates: Ecology, influence on soil fertility, and effects on plant growth* (1st ed., pp. 118-119). London: Chapman & Hall.

Gevaña, D., Pampolina, J., Kim, D., & Im, S. (2013). Plant Diversity and Aboveground Crabon Stock Along Altitudinal Graients in Quezob Maountain Range in Southern Mindanao, Philippines. *Journal In Environmental Science And Management.*, *16*(1), 20-28.

Kimmins, J. 2006. Forest Ecology. Forests and Forest Plants, 1. Retrieved from http://www.eolss.net/sample-chapters/c10/e5-03-01-06.pdf on June 20, 2016

Nagendra, H. (2002). Opposite trends in response for the Shannon and Simpson indices of landscape diversity. *Applied Geography*, *22*(2), 175-186. http://dx.doi.org/10.1016/s0143-6228(02)00002-4

Nair, K. (2007). *Tropical forest insect pests: Ecology, impact, and management* (pp. 40-41). Cambridge, UK: Cambridge University Press.

Smith, T., & Smith, R. (2006). *Elements of ecology* (4th ed., p. 658). San Francisco: Benjamin Cummings. ISBN 0471161845, 9780471161844

Strömberg, C. (2011). Evolution of Grasses and Grassland Ecosystems. *Annual Review Of Earth And Planetary Sciences*, *39*(1), 517-544. http://dx.doi.org/10.1146/annurev-earth-040809-152402

Summerville, K., Ritter, L., & Crist, T. (2017). *Forest moth taxa as indicators of lepidopteran richness and habitat disturbance: a preliminary assessment.* Retrieved 23 June 2017, from

Szocs, L., George, M., Thuroczy, C., & Csoka, G. (2015). Parasitoids of the lime leaf miner Phyllonorycter issikii (Lepidoptera: Gracillariide) recorded throughout the area it recently colonized. *European Journal Of Entomology*. http://dx.doi.org/10.14411/eje.2015.101

Yi, Z., Jinchao, F., Dayuan, X., Weiguo, S., & Axmacher, J. (2012). A Comparison of Terrestrial Arthropod Sampling Methods. *Journal Of Resources And Ecology*, *3*(2), 174-182. http://dx.doi.org/10.5814/j.issn.1674-764x.2012.02.010