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Insect Diversity in an Organic Rice Farm in Brgy. Langkong, M'lang, North Cotabato, Philippines

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Abstract

Understanding the diversity of insects associated with rice cultivation can provide information about the composition and structure of such ecosystems, which can be applied to integrated pest management. The study identified and classified beneficial and harmful insects and determined the species richness, species evenness, and diversity in an organic rice field in Barangay Langkong, M'lang, North Cotabato, Philippines. Sweep net and light traps were used in collecting insects. Insects were identified morphologically up to the nearest possible taxa. It was found that among the 3,796 insects collected, 2,659 were identified as harmful and 1,137 as beneficial. The species richness in the area is 2.35, and the species evenness has a value of 0.737. Based on Shannon-Weiner Diversity Index, the study area is high in species diversity since the value of the species diversity is 2.21.

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According to Regannold et al. (1990), the organic cultivation of rice has been regarded as a sustainable system because it avoids the problems such as pest resistance, resurgence, and pesticide residue. The study by Kajimura et al. (1993) revealed that the population of the rice brown planthopper and the white-backed planthopper were much lower in organically farmed than in chemically fertilized rice fields. An important principle in integrated pest management is to maximize natural control, and, therefore, the temporal changes in arthropod abundance, diversity, species richness, and community structures are important considerations in designing pest management strategies (Altieri, & Nichols, 1999).

Organic rice production in the Philippines has been expanding since 1986 and has grown very rapidly, especially in the last couple of years. Organic farming benefits small farmers mainly in two ways: first, by lowering the production cost and increasing the product's price; second, by improving the farm environment, farmers' health conditions, and fertility of their land (IRRI, 2016). Organic farming potentially improves those effects from so-called modern technologies with high-yielding varieties. The other benefit is that farmers can improve the fertility of their land, environment, biodiversity, soil and water quality, and health condition. Farmers' health has been damaged due to the adoption of pesticides on their farms. The biological control programs promote one or two premier natural enemies to suppress pests (Zhang et al., 2013). Whereas, in conventional farming, the inputs are expensive for every cropping season at an increasing rate. The intensive chemical input used for conventional farming has made the soil very acidic, polluted water and killed beneficial insects and animals over the years, and climate change is one of the global issues that can give impact to organic rice farming, complex and unpredictable changes in weather patterns like extreme heat and rainfall, change in rainfall pattern, increase temperature, and increase the frequency of typhoons and dry spell (Escabarte & Montecalvo, 2012). However, most farmers were entirely unaware of the beneficial organisms found in rice crops. They had poor knowledge and recognition of harmful and beneficial insects (Asghar, 2010).

Proper identification and knowledge of insect pests are necessary for developing efficient insect pest control. Thus, this study could be helpful in the production of rice through the identification of harmful and beneficial insects in the field as insect pests are the main problem in rice production, it affects the plant physiology leading to a reduction in measurable yield, utility, or economic return (Nasiruddin & Roy, 2012). The identification of insects associated with organic rice crop in Brgy. Langkong, M'lang, Cotabato, Philippines, is necessary to determine the health of the field. It allows the rice farmers practicing organic farming to plan integrated pest management strategies and proper farming practices.

The study's objective was to identify insects and examine insect abundances and diversity to provide a theoretical basis for the sustainable control of organic rice pests.

Methodology

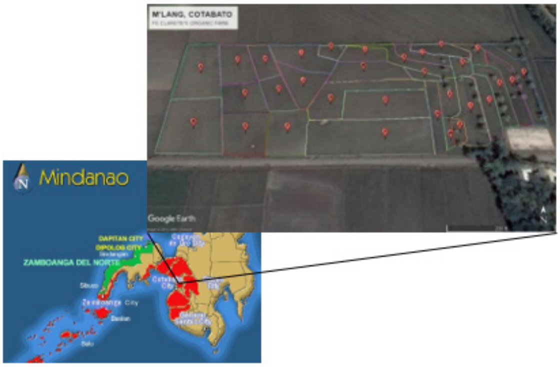
Study Area

The study was conducted in an organic rice field in Barangay Langkong, M'lang North Cotabato, Philippines. Mrs. Fe Clarete's organic rice farm has a total area of ~25,000 m^2, and the owner has practiced organic farming for 22 years. The farm receives certifications from the Certification for Environmental Standards - GmbH (CERES) and the U.S. Department of Agriculture (USDA), which means that the organic rice produced on her farm is qualified for export to Europe and the USA. The coordinates of the area studied are N 6°92'30" E 124°89'75", N 6°92'33" E 124°89'69", N 6°92'97" E 124°89'89", N 6°92'36" E 124°89'03", N 6°92'34" E 124°89'77", and N 6°92'44", E 124°89'52", N 6 °92'33" E 124°89'39", N 6°92'59" E

124 °79'10". There are two varieties of rice planted on this site: RC 160 and black rice. Figure 1 shows the map of the study site. The red dots showed the location of the sampling plots.

Figure 1

Area of M'lang Rice Field (Google Earth, 2016)



Insect Collection

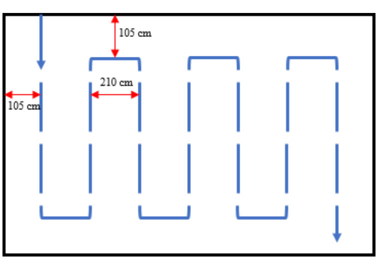
Insects were collected using a sweep net and a light trap. The collection of insects to the six randomly selected paddies happened on October 4-6, 2016, January 18-20, 2017, and March 1-3, 2017. Sweeping, performed from 8:00 am to 9:00 am, and 4:00 to 5:00 pm. Insects collected using light traps was done at 6:00 pm to 5:00 am the next day to catch insects with different spawning times (Ubaub, 2015).

B.1. Sweeping. The sweep net was swung side by side in 180° arc; the hoop end was nearest to the ground, taking one step per stroke and covering all the places in the sampling site. The net was swung as deeply as possible in shorter vegetation while in taller vegetation, it was swung just enough to keep the upper edge of the sweep net opening even with the top of the plants (Gibb & Oseto, 2010).

The method used was the "U" shaped walking sampling pattern (Figure 2). The distance between the U-shape correlates with the measurement of the two sweep nets. The arrow indicates the walking pattern in the paddies. The speed was constant to uniformly collect insects throughout the field (Ubaub, 2015). Insects collected were transferred to a container.

Figure 2

"U" shaped walking sampling pattern



B.2. Light trap. Insect species are attracted to light with various wavelengths. The random sampling method was used using light traps (Figure 3). Eight traps were established in the field on a one-to-one ratio for randomly chosen eight paddies. The light traps were set up at the center of each paddy before dust and collected at dawn.

The traps were made of a plastic container, funnel, light, and a wooden pole. The mouth of a four-liter water container was cut in a cross-section and used as a funnel, and the remaining wide-mouthed plastic jar contained a small amount of cotton with ethyl alcohol. The light trap was hung to a pole at 5 feet above the ground (Macgown, 2006). Eight light traps were established with 12 watts of rechargeable light bulbs.

Figure 3

Light Trap

The collected insects were placed in a killing jar that contained cotton soaked with ethyl alcohol to kill the insects. Then the insects were taken to the laboratory for sorting, identification, and documentation. Proper preservation technique follows Hahn (2017) for larger insects. Micrographs of smaller insects were taken at 100x using a bright field microscope (Amscope).

C. Specimen identification. Insect specimens were identified and classified using identification keys (Shepard et al., 1987), articles (Tiple et al., 2012), other available internet resources, and previous research. Dr. Larry V. Aceres, an entomologist from the University of Southeastern Philippines, Tagum campus, confirmed the initially identified species.

Measurements were done using a ruler and an ocular micrometer attached to a microscope. Photographs were taken using a Canon EOS 7D Mark-II Digital SLR Camera.

D. Statistical analysis. Species richness refers to the number of different species represented in an ecological community, landscape, or region (MEA, 2005). It is simply a count of species (Brown, 2006). A related term, evenness (E), is another dimension of diversity that defines the number of individuals from each species in the same area (Wikibooks, 2011).

Shannon-Weiner Diversity Index was used to measure the diversity of insects in the study area.

It was also used to compare the differences in the diversity of the species among the sub-site, H, of each of the study sites was computed. In the equation, Shannon-Weiner Diversity Index is H=-∑piIn(pi), where H represents all the species that are presented in the sample and randomly sampled, pi is the proportion of individuals found in its species (Nolan & Callahan, 2005).

Results and Discussion

A total of 3,796 insects were collected. Among the collected insects, 2,657 were identified as harmful, which belongs to eight families, whereas only 1,139 insects were classified as beneficial, which belongs to seven families (Table 1). It was observed that there were more harmful insects than beneficial ones in the study area. Beneficial insects pollinate crops and aerate the soil, while harmful insects eat and kill the plant. Thus, there is a need to control the number of harmful insects to have a higher yield of rice crops.

Table 1

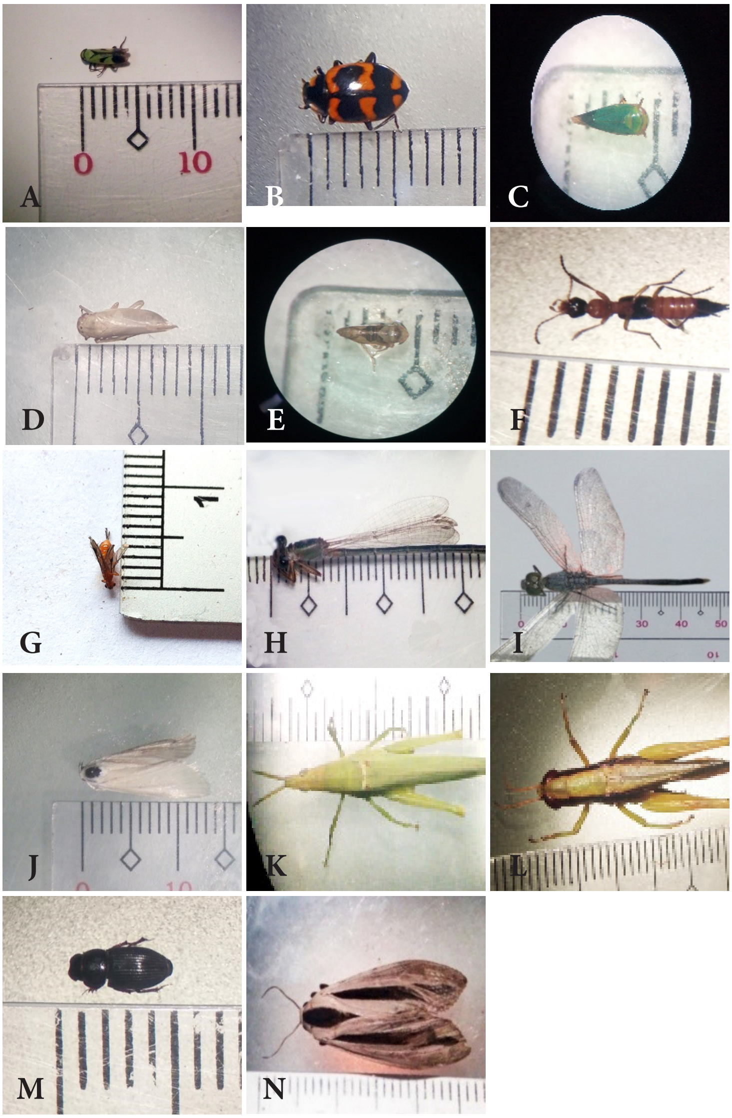
Identification and Classification of Insects

Classification	Order	Scientific Name	Common Name	No. of Individual
Harmful	Cicadellidae	*Nephotettix sp.*	Rice leafhopper	865
			Green Paddy Leafhopper	217
			Green Rice Leafhopper	171
		Cofana sp.	White Leafhopper	118
		Recilia sp.	Zigzag Leafhopper	287
	Alydidae	*Leptocorisa sp.*	Slender Rice Bug	387
	Pentatomidae	*Scotinophara sp.*	Rice Black Bug	341
	Scientific Name		Stink bug	15
	Scientific Name	*Podisus sp.*	Spined soldier bug	15
	Pyralidae	*Scirpophaga sp*	White Stem Borer	203
	Pyrgomorphidae	*Atractomorpha sp.*	Smaller longheaded Locust	13
	Acrididae	*Hieroglyphus sp.*	Brown Grasshopper	14
	Scarabaeidae	*Aphodius sp.*	Black bettle	11
	Erebidae	*Creatonotos sp.*	Moth	2
Total				**2,659**
Beneficial	Coccinellidae	*Micraspis sp*	Lady Bird beetle	432
		Coccinella sp.	Transverse lady beetle	114
		Harmonia sp.	Maculate ladybird	187
	Formicidae	*Camponotus sp.*	Black Ant	7
	Hydrophilidae	*Hydrophilus sp.*	Great water silver beetle	26
	Staphylinidae	*Leistrotrophus sp.*	Rove beetle	7
	Chalcididae	*Opius sp.*	Wasp	1
	Coenagrionidae	*Agriocnemis sp.*	Damselfly	235
	Libellulidae	*Diplacodes sp.*	Ground Skimmer	128
Total				**1,137**
Grand Total				**3,796**

Harmful Insects

Figure 4

Micrographs were taken at 100x using a bright field microscope (Amscope).



A. Rice Leafhopper; B. Green Paddy Leafhopper; C. Green Rice Leafhopper; D. White Leafhopper; E. Zigzag Leafhopper; F. Slender Rice Bug; G. Rice Black Bug; H. Stink Bug; I. Spined Soldier Bug; J. White Stem Borer; K. Smaller Longheaded Locust; L. Brown Grasshopper; M. Scarab Bettle; and N. Moth

Beneficial Insects

Figure 5

Micrographs were taken at 100x using a bright field microscope (Amscope).

A. Lady Bird Beetle; B. Transverse Lady Beetle; C. Maculate Ladybird; D. Black Ant; E. Great Water Silver Beetle; F. Roove Beetle; G. Wasp; H. Damselfly; and I. Ground Skimmer

Species Richness, Evenness, and Diversity of Insects

Species richness refers to the number of different species represented in an ecological community, landscape, or region (MEA, 2005). It is simply a count of species (Brown, 2006). The species richness in the area is 2.305. More extraordinary species richness and productivity make an ecosystem more sustainable and stable.

Evenness refers to the measure of species abundance or the proportion that each species comprises as a whole. The species evenness has a value of 0.737 which means that the community's diversity index or measure of biodiversity is even. A high evenness value signifies that all species are evenly distributed within a study area. A lesser value of evenness, especially the one approaching zero, indicates a significant difference in the distribution and abundance of species. Knowing the species abundance can provide insight into how a community functions.

Shannon-Weiner Diversity Index was used to determine the species diversity in the sampling area. The diversity index value usually ranges from 1.5 to 3.5 and does not commonly exceed 4.0 (Kent & Coker, 1992). An area is considered diverse if the value of the Shannon-Weiner Diversity Index is greater than 1.5.

Table 2

Species Diversity of Insects in the Study Area

Species	Total number of individuals
Nephotettix sp.	1253
Cofana sp.	118
Recilia sp.	287
Leptocorisa sp.	387
Scotinophara sp.	356
Podisus sp.	15
Scirpophaga sp	203
Atractomorpha sp.	13
Hieroglyphus sp.	14
Aphodius sp.	11
Creatonotos sp.	2
Micraspis sp	432
Coccinella sp.	114
Harmonia sp.	187
Camponotus sp.	7
Hydrophilus sp.	26
Leistrotrophus sp.	7
Opius sp.	1
Agriocnemis sp.	235
Diplacodes sp.	128
TOTAL	**3,796**
Shannon-Weiner Diversity Index	**2.210**
Species Evenness	0.737
Species Richness	2.305

Table 2 shows the species diversity of insects in the study area. A total number of 3,796 individuals of insect species in an organic farm in Mlang Cotabato were found.

The result shows that species diversity in the area is high, as reflected in the table, having a value of 2.210. According to Shannon-Weiner Diversity Index, if the index value is greater than 1.5, the area is said to be diverse.

According to Etile (2012), diversity is an important factor in maintaining the health of an agroecosystem. The diversification of crops tends to increase natural enemy abundance and diversity. It provides more opportunities for natural enemies to survive in agricultural systems. This would also provide support for insect biological control. Monoculture farms are susceptible to pest outbreaks because of a lack of diversity that may hinder the encouragement of natural enemies (MEA, 2005). If an ecosystem has poor species diversity, it may not function properly or efficiently. A more diverse ecosystem has a more remarkable ability to withstand environmental stresses like invasive infestations, and it tends to be more productive. In a healthy ecosystem, diverse and balanced several species exist to maintain the balance of an ecosystem. In an ecosystem, all the species depend on each other directly or indirectly. So, to make a more efficient, productive, and sustainable ecosystem, it is essential to maintain high species diversity.

Conclusion and Recommendations

A total of 3,796 insects were collected on an organic rice farm in M'lang, North Cotabato. As observed, there were more harmful insects collected than beneficial insects. Among the insects collected, 2,659 were harmful, which belonged to eight families, whereas there were 1,137 identified beneficial insects which belong to seven families. The species diversity in the study area is high; therefore, insects in the organic farm in M'lang Cotabato are diverse.

It is recommended that a longer duration of the sampling period in the area. The seasonal weather factors such as average temperature, humidity, and total rainfall in the area must be recorded to enhance the result. Further studies should be conducted in a conventional rice field in the same area to compare the findings.

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