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Diversity and Abundance of Insects on Pineapple (*Ananas comosus* (L.) Merr.) Plantation at Bolaang Mongondow District

Juliet Merry Eva Mamahit[1]

[1]Plant Protection Study Program, Faculty of Agriculture, Sam Ratulangi University, Manado North Sulawesi 95115, Indonesia

Abstract : Bolaang Mongondow District is one of the centers of pineapple production in Indonesia that reside in province North Sulawesi, Indonesia. This research was aimed to know diversity and abundance of insect in pineapple plantation, detect species evenness of insect in to type agroecosystem of pineapple with polyculture and monoculture systems. This research was carried out at pineapple plantation on Lobong village, Bolaang Mongondow District. Insect diversity was observation in pineapple plants will be done by using pith fall traps. The trapping was put in two land research locations that have different system that's polyculture and monoculture agroecosystem. The sample from trapping was putted into the sample bottle was sorted and identified. The analysis was done to detect diversity of insect with measures index of diversity Shannon and index of evenness Shannon-Wiener. The result showed that biodiversity of insect on pineapple plant that applies cultivation polyculture system more various from in cultivation monoculture system. Total family of insect that found at polyculture land that were 17 families with totals 1614 individuals and monoculture 12 families with totals 1450 individuals. The Shannon and Evenness diversity index in plants with polyculture systems were 0.664 and 0.571 higher than in monoculture systems (0.571 and 0.206). All types of insects that were found both in pineapple plantations were polyculture and monocultures have almost the same level of evenness (E <1).The both of system agriculture for apply system polyculture also monoculture was found family Formicidae in the order Hymenoptera be insect dominate of the area pineapple plantations.
Keywords : diversity, abundance, evenness, insect, *Ananas comosus*, pineapple.

1. Introduction

Indonesia is a tropical country that is rich in plant diversity because its position stretches across the equator is very beneficial because it also has biodiversity, especially insects which are high. However, insect diversity in Indonesia is still largely unexplored, due to the lack of interest among researchers and entomologists in studying insect diversity. This was revealed from around 1,000,000 species of insect world that have been described, only a little is known in Indonesia. The results of new identification of about 25.000

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species of insects that have been revealed and stored in the Bogor Zoological Museum [1].Pineapple cultivation techniques that used to occupy only dry land, or utilize land on the edge of the forest with a polyculture or intercropping cultivation system, have now been planted on a wider area with a monoculture cultivation system.

The destruction of ecosystems or habitats is very potential as one of the causes of insect extinction. The pattern of agricultural systems towards monoculture tends to reduce the diversity of insects that exist in plantations[2]. In addition, the use of agricultural techniques that pay less attention to the environment can cause the extinction of some important insects. One of the control techniques that is expected to be able to minimize the reduction in insect diversity is to apply an environmentally friendly agricultural pattern that is based on the principle of sustainable agriculture. One environmentally friendly technique is Integrated Pest Management (IPM). This control is an act of pest management that carefully considers the various control techniques available, so that it does not harm and reduce risks to human health and the environment [3]. To reduce the risk of decreasing the diversity of insects in their habitat, in addition to the application of IPM in the cultivation system, the need for public awareness of the benefits of insects in life, efforts to conserve insect conservation are associated with plants[4, 5]. Understanding the diversity of insects in various habitat conditions needs to be known, so that insect preservation efforts can be done.

The objective of this research were: (1) examine insect diversity and abundance in pineapple plantations, (2) species evenness of insect in to type agroecosystem of pineapple with polyculture and monoculture systems, and (3) study the types of insects that dominate the pineapple planting area, both of which apply polyculture and monoculture planting systems.

2. Material and Methods

2.1. Survey Location

Prior to the research, a survey was conducted to determine the location for insect sampling, which is an area that is widely planted with pineapple plants, namely in the village of Lobong, Bolaang Mongondow. Then determined each of the two pineapple plantation that have different planting systems, namely with monoculture and polyculture agroecosystems.

2.2. Collection, Identification and Sampling Techniques with Pith Fall Trap

The method of collecting insects associated with pineapple plants is done by using pith fall trap. These traps were placed at four plantation locations that had different agroecosystems, namely two locations that had a polyculture agroecosystem and two locations that had a monoculture agroecosystem. Each plantation is placed 9 traps placed in the diagonal direction of the plantation. Each pitfall trap used was a plastic aqua bottle (240 ml) filled with 70% alcohol mixture and added a little soapy water with the height of the mixture as high as ± 5 cm. The opening of the trap is planted parallel to the surface of the ground and left for 3 days.These samples are put into a sample bottle containing 70% alcohol and taken to the Plant Pest and Entomology Laboratory, Faculty of Agriculture, Sam Ratulangi University to be identified by the insect identification team. The references used were references for identification[6,7,8].

2.3. Parameters of observed:

1. Insect diversity in two agro-ecosystem conditions (polyculture and monoculture)

2. Pineapple planting conditions

2.4. Data Analysis

The number of species found is counted and tabulated. Data on the number of individuals analyzed to calculate the diversity and evenness of insects found. Species diversity found was calculated using the Shannon diversity index[9,10]. The Shannon Diversity Index is calculated using the formula:

$H' = - \Sigma pi \ln pi$

Where,

pi = proportion of abundance in each species = ni / Ni ni

N = total abundance

While the species evenness index found was calculated using the Shannon-Wiener (eveness) evenness formula:

E = H '/ ln S

Where,

S = number of species [9,10.]

3. Results and Discussion

3.1. Composition of Insects

The results showed that the composition of insects found in pineapple plantations in the polyculture planting system consisted of eight orders of insects. The eight orders are Hymenoptera, Colembola, Coleoptera, Dermaptera, Diptera, Lepidoptera, Orthoptera and Thysanoptera (Figure 1). The highest percentage of insect in pineapple was Hymenoptera. This Orders the most dominant of insects found which can reach 93.5%, while insects from the Order Diptera (2.4%), Coleoptera (1.9%) and Orthoptera (1.8%), while the other four orders namely Colembola, Dermaptera, Lepidoptera and Thysanoptera had the lowest composition of insects. In the monoculture pineapple planting system, it was found that the composition of insect orders was lower than the polyculture planting system which were only five insect orders, namely: Hymenoptera(912,6%), Coleoptera (3.0%), Diptera (1.4%), Lepidoptera (0.3%) and Orthoptera (3.7) (Figure 2). Just like in polyculture pineapple plants, the dominant order found in monoculture system was order Hymenoptera. This study shows the Hymenoptera group indeed dominates the presence of pest insects in pineapple plantations. Some research also reported that the order Hymenoptera is a large number of soil insects is obtained[11,12]. The Hymenoptera Order dominates more than any other order due to the fact that this order does indeed live on the ground and has a high adaptability. The dominance of soil insects in a habitat is influenced by the environment that is suitable for supporting life[11] and these insects have evolved to adapt to agricultural land[12].

Hymenoptera was the dominant order found during research. Some studies also report that the order Hymenoptera is a soil insect that is widely obtained. The percentage of insects of the Hymenoptera Order compared to other soil insects can exceed 67.85% [11]. Percentage of insects of the Order Hymenoptera compared to other soil insects more than 50%[13].

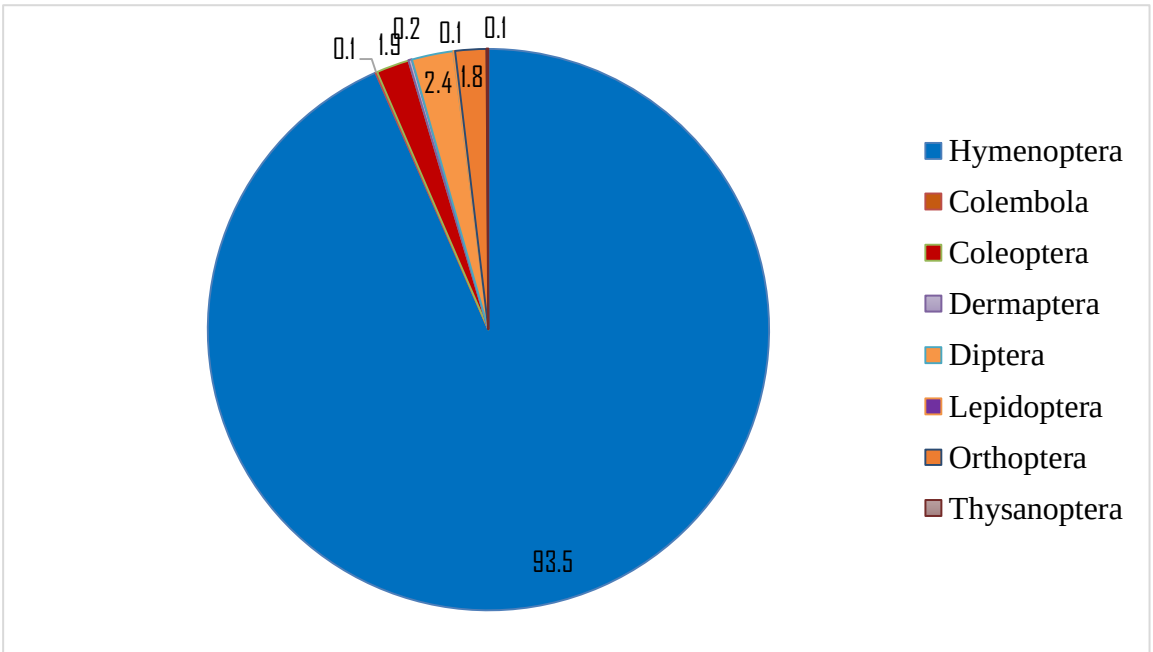

Figure 1. The composition of insects on pineapple plants that were planted with polyculture system

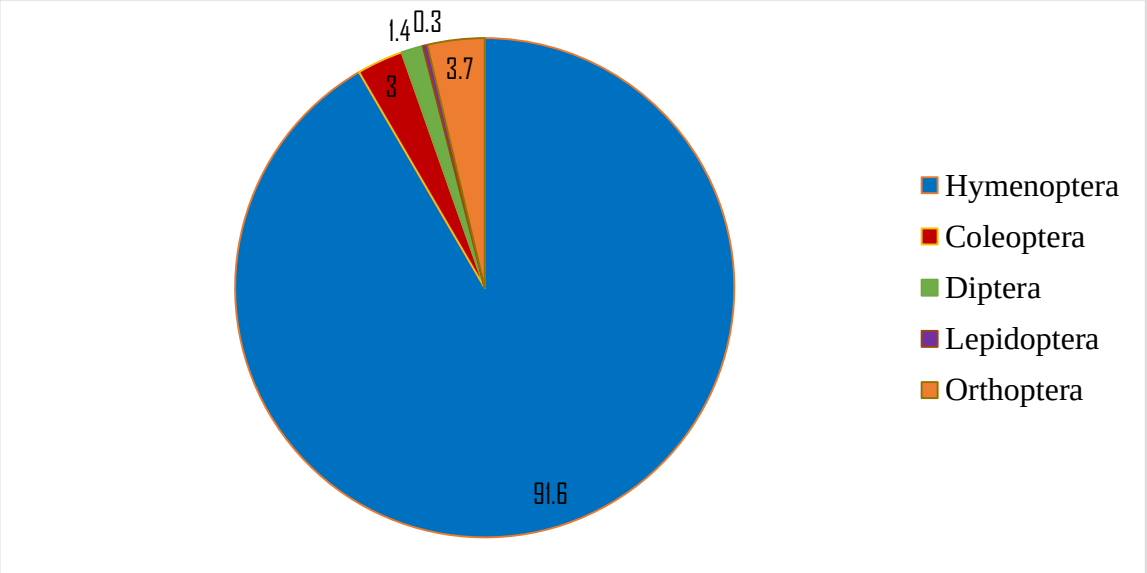

Figure 2. The composition of insects on pineapple plants that are planted with monoculturesystem

3.2. Insect Diversity and Abundance in Pineapple Plantations Polyculture and Monoculture System

The results of the study showed that the dominant insects found in pineapple polyculture system were from the Hymenoptera Order with 1509 individuals followed by the Diptera Order 34 individuals and Coleoptera 30 individuals and Orthoptera 29 individuals (Figure 3). Likewise the results data of population and diversity in pineapple plants in monoculture plantations found more insect population numbers in the order Hymenoptera (Figure 4).Whereas the Colembola, Dermaptera, Lepidotera and Thysanoptera had the lowest abundance of insects. The dominant insect was the Order Hymenoptera, especially from the Formicidae family which can reach thousands of individuals. These insects have the highest abundance because these ants (Formicidae) are generally cosmopolitan or can be found anywhere. For example, the ants found are mostly from the *Solenopsis* sp[14]. These ants are arborical and terrestrial which find their food from the secretions of plants rich in carbohydrates and exudates released by other insects [15]. The presence of ants is also caused by ants always associated with the presence of mealybug insects (Pseudococcidae). Ants benefit by eating fluids released by mealybug [4.15]. The species of mealybug pest in pineapple plants is the *Dysmicoccus brevipes* [4,5,16,17] and *Dysmycoccus neobrevipes*[18].

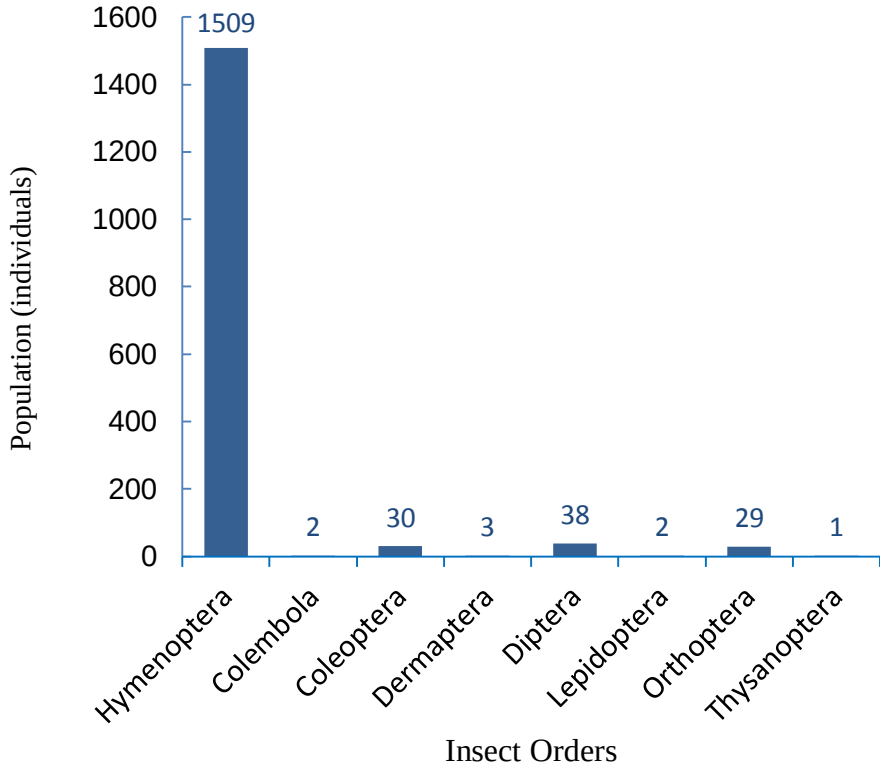

Figure 3. Population of insect in pineapple plantations in polyculture system

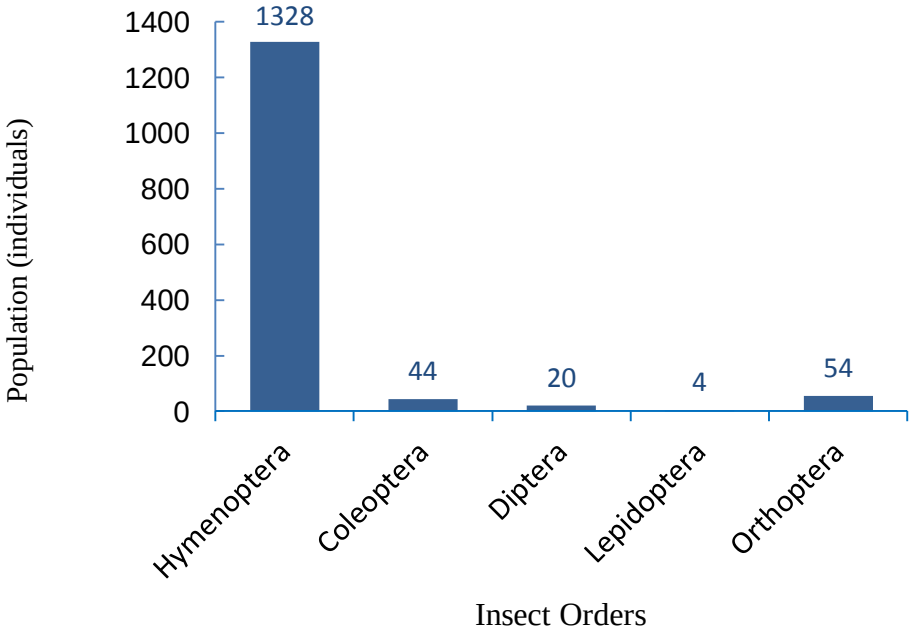

Figure 4. Population of insect in pineapple plantations in monoculture system

The number of insect species found in pineapple plantations were more often found in polyculture pineapple plantations (1614 individuals; 17 families) than monoculture pineapple plantations (1450 individu; 12 familes) (Table 1). This research, as the same as the other research found more insects on polyculture land has 7 families compared to monoculture land found only 5 families in Labat village Kupang [19].The data showed that the dominance of insects found was family Formicidae: Hymenoptera Order, which is commonly found in terrestrial ecosystems. Another family of the Hymenoptera Order was from the Mymaridae family which is a

parasitoid insect that plays a role in the natural control of various pest species. Some insects that were found to act as natural controllers whose ecological functions as predators include the familes: Anobiidae, Carabidae, Staphylinidae, Forficulidae, Blattidae and Gryllidae. Most of the insects found included in the group of insect pests that often cause damage to plants, among others, from the familes: Scarabaeidae, Melandryidae, Drosophilidae, Tephritidae, Pyralidae, Acrididae, Tettigoniidae and Thripidae. Other insects found in pineapple agroecosystems play a role as decomposers, among others: family Entomopbryonidae (Collembola). The existence of Colembola in the field is very lacking, this is likely influenced by the overuse of insecticide use by farmers, which causes residues in plantations and can be left on the soil surface, thus affecting the presence of Collembola.

The high diversity of insects on pineapple plants that apply polyculture was due to the diversity of plants that exist in plantations is higher in polyculture plantations than monoculture plantations. More and more plants allow more insects and habitat for insects. Crop diversity also enhances resilience to climatic variability and favors arthropods and microorganisms involved in improved nutrient cycling, soil fertility, pest regulation[19], temperature and humidity[20].

Besides that in monocultures it is easier to decrease insect population due to input in the improvement program of his farming business. This results show that in pineapple plantations 19 families were found in eight orders of insects. The Coleoptera Order has a greater number of families (five families) than the Diptera Order (four families) and the Orthoptera Order (four families).

According to[21], the important problem of monoculture farming systems is the decreased plant resistance to insects attacking. This is caused by unwise use of pesticides. The process of simplifying the environment into agricultural monoculture has an impact on biodiversity in terms of: (1) expansion of agricultural land results in loss of natural habitats, (2) loss of various types of useful insects due to loss of wild plants as a food source, use of synthetic chemicals and other activities, and (3) erosion of various genetic sources due to uniform increase in high-yield crop varieties.

Table 1. Population of insects found on pineapple plantations that apply polyculture and monoculture cultivation systems

Ordo/Family	**The population of insects in two cultivation systems (individuals)**	
	Polyculture	**Monoculture**
Collembola		
Entomobryidae	2	0
Coleoptera		
Anobiidae	19	21
Carabidae	0	1
Melandryidae	1	0
Scarabaeidae	9	19
Staphylinidae	1	3
Dermaptera		
Forficulidae	3	0
Diptera		
Bombiliidae	10	0
Drosophilidae	17	9
Tachinidae	11	0
Tephritidae	0	11
Hymenoptera		
Formicidae	1508	1327
Mymaridae	1	1
Lepidoptera		
Pyralidae	2	4
Orthoptera		
Acrididae	18	22

Blattidae	1	1
Gryllidae	9	31
Tettigoniidae	1	0
Thysanoptera		
Thripidae	1	0
Grand Total	1614	1450

3.3. Index of Diversity and Evenness of Species

Based on Shannon diversity index calculation in polyculture plantations (H'= 0.664) higher than monoculture diversity index (H' = 0.571) (Table 2). The value of the diversity index is influenced by the number of species insects were found. Based on the results of data analysis, it was known that the diversity index value on polyculture and monoculture pineapple plantation has a low value (H'=1). This is in line with the results of observations on the number of species and the number of individual insects found in polyculture pineapple plantations more than monoculture pineapple plants. This is doe to the polyculture plantation that the pineapple planted under coconut trees, besides there are also bananas, papayas, wood trees and broadleaf weeds. The existence of other plants besides pineapple allows the land to be more humid, and the availability of host plants is quite a lot for insect life.High and low diversity of insects is influenced by the presence of food sources and favorable climate. As the other researchers found the diversity index in monoculture and polyculture farms are H '= 1.08-1.66[19], species diversity index soil insects on Mount Tumpa were H '1.5 - 3.5[11]. Diversity increases, so do opportunities for coexistence and beneficial interference between species that can enhance agroecosystem sustainability [21].

Table 2. Shannon diversity index, evenness, number of species and number of individual insects in polyculture and monoculture pineapple plantations

Planting Systems	Diversity (H')	Evenness (E)	Number of Families	Number of Individuals
Polyculture	0.664	0.209	24	1614
Monoculture	0.571	0.206	16	1450

The results of the analysis of the evenness index of pineapple insects on polyculture (E = 0.209) and monoculture farms (E = 0.206) are close to 1 (<1). According[22], the value of E close to 1 indicates that all species have almost the same level of evenness. Based on the evenness index in both monoculture and polyculture pineapple planting systems, it was found that all insects were found to have nearly equal. If the evenness index is > 0.5, then the evenness is high [23, 24].

The diversity and evenness of insects varies due to the influence of environmental pressure factors such as temperature, humidity and thickness of the titter. Temperature and humidity are factors that influence the development of soil insect populations. That temperature effective for the development of soil insects is15 ° C (minimum temperature), 25 ° C (optimum temperature), 45 ° C(maximum) [11]. Other than that, the existence of human activities such as conversion of forests that were dominated by forest plants into monocultures such as pineapples plant farming can decrease value diversity of soil insects in the study area affect insect species that can found alive in the pineapple plant ecosystem, because there are insects certain whose lives require protection that can be provided by the canopy of woody plants from polyculture farming systems.

4. Conclusions

The number of insect families found in pineapple polyculture plantations were 17 families with a total of 1614 individuals and in monoculture plantations 12 families with a total of 1450 individuals. The diversity index in of insects in pineappe plants with polyculture planting systems was 0.664 higher than those in monocultures 0.571. All types of insects that were found both in pineapple plantations were polyculture and monocultures have almost the same level of evenness (E <1). The ant insects of the Formicidae family are the types of insects that dominate the pineapple planting area, both of which apply polyculture and monoculture planting systems.

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