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Diversity of Soil Insects on Vegetable Gardens in Tomohon City

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Abstract Diversity is one indicator of the stability of a community. One of the resources that play a role in the community is ground insects. Insects as a component of biodiversity have an important role in the food web, namely, as herbivores, carnivores, and detritivores. In the Tomohon City area, it is a potential source of vegetable producers and has high biodiversity and has not been studied much, such as soil insects on vegetable crops. There are several parameters that can be measured to determine the state of an ecosystem, for example by looking at the value of diversity. This study aims to determine the diversity of soil insects using the pitfall trap technique on vegetable fields in Tomohon City. Soil insect sampling was carried out at three vegetable production centers in the city of Tomohon, North Sulawesi using the pitfall trap method. The traps were set at 10 points randomly and spread out at each center of vegetable crop production. The traps were set for two days and repeated as many as three times. The collected insects were sorted and identified and numbered to obtain the diversity index value using the Shannon-Wiener formula. The results of the study found eight orders consisting of 18 families of insect species including decomposers (four families), detritivores (two families), predators (seven families), herbivores (five families) to moderate and the value of the dominance index ranges from 0.125 – 0.710 .
Key-words : Insect diversity, soil insects.

1. Introduction

Soil insects are one of the groups that are often ignored even though the life of this group of soil insects has a relationship that is very dependent on the environmental situation in which they live. Soil insects have invaluable potential, especially in helping to remodel soil organic matter, as well as being one of the environmental balancers. Some of them soil insects can be an indicator of the fertility level of a soil or the condition of a soil[1]. Biodiversity is defined as the viability and alternation between living organisms of all sources of life. It can be studied at many levels, including diversity within species as well as between species in

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ecosystems. At the highest level, biodiversity can be seen in all the different species throughout the earth. On a smaller scale, biodiversity is studied in a particular ecosystem by identifying the particular organisms that live in it[2]. Biodiversity, including the number, abundance, and composition of genotypes, populations, species, functional species, communities and landscapes, greatly influences the provision of ecosystem services[3]. According to[4], the diversity of organisms in the tropics is higher than in the sub-tropics, this is because the tropics have species richness and species evenness.

Biomonitoring has the main objective of using living organisms in an ecosystem to monitor the impact of disturbances on the management of an ecosystem. For example, to show that disturbances in the form of chemical infestations in the soil on biodiversity in an agroecosystem result in decreased productivity. Insects are taxa that can be used as indicators of an agroecosystem because they have narrow amplitude to changes in microclimate. For this reason, by examining the diversity of soil insects, the diversity of insects that have different roles can be explored[5]. Farming in the field of vegetable crops in the city of Tomohon generally uses chemicals such as artificial fertilizers, namely nitrogen, phosphate, potassium and often use pesticides in controlling pests and diseases on vegetable crops, resulting in decreased productivity and can even lead to crop failure. In order to better understand the processes that occur with regard to productivity decline, various studies are needed on the impact of pesticide residues on biodiversity. One important indicator that can be used is soil insects because insects are quite sensitive to changes in their surrounding habitat.

From this research, it is hoped that by knowing the diversity of soil surface insects found in Tomohon City, it is also possible to know the factors that distinguish the types of ground insects in vegetable crops and for an inventory of soil surface insect diversity which has not been studied in the area.

2. Experimental

Three villages were selected for each region or center for vegetable and flower production, and for each village the location of the vegetable gardens was determined. The number of locations as a place for collecting soil insects in Tomohon City consists of 10 points where samples are taken. Then for two days the soil insects that entered the pitfall trap were collected and repeated three times. Each sampling location used a compass or GPS (Global Positioning System), so that the position of soil insects found in Tomohon City could be known.

Macroscopic observations to obtain initial data on insects that live on several types of host plants, supporting data for identification. Microscopic observations were made to determine the species of soil insects present in vegetable gardens as samples. Furthermore, the identification of these insects is carried out to ascertain whether each type of soil insect that lives on vegetable crops is carried out.

Identification of insects from vegetable gardens was carried out morphologically. The morphological characteristics of the soil insects that have been obtained were matched to the family level according to the books and web of identification keys, among others[6,7].

Population data of each type of insect obtained by the research results were processed in a quantitative descriptive manner and to calculate the diversity index using the following formula[8].

$$H' = \sum_{i=1}^{s} (pi)(\ln pi)$$

H' = Shannon-Wiener diversity index
s = Number species in community
pi = proportion of total sample belonging to i^{th} species
Ln = Natural log
The value of H' is defined as follows:
$H' < 1$ = Low diversity
H' 1-3 = Middle diversity
$H' > 3$ = High diversity

To calculate the dominance index value can be calculated using the following formula[9].

$$C = \sum_{i=1}^{n} \left[\frac{n_i}{N} \right]^2$$

C : Dominance Index
ni : Number of individuals of a species
N : Total individuals of all species

3. Results and Discussion

a. Soil Insects and Their Role

Insect identification was carried out in vegetable gardens in Matani and Kamasi Villages, Central Tomohon Sub-district and Kakaskasen Village, North Tomohon Sub-district, Tomohon City. Insect species found in eggplant gardens in Matani Village can be seen in Table 1.

Table 1. Insect species found on Eggplant (*Solanum melongena* L) garden in Matani Village

Ordo	Family	Roles	Population
Collembola	Hypogastruridae	Decomposer	5837
	Isotomidae	Decomposer	672
	Sminthuridae	Decomposer	131
	Entomobrydae	Decomposer	382
Coleoptera	Carabidae	Predator	8
Hymenoptera	Formicidae	Predator	104
Orthoptera	Grylidae	Herbivore	3
	Acrididae	Herbivore	1
			N=7138

Table 1. shows the results of the research on the types of insects found in eggplant (*Solanum melongena* L). In Matani Village, there were four orders consisting of eight families, the order Collembola has a larger population than the orders Coleoptera, Hymenoptera, and Orthoptera. The total population of all orders found was 7138 individuals. The role of the order Collembola as a decomposer was very dominant with a percentage of 98.37% while predators were 1.57% and herbivores were 0.06% (Figure 1).

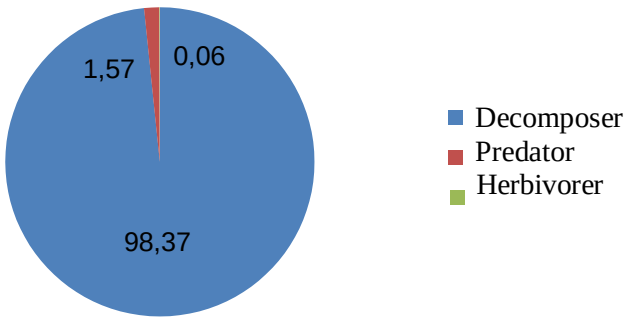

Figure 1. Diagram of soil insects based on their role in the eggplant gardens, Matani Village

Insect species found in spinach (*Spinacia oleracea* L) gardens in Matani Village are listed in Table 2. This table shows the insect species in the Spinach (*Spinacia oleracea* L) garden. In Matani Village, there are four orders with eight families, the order Collembola has a larger population than the orders Coleoptera, Hymenoptera, Orthoptera and the total population of all orders were 11,944 individuals. The role of the order Collembola as decomposers was very dominant with a percentage of 99.57% while predators were 0.38% and herbivores are 0.05% (Figure 2)

Table 2. Types of insects found in Spinach (*Spinacia oleracea* L) Fields in Matani . Village

Ordo	Family	Roles	Population
Collembola	Hypogastruridae	Decomposer	9990
	Isotomidae	Decomposer	1110
	Sminthuridae	Decomposer	242
	Entomobrydae	Decomposer	550
Coleoptera	Carabidae	Predator	12
	Scolytidae	Predator	2
Hymenoptera	Formicidae	Predator	32
Orthoptera	Grylidae	Herbivore	6
			N = 11.944

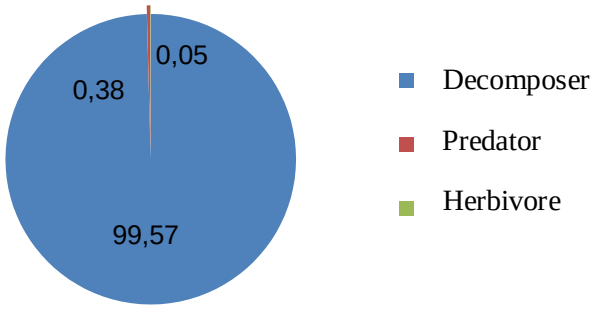

Figure 2. Diagram of soil insects based on their role in the spinach gardens, Matani Village

Table 3 shows the results of the study. Types of insects found in Caisin (Brassica juncea L) Plantation In Kakaskasen Village, there are 6 orders consisting of 10 families, the order Collembola has a larger population than the orders Coleoptera, Hymenoptera, Hemiptera, Isopoda. , Orthoptera and the total population of all orders found was 665 The role of the order Collembola as a decomposer was very dominant with a percentage of 89.63% while predators were 9.02%, herbivores 0.90% and detritivores 0.15% (Figure 3).

Table 3. Types of insects found in the garden of Chinese mustard (*Brassica juncea* L) in Kakaskasen Village

Ordo	Family	Roles	Population
Collembola	Hypogastruridae	Decomposer	396
	Isotomidae	Decomposer	172
	Sminthuridae	Decomposer	28
Coleoptera	Scarabidae	Predator	1
	Staphylinidae	Predator	3
	Tenebrionidae	Predator	7
Hymenoptera	Formicidae	Predator	49
Orthoptera	Grylidae	Herbivore	2
Hemiptera	Aphididae	Herbivore	4
Isopoda	-	Detrivore	3
			N=665

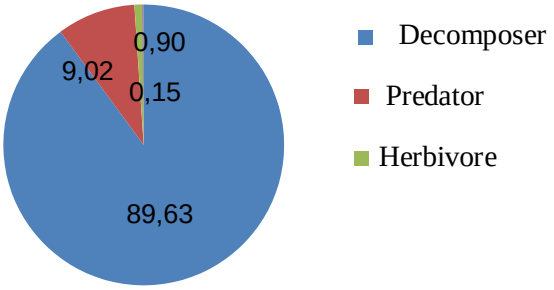

Figure 3. Diagram of soil insects based on their role in the Chinese mustard gardens in Kakaskasen Village

Table 4 shows the results of research on insect species found in the Pak Choy garden (*Brassica rap* L) in Kakaskasen Village, there are five orders consisting of 10 families, the order Collembola has a larger population than the orders Coleoptera, Hymenoptera, Dermaptera, Orthoptera and total population of all orders found was 3663 The role of the order Collembola as a decomposer was very dominant with a percentage of 98.88% while predators were 0.38% and herbivores were 0.74% (Figure 4).

Table 4. Types of insects found in Pak Choy (*Brassica rap* L) garden in Kakaskasen Village

Ordo	Family	Roles	Population
Collembola	Hypogastruridae	Decomposer	2498
	Isotomidae	Decomposer	1103
	Sminthuridae	Decomposer	21
Coleoptera	Carabidae	Predator	7
Dermaptera	Foficulidae	Predator	3
Hymenoptera	Formicidae	Predator	18
	Geridae	Herbivore	8
Orthoptera	Grylidae	Herbivore	1
	Tetrigidae	Herbivore	2
	Grykotalpidae	Herbivore	2
			N=3663

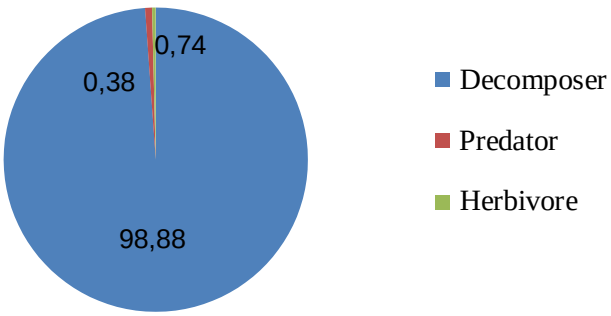

Figure 4. Diagram of soil insects based on their role in the Pak Choy gardens in Kakaskasen Village

Table 5 shows the insect species found in the cabbage (*Brassica oleraceae* L) garden in Kamasi Village, there are seven orders consisting of nine families, the order Hymenoptera, the Formicidae family has a larger population than the orders Coleoptera, Collembola, Diptera, Orthoptera and the total population of all orders found was 122. The role of the order Hymenoptera, family Formicidae, as a predator was very dominant with a percentage of 54.10%% while decomposers were 32.79% and herbivores were 13.11% (Figure 5).

Table 5 shows the insect species found in cabbage (*Brassica oleraceae* L.) garden in Kamasi Village

Ordo	Family	Roles	Population
Collembola	Hypogastruridae	Decomposer	11
	Isotomidae	Decomposer	18
	Sminthuridae	Decomposer	4
Coleoptera	Scarabidae	Predator	13
Hymenoptera	Formicidae	Predator	53
Orthoptera	Grylidae	Herbivore	16
Aranea	Lycosidae	Predator	8
Acarina	-	-	7
Diptera	-	Decomposer	7
			N=122

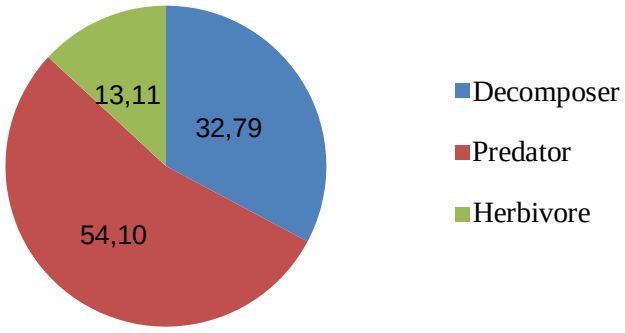

Figure 5. Diagram of soil insects based on their role in cabbage gardens in Kamasi Village

Table 6 shows the insect species found in the chayote (*Sechium edule*) gardens in Kamasi Village, there are six orders consisting of 8 families, the order Collembola has a larger population than the orders Coleoptera, Hymenoptera, Dermaptera, Orthoptera and the total population of all orders found as many as 392 individuals. The role of the order Collembola as decomposers is very dominant with a percentage of 71.43%, while predators are 25.51% and herbivores are 3.06% (Figure 4).

Table 6. Types of insects found in the chayote (*Sechium edule*) gardens in Kamasi Village

Ordo	Family	Roles	Population
Collembola	Hypogastruridae	Dekomposer	118
	Isotomidae	Dekomposer	116
	Sminthuridae	Dekomposer	46
Coleoptera	Scarabidae	Predator	31
Dermaptera	Forfeiculidae	Predator	23
Hymenoptera	Formicidae	Predator	50
Orthoptera	Grylidae	Herbivora	8
			N=392

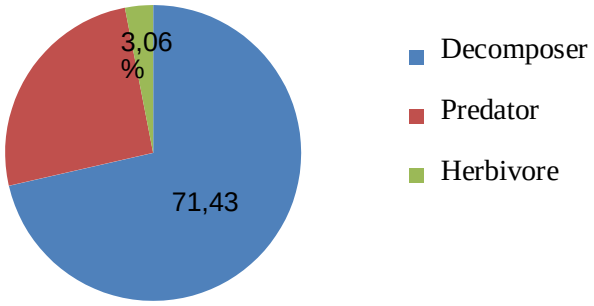

Figure 6. Diagram of soil insects based on their role in chayote gardens in Kamasi Village

Based on the results of the research on the types of insects found in the Villages of Matani, Kamasi and Kakaskasen, Tomohon City, the types of insects from the order Colembolla have a dominant population in vegetable growing fields. Organisms that are often found associated with soil and plants in agroecosystems include the Collembola group and other types of arthropods. As stated by[10] that Collembola is generally known as an organism that lives in the soil and has an important role as a decomposer of soil organic matter. In the agricultural ecosystem, Collembola is found in abundance. Collembola in agricultural ecosystems is an alternative feed for various types of predators. As prey or alternative feed for predators, Collembola contributes to maintaining the survival of predators who are natural enemies of various types of pests. As reported by[11] that Colembola not only acts as a decomposer organism, but also acts as a buffer to maintain the presence of predators. Based on the results of the study, the percentage of predators on vegetable fields was very small. As mentioned by[12], the abundance of Colembola is influenced by the amount of litter, C-total, N-total, and rainfall.

b. Diversity of Insects in Vegetable gardens

The results of the diversity analysis on the types of insects found in vegetable gardens can be seen in Table 7.

Table 7. Number of orders, number of families, value of diversity index, value of insect dominance index in vegetable gardens

Informations	**Vegetables Gardens**					
	A	B	C	D	E	F
Number of orders	4	4	6	5	5	5
Number of families	8	8	10	10	7	7
H′	0,705	0,630	1,122	2,786	1,796	1,175
C	0,681	0,710	0,459	0,556	0,235	0,215

Description: A= Eggplant, B= Spinach, C= Chinese mustard; D= Pak Choy, E= Cabbage, F= Chayote, H'= Shannon Wiener Diversity Index, C= Dominant Index

Table 7 shows that in eggplant, spinach, Chinese mustard, Pak Choy, cabbage, and chayote based on the results of the calculation, the Diversity Index Value (H') ranges from 0.630 to 2.786 with the category of diversity being low to medium and the Dominance Index value ranging from 0.215 to 0.710 with low dominance. A community is said to have a high level of species diversity if the community is composed of many species with the same or almost the same species abundance. On the other hand, a community is said to

have a low level of species diversity if it is composed of a few dominant species[8]. Pesticide application also affects insect diversity[13]. Based on the results of interviews with farmers who manage vegetable crops, it is stated that the use of pesticides in the form of insecticides, fungicides and herbicides is routinely applied so that the cultivation of vegetable crops remains of good quality.

4. Conclusions

Diversity of soil insects in vegetable gardens in Tomohon City found eight orders consisting of 18 families, namely decomposers (four families), detritivores (two families), predators (six families), herbivores (six families), with a diversity index (H') ranged from 0.630 – 2.786 with low to moderate diversity category and the dominance index value ranged from 0.125 – 0.710

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