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Diversity of Insect Pests in Plants of Coffee (Coffea arabica L.) in Sigumpar, Humbang Hasundutan, North Sumatera

Nursal[1], Halason P Purba[1],

[1]*Departement of Biology, Faculty of Mathematics and Natural Sciences, Universitas Sumatera Utara, Medan, Indonesia*

Abstract. Both methods were carried out in 5 locations based on the age of coffee, 3, 5, 10, 15, and 20 years. The area of the Searching and Direct Observation and Hand Picking method is 20x20 meters which was carried out diagonally. Data collected included the number of species and individuals, density (K), relative density (KR),attendance frequency (FK), diversity index (H '), equitability index (E) and its similarity index (IS). The results of the observation showed that 4 pest orders, 8 families, 10 species and 225 individuals were obtained. During the day 9 species of insects were found with 4 orders, 7 families, and 198 individuals and at night there were 4 types of insects with 2 orders, 3 families and 31individuals. Hypothenemus hampeii is the species with the highest K, KR and FK values of all locations with each value of 0.045 ind / m2, 41.86% and 100%. The highest Diversity Index (H ') value is found at location 5 (1,841) and the lowest value at location 1 (1,178). The highest Equitability value (E) is found in location 1 (0.849) and the lowest value at location 5 (0.799). The highest Similarity Index (IS) is found in locations 4 and 5 with a value of 94.73% and the lowest at locations 1 and 5 with a value of 57.14%.

Keyword: diversity, coffee, insect pests, Sigumpar

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1 Introduction

Coffee is a mainstay plantation commodity that has a major contribution to the economy in Indonesia as a source of foreign exchange. Indonesia is the third largest coffee exporting country in the world after Brazil and Vietnam with the export value of Indonesian coffee in 2014 around 5,6% of total world exports after Brazil 16,07% and Vietnam 10,34%. The total area of Indonesian coffee plantations is 1,331,000 ha, of which 96% are people's plantations and 4% are owned by the government. Total production is around 738,000 tons[1,2].

North Sumatra Province is one of the provinces in Indonesia which has quite good natural potential in producing plantation products, especially in the commodity of coffee beans. Arabica

**Corresponding author at: Departement of Biology, Faculty Mathematics and Natural Science, Universitas Sumatera Utara, Medan, Indonesia

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coffee plantations in North Sumatra Province are located in highlands ranging from 1000 to 1650 meters above sea level which are widely spread in several districts, namely North Tapanuli., Toba Samosir, Samosir, Humbang Hasundutan, Simalungun, Dairi, Karo, Mandailing and South Tapanuli. Humbang Hasundutan Regency has Arabica coffee which is famous for its trademark Kopi Lintong. Lintong coffee is grown in the Lintongnihuta District, which is in the southwest of Lake Toba, in the Humbang Hasundutan Regency [3,4]. Lintongnihuta District consists of 22 villages of which Sigumpar Village is one of them[5].

Sigumpar Village is an agricultural village that relies on coffee as a livelihood. The coffee produced from Sigumpar village has good quality as evidenced by the Lintong Coffee trademark which has been exported and the establishment of coffee business cooperation with foreign companies. But lately the production and quality of coffee in Sigumpar Village has decreased and is not optimal.

The decline in coffee production is caused by the age of the plant and its low quality and is also exacerbated by pest attacks on coffee plants. The situation in the field is that there are pests that interfere with the productivity of coffee plants that attack the roots, twig, flower, fruit and leaves. The effects of pests on coffee plants will cause the condition of the coffee fruit to become hollow and hollow up to 65% of the fruit planted. So that the resulting coffee production is only around 35% with poor quality. Pests will always cause problems every year because pests reduce the quality and quantity of production [6,7].

The results of research by [8] showed that the pests found on coffee plants were the twig borer (Xylosandrus compactus)., seed borer (Hypothenemus hampeii), green tick (Coccos viridis), mealybug (Ferrisia virgata), humpback ticks (Homoptera: membracidae), stem borer (Zeuzera coffeae) and aphids (Aphis sp.). Based on the information and field data obtained,there are insects that become pests that attack coffee plants in Sigumpar Village. Based on that, The author feels the need to conduct research on the Diversity of Insect Pests in the People's Coffee Plantation in Sigumpar Village, Humbang Hasundutan Regency, North Sumatra.

2. Research Methods

2.1. Research Methods

Determination of the location of this study was carried out by using the Porposive Sampling method, namely determining the location by choosing. The selected location is a location that can represent or approach the truth with the overall situation. While the sampling was carried out using the Light Trap and Hand Searching and Direct Observation and Hand Picking methods.

2.2.Research Implementation

2.2.1.How it Works

This research was conducted on an area of 1 hectare on the people's plantation of Sigumpar Village, Lintongnihuta District using Light Trap, Searching and Direct Observation and Hand Picking Methods. Each observation measured abiotic factors which include temperature, humidity and light intensity. The samples obtained were then taken to the Animal Systematics laboratory, Department of Biology, University of North Sumatra for identification up to the genus level.

2.2.2. Light Trap Method

Light traps are used to catch insects that respond or are sensitive to light at night [9]. The Light Trap method is carried out at night. Installation of light traps (Light Trap), is carried out at 19.00 WIB and ends at 06.00 WIB the next day. The light trap is placed 50 meters towards the coffee plantation to avoid interference from other light sources and is placed between the coffee plant canopy as high as 1 meter by hanging the tool on a modified or broti pole. This method was carried out 2 times at each location with an interval of 3 days at each location. The lamp used is a 50 watt lamp. Light traps are used to catch insects that have a response or are sensitive to light at night (Noctunal).

2.2.3. Searching and Direct Observation and Hand Picking Methods

During the day, samples were searched using the Search and Direct Observation method in coffee plantations. This direct search and observation is useful for finding insects that make coffee plants their homes or leaf-eating insects. After finding samples in the form of larvae, pupae and imago (adults) they were collected using the Hand Picking method to be put into sample bottles [9]. The sample search was carried out 2 times at 5 predetermined points with an area of 20 x 20 m diagonally. The search for samples during the day was carried out at intervals of 3 days with an observation period of 2 weeks.

2.4. Identification of Sample

Insects from the field that have been preserved are then identified and sorted to separate pest insects and non-pest insects and then the number of individuals from each species obtained is counted. For small insects, identification is done using a light microscope. This identification uses the following reference books:

a. Introduction to Insect Studies, by[10].

b. Key to Insect Determination, by [11]

2.5. Area Description

The area that is the location of this research is a people's coffee plantation area of 1 hectare located in Sigumpar Village, Lintongnihuta District, Humbang Hasundutan, North Sumatra. The area used as the sampling location is a coffee plantation with 5 observation plots which are divided based on the age of the coffee plant with a size of 20 x 20 m per plot. Observation area of coffee plants aged 2, 5, 10, 15, 20 years.

2.6. Data Analysis

The data obtained were then tabulated and calculated the values of Density, Relative Density, Frequency of Attendance, Diversity Index, Equitability Index and Similarity Index with the following formula:

a. Population Density (D)

$$D = \frac{Number\ of\ individuals\ of\ a\ type}{Number\ of\ sample\ units} \quad (1)$$

b. Relative Density (RD)

$$RD = \frac{The\ density\ of\ a\ type}{Total\ density\ of\ all\ types} x100\ \% \quad (2)$$

c. Attendance Frequency (AF)

$$AF = \frac{The\ number\ of\ sample\ plots\ occupied\ by\ a\ species}{The\ total\ number\ of\ sample\ units} x100\ \% \quad (3)$$

Information :

0-25% = the constancy is very rare

25-50% = the constancy is rare

50% -75% = frequent constants

> 75% = the constancy is very frequent [14]

d. Diversity Index (diversity)

$$\boldsymbol{H' = \sum_{i=1}^{s} pi \ln pi} \quad (4)$$

Information :

H′ = diversity index

Pi = proportion of species to i in community (ni / N)

s = number of species in the community

e. Equitability Index (Uniformity)

$$E = \frac{H'}{H\ Max} \quad (5)$$

E = Equitability Index

H max = ln S (S = number of genera).

f. Simirilaty Index

$$IS = \frac{2C}{a+b} x\ 100\ \% \quad (6)$$

IS = Sinirilaty Index

a = total species for location a

b = total species for location b

c = total species for location a and b

3. Result and Discussion

3.1.Diversity of Insect Pests

The results of research on the diversity of insect pests on coffee plants in Sigumpar Village, Humbang Hasundutan Regency, North Sumatra indicate that at the research location there are 10 types of insect pests as shown in Table 1 below:

Table 1. Family, Species and Number of individuals from insect pests found on coffee plants in Sigumpar Village.

No	Family	Species	Observation Time and Number of Insects												Total
			Day						Night						
			1	**2**	**3**	**4**	**5**	**Amount**	**1**	**2**	**3**	**4**	**5**	**Amount**	
1	Aleyrodi	*Bemisia tabacci*	-	2	4	4	5	15	-	-	-	-	-	-	15
2	Aphidida	*Aphis gossypii*	-	-	-	1	2	38	-	-	-	-	-	-	38
3	Coccoide	*Coccus viridis*	4	5	7	8	4	28	-	-	-	-	-	-	28
		Coccus hesperdium	2	2	4	3	5	16	-	-	-	-	-	-	16
4	Cossidae	*Zeuzera*sp.	-	-	-	-	1	1	-	-	1	2	2	5	6
5	Curculionidae	*Hypothenemus hampeii*	8	12	12	17	18	67	2	3	3	5	8	21	88
		Xylosandrus compactus	2	2	2	4	4	14	-	-	-	-	-	-	14
6	Drosophi	*Drosophila*sp.	-	2	2	4	4	12	-	-	-	-	-	-	12
7	Noctuida	*Spodoptera*sp.	-	-	-	-	-	-	-	-	-	-	1	1	2
8	Saturniidae	*Cricula trifenestrata*	-	-	1	1	2	4	-	-	1	1	2	4	8
		Total	16	25	32	59	63	195	2	3	5	8	13	31	225

Information :

1: 3 years old coffee plant

2: 5 year old coffee plant

3: 10 year old coffee plant

4: 15 year old coffee plant

5: Coffee plant 20 years old

Table 1 shows that the insect pests obtained consisted of 8 families with 225 individuals during the day and night observations. During the day the insect pests obtained consisted of 7 families, 9 species with 195 individuals. The most dominant insect pest was the species Hypothenemus hampeii from the family Curculionidae with 67 individuals. Hypothenemus hampeii is an insect that can be found at every research point. This is thought to occur because this insect is the main insect pest on coffee plants that attacks coffee, both young and old. According to [12], the coffee berry borer (H. hampeii Ferr.) is a major pest on coffee plantations worldwide.

PBKo pests attack fruit when it is still young and ripe. Attacks on young fruit can cause fruit drop, while attacks on old (ripe) fruit result in a decrease in quality [13,14]. The attack rate of H. hampei is strongly influenced by growing environmental conditions such as temperature, humidity, altitude, cultivation methods, and plant varieties. Environmental conditions greatly affect the ability of the H. hampei beetle to attack coffee cherries [15,16].

The condition of the coffee plantations in Sigumpar Village which is lush and dense and high humidity is an important factor that makes these PBKo insects able to live well on coffee plants. This is in accordance with [17] who said that H. hampei insects are known to like lush coffee plants with dark shade. This condition seems to be related to the origin of PBKo pests, namely Africa, where PBKo insects attack wild coffee plants under humid tropical forests. Similar conditions were also found in Brazil, where heavy attacks of PBKo pests usually occur in coffee plantations with heavy shade and fog, so that the humidity is quite high.

The fewest species during the day are Zeuzera sp. with 1 individual, this small number is thought to be because the coffee plant is not the main crop attacked. This insect pest attacks the branches and stems of coffee plants by making holes in them so that they are more difficult to find. According to the [18], Zeuzera sp. In addition to attacking quinine, this pest also attacks cocoa, tea, teak, mahogany, bungur, coffee, various fruit trees and ornamental plants. The red to brown larvae burrow into the wood or branch tissue, causing the affected twigs to dry up and die. The pupae of this insect pest are usually found in the borehole.

Table 1 also shows that at night the insect pests obtained were 4 species with 4 families and 31 individuals. The most dominant species was H. hampei from the family Curculionidae with 21 individuals. The large number of these insect pests is thought to be because these insects move at night to lay their eggs into the coffee cherries. According to [17,19] female H. hampeii insects fly to lay their eggs on coffee cherries. Male insects H. hampei can not fly, so they stay in their burrows in the seeds. Female insects fly in the afternoon, which is around 16.00 to 18.00.

Females breed on green coffee cherries that are ripe to red, usually make a hole from the end and lay the egg on the fruit. The female beetle flies from tree to tree to lay eggs. When the eggs hatch, the larvae will eat the contents of the fruit, causing a decrease in the quality of the coffee.

At night observations, the least species found were Spodoptera sp. with 1 individual only. This insect pest was only found at location 5 with the age of the coffee plant which had reached 20 years. Spodoptera sp. not insect pests that usually attack coffee plants, making coffee plants a place to live and breed. These insects are thought to have migrated from peanut and corn plants around the coffee plantation at location 5. [20] said that Spodoptera sp. or better known as armyworm is a lot of insects found and become an important pest in the tropics. Usually these insects are found in agricultural crops such as corn, sorghum, tomatoes, chilies, cotton, cabbage, soybeans, peanuts, sweet potatoes and others.

Table 1 shows that there are insect pest species obtained both during the day and at night. The species were H. hampei, Zeuzera sp., and Cricula trifenestrata. Hypothenemus hampei was found in the adult phase (beetle) during day and night observations. Zeuzera sp., and C. trifenestrata were found in the form or larval phase during daytime observations and adult (moth) phases during night observations.

*Hypothenemus hampei*can be found during the day and night presumably because these insects prefer arabica coffee plants. According to [21] beetle H. hampei flying horizontally likes the area around the plant canopy. In the search for hosts, there are differences in the level of preference for the type of host based on the species in the Coffea genus. The results of research in India on a field and laboratory scale showed that the attack of H. hampei was higher in C. arabica species than in other coffee species.

The temperature during the day and night observations is 24.8°C and 17.6°C, humidity during the day and night ranges from 96.8 and 98.4. According to [14], H. hampeii can live at a temperature of 15-35°C, the optimal temperature for egg development is between 30-32°C and for larvae, pupae and adults 27-30°C. Female insects can burrow coffee cherries between temperatures of 20-33°C, on temperature below 15°C and above 35°C female insects fail to pick up coffee cherries or are able to pick up coffee cherries but do not lay eggs.

*Cricula trifenestrata*during the day found in the form of larvae and at night found in the adult phase. In the larval phase of this insect pest is diurnal which is active during the day and the adult phase is nocturnal which is active at night. This insect is not the main insect that attacks coffee plants but attacks other agricultural crops. According to the [18], C. trifenestrata lives in various hosts ranging from avocado, kedondong, cinnamon, guava, walnuts, mango and cocoa. Adult insects (imago) in the form of moths measuring 6-8 cm dull reddish brown, active at night and attracted to light. The destructive life phase is the larva because it is polyphagous (leaf eaters) consisting of 4-5 instars, black with white spots and white down.

Same as C. trifenestrata, insect pests Zeuzera sp. also found in the larval phase during the day and the adult phase at night. This insect pest is also a nocturnal insect that is active at night. According to the[18], Zeuzera sp. is a branch borer pest with adult insects in the form of moths that are polyphagous (leaf eaters). This moth is white with black spots that are nocturnal or active at night.

3.2 Comparison of Insect Pest Numbers Based on Plant Age

Table 1 shows the number of insect pests that were most commonly found at locations 4 and 5. For more details, see Figure 1 below:

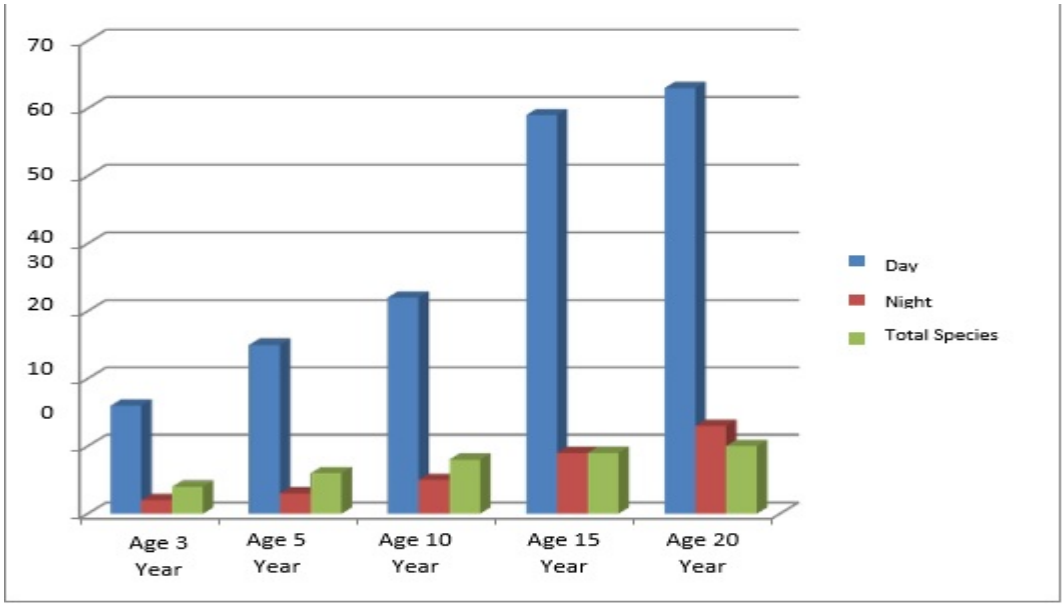

Figure 1. Comparison graph of the number of individuals based on the Age of Coffee Plants.

Figure 4.2 shows that at location 1 (coffee plant age 3 years) the number of species and the number of individuals found was at least 4 species with 18 individuals. Location 5 (coffee plant age 20 years) the most number of species and individuals found is 10 species with 94 individuals. At locations 1-3 the number of insect pests found was less than at locations 4 and 5. This was suspected because farmers paid more attention to young coffee plants. Farmers apply fertilizer, eradicate weeds, pruning and install extractant liquid in bottles which are then hung on the coffee canopy. This farmer's treatment can reduce insect attacks pest.

Locations 4 and 5 were the locations most attacked by insect pests. This is presumably because coffee farmers pay less attention to the state of the coffee plant. Lack of attention to old coffee plants (aged 15 years and over) resulted in coffee plants being attacked by insect pests. According to [14]the age of the coffee plant can affect the level of coffee production, if the age of coffee increases or increases then coffee production will decrease. According to[22], coffee plants that have reached the age of 20 years, their production will decrease and become less productive.

*Spodoptera*sp. found at location 5 shows that planting other plants around coffee plants results in the discovery of insect pests that should not be insect pests of coffee. Spodoptera sp. The ones found were thought to have migrated from peanut and corn plants planted around coffee plants. Insects have the ability to adapt to their surroundings. According to[23], Spodoptera sp. attack by biting or sucking the liquid leaves or leaf buds of coffee plants. According to[24], insects are very easy to adapt to the surrounding environment, although insects like certain plants and if the plant is disturbed or absent, it can still live by eating other plants.

There are several factors that cause agricultural land to be attacked by insect pests ranging from environmental factors and factors from the plant itself. According to the[18] , the phenomenon of pest attacks due to several things such as: (1) pest biology, (2) climate or weather changes, (3) new pests or migratory pests, (4) ecological changes (availability of abundant food for pests), (5) absent or reduced role of factors biotic (predators, parasitoids, and pathogens, (6) unwise treatment of chemical insecticides which results in the killing of target pest resistance and natural enemies. Pest attacks can occur by one factor or a combination of two or more causative factors.

3.3 Insect Pest Phase when Found, Plant Part Attacked and Pest Type

The insect pest phase when found, the part of the coffee plant that was attacked and the type of pest on the coffee plant in Sigumpar Village, Humbang Hasundutan Regency, North Sumatra can be seen in Table 2 below:

Table 2 Phase of insect pests when found, parts of coffee plants attacked and types of pests on coffee plants in Sigumpar Village, Humbang Regency Hasdownloadan, Sumatera Utara.

No	Species	Insect Phase When Found	Plant Part Attacked	Information
1	*Aphis gossypii*	Larvae and Adults	Leaf	Secondary Pest
2	*Bemisia tabaci*	Mature	Leaf	Secondary Pest
3	*Coccus hesperidum*	Mature	Young Stem	Main Pest
4	*Coccus viridis*	Mature	Young Stem	Main Pest
5	*Criocula trifenestrata*	Larvae and Adults	Leaves (Larva)	Secondary Pest
6	*Drosophila*sp.	Larvae	Fruit (Larva)	Post Harvest Pests
7	*Hypothenemus hampei*	Larvae and Adults	Fruit	Main Pest
8	*Spodoptera*sp.	Mature	Leaves (Larva)	Migrant Pests
9	*Xylosandrus*	Mature	Twig	Main Pest
10	*Zeuzera*sp.	Larvae and Adults	Leaves (Larva)	Secondary Pest

Table 2 shows the dominant insect phase when found is the adult phase. Drosophila sp is a pest insect that is only found in the larval stage. The most dominant part of the coffee plant that

is attacked by insect pests is the leaves. The main insect pests on coffee plants found were 4 species, namely: *Coccus hesperdium, Coccus viridis, Hypothenemus hampeii and Xylosandrus compactus*. There were 4 species of secondary insect pests, namely: Aphis*gossypii*, *Bemisia tabacci, Cricula trifenestrata* and *Zeuzera* sp..*Spodoptera*sp. was the only insect found which was a migratory pest insect. *Drosophila* sp. found in coffee cherries that have been harvested, therefore *Drosophila* sp. called post-harvest pests.

The main pests are key pests which are pests that attack plants with heavy intensity, over a long period of time in a large area and can cause damage and loss so that efforts are needed to control them. Secondary pests are pests that do not attack vital parts of the plant. This pest attack is still able to be tolerated by plants. Migratory pests are pest species that have a mobile nature. These pests do not come from local plants but insects that move. This pest causes insignificant losses in a short period of time because this pest will move back[25].

Adult insects that are nocturnal (nocturnal) are active only to lay their eggs on coffee plants. This is shown in the sample of night observations where all the insects obtained are already in the adult phase (imago). During daytime observations, the insect samples obtained were in the larval and adult stages. The phase of the insect life cycle that tends to be harmful and damaging to agricultural and plantation crops is the larval phase. This insect pest attack is very detrimental to humans. According to the [18], the dominant phase or stadia that becomes a pest that is harmful to agricultural crops is the larval phase which usually attacks the leaves, fruit, twigs and stems of plants.

3.4 Density,Relative Density and Frequency of Presence of Insect Pests

Data on Density, Relative Density and Frequency of Presence of Insect Pests in Sigumpar Village, Humbang Hasundutan Regency, North Sumatra can be seen in Table.3 below:

Table 3 Density Data (eng/m2),Relative Density (%) and Frequency of Presence (%) of Insect Pests at Each Location in the Village

No	Species	Location 1			Location 2			Location 3			Location 4			Location 5		
		K (eng /m2)	KR %	FK %	K (eng /m2)	KR %	FK %	K (eng/ m2)	KR %	FK %	K (eng/ m2)	KR %	FK %	K (eng /m2)	KR %	FK %
1	*Aphis*	-	-	-	-	-	-	-	-	-	0.02	26	2	0.0	23	5
2	*Bemisia tabacci*	-	-	-	0.0 025	7. 14	5 0	0.00 5	10 .8 1	5 0	0.00 5	5. 97	5 0	0.0 062 5	5. 81	5 0
3	*Coccus hesperdium*	0.0 025	11 .1 1	2 5	0.0 025	7. 14	2 5	0.00 5	10 .8 1	2 5	0.00 375	4. 47	5 0	0.0 062 5	5. 81	5 0
4	*Coccus viridis*	0.0 05	22 .2 2	5 0	0.0 062 5	17 .8 5	5 0	0.00 875	18 .9 1	5 0	0.00 1	11 .9 4	5 0	0.0 05	4. 65	5 0
5	*Cricula trifenestrata*	-	-	-	-	-	-	0.00 25	5. 4	2 5	0.00 25	2. 98	5 0	0.0 05	4. 65	7 5
6	*Drosophi la*sp.	-	-	-	0.0 025	7. 14	2 5	0.00 25	5. 4	2 5	0.00 5	5. 97	5 0	0.0 05	4. 65	2 5
7	*Hypothen emus hampeii*	0.0 125	55 .5 5	7 5	0.0 187 5	53 .5 7	1 0 0	0.01 875	40 .5 4	1 0 0	0.02 75	32 .8 3	1 0 0	0.0 45	41 .8 6	1 0 0
8	*Spodopte ra*sp.	-	-	-	-	-	-	-	-	-	-	-	-	0.0 012 5	1. 16	2 5
9	*Xylosand rus compactus*	0.0 025	11 .1 1	2 5	0.0 025	7. 14	2 5	0.00 25	5. 4	5 0	0.00 5	5. 97	5 0	0.0 05	4. 65	5 0
10	*Zeuzera* sp.	-	-	-	-	-	-	0.00 125	2. 7	2 5	0.00 25	2. 98	5 0	0.0 037 5	3. 48	7 5
Total		0.0 225			0.0 35			0.0 462 5			0.0 837 5			0.1 075		

Description:

Location 1: 3 Years Old Coffee Plant
Location 2: 5 year old coffee plant
Location 3: 10 year old coffee plant
Location 4: 15 year old coffee plant
Location 5: 20 year old coffee plant

Values of Density (K) and Relative Density (KR) and Frequency of Presence (FK) of insect pests can be seen in Table 4.2 above. At each research location (location 1,2,3,4,and 5) has a density (K),The highest relative density (KR) and frequency of presence (FK) were *Hypothenemus hampeii*. This is because this species is able to attack coffee cherries on coffee plants that have fruit at all age levels and coffee is the main plant attacked by this species and the coffee plant environment supports the development of this insect pest. While the value of K,KR,and the lowest FK at locations 1 and 2 were *Xylosandrus compactus* and *Coccus hesperdium*. K . value, and the lowest KR at location 3 is *Zeuzera* sp.,but at location 4 the value

of K, and the lowest KR was in *Zeuzera* sp. and *Cricula trifenestrata*. K . value,The lowest KR and FK at location 5 were *Spodoptera* sp.

According to[26], female imago of PBKo (H. *hampeii*) can attack at all age levels of coffee cherries. The female beetle of this insect attacks coffee cherries from the time the fruit is forming (8 weeks after flowering) until harvest time. According to [27] coffee berry borer insects,*H. hampei*is a major pest of coffee plants that results in substantial yield losses.

The high frequency of presence of insect pests on coffee plants in Sigumpar Village is thought to be due to environmental abiotic factors that support life,insect growth and development. Environmental abiotic factors include temperature,humidity and light intensity. The temperature obtained during daytime observations in all locations which is between 24-26oC (Appendix 4). According to [28]most animals,including insects depend on air temperature for their body metabolism. Some experts classify insects as ectothermic animals, which means they get their body heat from their environment. Insects are classified as ectothermic animals because their body temperature is usually 10^{o}C to 20^{o}C.

At night the ambient temperature is 17-18oC (Appendix 4), Even though the environmental temperature is quite low, insects are still able to carry out their activities according to the opinion of [29] animals in the terrestrial environment live in the temperature range between 0 - 40^{o}C. The body temperature of insects has a very large influence on their physiological functions. Most insects that survive below 0^{o}C is in the inactive state. For insects that are in a state of rest, His body temperature is in the range of the temperature of his environment and his metabolic rate increases as the temperature of his environment increases.

In most areas, Tropical climatic conditions are suitable for the development and reproduction of insects. Temperature also has an important influence on the life and development of insects [30].Air temperature has a very big influence on the life of organisms that live on land because air temperature is a limiting factor for the life of organisms and the temperature range suitable for organisms also varies depending on the type of organism.

The humidity at the study site ranged from 96-97% during the day and 98-99% at night. Air humidity affects insects in carrying out their activities because the insect's body is composed of water. According to [31], air humidity plays a very large role in the moisture content of the insect body so that it regulates the activity of organisms and the spread of insects.

According to [32], the water content in the insect's body varies,generally ranged from 50-90%. Insects try to balance the water content in their bodies to survive. Humidity also affects the ability to lay eggs and insect growth. Air humidity affects the biological process of insects,where the optimum air humidity range is generally 73-100%. Humidity that is too high or too low can inhibit insect activity and life,except for insects that live in wet places. The optimum humidity of insects differs according to the type and stage (stage of life) in each development.

The intensity of light also plays a role in the life of insects because insects carry out their activities at sufficient light intensity. According to [28], insects obtain their internal body temperature by direct activity during the day with a fairly high light intensity.

The high relative density values obtained for the Hypothenemus hampeii species at all observation locations indicate that this insect pest prefers coffee plants compared to species from other families. According to [33],if the Relative Density (KR) value is greater than or equal to 15% (≥15),and Frequency of Attendance is greater than or equal to 25% (≥25%),then the area is very good and supports the life and breeding of these animals.

3.4 Diversity Index (Shannon-Weiner) and Insect Equitability Index Pest

Value of Diversity Index and Insect Pest Equitability Index on Coffee plants can be seen in Table 4 below.

Table 4 Diversity Index Value (H'),Equitability Index (E) at Each Location Penresearchers in Sigumpar Village

	Location 1	Location 2	Location 3	Location 4	Location 5
H	1,178	1,452	1,746	1,763	1,841
E'	0,849	0,81	0,841	0,802	0,799

Description:
Location 1: 3 Years Old Coffee Plant
Location 2: 5 year old coffee plant
Location 3: 10 year old coffee plant
Location 4: 15 year old coffee plant
Location 5: 20 year old coffee plant

The Diversity Index values at the five locations ranged from 1,178-1,841 belonging to the low diversity value. The highest diversity index at location 5 is 1,841 of which there are 10 species,and the lowest was at location 1 with a value of 1,178 as many as 4 species. According to[33], the Diversity Index value smaller than 2 is low,Furthermore, it is explained that the Diversity Index value will give a low value for a small number of species and a high value for a large number of species.

The Equitability Index at the five locations showed that the distribution of insect pests was evenly distributed because they were at a value of 0-1. This index value indicates that the uniformity of insect pests in the village community plantation area Sigumpar quite evenly. This shows that the habitat and environmental conditions in this smallholder plantation area support the existence and life of these insect pests. According to [34] uniformity values ranged from 0-1. The uniformity value of 1 indicates the distribution of the number of individuals in each species is very uniform or even. Conversely, if the value of uniformity is getting smaller, the uniformity of a population will also be small.

The small diversity of insect pests can be caused by farmers' protection of coffee plants. Farmers protect coffee plants in several ways, including:

a. Breaking vegetative branches (twigs that grow from the main stem and grow vertically but do not produce flowers or fruit).

b. Place the liquid attractant around the coffee canopy.

c. Clean the soil around the coffee from weeds.

d. Kill or dispose of any insect pests that are found. This action is also included in various efforts and activities to eradicate pest attacks.

According to [35], plant pests are very detrimental to humans, so various ways have been done by humans to eradicate them. These efforts are aimed at eradicating plant pests by using: a. mechanical means (checking and supervising plants); b. improve and regulate soil and plant cultivation; c. by biological and chemical means.

According to [10], insects cause losses due to eating activities and other activities of insects such as hoisting and laying insect eggs that can damage plants. Many insects eat the plants that are planted. Most types of plants, including all types of plant products that are growing are attacked and damaged by insects.

3.5 Insect Pest Similarity Index

The value of the Similarity Index (IS) at each location can be seen in Table 4 below.

Table 5 Data of Similarity Index (IS) at each research location in Sigumpar Village

IS	Location 1	Location 2	Location 3	Location 4	Location 5
Location 1	-	80%	72.72%	61.53%	57.14%
Location 2	-	-	85.71%	80%	75%
Location 3	-	-	-	94.11	88.88%
Location 4	-	-	-	-	94.73%
Location 5	-	-	--	-	-

Description:

Location 1: Location of 3 Years Old Coffee Plant

Location 2: Location of a 5-year-old Coffee Plant

Location 3: Location of a 10-year-old Coffee Plant

Location 4: Location of a 15-year-old Coffee Plant

Location 5: Location of a 20-year-old coffee plant

The highest similarity index is at locations 4 and 5 with a value of 94,73% categorized as similar,but not much different from locations 3 and 4 with a value of 94,11%. one of the factors that affect the similarity of species at location 3,4 and 5 is the age of coffee plants that are getting old, especially location 5 is a coffee plant that is 20 years old. The lowest Similarity Index value is at location 1 and 5 with a value of 57,14%,This is due to the large age difference where the location of 1 coffee plant is 3 years old and the location of 5 coffee plants is 20 years old. This low value is also influenced by the activities of farmers who protect young plants more than old plants.

According to [34], the smaller the similarity index, the less similar the species is between the two locations,and is strongly influenced by the conditions of environmental factors found in the area.

4. Conclusion

From the results of research on the diversity of insect pests on coffee plants in Sigumpar Village, Humbang Hasundutan Regency, it can be concluded as follows:

a. Found 10 types of insect pests consisting of 4 orders,8 Families and 225 individuals. During the day found 9 types of insects with 4 orders, 7 families, and 198 individuals and at night found 4 types of insects with 2 orders, 3 families and 31 individuals.

b. During the day, location 1 (coffee plant age 3 years) found 4 species with 16 individuals. Location 2 (aged 5 years) found 5 species with 25 individuals. Location 3 (age 10 years) found 8 species with 32 individuals. Locations 4 and 5 (aged 15 and 20 years) found 9 species with 59 and 63 individuals, respectively. At night, locations 1 and 2 found 1 species with 2 and 3 individuals each. Locations 3, 4 and 5 found 3 species with 5, 8 and 13 individuals respectively. Locations 4 and 5 are locations with the highest number of insect pests both during day and night observations.

c. The highest values of Density (K), Relative Density (KR) and Frequency of Presence (FK) were at location 5 followed by location 4, while the lowest values were at location 1. Hypothenemus hampeii was the species with the highest K, KR and FK values of all species. obtained in all location with each value of 0.045 ind/m2, 41.86% and 100%.

d. d.The highest Diversity Index (H') value was found at location 5 (1.841) followed by location 4 (1.763) and the lowest value at location 1 (1.178). The highest Equitability (E) value was found at location 1 (0.849), followed by location 3 (0.841) and the lowest value was at location 5 (0.799).

e. The highest Similarity Index (IS) is found at locations 4 and 5 with a value of 94.73% and the lowest at locations 1 and 5 with a value of 57.14%.

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