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Diversity of Soil Arthropods in Three Elevations of Coffee Plantations, Tebat Pulau Village, Bermani Ulu, Rejang Lebong District

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ABSTRACT: Coffee is a leading commodity in Bengkulu Province, whose production still needs to be improved. One of the supporting factors for coffee fruit production is the existence of a good soil arthropod ecosystem. Information regarding the diversity of soil arthropods can be considered in evaluating coffee plants' health. This research aims to obtain initial data on the diversity of soil arthropods and their role in central coffee plantations in Tebat Pulau Village, Bermani Ulu District, Rejang Lebong Regency. This research began with taking soil samples from productive coffee plantations. The type of coffee plant sampled was robusta coffee at an altitude of 900, 1000, and 1100 meters above sea level. Next, the soil taken is placed in the bottom funnel. Arthropods obtained from the Berlesse funnel were identified and counted. The results of counting arthropods are used to calculate diversity, dominance, and evenness index numbers. The results show moderate variability in the three types of elevation: low dominance, high evenness. Research also shows that the highest number of arthropods is found at an altitude of 900 m, and the most common type is acarina.

Keyword : arthropods, ecology, coffee plantation, soil

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INTRODUCTION

Bengkulu is a province located on Sumatra Island with an extensive agricultural sector. Apart from economic benefits, coffee plantations are a source of germplasm for soil fauna habitat. Soil fauna, including soil arthropods, play an important role in coffee plantation ecosystems. As organisms that live in the soil, these animals help maintain the health of the soil and plants, as well as improve soil structure and the availability of nutrients for coffee plants. Also, soil fauna helps improve coffee plants' soil structure and nutrient availability.

Arthropoda is the largest phylum of the animal kingdom. The number of species in arthropods is greater than that of all species of other phyla. Arthropods are the dominant animals in this world. Arthropods are the largest phylum, so they are found everywhere in forests, lowlands, and highlands. One class of anthrophoda that is often encountered is insects (insects).

Arthropods can live in freshwater, land, and sea. Kinasih et al. (2017) state that arthropods are one of the fauna that lives on land.

Several types of soil fauna, such as earthworms, forest cockroaches, and decomposing insects, help decompose organic material and convert it into organic material that plants more easily digest. This process increases the availability of nutrients for coffee plants and improves soil structure to increase water storage capacity and water infiltration in the soil.

Soil fauna can also help increase coffee beans' productivity and quality. Several types of soil fauna, such as wood borers and termites, help break down organic matter buried in the soil and accessible the nutrients therein. In addition, several types of soil fauna, such as earthworms and decomposing insects, can increase the number of microorganisms in the soil that help decompose organic matter.

Soil arthropods on coffee plants have various important roles in maintaining plant health and productivity, including as predators and decomposers. Dindal stated that arthropods are important fauna in the ecosystem. Several types of soil arthropods, such as ground beetles (*Carabidae*) and ground spiders (*Gnaphosidae*), are natural predators that can eat pests on coffee plants, such as armyworms (*Helicoverpa armigera*) and leaf cutters (*Xylotrechus chinensis*). In addition, several types of soil arthropods, such as earthworms (*Lumbricidae*) and decomposer insects (*Isoptera*), are natural decomposers that help decompose plant remains and improve soil structure. Decomposition in ecosystems will be slow if soil arthropods are not present in the ecosystem to fill niches (Gesriantuti et al., 2016)

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Exploring the diversity and abundance of arthropods is needed as a first step in implementing control techniques by utilizing existing natural enemies. Monitoring agroecosystem components, especially arthropods, needs to be equipped with information on the number of individuals, their role in an ecosystem, and various factors that influence them.

RESEARCH METHODS

Research Location

This research was conducted on a coffee plantation in Tebat Pulau Village, Bermani Ulu District, Rejang Lebong Regency. The coffee plantations used as samples are coffee plantations that are already producing. The type of coffee sampled was robusta at an altitude of 900,

1000, and 1100 meters above sea level. Each elevation has three repetitions.

Fig 1 Soil ring used for soil sampling

Research Data Source

The data source for this research uses primary data. Primary data is research data obtained from direct data collection. Data was obtained by randomly taking land in the coffee plantation area. A sampling ring was used in this study to equalize the weight and amount of soil taken. Ten soil samples were taken from each area, and then the soil samples were placed in a bottomless funnel for one month with a light period of 12 hours in light and 12 hours in darkness. The holding bottle, the bottom of the funnel, is filled with 70% alcohol to preserve the arthropods. Next, the samples were identified based on morphology with the identification key of Borror et al. (1996). They counted the numbers and recorded them based on genus, family, and ordo, and it calculated and then matched based on the diversity, dominance, and evenness index.

Fig. 2. Berlesse funnel

Data Analysis

The analysis of the data on the quantity and types of arthropods obtained is determined by the diversity index using the Shannon-Wiener Index (1963):

$$H' = - \Sigma (pi) (\log pi)$$

Explanation:
H′ = species diversity index
Pi = proportion of the total number of samples of species-i

Table 1. Value of diversity index

Value index H	Category
H<1	Low diversity
1<H<3	Moderate diversity
>3	High diversity

Next, calculations of the dominance index (Odum 1966) are made using the following method:

$$C=\Sigma (Pi)^2$$

Explanation :
C=domination index
Pi=ni/N
Ni= The number of individuals-n
N= Total number of arthropod individuals

Table 2. Value of the dominance index

Index value C	Category
0-0,50	Low domination
0,5-0,75	Moderate domination
>3	High domination

We calculate the evenness index with the following:

$$E = H' / \ln S$$

Explanation
H'= diversity value
S= total types

Tabel 3. Evenness indeks values

Evennes index	Category
0 < E < 0.4	Low evenness
0.4 < E < 0.6	Moderate evenness
0.6 < E < 1.0	High evenness

RESULT AND DISCUSSION

Arthropods, as one component of biodiversity, have an important role in the food web, namely as herbivores, predators, parasitoids, and detritivores. Herbivorous arthropods eat plants, and some act as pests because they are economically detrimental.

The number of arthropod types obtained in the research was nine ordos, with a total number of individuals being 27 at an altitude of 900 meters above sea level, 45 at an altitude of 1000 meters above sea level, and 29 at an altitude of 1100 meters above sea level (Table 4). The research results show that the highest number of individuals were arthropods obtained from a height of 1000 meters above sea level. It shows that the most suitable conditions for the survival of arthropods in the coffee plants of Tebat Pulau village are at an altitude of 1000 meters above sea level. Changes in vegetation and supporting factors influence the existence of many types of arthropods or their populations in an ecosystem (Fauzi et al., 2023).

Table 4. Arthropods obtained from Berlese funnel at three elevations

Ordo	Family	Genus	ELEVATE (MDPL)		
			900	1000	1100
Acarina	Phytoseiidae	-	10	14	11
Coleoptera	Tenebrionidae	Tenebrio	10	5	14
Hymenoptera	Formicidae	Oecophylla	5	10	1
Arachnida	arachnidae	-	1	0	0
Isoptera	Termitidae	-	1	0	1
Dermaptera	-	-	0	6	0
Scolopendromorpha	Geophilidae	-	0	4	0
Coleoptera	Carabidae	-	0	1	0
Orthoptera	Gryllotalpidae	-	0	2	0
Coleoptera	Chrysomelidae	-	0	3	0
Colembolla	-	-	0	0	2
Total			27	45	29

The arthropods obtained include Coleoptera, Collembola, Orthoptera, and Acarina, which act as detritivores or phytophages. Other orders found are Scolopendra, Dermaptera, and Arachnid, which act as predators. With the presence of predators and their prey (phytophages and detritivores), it can be assumed that the environmental conditions of the people's robusta coffee plantations in Tebat Pulau village can support the life of the soil arthropods obtained in this research.

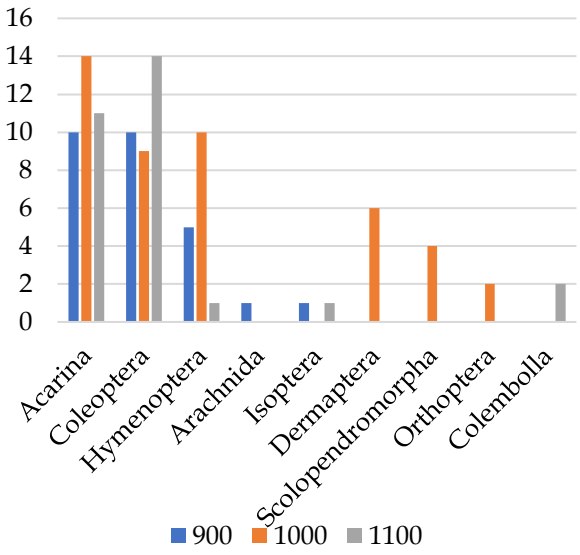

Fig. 3. The types of soil arthropods obtained based on elevation

The most common type found in this research was Acarina at all three types of elevation. Furthermore, the most common type is Coleoptera, followed by Hymenoptera (Figure 3). At the three elevations, 1000 meters above sea level has more arthropods than the other two. This condition is because the biotic and abiotic ecosystem factors that best support the life of soil arthropods in Tebat Pulau village are at an altitude of 1000 meters above sea level.

Table 5. Index value

Indeks value	Elevation (meters)		
	900	1000	1100
Diversity	1,292	1,829	1,136
Domination	0,311	0,191	0,384
Equitability	0,803	0,880	0,706

Species diversity is a community-level characteristic based on the biological organization found in an ecosystem (Soegianto, 1994). The research results for the index values in Table 5 show that the diversity index values at the three elevations (900, 1000, and 1100 masl) are in the medium diversity position. This condition can be seen based on the Shannon-Wiener diversity index (1963), which states that diversity in a population between 1 and 3 can be categorized as moderate diversity. These results show that the types of soil arthropods found at the three elevations on Tebat Island are quite diverse and live in an adequate and balanced ecosystem. Ecosystems with various resources will have higher diversity than ecosystems with low natural resources (Lawton et al., 1998). The higher the number of arthropod families, the higher their abundance (Evangelia, 2016)

The dominance index values in this study indicate no dominance or very low dominance in the soil arthropod population found at the three elevations. Sirait, in 2008, stated that if the diversity index is high, the dominance index value will be lower and vice versa. Low species dominance indicates that the number of individuals of each species is relatively the same and spread evenly so that no particular species dominate other species or certain plain areas (Dina, 2017). The dominant species is abundant because it has many individuals, biomass, and important value to dominate the community (Oka, 1995).

The evenness index value shows that the soil arthropods that live on the three elevations in Tebat Pulau village are in a condition of high evenness. This condition can be seen from the evenness index; an index value above 0.6 indicates that the arthropod population is in a state of high evenness. Low dominance and high evenness in distribution indicate the ability of each species to maintain its population and species diversity (Oka, 1995).

CONCLUSION

The number of types of soil arthropods obtained was nine orders. The largest number of orders is the acarina type. Calculation of diversity index values shows that the population of soil arthropods at all three elevations is in a medium position; there is no dominance at all three elevations; and at the three elevations of the sampling location, the arthropod population was in a condition of high evenness.

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