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Bioscience Research

Print ISSN: 1811-9506 Online ISSN: 2218-3973

Journal by Innovative Scientific Information & Services Network

RESEARCH ARTICLE BIOSCIENCE RESEARCH, 2020 17(1): 451-458. **OPEN ACCESS**

Population of diversity index and soil mesofauna domination index and correlation with environmental factors in vegetation of plantation crops

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The existence of soil fauna can be used as a parameter of soil quality, soil fauna which is used as an indicator of soil fertility certainly has a relatively abundant amount. One type of soil fauna is the soil mesofauna. The existence of soil mesofauna groups in a habitat is very dependent on the environmental conditions. Field research was carried out in the Lampung State Polytechnic garden under stands of cacao, rubber, coconut, oil palm, coffee and on grass vegetation. Laboratory research was conducted at the Laboratory of Chemical Analysis and the Lampung State Polytechnic Food Laboratory. The study was conducted in September-October 2017The study aimed to obtain, population, diversity index, and dominance index of soil mesofauna in various vegetation plantations, and obtain a correlation between population, diversity index, dominance index of soil mesofauna found with environmental factors. The results of the study showed that soil mesofauna on various fields with plantation vegetation were found in 5 groups of soil mesofauna (Acarina, Araneae, Collembola, Hymenoptera, Symphyla) and the rest were not included in the 5 orders. Acarina is the most common order. The highest mesofauna population was found under the vegetation of rubber plants as many as 95 head dm-3, while the lowest mesofauna was found in vegetation which was 27 dm-3. Mesofauna diversity index in each treatment was included in the low category with H values ranging from 0.42 to 1.05. The population of soil mesofauna correlated positively with all environmental factors (organic C, pH, and water content) or showed a direct relationship. Diversity index, and dominance index of soil mesofauna negatively correlated with all environmental factors (organic C, pH, and water content) or showed opposite directions.

Keywords: plantation, soil, mesofauna, and environment

INTRODUCTION

Land is a medium where plants grow and habitat for various soil organisms that live in it. According to the Bio Intelligence Service (2010), organisms that inhabit large amounts of soil ecosystems are estimated to reach one quarter of the number of organisms that exist on earth. Soil fauna is one of the determinants of ecosystem sustainability. According to Breure (2004), soil microorganisms are responsible for most biological processes (60-80%) related to organic material decomposition and nutrient cycling, so the presence of soil fauna can be used as a parameter of soil quality. (Ibrahim, 2014).

Plants are a bridge between the ecosystems in the soil and the ecosystem above it. According to (Hooper et al. 2001), changes in food quality and quantity caused by changes in plant diversity will change the amount, activity and diversity of soil fauna. These include the processes of soil formation, soil structure, and soil biota communities (Heemsbergen et al., 2004). The interaction between plant diversity and underground communities has yet to be conducted intensive

research. Carney and Matson (2005), states that there is a strong interaction between plant diversity and the diversity of soil organisms found, allegedly plants become mediators of changes in the community of organisms in the soil.

From a number of fauna that play a role in the process of littering, there is one group of fauna classified as soil mesofauna. Soil mesophuna is a soil fauna with a body size of 0.16 - 10.4 mm. Mesofauna acts as the initial remover of litter / organic material into small sized fragments that are ready to be overhauled by other soil microbes. In its metabolism, mesofauna emit faeces that contain various nutrients in a form available to plants and other life that is in the soil.

MATERIALS AND METHODS

The study was conducted in September to October 2017, during the transition period between the rainy season before the dry season. Field research was carried out in the Lampung State Polytechnic's garden. Soil sampling will be divided into several treatments according to the existing vegetation of plantation crops. The laboratory research was conducted at the Chemical Analysis Laboratory and the Lampung State Polytechnic Food Laboratory. The tools used in this research activity are ground drill, sample ring, zeiss microscope, Berlese (Tullgreen), baker's glass, petri dish, tweezers, 25 watt light bulb, 2 mm hollow sieve, analytical balance, burette, stative, erlenmeyer , jars, and window film. The materials used in this research activity are soil samples, distilled water, $K_2Cr_2O_7$, H_2SO_4, diphenylamine indicators, ammonium ferro sulfate, and ethanol

Data Analysis

This research was arranged in a Randomized Block Design (RBD) consisting of six treatments with three replication, so that in this study there were 18 experimental units with codes for each treatment as follows:

V1 : Vegetation of coconut plants
V2 : Vegetation of palm oil
V3 : Vegetation of cacaoa
V4 : Vegetation of coffee
V5 : Vegetation of rubber plants
V6 : Vegetaton of weed

The homogeneity data were analyzed using the barlett test. For population, diversity index, dominance index, analysis of variance (ANOVA) is carried out. If F is calculated there is a significant difference, then it is continued with the average price test using the Least Significant Difference (LSD) method at the 5% test level. To test the correlation between population, diversity, diversity index, dominance index of soil mesofauna found with environmental factors (C-organic, soil pH, and water content,) correlation analysis was performed.

RESULTS AND DISCUSSION

Population of soil mesofauna

The results of analysis of variance (Anova) population of soil mesofauna on various plantations of plantations (cocoa, rubber, coconut, oil palm, coffee, and grass vegetation) showed results that were not significantly different.

Figure 1 shows the population of soil mesofauna under rubber vegetation tends to be higher compared to the population of soil mesofauna in other plantation plants which is 95 dm^{-3}. The lowest soil mesofauna population is found in open land with grass vegetation that is equal to 27 dm^{-3}. This is presumably because on land with rubber vegetation, maintenance is no longer carried out which causes litter conditions under the rubber canopy more, and soil moisture is better maintained, so that the C-organic content and soil moisture under the rubber plant canopy are higher than in other vegetation. Foth (1994), said that soil mesofauna require organic material which is a source of energy as well as a shelter.

The low soil mesofauna found in other plantations vegetation is thought to be due to intensive maintenance of vegetation of cocoa, coffee, coconut and palm oil plants including weeding, fertilizing, and sanitation causing more plant litter to be found outside the plant disc. This causes the soil moisture and organic matter content in the disk area to be low. Gunadi et al. (1993, in Suhardjono et al. 2000), reported a very clear difference in the floor of the merkusii pine forest which was littered completely and left unchecked. In the cleared area the number of residences is 61% from 91%, while the number of families is only 50% of 80%.

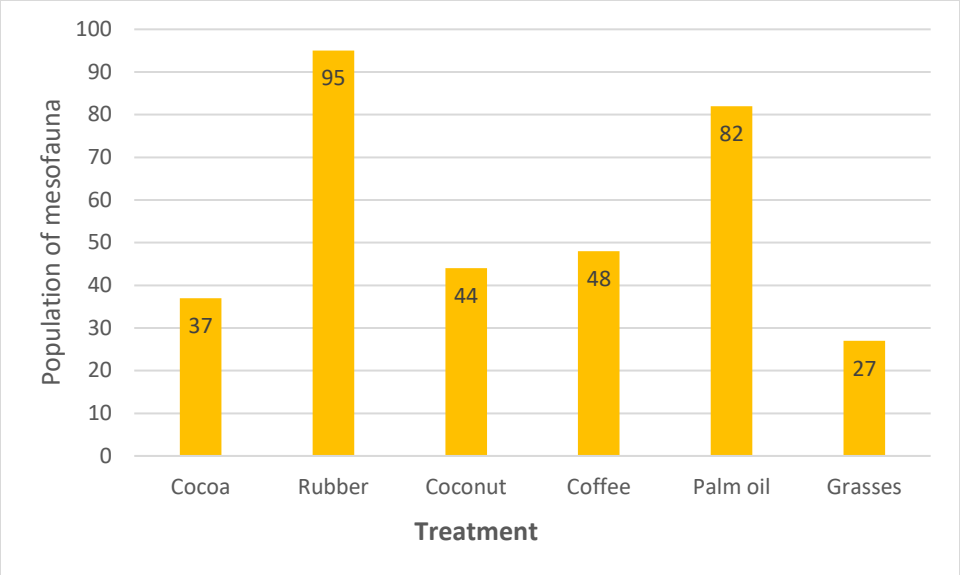

Figure 1: Population of soil mesofauna in various fields with plantations vegetation.

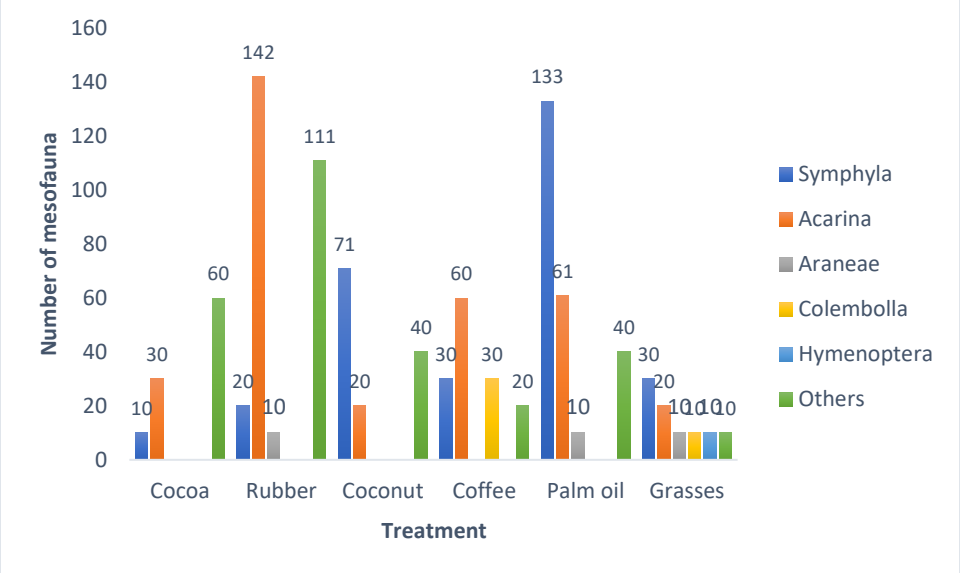

Figure 2: Number of soil mesofauna on various lands with plantation vegetation.

The number of soil mesofauna is based on the ordo

The results of observing the diversity of soil mesofauna on various lands with plantations of plantations, obtained 5 groups of soil mesofauna namely, the ordo *Acarina, Araneae, Collembola, Hymenoptera, Symphyla*, and the rest are not included from the 5 orders (Figure 2).

Figure 3 shows the various mesofauna orders found under the vegetation of plantation crops. The Acarina Order is the most consistent order found in all treatments compared to other orders. This is presumably because *Acarina* has a wide distribution of the environment. Wall & Shearer (2001), said that Acarina is distributed all over the world including terrestrial and water ecosystems.

The *Hymenoptera* (ant) order is the least found compared to other orders. The Hymenoptera Order is only found in grass vegetation, with a relatively small amount of only 10 dm-3. This is thought to be due to the influence of the type of plant organic matter on the habitat of Hymenoptera.In line with the opinion of Andersen et al. (2009), that Hymenoptera has a certain location in choosing where to live and find food.

Diversity index soil mesofauna

The level of diversity of mesofauna in various plantations of plantations belongs to the low category, because the Diversity Index value <1.5. This is presumably due to the ecological environment of the plantation where the samples were taken in the conditions that began to be disturbed. Foth (1998), said that the level of diversity of mesofauna is determined by the availability of energy and environmental ecological capacity. Ricardo (2015), added that the category of low mesofauna diversity in disturbed land is on intensively used agricultural land compared to forest land and newly opened agricultural land.

vegetation with H' values of 1.05 and 1.01 while the average index of soil mesofauna diversity (H ') tends to be lower in grass vegetation that is equal to 0.42. This is thought to be related to the condition of plant roots. The roots of coffee and oil palm plants are commonly found in tillage areas. This is consistent with the results of research by Nazari and Sota (2012), who said that the distribution of tertiary roots and palm oil quarters is dominant in the horizontal direction between 2.5 m - 4.0 m from plant stems with a maximum depth of 0.3 m as well as coffee plant roots. Najiyati and Danarti (2012), said that coffee roots are relatively shallow, more than 90% of the root weight of coffee plants are found in the 0-30 cm processing layer. Zhangfeng et al. (2007), said that plants exert an influence on soil organisms through carbon supply provided by root exudates. The existence of the supply of the substrate causes the diversity of soil fauna in the rhizosphere much higher compared to the soil environment far from the roots of plants

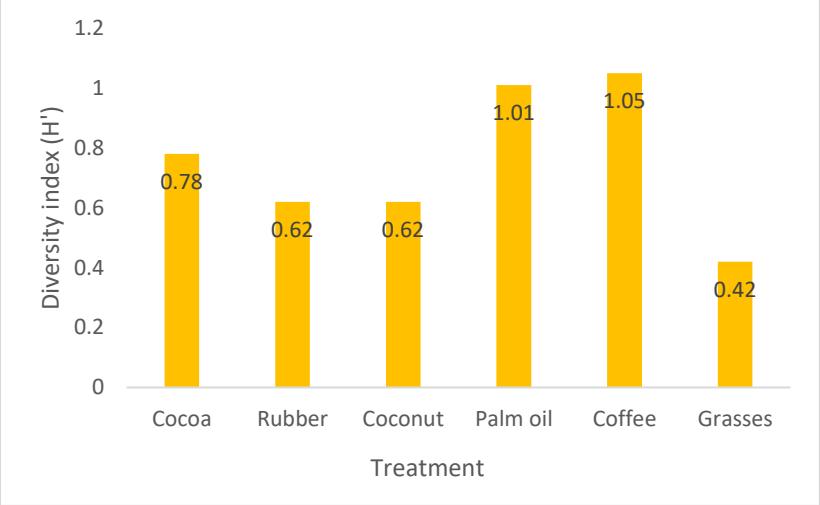

Figure 3. The average index of diversity of soil mesofauna in various lands with plant vegetation.

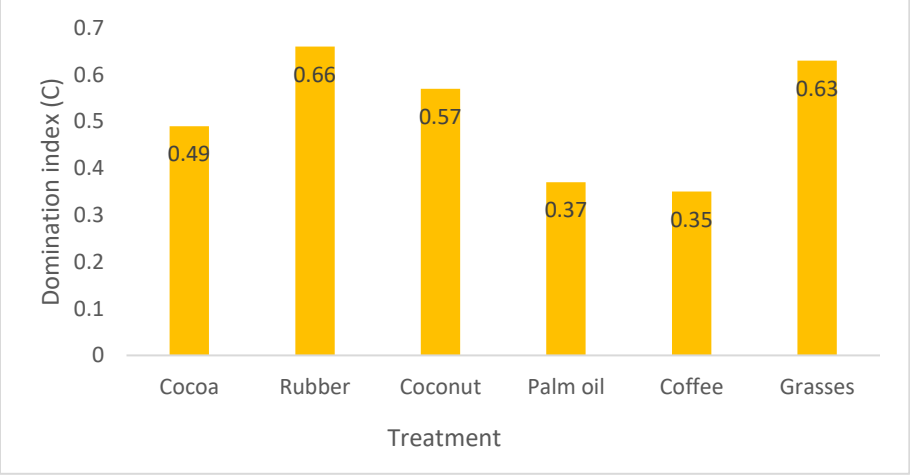

Figure 4. Average index of dominance of soil mesofauna in various lands with crop of plantations.

Index of soil mesofauna domination

The results of the analysis of variance (Anova)

revealed that various crop of plantations on the dominance index (C) of soil mesofauna showed results that were not significantly different. The average index of dominance of soil mesofauna in various lands with plantations of plantations is shown in Figure 4

A low dominance index value indicates that the land is dominated by little or one type of soil mesofauna. This is in accordance with the statement of Krebs (1989), the value of C which is getting closer to 0, the lower the dominance index or dominated by little or one type of soil mesofauna. C value is getting closer to 1, the greater the dominance index or tends to be dominated by several soil mesofauna.

The graph above shows the average dominance index of soil mesofauna (C) tends to be higher under the rubber plant vegetation that is equal to 0.66, while the average dominance index of soil mesofauna (C) tends to be lower below the coffee plant vegetation which is equal to 0.35. This is thought to be related to the preferred level of soil mesofauna to the plant's organic material because organic material is used as a source of energy (food) and is a shelter for soil mesofauna, is one important factor in determining the number and type of soil mesofauna (Borror et al, 1992) . Mesofauna is also very sensitive to changes in vegetation and the environment. The number and type of mesofauna are directly proportional to the environment that supports to grow and multiply (Sugiyarto et al. 2001).

Effect of Various Types of Vegetation on Environmental Plantations (C-organic, pH, and moisture content)

Supporting variable analysis (C-organic, pH, and water content) was conducted to determine the effect of environmental factors on population, diversity index (H ') and dominance index (C) of soil mesofauna on various lands with crops of plantations. A summary of the results of the analysis of some soil chemical properties (C-organic, pH, and water content) on various lands with crops of plantations is presented in table 1.

Table 1: Summary of observations of some soil chemical properties (C-organic, pH, and water content) on various vegetation plantations

Suporting	Treatment
Variabel	**Various of plantation vegetation**
C-organic (%)	$0,76^{ns}$
pH	$2,41^{ns}$
Water level (%)	$3,87^{*}$

Information: ns = not signifcant, * = significant

Results of analysis of variance (Anova) C-organic content (%) and soil pH on various crops of plantations showed no significant difference, while the results of analysis of variance (Anova) on water content (%) showed significantly different results. Vegetation plays a role in increasing the content of organic matter, the amount and thickness of litter, soil biota and the formation of other soil properties (Asdak, 2002).

Correlation of mesofauna population, diversity index and dominance index of soil mesofauna to some soil chemical properties (C-organic, pH, and water content).

Table 2. Summary of the correlation analysis results of some soil chemical properties (C-organic, pH, and water content) on the population, diversity index and dominance index of soil mesofauna

Variabel	R Value		
	Mesofauna Population	**Index of mesofauna diversity**	**Index of dominatios**
C-Organic	0,0032 ns	-0,0006 ns	-0,0006 ns
Soil pH	0,5917 ns	-0,1147 ns	-0,1153 ns
Water level	0,2585 ns	-0,0501 ns	-0,0503 ns

Information: ns = not significant, * = significant

Table 2 shows that the relationship between mesofauna populations and soil C-organic content has a positive relationship or shows a direct relationship with the coefficient of determination of 0.0032. This means that the higher the C-organic content of the soil, the population of soil mesofauna will increase. This is in accordance with the statement of Soepardi (1983), if the amount of organic matter in the soil is high then the population of soil fauna will increase. According to Atmojo (2003), organic matter is a source of energy for various soil fauna. For soil fauna, the availability of

food will support life and cause its breeding to be fast so that the fauna population will be abundant.

The relationship between the population of soil mesofauna with groundwater content is positive linear with a coefficient of determination of 0.2585 this shows a direct and weak relationship. This is in line with the results of research by Nurhadi & Widiana (2009), which revealed that moisture or soil water content determines the presence of land surface animals.

The relationship between mesofauna population and soil pH is positive linear with a coefficient of determination of 0.5917, this shows a direct and quite strong relationship. The positive value indicates that an increase in soil pH will be followed by an increase in the population of soil mesofauna and vice versa with a tolerance limit of pH 6-8. According to Hanifah et al.(2005), soil acidity greatly influences the population and activity of soil fauna so that it becomes a determining factor as well as limiting the spread and also its population.

The relationship between the diversity index of mesofauna with all abiotic factors shows a negative or opposite direction relationship. The relationship between the diversity index of mesofauna with the soil C-organic content is negative or shows an inverse relationship, with a coefficient of determination of -0,0006 or shows a very weak relationship. This is thought to be related to the low diversity of organic matter, because the use of plantation land with a monoculture system causes organic material to come from only one type of litter. According to Sugiyarto *et al*., (2007), the diversity of soil fauna is influenced by the variety of food available in their habitat.

The relationship between the diversity index of soil mesofauna with soil water content is linearly negative with a coefficient of determination of -0.0501, this shows the relationship of the opposite direction and weak. An increase in groundwater content will reduce the diversity index of mesofauna in the soil but within certain tolerance levels of water content. Most soil mesofauna like moist soil conditions but not wet. (Schoeder, 1984 in Notohadiprawiro 1998).

The relationship between mesofauna diversity index and soil pH is negative linear with a coefficient of determination of -0.1147, this shows the opposite relationship (Abdulkadir, 1980 in Sastrodiharjo, 1987), states that litter, temperature, pH, and soil moisture will cause different soil arthropod compositions.

The relationship between the mesofauna dominance index with all abiotic factors is also linearly negative or in the opposite direction. The relationship between the dominance index of mesofauna soil and the C-organic content of the soil is negative linear or shows the opposite direction, with a coefficient of determination of -0,0006 or shows a very weak relationship. This is presumably because the presence of mesofauna is more determined by the variety of organic materials available in their habitat. Sugiyarto et al.(2007), said that the diversity of soil fauna is influenced by the variety of food available in their habitat.

Correlation between the dominance index of mesophuna and soil moisture content is linearly negative with a coefficient of determination of -0.0503, this shows an inverse and weak relationship. This is thought to be caused by environmental conditions at the time of soil sampling is the end of the rainy season, so that the ground water content is still relatively high, if the soil water content is too high in general, it will disturb the life of the soil fauna in it. Sugiyarto (2000), said that an increase in groundwater content can reduce air content in the soil, so that various types of soil fauna that take oxygen directly from the air will not be able to adapt to high water content. Conversely, soil fauna that can take oxygen from water can adapt to the environment.

The relationship between mesofauna dominance index and negative soil pH is negative with a coefficient of determination of -0.1147, this indicates an inverse and weak relationship. In general, fauna in the soil is not resistant to soil conditions that are too acidic. Soil fauna has an optimum pH range for development and growth between 6.0-7.2. (Lee, 1959 in Sudharto and Suwardjo, 1987). So that on acid soils, mesofauna species are derived from mesofauna which are tolerant to acidic pH. Wallwork (1970), said that areas with soil pH are acidic so the number of prominent soil fauna is mesofauna from the Acarina group.

CONCLUSION

The conclusions of the study showed that soil mesofauna on various fields with plantation vegetation were found in 5 groups of soil mesofauna (Acarina, Araneae, Collembola, Hymenoptera, Symphyla) and the rest were not included in the 5 orders. Acarina is the most common order. The highest mesofauna population was found under the vegetation of rubber plants as many as 95 head dm-3, while the lowest mesofauna was found in vegetation which was 27 dm-3. mesofauna diversity index in each treatment was included in the low category with H values

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CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

ACKNOWLEGEMENT

The research has been successfully done with the help others, so the author thanks to Ir. Made Same, M.P and Ir. Wiwik Indrawati, M.P., for their contribution in this research

AUTHOR CONTRIBUTIONS

Ir. Any Kusumastuti, M.P., is the lead author who conducts research in field and laboratorium. Dian Ayu Afifah, S.Si., M.Sc. and Dimas Prakoswo Widiyani, S.P., M.P. is Second author who help first author in field and analyting of data.

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