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Population and Diversity of Soil and Leaf Litter Mesofauna in Arable Soils at The Agriculture Experimental Field of University of Lampung

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ABSTRACT

The research was conducted to study the population and diversity of soil and leaf litter mesofauna in arable soils under different types of vegetation and slope at the Agriculture Experimental Field (AEF) of University of Lampung. The study was designed to use a survey method. The soil and leaf litter samples were taken from different vegetation types and slope classes. Observational variables included population and diversity index of soil mesofauna (H'), soil temperature, soil moisture content, soil pH, soil organic-C, soil total-N, and soil C/N ratio were measured. The data of population distribution were presented in a boxplot diagram and the correlation between soil properties and mesofauna population or mesofauna diversity index were presented. The results showed that the most abundant soil mesofauna was observed in the plot with sugarcane vegetation, either sampled at the end of dry season (November 2015) or at the end of rainy season (April 2016). However, the highest number of leaf litter mesofauna was found in the plot with cassava vegetation. The result suggested that the cassava leaf litter most likely become the preferred substrate for mesofauna. In all treatments, the values of mesofauna diversity index (H') are categorized as low according to the Shannon-Weaver index. Two predominant orders frequently found in almost all vegetation types were Acarina and Collembola. The results of correlation analysis indicated that only soil pH sampled in November 2015 is positively correlated to the mesofauna population (range of pH 5.0 to 6.6). Soil moisture content sampled in November 2015 and soil C/N ratio sampled on April 2016 are positively correlated to the diversity index of soil mesofauna, respectively. Soil total-N sampled in November 2015 is negatively correlated to the soil mesofauna diversity index. The increase of leaf litter biomass appears to promote the increase of the leaf litter mesofauna population, but not the diversity index.

Keywords: Diversity index, leaf litter, soil mesofauna, vegetation

ABSTRAK

Penelitian ini dilakukan untuk mempelajari populasi dan keanekaragaman mesofauna tanah dan serasah, yang dibedakan pada setiap vegetasi dan kelerengan yang ada di Laboratorium Lapang Terpadu Universitas Lampung. Metode yang digunakan dalam penelitian ini adalah metode survei. Pengambilan sampel tanah dibedakan berdasarkan vegetasi dan kelas kelerengan. Variabel pengamatan meliputi populasi dan Indeks Keanekaragaman, serta analisis tanah (suhu, kadar air, pH, C-organik, N-total, dan C/N rasio tanah). Sebaran data populasi disajikan dalam bentuk diagram *boxplot*. Data dianalisis dengan uji korelasi antara beberapa sifat fisik dan kimia tanah dengan populasi dan keanekaragaman mesofauna tanah. Hasil penelitian menunjukkan bahwa vegetasi tebu menjadi vegetasi dengan populasi mesofauna tanah tertinggi baik pada November 2015 maupun April 2016. Singkong menjadi serasah yang disukai bagi mesofauna serasah sehingga populasi mesofauna serasah tertinggi terdapat pada serasah singkong. Pada seluruh perlakuan, Indeks Keanekaragaman (H') mesofauna serasah menurut kategori *Shannon-Weaver* termasuk dalam kategori rendah. Terdapat dua ordo yang mendominasi yaitu Acarina dan Collembola. Analisis tanah pada bulan November 2015 menunjukkan hanya pH tanah yang berkorelasi positif dengan populasi mesofauna tanah dengan rentang nilai pH 5,0-6,6. Kadar air tanah (November 2015) dan C/N rasio tanah (April 2016) berkorelasi positif dengan Indeks Keanekaragaman mesofauna tanah, sedangkan N-total (November 2015) berkorelasi negatif dengan Indeks Keanekaragaman mesofauna tanah. Peningkatan biomassa serasah dapat meningkatkan populasi mesofauna serasah, namun tidak meningkatkan Indeks Keanekaragaman (H').

Kata kunci **:** Indeks keanekaragaman, mesofauna tanah, serasah, vegetasi

INTRODUCTION

The Agriculture Experimental Field (AEF) is the most productive agricultural field at the Faculty of Agriculture, University of Lampung, consisting of five land classes with different slopes. The slope is one of the factors affecting the soil organic matter content and the availability of nutrients. The vegetation type on the AEF is very diverse, consisting of the tree stands to natural vegetation, treated or untreated land, as well as intensive agricultural land. The types of vegetation on the AEF are identified as cogon grass, sugar cane, cassava, rubber, rice, bamboo, banana, and cocoa as well as intensive farming of cassava-maize-cassava. Various types of vegetation on the AEF are believed to play a major role in controlling the presence of different types of soil biota, including mesofauna.

In the terrestrial ecosystem, the soil fauna involves in nutrient status of the soil via organic matter decomposition as well as plant debris (leaf litter) and soil mixing. Soil mesofauna, as part of soil fauna, also plays an important role in soil ecosystems. Hence, mesofauna population and diversity in soil can be used as parameters of soil fertility. The existence of mesofauna in soil is strongly affected by environmental factors, such as soil temperature, pH, and other soil properties. Furthermore, in this study, the land slope is considered as the main environmental factor affecting the soil organic matter content and the availability of nutrients (Hidayat *et al.* 2012).The research was conducted to study the population and diversity of soil and leaf litter mesofauna from different vegetation types and slopes at The Agriculture Experimental Field (AEF), University of Lampung.

MATERIALS AND METHODS

The Research Site

This study was conducted at The Agriculture Experimental Field (AEF), Faculty of Agriculture, University of Lampung (Unila), in November 2015 until July 2016. The study site is located at 5°22'11.38" S and 105°14' 25.96" E to 5°21' 58.35" S and 105°14' 43.83" E (Figure 1). The altitude of the study site is 110 – 130 m above sea level. The average annual rainfall is around 9.1 – 19.6 mm. The range of average monthly temperature is 27°C to 30°C. There are five slope classes consisting of different vegetation types. There are eight vegetation types, namely, rice *(Oryza sativa)*, cassava *(Manihotu utilissima*, cogon grass (*Imperata*

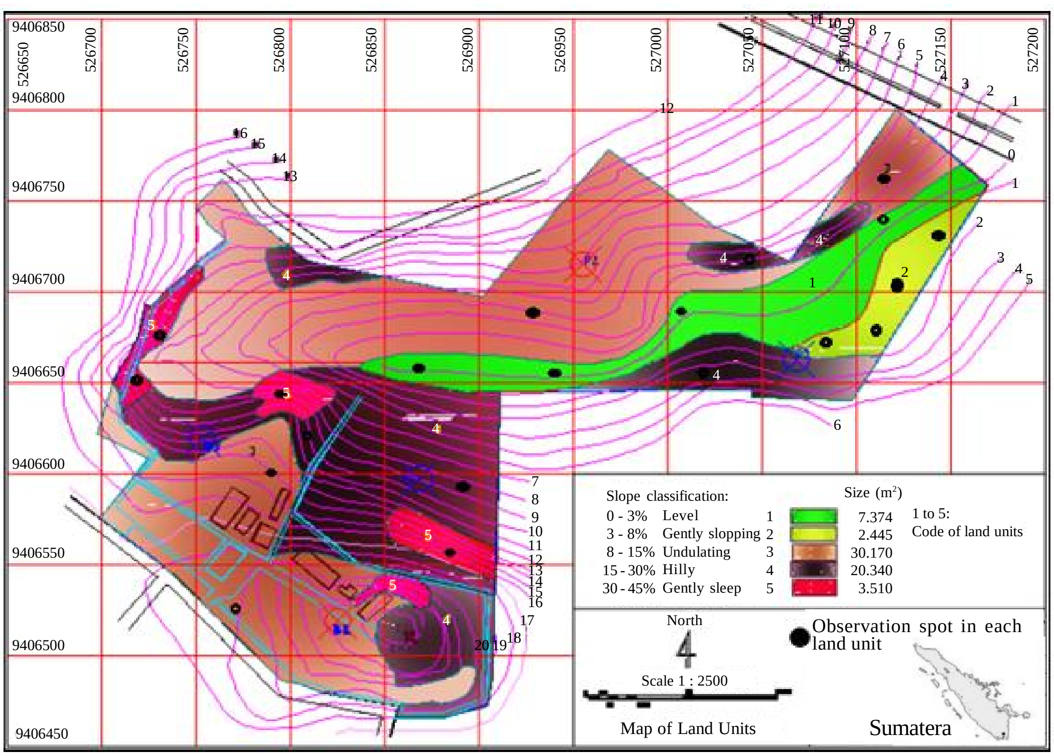


Figure 1. Vegetation types and slope classes at the site of The Agriculture Experimental Field (AEF) of University of Lampung (Banuwa *et al.* 2014). ●: grass, ●: cassava, ●: cacao, ●: rice, ●: rubber, ●: banana, ●: bamboo, ●: cane.

cylindrica, cocoa (*Theobroma cacao)*, bamboo (*Bambusa* sp.), banana *(Musa paradisiaca),* rubber *(Hevea brasiliensis)* and sugar cane (*Saccharum officinarum*).

Data Collection

The soil analysis was conducted at the Laboratory of Soil Science, Department of Soil Science, Faculty of Agriculture, University of Lampung. The research was conducted using a survey method (non-experimental design). The collection of the data was based on the observation points to determine the condition of the vegetation at the research site, namely The Agriculture Experimental Field (AEF), University of Lampung. The soil samples were collected in November 2015 (at the end of dry season) and April 2016 (the end of rainy season). The soil samples were collected using a 5 cm diameter core sampler after removing the leaf litter layer in each observation point. The leaf litter were collected at the rainy season (March 2016) with three replicates. The main variables such as soil mesofauna population (individual dm^{-3}) and Shannon-Weaver Diversity Index were determined according to the method of Odum (1983) as follows:

$$\text{Total population } (dm^{-3}) = \frac{\text{Total soil mesofauna (individual)}}{\text{Core sample volume } (dm^{-3})}$$

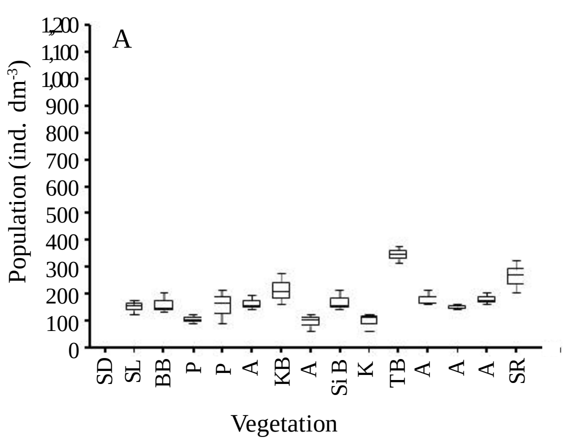
Diversity Index (H') = $-\Sigma$ [(ni / N) ln (ni / N)]
Note: H'= Shannon-Weaver diversity index
ni = Number of Type-I individuals
N = Total number of individuals

The soil properties such as soil temperature (^{o}C), soil moisture content (%), soil pH, total-N (Kjeldahl method), organic matter content (Walkley and Black method), and soil C/N ratio were measured. The soil properties were then correlated with the soil mesofauna population or with soil mesofauna diversity index.

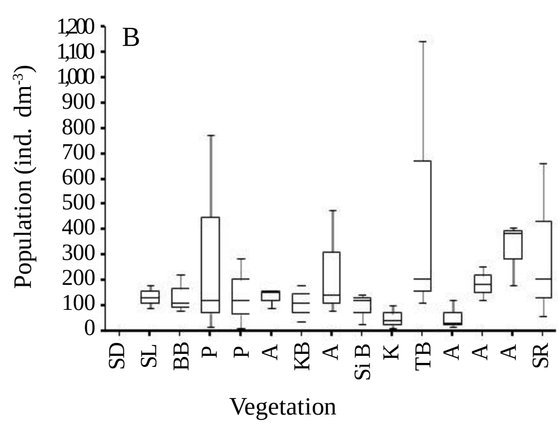
RESULTS AND DISCUSSION

Population of Soil Mesofauna

Due to the collected data were not homogenous, the statistical analysis of the data was not performed. Instead, the data were presented using a boxplot diagram. Figure 2 showed the distribution of soil mesofauna population for all vegetation sampled at the end of dry season (November 2015) and at the end of rainy season (April 2016). The abundance of soil mesofauna at the end of dry season was much lower than that of the rainy season. The result suggested that seasonal climatological variation might influence the distribution and/or diversity of soil mesofauna. The study of Kethely (1990) reported that dry conditions in the upper soil horizons would limit soil fauna activity, while moist conditions would present an opportunity for an increase of activity and reproduction of soil fauna due to higher organic



A. Distributionof soil mesofauna sampled at the end of dry season (November 2015).



B. Distribution of soil mesofauna sampled at the end of rainy season (April 2016).

Figure 2. Distribution of soil mesofauna population in arable soils under different types of vegetation and slopes at The Agriculture Experimental Field of University of Lampung. SD= paddy field (level 0-3%), SL = cassava (gently sloping 3-8%), BB = bamboo (undulating 8-15%), P_1B = banana #1, P_2B = banana #2, A_1B = cogongrass #1, KB = cacao, A_2B = cogon grass #2, SiB = cassava (intensive tillage), KrB = rubber, TB = sugar cane, A_1R = cogon grass#3(hilly 15-30%), A_2R = cogon grass #4, A_3R = cogon grass#5 and SiR = cassava.

matter input and microbial activity. Meanwhile, the highest mesofauna distribution was found in soil samples taken at the end of dry season as indicated by an almost symmetrical boxplot diagram. In contrast, asymmetrical boxplot diagram of soil mesofauna in all vegetation types was found at the beginning of rainy season.

The highest population of soil mesofauna sampled in November 2015 were found in the plot with sugar cane vegetation (TB) (337 individual dm^{-3}), followed by the plot with cassava vegetation (SiR) (260 individual dm^{-3}) and the plot with cocoa vegetation (KB) (198 individual dm^{-3}) (Table 1). Similarly, the highest population of soil mesofauna sampled in April 2016 was also observed in the plot with sugar cane vegetation (486 individual dm^{-3}), while the second and the third highest population were observed in the plots with cogon grass (A_3R) (326 individual dm^{-3}) and cassava (SiR) (313 individual dm^{-3} respectively) (Table 1). The plot with sugar cane vegetation showed the highest soil mesofauna population in November 2015 and April 2016, i.e. 337 individual dm^{-3} and 486 individual dm^{-3}, respectively (Table 1), possibly due to the amendment of organonitrophos fertilizer, which is an organic fertilizer made from a mixture of cow dung and monosodium glutamate solid waste enriched with nitrogen-fixing microbes as well as phosphorus-solubilizing microbes (Lumbanraja *et al.* 2013). Changes in the soil fauna community after fertilization is primarily caused by food quantity and quality, and modification of soil physical and chemical properties (Wang *et al.* 2016). The addition of organic matter in the fertilizer composition, serves as an energy as well as carbon source for the soil mesofauna so that it can increase the mesofauna population.

The plots with cassava vegetation, i.e. SiL, SiB, and (SiR) were located at different slopes i.e. sloping, undulating and hilly, respectively. However, the highest population was found in the land with the slope of 15-30% (hilly) in which the range of mesofauna population was 259-313 individuals dm^{-3} (the second highest after sugar cane). The land with cassava vegetation (SiR) has been conserved through terracing techniques to flatten the land, so that runoff and erosion can be reduced (Utami 2000). In addition, the vegetation is surrounded by perennial plants (agroforestry), which have a large canopy and can contribute as mulch and green manure (Sumarno *et al.* 2011). The study of Chanan (2012) suggested that organic materials (biomass) derived from perennial plants are able to store carbon for a long term. The soil organic carbon content in cassava plot (SiR) is relatively higher than that in other cassava plots, thus in this case the slope does not affect the soil mesofauna population.

There are eight orders of mesofauna identified in the Agriculture Experimental Field, namely Acarina, Collembola, Diplura, Pseudoscorpions, Symphyla, Araneae, Coleoptera and Isopoda (Table 1). The predominant order in all soil samples taken both in November 2015 and April 2016 is Acarina, with an average of total population ranging at 31-333 individual dm^{-3}, followed by Collembola ranging at 3-153 individual dm^{-3}. The mesofauna Isopod was found mainly in the soil samples taken in April 2016, because the soil moisture content of the soil samples taken in April is higher than that in the samples taken in November 2015. The study of Singh *et al.* (1991) showed that during the wet season Isopods gather on the soil surface and migrate to the sub soil during dry season. Other soil mesofauna namely Diplura, Symphyla, Coleoptera, and Pseudoscorpiones are not always found in every soil sample.

Soil Mesofauna Diversity Index

The highest diversity index (H') of soil mesofauna sampled in November 2015 was observed in the plot with cogon grass (A_2B) at 0.61, followed by the plot with rubber plantation (KrB) at 0.57 and cocoa plantation (KB) at 0.49 (Table 2). In April 2016, the highest diversity index (H') of soil mesofauna was observed in the plot with cassava vegetation (SL) at 0.77 followed by the plot with cogon grass (A_2R) at 0.70, and cogon grass (A_1R) at 0.69. Based on the data in Table 2, in general the highest Diversity Index (H') of soil mesofauna was found in the plot with cogon grass (A_2B) at 0.70, consisting of four orders of mesofauna, while the lowest diversity index of soil mesofauna sampled in November 2015 was observed in the plots with cassava vegetation, consisting of one order. However, in general, the diversity indexes of soil mesofauna under different vegetation types are still categorized as low based on Shannon-Weaver category (Table 2).

Correlation between Soil Properties and Soil Mesofauna Population and Diversity Index (H ')

Physical and chemical properties in of soil samples taken in each plot with different vegetation types in November 2015 and March 2016 are presented in Table 3 and 4. The soil properties vary under different vegetation types.

The results of correlation analysis showed that during the first sampling (November 2015), soil pH is positively correlated to soil mesofauna population. The range of the soil pH is between 5.02 (acid) -

Table 1. Number of different order of soil mesofauna in arable soils under different types of vegetation at the Agriculture Experimental Field of Unila.

No	Vegetation	Order and Abundance			
		November 2015		April 2016	
		individual dm^{-3}		individual dm^{-3}	
1	Paddy Field (SD)	-	0		0
2	Cassava (SL)	1. Acarina	129	1. Acarina	102
		2.Collembola	20	2. Collembola	34
				3. Diplura	7
				4. Symphyla	3
		Total	149	Total	146
3	Bamboo (BB)	1.Acarina	132	1.Acarina	99
		2.Collembola	10	2. Collembola	41
		3. Diplura	13		
		4. Symphyla	3		
		Total	159	Total	140
4	Banana (P_1B)	1. Acarina	102	1. Acarina	245
		2.Collembola	3	2. Collembola	61
		Total	105	Total	306
5.	Banana (P_2B)	1. Acarina	149	1. Acarina	34
		2.Collembola	7	2. Collembola	105
		Total	156	Total	139
6.	Grass (A_1B)	1. Acarina	139	1. Acarina	93
		2.Collembola	13	2. Collembola	51
		3. Symphyla	10	3. Diplura	3
				4. Isopoda	3
		Total	163	Total	150
7.	Cacao (KB)	1. Acarina	150	1. Acarina	75
		2.Collembola	75	2. Collembola	35
				3. Isopoda	3
		Total	198	Total	113
8.	Grass (A_2B)	1. Acarina	68	1. Acarina	161
		2.Collembola	27	2. Collembola	75
				3. Isopoda	14
				4. Araneae	3
		Total	95	Total	253
9.	Cassava (SiB)	1. Acarina	157	1. Acarina	95
				2. Collembola	3
		Total	157	Total	98
10.	Rubber (KrB)	1. Acarina	98	1. Acarina	31
				2. Collembola	20
				3. Isopoda	14
				4. Coleoptera	3
		Total		Total	68
11.	Sugar cane (TB)	1. Acarina	288	1. Acarina	333
		2.Collembola	14	2. Collembola	153
		3. Symphyla	30		
		Total	337	Total	486
12.	Grass (A_1R)	1. Acarina	137	1. Acarina	47
		2.Collembola	13	2. Collembola	10
				3. Isopoda	3
		Total	150	Total	60

Table 2. Diversity index (H') of soil mesofauna in arable soils under different types of vegetation and slope at the Agriculture Experimental Field of Unila.

Slope Classes	Vegetation	Diversity Index		Shannon-Weaver Category
		End of dry season (November 2015)	End of rainy season (April 2016)	
(0-3%)	Paddy Field (SD)	-	-	-
(3-8%)	Cassava(SL)	0.49	0.77	Low
(8-15%)	Bamboo (BB)	0.42	0.61	Low
	Banana (P1B)	0.15	0.20	Low
	Banana (P2B)	0.12	0.30	Low
	Grass (A_1B)	0.37	0.69	Low
	Cacao (KB)	0.49	0.60	Low
	Grass (A_2B)	0.61	0.70	Low
	Cassava(SiB)	0.00	0.09	Low
	Rubber (KrB)	0.57	0.36	Low
	Sugar Cane (TB)	0.32	0.62	Low
(15-30%)	Grass (A_1R)	0.26	0.26	Low
	Grass (A_2R)	0.39	0.36	Low
	Grass (A_3R)	0.21	0.64	Low
	Cassava (SiR)	0.34	0.25	Low

Table 3. Chemical and physical characteristics of arable soils under different vegetation types at the Agriculture Experimental Field of Universiti of Lampung sampled in November 2015.

Sample Site	Organic C (%)	Total N (%)	Soil pH	Soil Moisture (%)	Soil temperature (^oC)
Paddy Field (SD)	2.37	0.42	5.02	43.7	29.0
Cassava (SiL)	1.52	0.06	6.38	10.3	29.7
Bamboo (BB)	1.42	0.07	6.65	14.2	29.0
Banana (P1B)	1.37	0.12	6.19	18.7	29.3
Banana (P2B)	2.26	0.13	5.80	24.1	29.0
Grass (A_1B)	1.56	0.06	6.26	10.4	30.3
Cacao (KB)	1.27	0.05	5.87	17.7	29.3
Grass (A_2B)	1.70	0.08	6.35	17.9	29.3
Cassava (SiB)	2.12	0.08	6.37	14.7	29.7
Rubber (KrB)	2.26	0.17	6.02	20.9	29.7
Sugar cane (TB)	1.70	0.13	6.49	16.0	29.3
Grass (A_1R)	2.00	0.14	6.81	15.2	29.3
Grass (A_2R)	1.80	0.10	6.51	12.0	29.7
Grass (A_3R)	1.38	0.08	6.30	18.6	29.7
Cassava (SiR)	2.15	0.21	6.27	22.5	29.3

7.0 (neutral). The highest average of soil pH was observed in plot with cogon grass vegetation (A_1R), *i.e.* 6.83 and the lowest soil pH was observed in paddy field (SD), *i.e.* 5.03. The studies of Suin (2003) and Wulandari *et al*. (2005) suggested that Collembola and Acarina requires different soil pH to survive, whilst Collembola and Acarina living in the soil with a neutral pH are usually called as the

Table 4. Chemical and physical characteristics of arable soils under different vegetation types at the Agriculture Experimental Field of Unila sampled in April 2016.

Sample Site	Organic C (%)	Total N (%)	Soil pH	Soil moisture (%)	Soil temperature (^oC)
Paddy Field (SD)	2.11	0.34	5.04	47.8	27.7
Cassava (SiL)	2.37	0.09	6.33	23.4	30.0
Bamboo (BB)	1.52	0.06	6.58	28.2	27.3
Banana (P1B)	1.38	0.09	6.20	25.7	27.7
Banana (P2B)	2.12	0.18	5.85	29.5	27.0
Grass (A_1B)	1.48	0.05	6.26	25.2	28.3
Cacao (KB)	1.63	0.06	5.89	25.5	28.0
Grass (A_2B)	1.38	0.06	6.33	23.0	28.3
Cassava (SiB)	1.27	0.05	6.34	23.5	27.0
Rubber (KrB)	1.27	0.11	6.07	24.5	27.0
Sugarcane (TB)	1.70	0.12	6.50	21.6	28.7
Grass (A_1R)	1.38	0.14	6.85	19.9	29.3
Grass (A_2R)	1.20	0.07	6.54	24.7	30.0
Grass (A_3R)	1.59	0.13	6.34	23.7	29.3
Cassava (SiR)	2.06	0.09	6.33	17.7	29.0

Table 5. Correlations between soil characteristics and soil mesofauna population.

Soil characteristics	r value	
	November 2015	April 2016
Soil organic C vs soil mesofauna population	0.24^{ns}	0.46^{ns}
Soil total N vs soil mesofaunapopulation	0.40^{ns}	0.28^{ns}
Soil C/N ratio vs soil mesofauna population	0.14^{ns}	0.01^{ns}
Soil pH vs soil mesofauna population	0.52^{*}	0.40^{ns}
Soil moisture vs soil mesofauna population	0.48^{ns}	0.48^{ns}
Soil temperature vs soil mesofauna population	0.09^{ns}	0.32^{ns}

* = correlated at 5% siginificance level, ns = not correlated at 5% significance level

Table 6. Correlations between soil characteristics and soil mesofauna diversity index (H').

Soil characteristics	r value	
	November 2015	April 2016
Soil organic C vs diversity index (H')	0.34^{ns}	0.10^{ns}
Soil total N vs diversity index (H')	0.52^{*}	0.49^{ns}
Soil C/N ratio vs diversity index (H')	0.44^{ns}	0.54^{*}
Soil pH vs diversity index (H')	0.40^{ns}	0.36^{ns}
Soil moisture content vs diversity index (H')	0.53^{*}	0.39^{ns}
Soil temperature vs diversity index (H')	0.28^{ns}	0.37^{ns}

* = correlated at 5% siginificance level, ns = not correlated at 5% siginificance level

indifference group. However, other soil parameters, namely organic carbon content, total-N, soil C/N ratio, soil moisture, and soil temperature are not correlated to soil mesofauna population sampled in November 2015 and April 2016 (Table 5). In addition, the results of correlation analysis showed that soil total-N is positively correlated to diversity index of soil mesofauna (November 2015), indicating that an increase in soil total-N will increase the Diversity Index (H') of soil mesofauna (Table 6). The soil moisture (November 2015) and soil C/N ratio (April 2016) are positively correlated to the Diversity Index (H'), indicating that an increase in soil moisture and soil C/N ratio will increase the soil mesofauna Diversity Index (H') (Table 6). The results suggested that there are different groups of mesofauna responding apparently to litter quality gradient at early stages of litter decomposition as indicated by high litter C/N ratio. However in other case some other groups of mesofauna seem to show preferences for high quality litter (Makulec and Szanser 2006; Pangaribuan 2015). A high soil C/N ratio means less nitrogen that has been decomposed (Setiawan 2003) and the soil contains high carbon, resulting in higher soil C/N ratio.

Population of Leaf Litter Mesofauna

Most of the population distribution pattern of the leaf litter mesofauna under different vegetation types are not normally distributed (Table 7). Examples of normally distributed population pattern were observed in the plots with the cassava vegetation (SiL) and cogon grass (A_1R). The average population of leaf liter mesofauna in each plot with different vegetation types can be seen in Table 7. The mesofauna distribution can be seen in Figure 3, while the population and diversity of leaf litter mesofauna are presented in Table 7. The leaf litter mesofauna population differs depending on the vegetation type. The highest population of leaf litter mesofauna was observed in the plot with cassava vegetation (SiR) at 706 individual 100 g^{-1}, followed by the plots with cassava vegetation (SiB) at 649 individual 100 g^{-1}, cogon grass (A_2B) at 447 individual 100 g^{-1}, and bamboo (BB) at 379 individual 100 g^{-1}. The lowest population of leaf litter mesofauna was in the plot with rubber plantation (KrB) at 65 individual 100 g^{-1}. The high population and type of leaf litter mesofauna found in the plots with grass and bamboo are likely due to the mesofauna prefers to both types of organic matter as a substrate and habitat (Setiawan 2003).

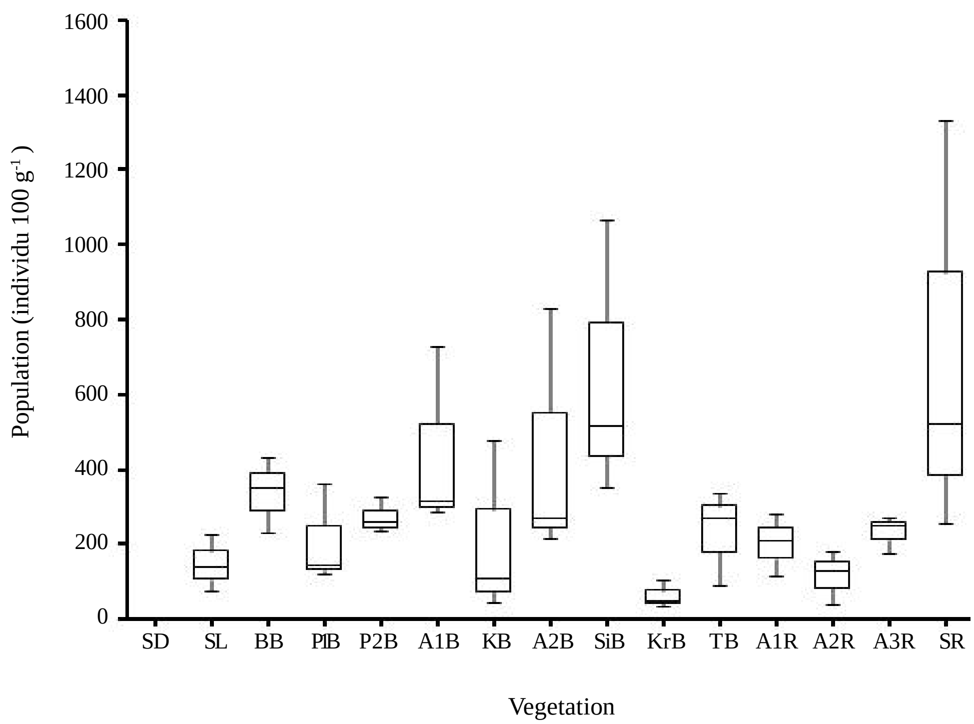


Figure 3. Distribution ofleaf littermesofauna population in arable soils under different types of vegetation and slopes at Agriculture Experimental Field of Unila sampled at the start of rainy season (March 2016). SD= Paddy Field (level 0-3%), SL = Cassava (gently slopping 3-8%), BB = Bamboo (undulating 8-15%), P_1B = Banana 1, P_2B = Banana 2, A_1B = Cogon Grass 1, KB = Cacao, A_2B = Cogon Grass 2, SiB = Cassava (intensive tillage), KrB = Rubber, TB = Sugar Cane, A_1R = Cogon Grass 3 (hilly 15-30%), A_2R = Cogon Grass 4, A_3R = Cogon Grass 5 and SiR = Cassava.

Table 7. Number of different order of the leaf litter mesofauna in arable soils under different types of vegetation at the Agriculture Experimental Field of Unila.

		Order and number of meso fauna (March 2016)					
No.	Vegetation	(individual dm^{-3})		No.	Vegetation	individual dm^{-3}	
1.	Paddy Field (SD) (0-3%)	-	-	9.	Cassava (SiB)	Acarina	514
						Collembola	134
		Total	0			Total	648
2.	Cassava (SiL) (3-8%)	Acarina	101	10.	Rubber (KrB)	Acarina	41
		Collembola	147			Collembola	22
						Isopoda	14
						Coleoptera	3
		Total	248			Total	80
3.	Bamboo (BB) (8-15%)	Acarina	257	11.	Sugarcane (TB)	Acarina	200
		Collembola	83			Collembola	34
		Diplura	2				
		isopoda	5				
		Symphyla	2				
		Total	349			Total	234
4.	Banana (P1B)	Acarina	170	12.	Grass (A1R) (15-30%)	Acarina	181
		Collembola	40			Collembola	23
						Symphyla	1
		Total	210			Total	205
5.	Banana (P2B)	Acarina	260	13.	Grass (A2R)	Acarina	79
		Collembola	16			Collembola	14
						Symphyla	1
						Isopoda	2
		Total	276			Total	96
6.	Grass (A1B)	Acarina	332	14.	Grass (A3R)	Acarina	202
		Collembola	113			Collembola	35
		Tysanophtera	18			Symphyla	9
		Symphyla	7				246
		Total	470			Total	492
7.	Cacao (KB)	Acarina	74	15.	Cassava (SiR)	Acarina	567
		Collembola	22			Collembola	136
		Isopoda	3			Tysanophtera	3
		Total	99			Total	706
8.	Grass (A2B)	Acarina	379				
		Collembola	67				
		Isopoda	14				
		Symphyla	15				
		Total	475				

There are seven orders of leaf litter mesofauna identified in the current study, such as Acarina, Collembola, Diplura, Symphyla, Tysanophtera, Coleoptera and Isopoda (Table 7). The order of the leaf litter mesofauna is dominated by Acarina, with the abundance of 41-567 individual dm^{-3}, then followed by Collembola with the abundance of 22-136 individual dm^{-3}. While other mesofauna such as Isopoda, Symphyla, Diplura, Coleoptera and Tysanophtera are not always found in each litter

Table 8. Diversity index (H’) of leaf litter mesofauna in arable soils under different types of vegetation and slope at the Agriculture Experimental Field of Unila.

Slope Class	Types of vegetation	Diversity Index (H')	Shannon-Weaver Category
1 (0-3%)	Paddy Field (SD)	-	-
2 (3-8%)	Cassava(SiL)	0.44	Low
3 (8-15%)	Bamboo (BB)	0.57	Low
	Banana (P1B)	0.36	Low
	Banana (P2B)	0.18	Low
	Grass (A_1B)	0.78	Low
	Cacao (KB)	0.37	Low
	Grass (A_2B)	0.65	Low
	Cassava(SiB)	0.50	Low
	Rubber (KrB)	0.76	Low
	Sugarcane (TB)	0.40	Low
4 (15-30%)	Grass (A_1R)	0.36	Low
	Grass (A_2R)	0.57	Low
	Grass (A_3R)	0.42	Low
	Cassava (SiR)	0.55	Low

Table 9. Biomass production and some soil characteristics of arable soils under different types of vegetation at the Agriculture Experimental Field Unila sampled at March 2016.

Types of vegetation	Biomass production (g m^{-2})	Organic C (%)	Total N (%)	C/N ratio
Paddy Field (SD)	nd	nd	nd	nd
Cassava (SL)	65	36.2	1.40	25.9
Bamboo (BB)	609	34.1	1.21	28.3
Banana (P1B)	256	34.8	1.59	21.9
Banana (P2B)	260	38.5	1.63	23.6
Grass (A_1B)	462	41.6	1.26	33.0
Cacao (KB)	850	19.9	0.51	38.8
Grass (A_2B)	244	37.2	1.21	30.6
Cassava (SiB)	400	37.5	1.48	25.3
Rubber (KrB)	288	19.9	0.51	38.8
Sugarcane (TB)	591	25.1	0.51	48.7
Grass (A_1R)	321	41.9	1.21	34.5
Grass (A_2R)	174	25.7	0.75	34.4
Grass (A_3R)	300	39.5	1.03	38.5
Cassava (SiR)	73	24.7	1.12	22.0

Table 10. Correlation test of some additional variables and leaf litter mesofauna sampled at March 2016.

Variable	r value	
	Litter Mesofauna abundance	Diversity Index (H')
Leaf Litter Biomass	0.76**	0.23ns
Soil Organic C	0.42ns	0.33ns
Soil Total-N	0.43ns	0.20ns
Soil C/N ratio	0.09ns	0.46ns
Soil Temperature	0.05ns	0.01ns
Soil Moisture	0.39ns	0.07ns

** = correlated at 1% siginificance level, ns = not correlated at 5% significance level

sample. The study of Alfred *et al.* (1991) showed that the abundance of Collembola in the Khasi Hills, Northeast India is lower than Acarina. It relates to the ability of mesofauna to adapt to environmental conditions and any vegetation types.

Diversity Index (H') of Leaf Litter Mesofauna

The Diversity Index (H') value of leaf litter mesofauna and soil mesofauna are similar, with the highest Diversity Index (H') of leaf litter mesofauna was found in plots with cogon grass (A_1B) (0.78), rubber (KrB) (0.76) and cogon grass (A_2B) (0.65). However, data in Table 8 showed that the diversity index (H') of leaf litter mesofauna is low according to Shannon-Weaver category.

Correlation between Litter Chemical Properties and the Abundance and Diversity Index (H') of Litter Mesofauna

The highest vegetation biomass was found in the plot with cocoa plantation (KB), while the lowest vegetation biomass was observed in the plot with cassava (SL) (Table 9). The results of correlation analysis showed that leaf litter biomass is positively correlated to litter mesofauna population, but not correlated to the Diversity Index (H') (Table 9). The result indicated that more leaf litter biomass will increase the mesofauna population, but not for the Diversity Index (H'). Mesofauna population is closely related to leaf litter biomass produced by each vegetation, thus biomass availability will determine the mesofauna density (Suin 2003). The leaf litter biomass correlates with the population, so higher biomass will increase the mesofauna population, which varies among vegetations. This result is in line with the study of Harahap (2015) which showed that leaf litter biomass is positively correlated to leaf litter mesofauna population. Soil organic-C, soil total-N and soil C/N ratio are not correlated to the population and Diversity Index (H') of leaf litter mesofauna (Table 10). An increase of organic C and total-N in leaf litter will increase the population of leaf litter mesofauna, as well as its C/N ratio and diversity index (H').

CONCLUSIONS

The highest population of soil mesofauna sampled in November 2015 and April 2016 was found in sugarcane cultivation area (TB), while the highest leaf litter mesofauna population was observed in the plot with cassava vegetation (SiR). The highest Diversity Index (H') of soil mesofauna sampled in November 2015 and April 2016 was found in the plot with cogon grass (A_2B), while the highest Diversity Index of leaf litter mesofauna was observed in the plot with cogon grass (A_1R), but all the Diversity Indexes obtained in the current study are classified as low based on Shannon-Weaver category. The predominant mesofauna in soil and leaf litter samples is the order of Acarina. Higher leaf litter biomass will increase mesofauna population, but not the Diversity Index (H'). Cassava can be grown in three different land classes without being affected by the slope.

REFERENCES

Alfred JRB, VT Darlong, SJS Hattar and D Paul. 1991. Micro arthropods and Their Conservation in Some North-East Indian Soil. In: Veeresh GK, D Rajagopal and CA Viraktamath. 1991. *Advances in Management and Conservation of Soil Fauna*. Oxford and IBH PublishingCO. PVT. LTD. New Delhi. pp 309-319.

Chanan M. 2012. Pendugaan cadangan karbon (C) tersimpan di atas permukaan tanah pada vegetasi hutan tanaman jati (*Tectona Grandis Linn*. F) (di Rph Sengguruh Bkph Sengguruh Kph Malang Perum Perhutani II JawaTimur). *J Gamma* 7: 61-73 (in Indonesian).

Kethely J. 1990. Chapter 21: Acarina: Prostigmata (Actinedida). In: DL Dindal (eds). *Soil Biology Guide*. John Wiley & Sons. Toronto, pp. 667-756

Lumbanraja J, Dermiyati, S Triyono and H Ismono. 2013. Pemasyarakatan aplikasi pupuk organik rakitan baru organonitrofos di kelompok tani dan pemberdayaan kewirausahaan kelompok tani di Kabupaten Lampung Selatan. *Proposal Hi-Link*. Universitas Lampung. Bandar Lampung (in Indonesian).

Harahap AIP. 2015. Pengaruh sistem olah tanah dan pemupukan nitrogen terhadap keanekaragaman dan populasi mesofauna pada serasah tanaman padi gogo (*Oryza Sativa* L.) Musim tanam ke-46. *Skrips*i. Universitas Lampung (in Indonesian).

Hidayat Y, K Murtilaksono and N Sinukaban. 2012. Characterization of surface runoff, soil erosion and nutrient loss on forest-Agriculture landscape. *J Trop Soils* 17: 259-266.

Makulec KI and M Szanser. 2006. Response of soil micro- and mesofauna to diversity and quality of plant litter. *Europ J Soil Biol* 42: 244-249.

Odum HT. 1983. System ecology: an introduction. John Willey & Sons, Inc., Gainesville, USA.

Poerwowidodo.1992. *Telaah kesuburan tanah*. Angkasa. Bandung.

Setiawan Y, Sugiyarto and Wiryanto. 2003. Hubungan populasi makrofauna dan mesofauna tanah dengan kandungan C, N dan Polifenol, serta Rasio C/N, dan Polifenol/N bahan organik tanaman. *J Biosmart* 5:134-137.

Singh J. 1991. Progress in Soil Zoology in India. In: Veeresh GK, D Rajagopal and CA Viraktamath. 1991. *Advances in management and conservation of soil fauna*. Oxford and IBH Publishing CO. PVT. LTD. New Delhi. pp. 12-139.

Suin NM. 2003. *Ekologi hewan tanah*. Bumi Aksara Jakarta.

Sumarno, J Winarno and I Prastomo. 2011. Kajian pengelolaan lahan berdasarkan tingkat bahaya erosi dan pola konservasi tanah dan air di Desa Ngadipiro Kecamatan Nguntoronadi, Kabupaten Wonogiri. *J Ilmu Tanah dan Agroklimatologi* 8: 13-22 (in Indonesian).

Pangaribuan YALDJ. 2015. Populasi dan keanekaragaman mesofauna tanah akibat pengolahan tanah pada pertanaman jagung (*Zea mays* L.) di tanah ultisol Gedung Meneng Bandar Lampung. *Skripsi*. Universitas Lampung. Bandar Lampung. 58 hlm.

Utami UBL. 2000. Pengaruh tindakan konservasi tanah terhadap aliran permukaan, erosi, kehilangan hara dan penghasilan pada usaha tani kentang dan kubis. *Manusia dan Lingkungan* 7: 98-107 (in Indonesian).

Wang S, HYH Chen, Y Tan, H Fan and H Ruan. 2016. Fertilizer regime impacts on abundance and diversity of soil fauna across a poplar plantation chronosequence in Coastal Eastern China. *Scientific Reports* 6: 20816.

Wulandari S, Sugiyarto and Wiryanto. 2005. Pengaruh keanekaragaman mesofauna dan makrofauna tanah terhadap dekomposisi bahan organik tanaman di bawah tegakan sengon (*Paraserianthes falcataria*). *J Bioteknologi* 4: 20-27 (in Indonesian).