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Population Density of Soil Mesofauna in Secondary Forest, Palm Oil Agroforestry using Agarwood Gharu and Community Rubber Gardens in Kampar District

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ABSTRACT

Soil mesofauna plays a role in fertilizing the soil and plants. Soil mesofauna is one of the soil organisms that can provide information about soil quality and fertility. This study aims to analyze the population density of soil mesofauna in secondary forests, oil palm agroforestry with agarwood and community rubber plantations in Kampar Regency. Soil sampling using purposive sampling method and soil mesofauna sorting using a barless tullgreen tool. The results showed that the total population density of soil mesofauna in oil palm agroforestry with agarwood was 102.67 indv/m2, rubber plantations were 96.00 indv/m2, and the secondary forest was 85.33 indv/m2. The soil mesofauna family that was primarily obtained in the secondary forest was the Hahniidae family (21 individuals), the oil palm agroforestry with agarwood was the Formicidae family (35 individuals) and in the rubber plantations, the Formicidae family (20 individuals). Information on the population density of soil mesofauna in secondary forests, oil palm agroforestry with agarwood and rubber plantations in Kampar Regency becomes data for better environmental management.
Keywords: *Population Density; Mesofauna, Secondary Forest, Agroforession, Palm Oil*

1. INTRODUCTION

One of the soil organisms that can provide information regarding soil quality and fertility is soil mesofauna. Collembola, Acarina, Enchytraida, and Rotifera are examples of soil mesofauna with body sizes ranging from 100 µm to 2 mm. The availability of energy and food supplies has a significant impact on the existence of soil mesofauna. Soil mesofauna can also be utilized to predict soil fertility. According to Suheriyanto (2012), a soil mesofauna is a group of soil organisms sensitive to signs of environmental change caused by human activities that harm the environment and biotic systems. The nitrogen cycle carried out by bacteria and fungi is strongly tied to soil mesofauna. Litter, dead animal and plant remains, bacteria, and fungi are all food sources for soil mesofauna. Soil mesofauna indirectly contributes to soil aggregation by producing faecal pellets, which are digested in the stomach alongside the decomposition process by bacteria and fungi.

Soil fauna characteristics can be utilized as indicators of soil quality. Specific groups or people, for example, can impact changes in soil structure (Knoepp et al., 2000; Bartz et al., 2014). Soil management practices and vegetation features influence soil quality. TOT or minimum tillage systems, constant ground cover, and crop rotation systems all produce conditions that affect the development of organisms in the soil. In practice, conventional tillage, monocultures, and the presence of cover crops all impact soil organisms' ability to survive (Bartz et al., 2013). According to Murthy et al. (2016), combining forest plants with agricultural crops has numerous positive effects on the soil and its biodiversity. Thamrin (2017) discovered that planting agarwood in rubber plantations can improve soil C-Organic, N-Total, C/N ratio, total microorganisms, respiration, worm population, and soil arthropods. Aini et al. (2010) also stated that the multistrata coffee plant agroforestry system has the ability to conserve soil biodiversity and discovered 12 different earthworm species. This study aimed to determine the population density of soil mesofauna in secondary forests, oil palm agroforestry with agarwood and rubber plantations in Kampar Regency.

2. MATERIAL AND METHOD

The research was conducted in secondary forests, oil palm agroforestry with agarwood and community rubber plantations in East Kampar District, Kampar Regency, Riau Province (Figure 1). Administratively, secondary forests are located in Kampar Village and Tanjung Bungo Village, East Kampar District, Kampar Regency and are located at coordinates 0° 18' 54.676" N and 101° 12' 21" E with an area of 100.8 Ha, oil palm agroforestry with agarwood is located in Sawah Baru Village, East Kampar District, Kampar Regency and is located at coordinates 0° 17' 35.722" N and 101° 11' 45.684" E with an area of 8 Ha and an average plant age of 25 years. E with an area of 8 hectares and an average plant age of 25 years and rubber plantations are

located in Sawah Baru Village, East Kampar Subdistrict, Kampar Regency and located at coordinates 0° 19' 46.456" N and 101° 11' 46.023" N with an area of 8 hectares and an average plant age of 15 years

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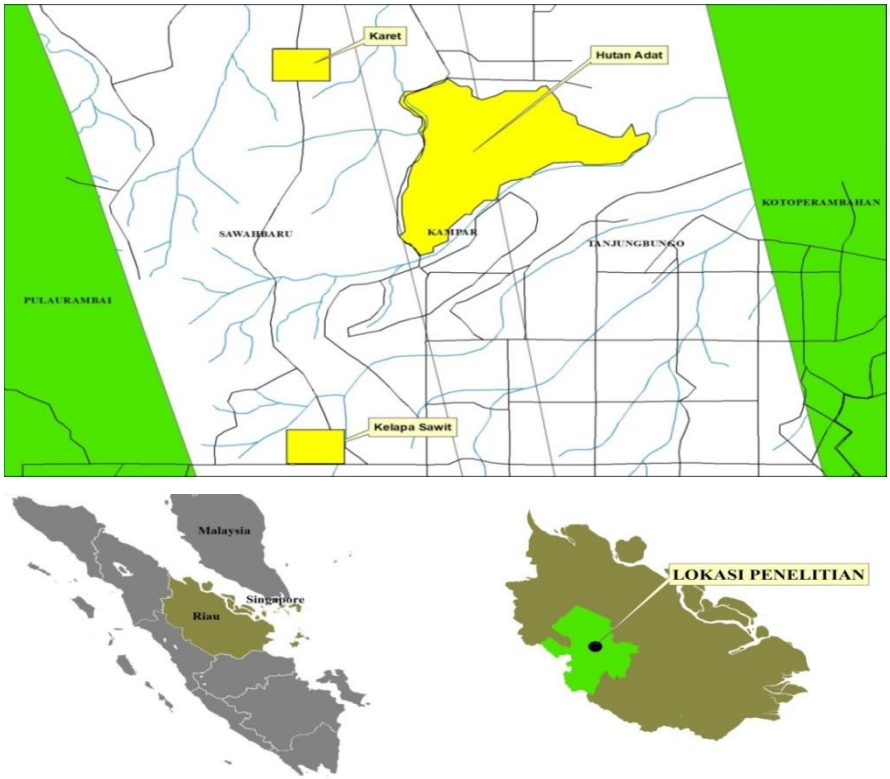

Figure 1. Research Location

The survey technique was employed in the research. At the same time, the Purposive Sampling method was used to choose soil sampling to be analyzed, and the zigzag approach was used to determine sample points with sample plots sized 20 x 20 m and four replications. Each sample plot contains three sampling points. The number of soil samples collected at each location was 12, for a total of 36 soil samples (Figure 2).

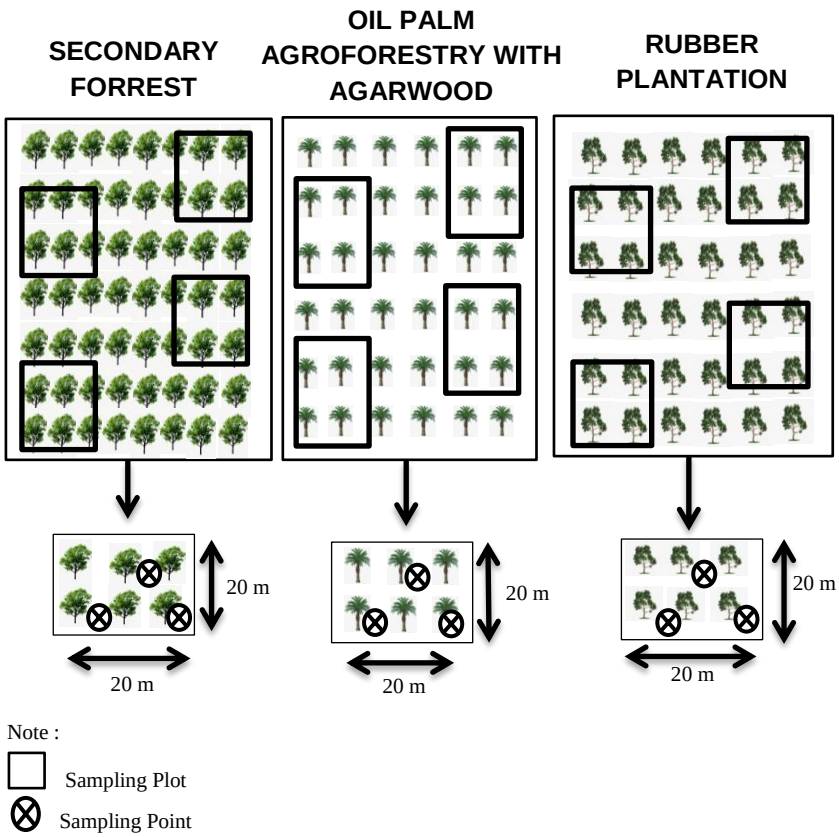

Figure 2. Sketch the locations of the soil sampling points

Soil sampling for soil mesofauna analysis was conducted at each soil sampling point using a 25 cm x 25 cm sample box at a depth of 0-20 cm (Figure 3). Soil sampling is performed by placing the sample box on the soil surface and then digging with a shovel to a depth of 20 cm.

Figure. 3. Soil sampling using a sample box

The soil samples were then placed in bags, tied to prevent excessive evaporation during the trip, and transported to the laboratory. The mesofauna samples were collected in the laboratory using the Berlesse-Tullgren tool. Soil samples were placed in the Berlesse-Tullgren tool under a 75-watt lamp for 24 hours and collected using a foil bottle containing 70% alcohol solution (Figure 4). The results of sorting the mesofauna were observed and identified using a digital microscope connected to a laptop, then counted and identified at the family level by observing the morphological characterization of the mesofauna found in reference books, namely Soil Biology Guide (Dindal, 1990), Borror and Delong's Introduction to The Study of Insects Seventh Edition (Triplehorn and Johnson, 2005), and Soil Animal Ecology (Suin, 2012).

Figure. 4 Soil mesofauna extraction with Barlesse Tullgreen

Data Analysis

Population density

The population density of one type or group of soil fauna can be expressed in terms of quantity or biomass per unit sample, area, volume, or catch unit. Population density is an important factor to consider when calculating productivity. The following formula calculates population density (Suin, 2012).

$$\text{Population Density} = \frac{\text{Total Pupulation}}{\text{Soil sample area}}$$

Relative density

Relative density is calculated by comparing the density of a species with the density of all species in the sample unit. Relative density is expressed as a percentage. Relative density is calculated based on the formula of Suin (2012) as follows:

$$\text{Relative Density} = \frac{\text{Density of a kind}}{\text{Total density of all types}} \text{ X } 100\%$$

3. RESULT AND DISCUSSION

Mesofauna Population Density

The results showed that the population density and relative density of soil mesofauna in secondary forests, oil palm agroforestry with agarwood and rubber plantations had different values (Table 1).

Table 1. Population density and relative density of soil mesofauna

No	Family	Secondary Forrest		Oil Palm and Agarwood Agroforestry		Rubber Plantation	
		KP (indv/m^2)	KR (%)	KP (indv/m^2)	KR (%)	KP (indv/m^2)	KR (%)
1.	*Acaridae*	0	0	1.33	1%	4.00	4%
2.	*Bourletiellidae*	0	0	1.33	1%	0	0
3.	*Ciidae*	1.33	2%	6.67	6%	0	0
4.	*Cheliferidae*	5.33	6%	0	0	0	0
5.	*Cryptophagidae*	2.67	3%	0	0	0	0
6.	*Cylisticidae*	0	0	1.33	1%	0	0
7.	*Entomobryidae*	0	0	18.67	17%	0	0
8.	*Formicidae*	9.33	11%	46.67	43%	26.67	28%
9.	*Hahniidae*	28.00	33%	1.33	1%	21.33	22%
10.	*Hypogastruridae*	1.33	2%	0	0	0	0
11.	*Japygidae*	6.67	8%	9.33	9%	16.00	17%
12.	*Lohmanniidae*	0	0	0	0	1.33	1%
13.	*Melyridae*	0	0	0	0	5.33	6%
14.	*Neanuridae*	2.67	3%	1.33	1%	0	0
15.	*Onychiuridae*	0	0	0	0	10.67	11%
16.	*Parasitidae*	17.33	20%	4.00	4%	0	0
17.	*Phalacridae*	9.33	11%	4.00	4%	0	0
18.	*Scarabaedae*	0	0	4.00	4%	10.67	11%
19	*Sminthuridae*	0	0	1.33	1%	0	0
20.	*Staphylinidae*	1.33	2%	0	0	0	0
21.	*Tomoceridae*	0	0	1.33	1%	0	0
	Total	85.33	100%	102.67	100%	96.00	100%

The highest total population density of soil mesofauna was found in oil palm agroforestry with agarwood, 102.67 indv/m2, and the lowest in secondary forest, 85.33 indv/m2. In line with the findings of Putri et al. (2019), the population density of Collembola in the 5-year-old oil palm plantation area was 1,475. The high population density of mesofauna may be due to the presence of palm fronds, which decompose into soil organic matter and serve as food. At the same time, the low population density of macrofauna is thought to be caused by the frequency of rubber sap collection by plantation owners, so human activities that may interfere with the existence of mesofauna become higher.

The Hahniidae and Formicidae families dominate the proportion of the total population density of soil mesofauna families in secondary forests, agarwood oil

palm agroforestry, and rubber plantations (Figure 1). Secondary forests have the highest percentage of total population density of 32.81% of 11 families, agroforestry oil palm with agarwood has a percentage of total population density of 43.21% of 15 families, and rubber plantations have a percentage of total population density of 27.78% of 8 families.

The difference in the percentage of total population density of soil mesofauna families is thought to be caused by differences in environmental conditions. According to Ganjari (2012), soil mesofauna is different in every place and time because mesofauna is mobile, which can move to places with suitable environmental conditions.

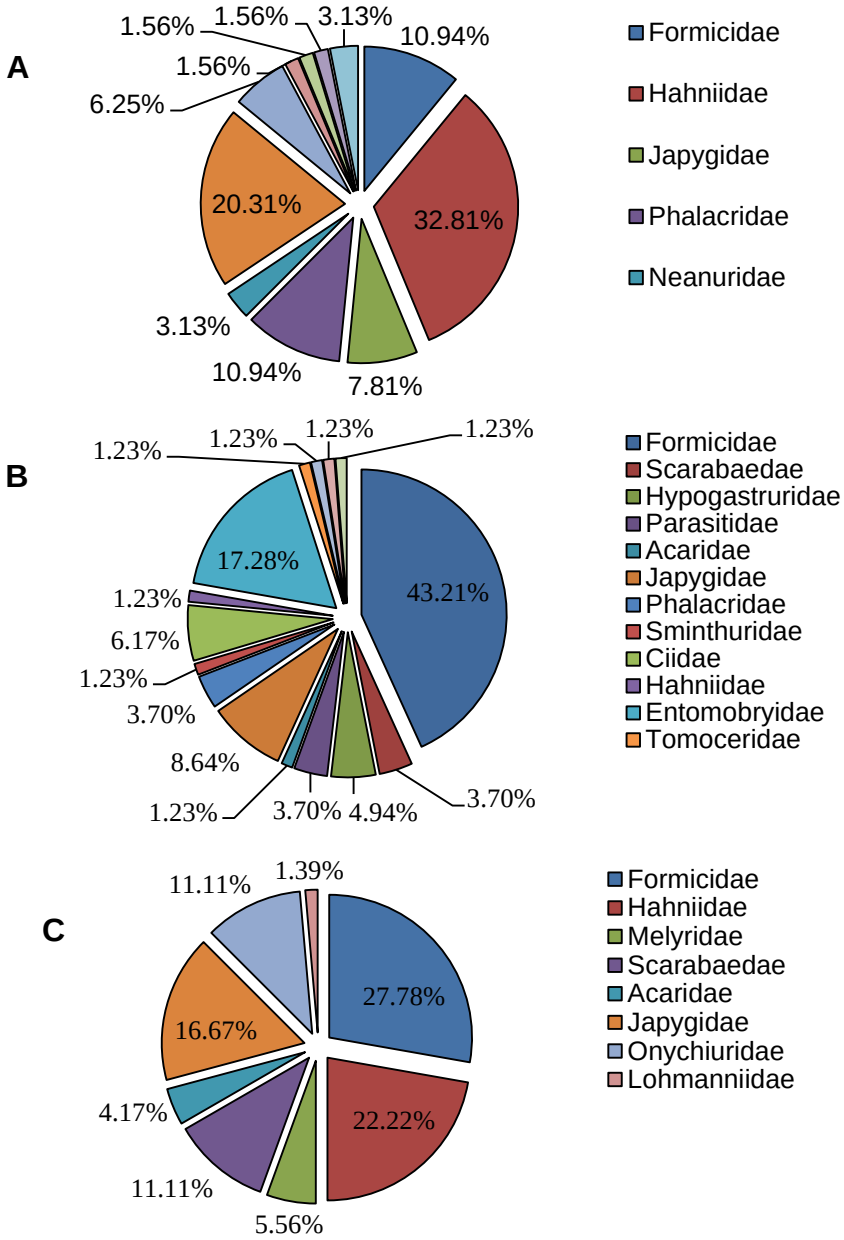

Figure 5. Percentage of total population density of soil mesofauna families in: A. Secondary Forest; B. Agroforestry of Oil Palm with Agarwood and C. Rubber Plantation

The family Hahniidae belongs to the order Araneae, which is a group of spiders that play a very important role in the ecosystem, namely as the main predators of insects, so they play a role in controlling the population of insect pests such as the orders Collembola, Coleoptera and Orthoptera. In accordance with the statement of Nasution, 2016 that spiders are insect predators that play an important role in controlling pests in the rice field ecosystem. Furthermore, Rachmawati, 2013 added that spiders can be found in various terrestrial ecosystems, both rarely and often encroached by humans.

The Hymenoptera order includes the Formicidae family. There are around 12,000 species of these organisms, with the majority of them found in the tropics. These creatures play a variety of tasks, including decomposers, pollinators, predators, and soil indicators. According to Arifin (2014), the Formicidae family is a group of ants that can maintain soil aeration and mixing, resulting in increased water infiltration and soil fertility. The Formicidae family is frequently employed as a bioindicator of environmental assessments, including forest fires, vegetation disturbance, logging, mining, waste disposal, and land use issues. Yuniar and Haneda (2015) discovered 5,484 Formicidae (ants) in four different ecological types in Bungku hamlet, Jambi Province.

4. CONCLUSION

According to the findings of this study, mesofauna population density in oil palm agroforestry with agarwood is 102.67 indv/m2, rubber plantation is 96.00 indv/m2, and the secondary forest is 85.33 indv/m2. The family Hahniidae (21 population) is the most numerous family of soil mesofauna acquired in secondary forests; the family Formicidae (35 population) is obtained in oil palm agroforestry with agarwood; and the family Formicidae (20 population) is obtained in rubber plantations.

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REFERENCE

Bartz, M. L. C.; Pasini, A.; Brown, G. G. 2013. Earthworms As Soil Quality Indicators In Brazilian No-Tillage Systems. Applied Soil Ecology. V. 69, 39-48.

Irfanul Arifin. (2014). Keanekaragaman Semut (*Hymenoptera: Formicidae*) pada berbagai subzona hutan pegunungan di sepanjang jalur pendakian Cibodas, Taman Nasional Gunung Gede Pangrango (TNGGP), *BIOMA* 10 (2) 2014, Program Studi Biologi FMIPA, Universitas Negeri Jakarta, Indonesia.

Knoepp, J. D. Et Al. 2000. *Biological Indices Of Soil Quality: An Ecosystem Case Study Of Their Use*. Forest Ecology And Management. V.138, P. 357-368.

Kartika Putri, Ratna Santi dan Sitti Nurul Aini. (2019). Keanekaragaman *Collembola* dan serangga

permukaan tanah di berbagai umur perkebunan kelapa sawit (*Elaeis guineensis Jacq*.), *Jurnal Ilmu Tanah dan Lingkungan*, Universitas Bangka Belitung, Kepulauan Bangka Belitung.

Leo Eladisa Ganjari. 2012. Kemelimpahan jenis Collembola pada habitat Vermikomposing, *Jurnal Widya Warta*, Fakultas MIPA, Universitas Katolik Widya Mandala Madiun.

Nurhasanah Nasution. (2016). Keanekaragaman laba-laba (*araneae*) pada ekosistem sawah dengan beberapa pola tanam di kota padang. *BioCONCETTA: Jurnal Biologi dan Pendidikan Biologi*. Akademi Perekam dan Informasi Kesehatan (APIKES) IRIS. Kota Padang, Sumatera Barat.

Suheriyanto, D. (2012). Keanekaragaman Fauna Tanah di Taman Nasional Bromo Tengger Semeru sebagai Bioindikator Tanah Bersulfur Tingi. Sainstis , 1 (2), 29-38

Rahmawaty. 2004. Studi Keanekaragaman Mesofauna Tanah di Kawasan Hutan Wisata Alam Sibolangit. Jurusan Kehutanan Program, Studi Manajemen Hutan, Fakultas Pertanian. Universitas Sumatra Utara. e-USU Respository