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Spatial distribution and functional characteristics of soil arthropods in super wet tropical rainforest, Indonesia

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ABSTRACT

The soil arthropods is an interesting thing to identify their existence, distribution and characteristics of several types of super wet tropical rainforest. This is caused this group is the main bioindicator with the highest amount of species among other soil fauna groups. This research was done on several types of super wet tropical rainforest area including natural forests, open area, mixed garden,and monoculture farming. Retrieving sample was done by using *pitfall traps* and *hand sorting*. The analysis and identification of soil arthropods there were 20 orders, 125 families and 305 morphospecies in the area ofsuper wet tropical rainforest. Distribution of soil arthropods in each type of land has a uniform and clustered tendency, where the distribution value of all land types is <1 and more than> 1, which means that all soil arthropods in the super wet tropical rainforest area are spread uniformly and clustered. While the characteristics of soil arthropods in super wet tropical rain forest areas are the phytophagous, saprophagous, predatory and parasitoid scattered on each type of land, where each type of land is dominate by predatory arthropod groups.Types of forest land and mixed garden have characteristics of soil arthropods that are more diverse than other types of land. Functionally, with the dominance of individual predator groups in each type of land the super wet tropical rainforest area shows that the balance of the ecosystem of the area is still maintained. However, in terms of species diversity, functional soil arthropods in open area types and monoculture farming dominated by the phytophagous group indicate that the condition of the land has begun to be disrupted and has the potential for continuous pest attacks on these types of land. Thus it can be concluded that the distribution and characteristics of soil arthropods are determined by the characteristics and management of the area.

Key words : *Functional, Fauna, Phytophagous, Predator*

Introduction

Soil arthropods are part of the dominant soil fauna group among other soil fauna groups. The ability of soil arthropods to maintain ecosystem balance can be seen from the abundance, diversity, distribution, and activity of soil arthropods in an area. Groups of soil arthropods can be found in various places both on the surface and in the soil (Carrillo *et al.*, 2011; Elhayati, 2017). Most of the soil arthropod groups play a role in carrying out the process of soil organic matter reform. This activity supports the occurrence

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of nutrient flow processes in the environment, thus making the land rich in organic materials that can be grown by various plants on it (deDeyn *et al.*, 2004; Wang *et al.*, 2014).

This super wet tropical rainforest area has high rainfall and does not have a real dry season with 6500 mm/year of rainfall and 73% - 80% relative humidity every month (Hermansah, 2010), where Kampichler and Bruckner (2009) state that this area is the right home for most soil arthropods. But, some of these areas have been converted into several types of land, as a consequence of increasing population growth which has resulted in a decrease in the distribution of abundance and diversity of soil arthropods (Frey, 2015). Reduced abundance of soil arthropods as a result of changes in forest land due to changes in vegetation and land management (Chamen, 2015). Tree felling will reduce land compaction, and the provision of intensive chemical compounds for plant maintenance is an effort to improve human welfare which must adhere to environmental rules. Distribution of soil fauna will be disrupted if the activity is carried out in violation of environmental conservation rules (Tullberg, 2010).

Changes in land types within an area will determine the characteristics of each soil arthropod in the area. Not always, the area of crop cultivation will reduce the distribution of soil arthropods. In certain periods, the cultivation area will be overgrown by grass vegetation which is a habitat that is in accordance with the activities of most soil arthropods. Under vegetation, many provide organic material needed by soil arthropods (Putra, 2012). Each type of land will show the presence of dominant soil arthropods that survive according to the conditions of the land type. The existence of a limiting factor in an area causes not all groups of soil arthropods are able to occupy the area (Liebig, 1840).

Functional characteristics of soil arthropods are important to study in order to understand the function of soil arthropods in a land type. Functional soil arthropods are needed in each type of land to describe the condition of the land ecosystem. These functional characteristics are seen from the type of nutrition used by soil arthropods to grow and develop. Without knowing the functional characteristics of soil arthropods in each land type in the super wet tropical rainforest area, it will be difficult to determine the level of quality of the land ecosystem.

Soil can be sterile which cannot maintain the plants, if the distribution and functional characteristics of soil arthropods decrease. Changes in forest land types will cause changes in the distribution and functional characteristics of soil arthropods. Review how the distribution and characteristics of soil arthropods in several types of land in the super wet tropical rainforest area will be discussed in this paper.

Materials and Methods

Research Site

This research was conducted in November 2017 until March 2018. The Soil arthropods in the field were taken using *pitfall trap* and *hand sorting* in the super-wet tropical rainforest, Ulu Gadut, Padang, West Sumatra (Fig. 1). Next, the soil arthropod samples were analysed in the laboratory of insect bioecology, Faculty of Agriculture, Andalas University. The tools and materials used in this research are writing tools, identification books for soil arthropods (Boror Identification book and Insect of Australia), rapia ropes, glass cups, mica plates, permanent markers, labels, v-pottube 100 cc, prophylin glycol, ethanol, machetes, plastics, microscopes, petri dish, logbooks, small brushes, tweezers, lighting lamps, square frames, white posters/sacks, label paper, tissue, masks, latex gloves, trays and rubber.

Data Collection

Determining the sampling points was carried out using the *purposive random sampling* method based on toposequence in each type of super-wet tropical rainforest in Pinang-Pinang. On each toposequence, 4 sampling plots were determined, where each plot had a sampling area of40 x 40 m. Then every month, a soil arthropod sample is taken for 4 months. While for taking the sampling method, it is done by using a *pitfall trap* using prophylin glycol and *hand sorting* for 4 months. Next, the soil arthropods are brought to the laboratory to be collected, identified and analysed. Soil arthropods are then collected in a 100 ccv-pot tube using alcohol 96%. Each tube is labeled the location of retrieval. Furthermore, each soil fauna in the collection tube was identified under a microscope using the 7th edition of the Borror Identification book, Identification of Insects of Australia, Taxonomy Web, and Bug Guide.

Data Analysis

Soil arthropods that have been identified are then calculated for their abundance and distribution on several types of land in the super wet tropical rain forest area. Then the functional identification of each order of soil arthropod groups was carried out to recognize the characteristics of each order in four types of land in the super wet tropical rain forest.

Results and Discussion

Number of soil arthropods

The results showed that at the study site the super wet tropical rainforest area was rich in soil arthropod groups, where 20 types of soil arthropods were found on several land types in the super wet tropical rain forest area (Table 1). In types of forest land and mixed garden found 16 orders of soil arthropods, while in open area types and monoculture farming found 15 orders of soil arthropods. This is directly proportional to the number of soil arthropod individuals obtained, wherein the type of forest land found 1043 individuals, in open area 668 individuals, in mixed of garden of 791 individuals and monoculture farming 618 individuals. Forests become ideal areas for soil arthropod groups. According to Carrillo *et al.*, (2011) forests provide a large pile of organic matter, and in forest ecosystems, soil arthropods play a role in facilitating soil fertility by accelerating the decomposition process of these organic materials. Furthermore, Wang *et al.*, (2014) stated that soil arthropods are important elements in ecosystems, especially in carrying out nutrient decomposition and cycle activities. So that the diversity of plant species in the forest will increase the number of populations and the diversity of soil arthropods, because forests are the natural habitat of most soil arthropods.

Changes in land use in the super wet tropical rainforest area have caused a decline in the abundance and diversity of soil fauna. This can be seen in Table 1 which shows that the abundance of soil arthropods is reduced in open area types, mixed garden and monoculture farming. Changes in above-ground vegetation of a type of land use cause changes in the structure of the composition of soil arthropods in these types of land. In open areas with a smaller number of trees and small grasses that are still growing in small amounts, the motion of the soil arthropods becomes narrower. According to De Fries *et al.*, (2015) developing countries in the tropics generally increase economic growth through the conversion of forest areas into agricultural land. In open area formed after the process land clearing will reduce and even eliminate vegetation on the surface of the soil which is the habitat of soil arthropods. According to Dislich *et al.*, (2016) the diversity of soil arthropods is important in maintaining ecosystem functions.Furthermore, Castro *et al.*, (2011) added that changes in land vegetation will affect climate conditions which can also directly change soil properties such as temperature, water content, chemical composition, and physical proper-

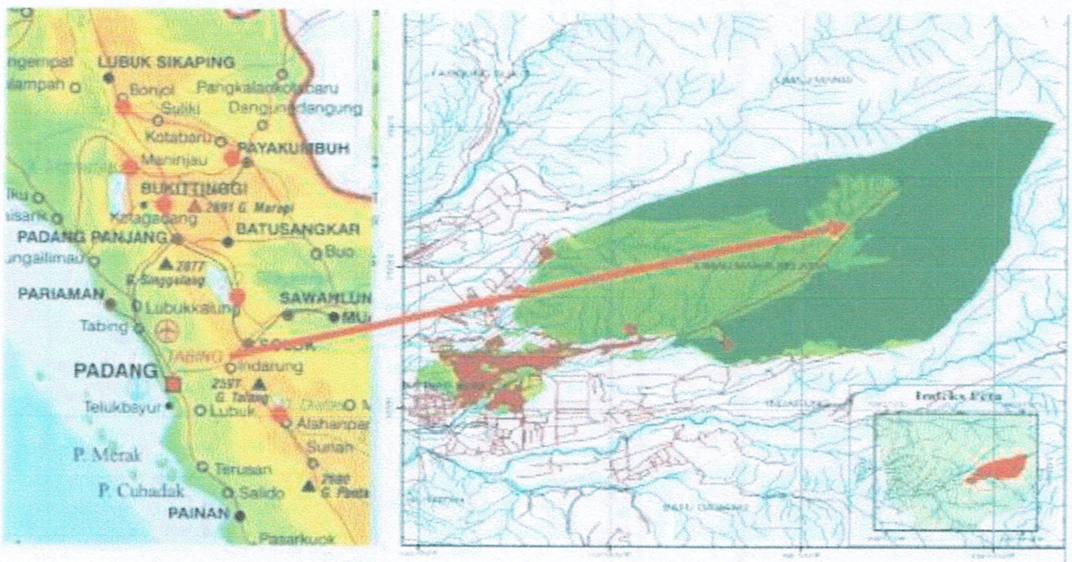


Fig. 1. Location of study area Pinang-Pinang, Ulu Gadut, West Sumatera

ties of the soil. This change has consequently caused a reduction in the soil arthropod community. The warmer temperature in the micro open area will cause the loss of some soil arthropods.

Table 1 shows that the abundance of the highest soil arthropod order in order hymenoptera and coleoptera. The dominance of the two orders of soil arthropods occurred in each type of land of super wet tropical rain forest. In the type of forest land are 655 and 115 individual orders of hymenoptera and coleoptera, then the type of open area are 451 and 79 individuals of order hymenoptera and coleoptera. The mixed garden land types there are 511 and 61 orders of hymenoptera and coleoptera, while in monoculture farming there are a number of hymenoptera and coleoptera as much as 425 and 50 individuals. The abundance of orders of hymenoptera and coleoptera shows that this group of orders has a high tolerance limit of life to environmental factors. According to Tawato (2014), the formicidae group are dominant in the hymenoptera order, which is one of the most important social soil arthropods, where these organisms are almost scattered in all habitats due to their high roaming ability. The formicidae group has a broad space for finding food nutrition, so it is called a scavenger predator because it preys on various fauna in litter and canopy. According to Borror *et al.*, (1988) that the order of Coleoptera has the largest number of species, this order composes about 40% of all types of insects. The lowest abundance of soil arthropods is in the order julida, psocoptera, isoptera, and phasmatodea (Table 1). This group was found in a land type of super wet tropical rain forest area, indicating that the group of arthropods had a wide range of space and a high limiting factor. According to Zulkaidah *et al.*, (2014) states that land use change causes a decrease or even loss of several species or orders of soil arthropods where the development of populations of soil arthropod groups is limited by enviromental factor.

Mixed garden areas have a plantation management system similar to monoculture farming systems, both of which require fertilizers, pesticides, and herbicides as part of plant care management. Table 1 shows more abundance of soil arthropods in mixed garden areas than monoculture farming. The diversity of cultivated plants as upper vegetation in mixed garden lands causes a variety of plant organic matter that falls above the soil, the organic

Table 1. Number of soil arthropods in the super wet tropical rainforest of Pinang-Pinang

Order Arthropods	Number of Soil Arthropods at Several Type Area in Super Wet Tropical Rainforest of Pinang-Pinang				TOTAL
	Forest	Open area	Mixed garden	Monoculture	
Araneae	46	27	51	13	142
Acarina	4	6	7	7	26
Blattodea	12	-	1	-	13
Coleoptera	115	79	61	50	308
Dermaptera	15	9	1	4	29
Diptera	41	26	42	43	151
Hemiptera	8	6	8	3	26
Hymenoptera	655	451	511	425	2036
Phasmatodea	-	-	1	1	1
Isoptera	-	-	-	1	1
Lepidoptera	1	2	2	3	8
Orthoptera	54	26	41	39	161
Psocoptera	1	-	-	-	2
Julida	-	1	-	-	1
Polydesmida	1	1	4	2	8
Geophilomorpha	-	2	-	-	2
Scolopendromorpha	4	1	1	1	7
Decapoda	1	1	1	-	3
Isopoda	20	-	7	2	29
Collembola	65	30	52	24	170
TOTAL	1043	668	791	618	3124

material is a nutrient for most soil arthropods. According to Loreau *et al.,* (2003) much of the literature has broadened the theoretical background of arthropod populations to communities which are a wider scope of hierarchy, mainly focusing on the influence of landscape heterogeneity on community structures. One of them is the meta-ecosystem concept based on the statement that adjacent ecosystems in heterogeneous exchange of material and energy will lead to mutualistic relationships in the distribution of soil arthropod groups. So that Janion (2014) argues that the abundance and diversity of soil arthropods can be influenced by landscape heterogeneity.

Monoculture farming have more intensive management of plant cultivation. The use of chemical compounds in groups of one type of plant as a practice of cultivating plant crops to improve the quality of crop productionis a common practice. The abundance of soil arthropods in this land type is lower compared to other land types. This is due to the intensive use of chemical intensively weeds and plant disrupting pests. Intensive use of chemical compounds in the practice of treating cultivated plants will cause accumulation which reduces the abundance and diversity of soil arthropods. According to Geissen *et al.,* (2009) intensive use of agrochemical materials, not only interferes with or eradicates weeds and disturbing pests, but also changes the diversity and structure of the arthropod community. According to Marczak *et al.,* (2007) the inclusion of agrochemicals into ecosystems can modify the functioning of soil arthropod ecosystems.

Distribution of Soil Arthropods

Distribution of soil arthropods in super wet tropical rain forest areas on several land types has a uniform and clustered tendency (Table 2), where the statement is taken from the formula of dispersion index morisita which is then converted into the uniform index formula and clumped index, so that obtained value of the distribution of soil arthropods after using the morisita index formula (Ip) is obtained. The values obtained from the Morisita distribution index range from -1 to 1, where according to Morisita (1962) the Ip value = 0 has the understanding that the pattern of spreading arthropods is random, then Ip values <0 then uniform arthropod dispersal patterns and if values Ip> 0, the pattern of spreading arthropods is clustered. Some types of soil fauna orders are not found in certain types of land, so the fauna distribution value of the land cannot be determined. According to Vinatier (2011). The spatial distribution of populations is affected by the dispersal abilities of the species, interactions among individuals, or habitat selection. Linking these ecological processes to spatial patterns is of primary importance for understanding and prediction purposes.

The Hymenoptera order has the highest morisita distribution value in each type of land compared to other soil arthropod orders, namely 0.508 in the type of forest area, 0.501 in the open area type, 0.510 in the mixed plantation area type and 0.501 in the monoculture garden area type. In the Mixedgarden are the highest distribution area of hymenoptera compared to other land types. This is because in this area there is a lot of lower vegetation in the form of weeds that grow and there is little use of chemical compounds in maintenance of cultivated plants. The level of diversity of tree plants accompanied by various types of weeds that grow makes this area occupied by many groups of hymenoptera orders. According to Maeto *et al. (*2009), the abundance and diversity of Hymenoptera species are related to the diversity of plants found in the ecosystem. Herry (2017) added that the tree species diversity increases the diversity of hymenoptera groups. Plant species and complex plant architecture in an ecosystem will increase the diversity of hymenoptera. The hymenoptera has a wide distribution, where the group of orders has a broad range of life tolerance and a narrow limiting factor.

The forest types in Table 2 show 8 orders with grouped distributions and 4 orders with uniform distribution. The dominance of groups of soil arthropods with clustered distribution shows that the forest area provides a source of nutrition for most of the order of soil arthropods. Forests as ideal habitat for soil arthropods cause an increase in the abundance of soil arthropods (Gao, 2014). According to Manton (1977) habitat will have a direct or indirect effect on the pattern of the spread of soil arthropods because soil arthropod groups have certain tolerance limits. The group of soil arthropods in the forest areas distributed in groups are Coleoptera, Dermaptera, Diptera, Hemiptera, Hymenoptera, Orthoptera, Scolopendromorpha and Collembola. The group is spread in the forest area, which is caused by an abundance of nutritional sources available in the forest. according to Rahayu (2014) distribution occurs in groups due to habitats that provide adequate food sources, so

Table 2. Distribution of soil arthropods at super wet tropical rain forest Pinang-Pinang Padang, Indonesia

Order Soil Arthropods	Forest		Open Area		Mixed Garden		Monoculture	
	IP	Information	IP	Information	IP	Information	IP	Information
Araneae	-0.067	Uniform	-0.008	Uniform	-0.443	Uniform	0.106	Clustered
Acarina	-0.035	Uniform	0.043	Clustered	0.111	Clustered	-0.216	Uniform
Blattodea	-0.039	Uniform	-		0.043	Clustered	-	
Coleoptera	0.189	Clustered	-0.187	Uniform	-0.161	Uniform	0.065	Clustered
Dermaptera	0.259	Clustered	-0.230	Uniform	-	-	-0.129	Uniform
Diptera	0.259	Clustered	-0.440	Uniform	0.503	Clustered	-0.362	Uniform
Hemiptera	0.302	Clustered	-0.035	Uniform	0.172	Clustered	0.086	Clustered
Hymenoptera	0.508	Clustered	0.501		0.510	Clustered	0.501	Clustered
Phasmatodea	-	-	0.001	Clustered	0.500	Clustered	-	
Isoptera	-	-	-		-	-	-	
Lepidoptera	-	-	-		0.043	Clustered	-0.259	Uniform
Orthoptera	0.382	Clustered	0.043	Clustered	0.505	Clustered	0.505	Clustered
Psocoptera	-	-	-		-	-	-	
Julida	-	-	-		-	-	-	
Polydesmida	-	-	-		-	-	0.086	Clustered
Geophilomorpha	-	-	-		-	-	-	
Scolopendromorpha	0.129	Clustered	-		-	-	-	
Decapoda	-		0.043	Clustered	-	-	-	
Isopoda	-0.150	Uniform	-		-0.129	Uniform	0.043	Clustered
Collembola	0.635	Clustered	-0.151	Uniform	-0.624	Uniform	0.507	Clustered

Note: IP: Distribution's value of Morisita index

there is no need for competition, even though food sources are the same. Furthermore, the uniform distribution pattern occurs in Aranea, Acarina, Blattodea, and Isopoda in the forest area because this group tends to compete for food nutrition, especially for predatory soil arthropods. According to Indriyanto (2006) uniform distribution occurs in solitary living groups of soil arthropods. In each type of land, food nutrition is available in limited quantities for certain fauna which causes competition to obtain this food source..

Soil arthropod groups with uniform distribution patterns dominate in open area. it group consists of orders Araneae, Blattodea, Coleoptera, Dermaptera, Diptera, Hemiptera and Collembola. Uniform distribution occurs in a fairly uniform environment. Open area with limited vegetation above the ground make this area homogeneous. According to Kamal (2011), the location of research with limited nutritional conditions caused many arthropod groups to compete and separate themselves to get food so that in this type of area tend to be found in small amounts of soil arthropods.

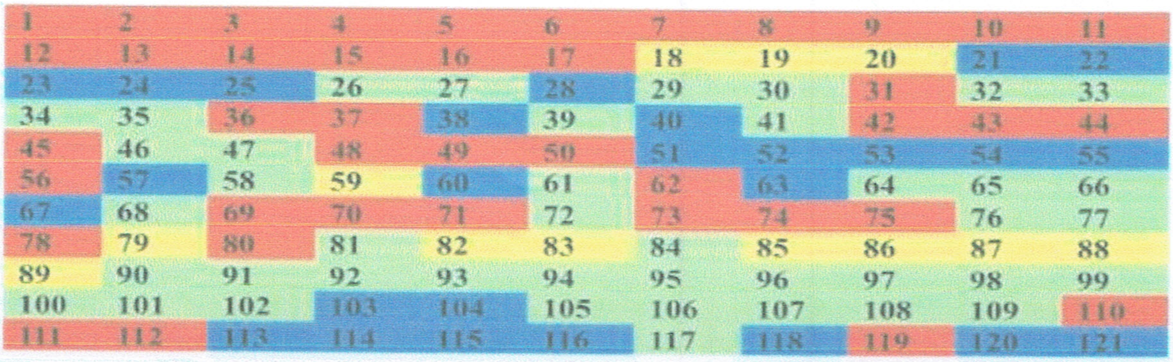
The mixed garden area with diverse plant types has a more dominant number of arthropods scattered in groups, where 8 orders of soil arthropods are distributed with clustered patterns, and 4 order of soil arthropods are uniformly distributed. The diversity of above-ground vegetation in mixed garden areas will cause more diverse numbers of soil arthropods in it. According to Rusnaningsih (2010), The pattern of arthropod distribution which tends to cluster is related to the life behavior and interests of the life of the soil arthropod group, which is very reasonable because soil arthropods will choose the most suitable living environment. Likewise, with monoculture plantations the distribution pattern of arthropod in the soil is also clustered.Although vegetation over this area is homogeneous, but lower vegetation that grows before the plantation maintenance phase facilitates effective space for soil arthropod groups to obtain nutritional sources.

The pattern of distribution of soil arthropods can be the same or different in several types of land in super wet tropical rainforest areas. There are types that have a clustered distribution pattern on each type of land, but there are also types that have a uniform pattern on one station and a grouping pattern on the other stations. According to McNaughton and Larry (1990), a particular distribution pattern is not always a characteristic of a particular type.

Functional Characteristics of soil arthropods on several types of land in super wet tropical rainforests

Functional characteristics of soil arthropods show that soil arthropods have an important role in their activities in the environment. Functional soil arthropods are generally divided based on the type of nutrient needed, wherein the results of the study show that in several types of land the super wet tropical rain forest area obtained 4 functional types of soil arthropods, namely phytophagous, predator, saprophagous and parasitoid. Each functional soil arthropod performs its role in order to maintain the balance of the ecosystem.

Fig.2 shows the functional distribution patterns of soil arthropods in the Pinang-Pinang area tropical rainforest areas consisting of phytophagous,



Note : Predator; Parasitoit; Saprophagous; Phytophagous

Fig. 2. The pattern of quantity distribution of soil arthropods in super wet tropical rainforest areas

1.Amphinectidae
2. Clubionidae
3.Dysderidae
4.Oonopidae
5. Trachelidae
6. Linyphiidae
7. Opiliones
8. Hahniidae
9. Lycosidae
10. Theraphosidae
11. Cybaeidae
12. Zodariidae
13. Diplocentridae
14. Pholcidae
15. Agenelidae
16. Corinnidae
17. Araneidae
18. Ixodidae
19. Erythraeidae
20. Dermanyssidae
21. Blattidae
22. Coryidae
23. Blaberidae
24. Cryptocercidae
25. Leiodidae
26.Curculionidae
27. Elateridae
28. Dryophthoridae
29. Anobiidae
30. Geotrupidae
31. Staphylinidae
32. Coccinellidae
33. Scarabaeidae
34. Telegeusidae
35. Palacridae
36. Trogossitidae
37. Carabidae
38. Clambidae
39. Elmidae
40. Latridiidae
41. Nitidulidae
42.Dytiscidae
43. Lampyridae
44. Silphidae
45. Agyrtidae
46. Anisolabididae
47. Forficulidae
48. Labiduridae
49. Agromyzidae
50. Dolichopodidae
51. Phoridae
52. Lonchaeidae
53. Drosophilidae
54. Sciaridae
55. Simuliidae
56. Aulacigastridae
57. Cecidomyiidae
58. Ceratopogonidae
59. Dixidae
60. Rhagionidae
61. Anisopodidae
62. Empididae
63. Scatopsidae
64. Asteiidae
65. Limoniidae
66. Milichiidae
67. Sphaeroceridae
68. Ulidiidae
69. Culicidae
70. Ochteridae
71. Reduviidae
72. Alydidae
73. Enicocephalidae
74. Saldidae
75. Nabidae
76. Delpachidae
77. Miridae
78. Formicidae
79. Torymidae
80. Ceraphronidae
81. Embolimidae
82. Ichneumonidae
83. Mymaridae
84. Pergidae
85. Crabronidae
86. Diapriidae
87. Aphelinidae
88. Halictidae
89. Eolophidae
90. Diapheromeridae
91. Rhinotermitidae
92. Crambidae
93. Erebidae
94. Hesperiidae
95. Tortricidae
96. Lasiocampidae
97. Tetrigidae
98. Acrididae
99. Rhaphidophoridae
100. Trigonidiidae
101. Mogoplistidae
102. Gryllidae
103. Grilotalpidae
104. Liposcelididae
105. Julidae
106. Polydesmidae
107. Xystodesmidae
108. Paradoxosomatidae
109. Andrognathidae
110. Schendylidae
111. Scolopendridae
112. Gecarcinucidae
113. Platyarthridae
114. Porcellionidae
115. Cylisticidae
116. Ligiidae
117. Armadillidiidae
118. Entomobrydae
119. Isotomidae
120. Hypogastruridae
121. Neanuridae

predators, saprophagous and parasitoid. The results showed that functional soil arthropods in several types of land in tropical rainforest areas were dominated by predator and phytophagous family groups (Fig. 2). Predatory and phytophagous soil arthropod groups have the same number of family arthropods as many as 41, whereas the saprophagous soil arthropod group has 26 family arthropods and 26 parasitoid groups having 12 families of soil arthropods, so that overall functional soil arthropod abundance are 121. Domination of predators against prey (phytophagous) causes growth and development of the total individual and type of phytophagous species to be controlled. Furthermore, Bruce (2015) explained that predators are controlling agents of ecosystems in the environment. The existence of predators in a type of land is very important in controlling the abundance of the phytophagous group. Under certain conditions in several land types such as mixed garden and monoculture farming, the abundance of the phytophagous group cause damage to plants which results in disruption of the growth and productivity of cultivated plants. The small number of families of saprophagous groups was found, due to the fact that the saprophagus soil arthropod group was dominated by microbial groups and the number of soil fauna acting as saprophagous tends to be less. According to Strong, *et al.*, (1984) groups of arthropods saprophagous that occupy an area have the ability to fractionate litter to a smaller size, which is very helpful in the process of decomposition carried out by soil microbes. The number of parasitoid was found a few in several types of land super wet tropical rain forest caused by many groups of arthropods in the trees looking for hosts in order to fulfill nutrition to survive and rarely on the ground. The existence of parasitic groups is needed in the world of plantations, where this group is often used as a biological controlling agent in removing pests and plant extraction. so that the increasing number of soil parasitoid will cause an increase in plant disturbing pests.. The existence of predatory and parasitic soil arthropod groups is very much needed in the world of plantations, where this group is often used as a biological controlling agent in removing pests and plant extraction.

Functional soil arthropods in the super wet tropical rainforest area are divided into four, namely the phytophagous, saprophagous, predator and parasitoid. The four functional parts of the soil arthropods are grouped according to their food sources (Husamah, 2017). Fig. 3 shows that the group of phytophagous and predator arthropods is more dominant than other arthropod groups. Then the saprophagous soil arthropod group was more dominant than parasitoid soil arthropods. According to Bruce (2015), The interaction between plants and phytophagous arthropods is one of the most important ecological interactions in nature. Thus, this relationship will affect the cycle of nutrition and energy in the food chain flow. The number of phytophagous that are dominant in an area with abundance and diversity of plants as a source of nutrition for the group causes predatory soil fauna groups to have high abundance. Furthermore, the balance of the ecosystem of an area will be achieved if the existence of predatory arthropod groups, saprophagous and parasitoid can still be found in the region.

Changes in the land type of super wet tropical rainforest areas have shifted the soil arthropod community both in terms of abundance and diversity of the soil arthropods. Functional changes in soil arthropods are interesting things to study, seeing how important the presence of soil arthropods is in carrying out the ecosystem functions of a region. Fig. 3 shows functional graphs of soil arthropod types on four land types in the super wet tropical rain forest. The phytophagous arthropod group dominates almost every type of land, namely open areas and monoculture farming in the super wet tropical rainforest area. The large number of phytophagous groups in open area types and monocultures shows that the land is a source of nutrients for the phytophagous arthropod group. The dominance of the phytophagous on a type of agricultural land is a threat to cultivated plants, and the phytopha-

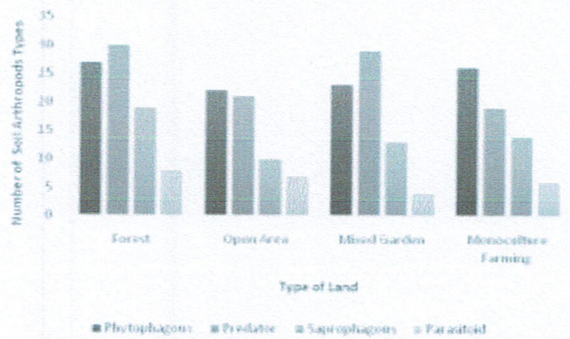


Fig. 3. Graphic of a number of functional types of soil arthropods in the super wet tropical rainforest area

gous group tends to visit cultivated plants as a source of nutrition.

Types of forest land and Mixed garden are dominated by predatory soil fauna groups (Fig. 3). According to Simpson (2012) that variations in vegetation texture of a land determine the functional characteristics of soil arthropod groups through the effects of abundance, diversity, and distribution of host plants. Furthermore, Vannier (2007) states that a vegetation the characteristics of the availability of functional groups of soil fauna are not only determined by plants that grow above ground level, but also by groups of natural enemies of the soil fauna. Fig. 3 also shows the existence of predators that dominate several types of land. This is in accordance with the rules of the ecological system which states that the abundance of phytophagous will also be followed by an increase in the abundance of predatory soil arthropods. According to Ødegaard (2004), the phytophagous group not only consumes plant leaves with one bite, but they colonize one individual plant. this is a strategy of plants to invite the arrival of predatory arthropod groups. According to Hagen (1987), predatory arthropod groups have extensive prey search space by understanding habitat characteristics and prey behavior. Furthermore, according to Tallamy (2004), an ecosystem of predatory arthropods is needed in the world of agriculture, due to the prey of this predator arthropod group is a phytophagous which acts as a pest for plants, especially cultivated plants. Group of soil arthropod predators are often identified with biological control agents in the world of agriculture.

Next Fig. 3 also shows the abundance of species from the arthropod saprophagous and parasitoid groups. Where among these two groups, arthropods saprophagous have a higher abundance compared to parasitoid arthropods which have only a few families of soil arthropods. The arthropod saprophagous group utilizes organic matter on the ground such as litter, dead animals and animal feces as nutrients. This group is a decomposer agent whose role is to decompose soil organic matter. The abundance of saprophagous arthropods is highest in forest land types and mixed garden areas which indicate that at both locations these are rich in organic matter. According to Strong, *et al.*, (1984) saprophagous is a group of soil insects that play a role in the process of forming a food chain for an ecosystem, where this group will decompose organic matter above the soil surface. Furthermore, parasitoid groups and microphytics feeders were found in smaller amounts. Low abundance in the parasitoid group is due to changes in land use in the super wet tropical rainforest area. According to Meidalima (2014) Agricultural management activities cause parasitoid insect habitats to experience environmental stress in the form of loss of wild plants as food sources, *shelter*, and *sinks* for parasitoid insect imams.

Fig. 4, shows that the number of individuals in the predator group is dominantly found in each type of land in the super wet tropical rain forest area. The forest area became the most popular group of predatory arthropods. According to Le Mellec (2018), the abundance and diversity of predators of a land type is determined by the abundance and diversity of phytophagous as a source of nutrition. Phytophagous insects are an important element of the forest and have a beneficial role in the forest ecosystem, where every single tree or plant usually has one or several types of phytophagous insects. The more diverse tree vegetation in the area, the more diverse the types and number of individual phytophagous arthropods will be. With the increasing variety of phytophagous arthropods, the predator group is also increasingly diverse. in open area types where only a few intact trees also have a abundance of predatory arthropod groups which are more dominant (Fig. 3). This type of land is only found in litter and decaying deciduous wood and the growth of several shrubs. According to Bird *et al.* (2004), Non-canopy tree habitats increase solar radiation up to the forest floor, the input of organic matter shrinks and temperature and humidity fluctuate high at 10 cm above the ground. As a result, the functional abundance of soil arthropods de-

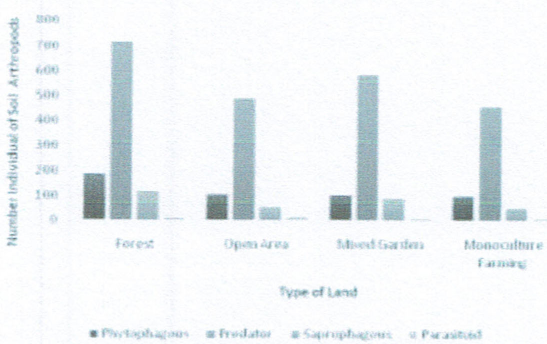


Fig. 4. Graphic of a functional number of soil arthropod individuals in the super wet tropical rainforest area

creased. In monoculture plantations, the number of functional predatory soil arthropods is lower than in mixed garden lands. Likewise with other arthropod groups, namely phytophagous, saprophagous and parasitoid. The low functional abundance of arthropods in monoculture areas is due to the homogeneity of land vegetation and management of maintenance of cultivated plants that are more intensive in the use of chemical compounds. According to Macfayden *et al.* (2011), intensive activities of monoculture agriculture affect the quantity and type of interactions that occur between soil fauna, because it generally reduces the composition and diversity of soil fauna species so that interactions occur more limited than natural ecosystems. Habitat modification and more intensive application of insecticides to monoculture agricultural ecosystems influence the interaction between soil arthropods and plants.

Conclusion

Changes in land type in the super wet tropical rainforest area affect the distribution of soil arthropods., wherein the forest area, mixed garden and monocultures are more predominantly soil arthropods which clustered while open areas are more predominantly uniform. This shows the the effect of soil vegetation dominance on the distribution of soil arthropods. Besides being seen from the aspect of its functional characteristics, predator arthropod groups were more dominant in each type of land in terms of the number of individuals. Whereas the number of functional types of soil arthropods in forest land and Mixed garden is dominated by predators, whereas open area types and monocultures is dominated by phytophagous. The high number of varieties of predators that dominate the type of forest land and Mixed garden indicate that the ecosystem in this type of land is still balanced and conversely, the high number of species of phytophagous in open area types and monoculture farming shows that this type of land potentially lead to continuous pest attacks.

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