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Diversity of Soil Arthropods in The Tea Plantation of PTPN XII Bantaran Blitar

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Abstract

Pruning tea leaves not only improve the productivity of the tea leaves but ecologically improve soil arthropods, which have very important role in the food chain. This study aimed to identify and analyze the diversity of soil arthropods in the tea plantation of PTPN XII Bantaran Blitar with pruning system. Observation of soil arthropods was performed by using hand sorted method on tea land with 25, 25 and 30 cm of each length, width and depth, respectively. Observations were performed at three stations, namely Pruning Year (PY) I, PY II and PY III, at which each station contains 10 observation point. The data were analyzed by PAST program 3.06 version. This study found soil arthropods about 45 specimens, consisting of 15 orders, and 33 families. The most abundant order is Coleoptera, as well the role of common soil arthropods are predator. Family Formicidae is the most common family found in tea plantation. In addition, the highest of soil arthropods diversity index is in PY III, i.e. 2,58.

1. INTRODUCTION

Tea had been known as a medicinal plant. The tea leaves (*Camellia sinensis* (L.) O. Kuntze) contain more than 700 chemicals, including some compounds closely related to human health are flavanoides, amino acids, vitamins (C, E and K), caffeine and polysaccharides (Bhagat, *et al*., 2010).

Tea is one of the plantation commodities that have an important role in an economy in Indonesia. Tea is Indonesia's export commodities as the country's foreign exchange after oil and gas. Tea production dropped significantly around 5,79 % in 2010 (Syaipulloh, 2010). Pest attack is thought to be one factor in decreasing the tea production

(Simanjuntak, 2002). The effort should be done to manage the ecosystem therefor pest populations can be controlled naturally by studying the structure of the ecosystem that consists of plants species, pests and their natural enemies, as well as the interaction between each other (Suheriyanto, 2008).

Diversity in an ecosystem plays an important role in maintaining the ecosystem stability (Kramadibrata, 1995). Diversity will tend to be low in the ecosystem which are controlled by physical and chemical factors, and will be high on the ecosystem are controlled by biological factors (Odum, 1998).

Soil arthropods are group of arthropods that inhabit the soil, generally of classes: Crustacea, Arachnida, Myriapoda and insects (Eisenbeis and Wichard, 1987). Arthropods have a very important role in the food chain, i.e. as decomposers, predators and prey for other arthropods (Samudra, 2013).

Soil arthropods can also describe the causal chain which connects land management decisions with productivity, health of plant and animal (Doran and Zeiss, 2000). Soil arthropod is a good indicator of the integrity of various kinds of ecosystem functions, such as food web, decomposition and reproduction (Maleque *et al.*, 2006). The research objective is to determine diversity of soil arthropods where found in the tea plantation of PTPN XII Bantaran Blitar.

2. MATERIALS AND METHODS

Time and Location

The research was conducted on May 2014 until September 2014 in the tea plantation of PTPN XII Bantaran, Wlingi District, Blitar Regency. The research location was divided into three stations (Figure 1), as follow: first station (7°59'0,55" S 112°20'55,72" E), second station (7°58'55,65" S 112°20'46,95" E) and third station (7°58'55,75" S 112°20'52,85" E).

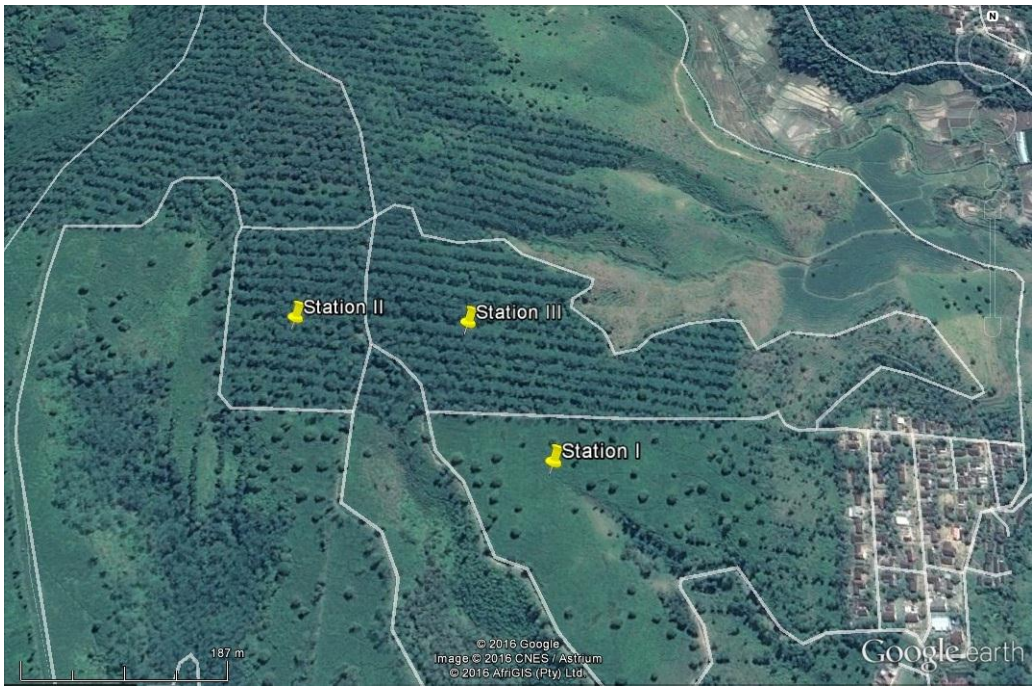

Figure 1. Research location (Google Earth, 2016).

Research Methods

The research location at the first station was the tea plant Pruning Year (PY) I ± 50 cm height, the second station was the tea plant PY II ± 80 cm height, and the third station was the tea plant PY III ± 120 cm height. At each station was determined 10 observation points and each point of observation was observed soil arthropods using hand sorted method, namely the soil was taken with 25 cm length, 25 cm wide and 30 cm depth. The soil sampling was done by using a soil drill. The soil was taken every 10 cm depth, placed on a white mat, and then separated by hand. Arthropods found were recorded, sampled and store in a bottle containing 70% alcohol to be identified in the laboratory. At each observation station was measured soil temperature and soil moisture. Soil samples were collected from each observation point and taken to the laboratory for analysis of water content, pH, soil organic matter, soil organic carbon and N total.

Data Analysis

The soil arthropods data (table 1), soil arthropod percentage (figure 2) and proportion of soil arthropods (figure 3) were analyzed using Microsoft Excel. The community analysis/diversity of soil arthropods (table 2) and analysis of PCA were analyzed using PAST 3.06.

Table 1. The soil arthropods in the tea plantation of PTPN XII Bantaran Blitar

Specimen	Order	Family	Total
1	Acarina	Acariformes	8
2	Araneae	Agelenidae	2
3	Araneae	Araneidae	6
4	Araneae	Dysderadae	6
5	Araneae	Linyphiidae	3
6	Araneae	Salticidae	4
7	Araneae	Thromisidae 1	10
8	Araneae	Thromisidae 2	5
9	Blattaria	Blaberidae	16
10	Blattaria	Blattellidae	1
11	Blattaria	Blattidae 1	38
12	Blattaria	Blattidae 2	13
13	Blattaria	Blattidae 3	6
14	Blattaria	Blattidae 4	6
15	Blattaria	Corydiidae	2
16	Coleoptera	Carabidae 1	2
17	Coleoptera	Carabidae 2	1
18	Coleoptera	Chrysomelidae	15
19	Coleoptera	Dermestidae	1
20	Coleoptera	Elateridae	3
21	Coleoptera	Nitidulidae	20
22	Coleoptera	Scarabaeidae 1	94
23	Coleoptera	Scarabaeidae 2	2
24	Coleoptera	Staphylinidae	2
25	Collembola	Entomobrydae 1	82
26	Collembola	Entomobryidae 2	176
27	Dermaptera	Carcinophoridae	54
28	Diptera	Anthomylidae	4
29	Hemiptera	Enicocephallidae	5
30	Hemiptera	Largidae	4

31	Hemiptera	Pyrrhocoridae	1
32	Hymenoptera	Chalcidoidea	1
33	Hymenoptera	Formicidae 1	72
34	Hymenoptera	Formicidae 2	165
35	Hymenoptera	Formicidae 3	125
36	Hymenoptera	Formicidae 4	220
37	Hymenoptera	Formicidae 5	1
38	Hymenoptera	Formicidae 6	2
39	Hymenoptera	Formicidae 7	10
40	Isopoda	Liqiidae	137
41	Isoptera	Termitidae	465
42	Orthoptera	Gryllacrididae	8
43	Polixenida	Polyxenidae	28
44	Scolopendromorpha	Scolopendrellidae	48
45	Setrtigerella	Centipidae	36

3. RESULTS

The identification result of soil arthropods that found in tea plantation PTPN XII Bantaran Blitar (Table 1) shows that there are 15 orders of soil arthropods, e.i. Acarina, Araneae, Blattaria, Coleoptera, Collembola, Dermaptera, Diptera, Hemiptera, Hymenoptera, Isopoda, Isoptera, Orthoptera, Polixenida, Scolopendromorpha and Setrtigerella order. Termitidae family Isoptera order is found in abundant amounts.

Coleoptera order cumulatively has the highest percentage of orders that are found in the tea plantation of PTPN XII Bantaran Blitar (Figure 2).

Araneae, Blattaria, Coleoptera and Hymenoptera orders have the same percentage on PY I. Blattaria and Hymenoptera orders on PY II have the same percentage. While on PY III the same percentage is Coleoptera and Hymenoptera orders

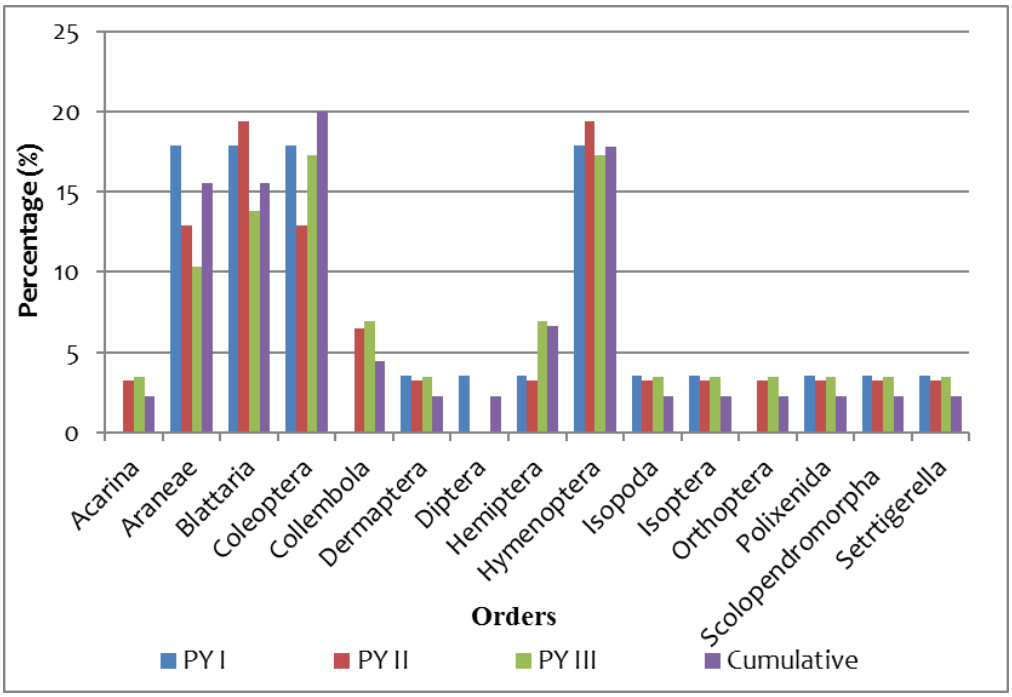

Figure 2. Soil arthropod percentage in the tea plantation of PTPN XII Bantaran Blitar

The highest role of soil arthropods in the tea plantation of PTPN XII Bantaran Blitar cumulatively is as predator (Figure 3). The highest percentage of predator on the PY I is 51.85% and the lowest on PY II is 35.48%.

The highest of soil arthropods as herbivore and detritivor is found on PY II and the lowest is on PY I. The highest role of soil arthropods as parasite is on PY III and the lowest is on PY I.

4. Discussion

Tea is planted at a dense distance and at a certain times is always pruned (Adisewojo, 1982). Pruning of tea plants is done a rotation that is 4 to 5 years (Sartika, 2003). Pruning aims to maintain the picking fields and obtain high crop productivity, encourage the tea plants growth to keep in vegetative phase and stimulate the new shoots growth (Efendi *et.al*., 2010). Pruning is an essential agronomic practice implemented for renovating vegetative growth at the expense of reproduction, to increase crop productivity in subsequent years. The pruning can eliminate pests that attack stems, branches, and maintenance foliage (Hazarika, *et al.*, 2009).

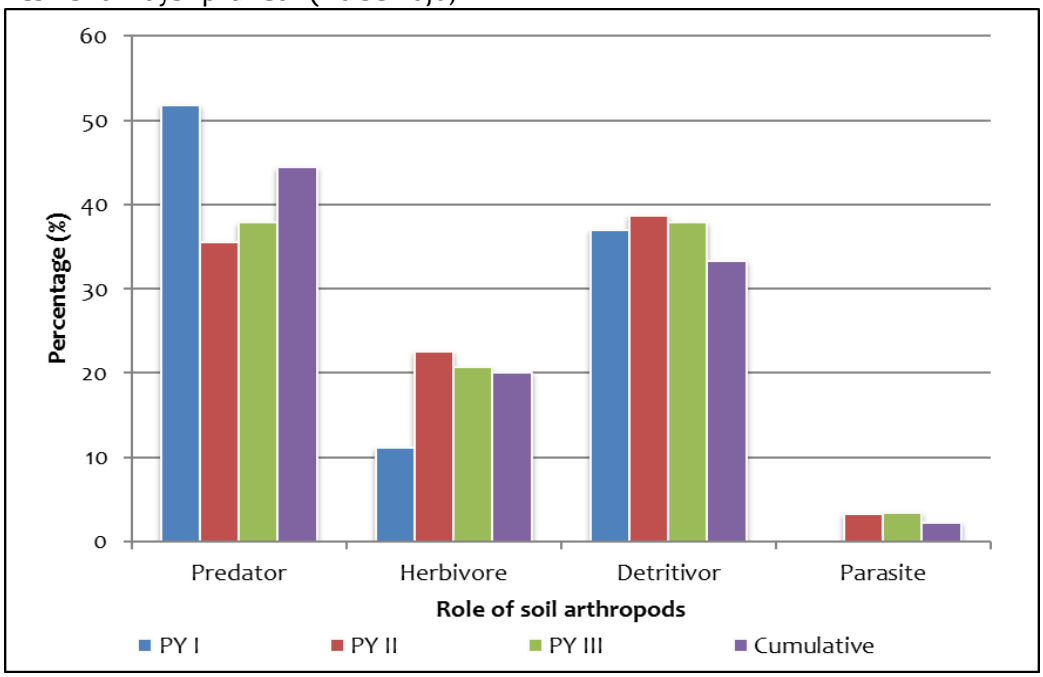

Figure 3. Proportion of soil arthropods in the tea plantation of PTPN XII Bantaran Blitar

Termitidae family is found very abundant in tea plantation PTPN XII Bantaran Blitar. Termitidae family abundance is caused by the availability of organic matter from the tea plant pruning. Termitidae is a primary decomposer of plant litter on the soil surface. Termitidae lives in colonies by making a nest in the ground, eat of dead wood and litter above the ground surface (Handru, *et al*., 2012).

Coleoptera order is order of soil arthropod which is cumulatively most common in the tea plantation of PTPN XII Bantaran Blitar. Coleoptera order can survive to all kinds of habitat and various types of food (Borror et al., 1996). Coleoptera order mostly roles as herbivores, some role as predators and as scavengers (Siwi, 1993). Cumulative? role of soil arthropods that are found in tea plantation of PTPN XII Bantaran Blitar is as predator. Predators can consume on more than one prey to complete the life cycle (Untung, 2006).

Table 2. Community analysis results

	PY I	PY II	PY III	Cumulative
Taxon number	28	31	29	45
Individul number	904	491	515	1.910
Diversity index of Shannon	2,19	2,52	2,58	2,70

The community analysis results of soil arthropods show that there are 45 taxon and the taxon number most commonly is found on PY II, the highest individual number is on PY I and the highest diversity index is on PY III, with the Shannon diversity index score: 2,58 (Table 2).

The greater species number and the more evenly species abundance, the community diversity will be higher. The high diversity in the community, a certain species population can not be dominant. In contrast, the low diversity in the community, one or two species may be dominant (Oka, 2005). In the diverse communities, a species can not be more dominant than the other, while in the less diverse communities, one or two species can achieve greater density than others (Price, 1997).

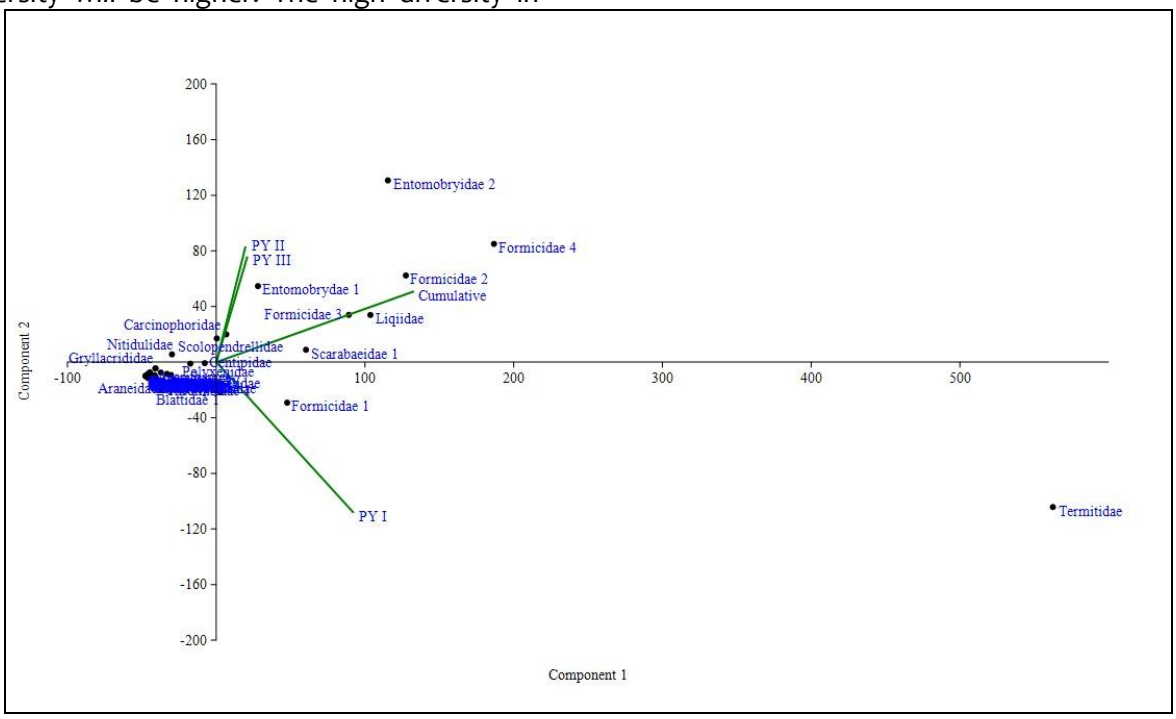

Figure 4. PCA of soil arthropod in the tea plantation of PTPN XII Bantaran Blitar

The result of PCA shows that Formicidae 2 family Hymenoptera order cumulatively characterizes the tea plantation of PTPN XII Bantaran Blitar. While Entomobrydae I family Collembola order characterizes PY II and PY III.

Dry season and increasing atmosphere temperature can contribute to increase the tea pest population due to short incubation period (Baruah *et al.*, 2012). Soil temperature greatly affects the activity of soil arthropods (Hanafiah, 2005). Activities of soil arthropods are very limited at temperatures below 10°C, the optimum activity rate of soil arthropods occur at temperatures 18 to 30°C.

The tea plants are influenced by excess and shortage of water. Growth, development

and yield of tea depend on soil humidity status (Bhagat *et al.*, 2010).

The humidity has an important role in changing temperature effect. In terrestrial environment there is very close interaction between temperature and humidity (Kramadibrata, 1995).

The humidity is an important factor affecting the distribution, activities and development of soil arthropods (Jumar, 2000). Average of soil water content in the tea plantation of PTPN XII Bantaran Blitar is 31,67%. Soil water content are low when less than 50%.

The pH value of the soil in the tea plantation of PTPN XII Blitar Bantaran is average 4.90. Soil with pH 4,5 to 5,5 is acidic (Sulaeman *et al*., 2005). Average of soil organic matter, organic carbon and total N from the analysis are respectively 2,63%, 1,48% and 0,2%. Soil organic matter with the value of 1,70 to 3,00%, organic carbon from 1,00 to 1,80 and total N amounted from 0,15 to 0,25 classified as moderate. While the C/N ratio of the soil analysis results is 7,67. C/N ratio is less than 10 classified as very low (Hazelton and Murphy, 2007).

Table 3. Soil analysis results

	PY I	PY II	PY III	Mean
Temperature (°C)	30,44	31,62	30,43	30,83
Humidity (%)	71,77	74,64	73,44	73,28
Water content (%)	33	34	28	31,67
pH	4,73	4,93	5,03	4,90
Organic matter (%)	2,73	2,66	2,51	2,63
C-organic (%)	1,43	1,54	1,46	1,48
N total (%)	0,21	0,2	0,19	0,20
C/N ratio	7,33	8	7,67	7,67

5. Conclusion

Soil arthropods were found very abundant in tea plantation of PTPN XII Bantaran Blitar is Termitidae family. The existence of Hymenoptera order Formicidae family is a characteristic that can be found in tea plantation of PTPN XII Bantaran Blitar. Cumulatively Coleoptera order has the highest percentage. Soil arthropods are found mostly acts as predators. The highest diversity is found in PY III with Shannon diversity index: 2,58.

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