Composition and structure community of arthropods in organic and conventional arabica coffee plantation

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Abstract. A series of observation was conducted in Arabica coffee plantation, in Bener Meriah Regency of Aceh Province, Indonesia. We investigated the difference of arthropods biodiversity in Arabica coffee plantation between organic and conventional farming system. The result showed that the composition and structure community of the arthropods in organic coffee plantation were higher than those of the conventional ones. In coffee plantations that are managed organically the number of orders and family of arthropod are far more than conventional ones, namely (10 orders, 65 families) and (7 orders, 31 families) respectively. Some of the arthropod species that were collected potentially have a role as predators or parasitoids of insect pests on the coffee plant. On organic coffee, fields were found 7 orders, 20 families and 45 species of arthropod that were potential as natural enemies of insect pests, while in conventional land only 4 orders, 13 families and 32 species were found. The others have a role as decomposers, pollinators, etc. The result of this research indicated that the organic farming system of coffee plantation has played an important role in maintaining the biodiversity of the insects in a coffee plantation.

1. Introduction
The problem of pest attack is still a major obstacle in the cultivation of arabica coffee plants, thus reducing the production of coffee beans in both quantity and quality. Inorganically grown crops, the presence of pests can generally be balanced by the presence of various natural enemies of pests. On the other hand, plantations that are managed conventionally (inorganic), even though pesticides have been used intensively, but the problem of pest attack still continues to occur even the problems are increasingly complex. This is presumably because in the conventionally grown crops there has been a drastic decline in the population of various natural enemy species due to being killed by various harmful chemical compounds [1-3].

Information about biodiversity in coffee plantation areas is needed in supporting the development of this commodity organically for the realization of sustainable agricultural systems and based on ecosystem sustainability. One very important component that plays a role in controlling various pests in coffee plants is predatory arthropods and parasitoid insects.

Due to the increasingly international market demand for coffee products that are free from contamination of chemical compounds, the expansion of the organic coffee plantation area must receive serious attention.
from all parties. One method of pest control that is very efficient and free of pesticide use is through the use of natural enemies of pests in the field. Therefore, efforts to inventory and preserve domestic natural enemies in coffee plantations are very urgent.

2. Research Methods
This study began by collecting various Arthropods species from Arabica coffee plantations in Aceh Tengah Regency and continued identification at the Biological Control Laboratory, Faculty of Agriculture, Syiah Kuala University. Arthropod species that were not able to be identified at the laboratory were identified in the Insect Bio-taxonomy Laboratory, Faculty of Agriculture, Bogor Agricultural Institute.

2.1. Research location
This study uses a survey method, to determine the diversity of arthropods in Arabica coffee plantations. Arthropods sampling method was carried out by purposive sampling method both in inorganic and organic coffee plantations. The sampling location was selected for coffee plantations that were managed inorganic and organic at an altitude of 1,100 - 1,300 m above sea level with an area of at least 10 Ha. Generally, the coffee plantation area in Aceh Tengah Regency is at this height, which is the most ideal condition for the growth of Gayo arabica coffee.

2.2. Sampling of Arthropods
The arthropods sampling was carried out by placing traps that were carried out three times in a period of two months. There are four types of traps used, namely pitfall trap, yellow-pan trap, light trap, and malaise trap. In both organic and inorganic coffee plantations, a plot of 1 Ha was chosen. Inside the plot are 4 pitfall traps, 4 yellow pan traps, 2 malaise traps, and 2 light traps. Pitfall trap and yellow-trap trap are filled with a mixture of water and detergent for up to half. Pitfall trap, yellow-pan trap, and malaise trap are installed for 12 hours starting from 6 am to 6 pm. Meanwhile, light traps were installed at night for 12 hours, from 6 pm to 6 am. In one plot, two light traps are installed by hanging on a wooden branch or milestone at a height of ± 3m. At the bottom of the light trap, a basin is installed which has been filled with a mixture of water and detergent which serves as a trap for Arthropods.

Every arthropod trapped, collected and then taken to the laboratory to be sorted and identified to the level of morphospecies. The morphology of the Arthropods was observed under a stereo-microscope (Olympus SZ51). To simplify the identification process, several guidebooks for insects and other arthropods identification are used (e.g. [4-6]). All arthropods that have the potential as natural enemies of coffee plant pests are photographed with a camera microscope (Leica M205C).

2.3. Variables observed
The variables observed are the composition and structure of the arthropod community. The arthropod composition (based on family) was also observed which has potential as a natural enemy for various coffee plant pests.

3. Results and Discussion
The composition and community structure of arthropods (based on the order) can be seen in Figure 1. In coffee plantations that are managed organically the number of orders of Arthropods is far more than conventional coffee plantations. The number of orders and families of arthropods in organic coffee plantation is 10 orders, 65 families and 125 species respectively, while those numbers in conventional one there are 7 orders, 31 families and 74 species respectively. This indicates that the organic farming system has played an important role in maintaining the biodiversity of the insects and other arthropod species in a coffee plantation. On the other hand, coffee plantations that are conventionally managed have decreased
arthropods populations, or even caused the extinction of several arthropod species. The use of synthetic pesticides in controlling pests or weeds intensively in coffee plantations that are managed conventionally is thought to have caused a decline in the population of arthropods. Research conducted by [7] also shows that the insect population in cow dung pats in the nature area and organic farmland is 50% higher than in conventional farmland. Various studies reviewed by [8] related to the influence of organic and conventional farming systems on insect populations. The results of the review show that in organic farmland species richness and abundance of insect populations are higher compared to conventional agricultural land. In organic farms, the abundance of insect species is 34% higher than conventional agricultural land.

In this study, we also investigated the differences in the composition and structure of arthropod communities that have potential as natural enemies found in organic with those found in conventional coffee fields. The results of the study showed that organic coffee fields were found to have a higher diversity of arthropods which had potential as a natural enemy compared to conventional coffee fields. On organic coffee, fields were found 7 orders, 20 families and 45 species of arthropod that were potential as natural enemies of insect pests, while in conventional land only 4 orders, 13 families and 32 species were found (Table 1).

**Figure 1.** The difference Arthropods biodiversity between organic and conventional coffee plantations (1,100 – 1,300 m altitude)

Generally, in organically-managed coffee plantations, populations of arthropods that are potentially as natural enemies are much higher than those conventional ones. It indicates that the applications of insecticides and various other chemical compounds in the conventional coffee plantation have a negative impact on the natural enemies of coffee plant pests. Quite a lot of research results show that the use of broad-spectrum synthetic pesticides is very bad for the natural enemies of insect pests [1-3]. Broad spectrum pesticides such as organophosphate disruptive to beneficial species, such as natural enemies and facilitate secondary pest outbreaks [4].
Table 1. Arthropods that function as natural enemies in organic and conventional coffee plantations

| Predator | Organic coffee plantation | Conventional coffee plantation |
|----------|---------------------------|--------------------------------|
|          | Order | Family | Total Species | Individual | Order | Family | Total Species | Individual |
| Hymenoptera | Formicidae | 14 | 1.901 | Hymenoptera | Formicidae | 12 | 2.922 |
|           | Vespidae | 1 | 3 | Vespidae | 1 | 16 |
|           | Dolichopodidae | 3 | 11 | Dolichopodidae | 2 | 2 |
| Diptera   | Asilidae | 1 | 1 | Syrphidae | 1 | 94 |
|           | Syrphidae | 1 | 2 | Lycosidae | 1 | 15 |
|           | Vespidae | 1 | 3 | Clubionidae | 1 | 10 |
|           | Dolichopodidae | 2 | 9 |
|           | Empididae | 1 | 3 | Trichoptera | 2 | 5 |
|           | Nabidae | 1 | 42 | Araneidea | 1 | 1 |
|           | Reduvidae | 2 | 9 | Hydropsychidae | 1 | 10 |
| Mantoidea | Mantidae | 1 | 1 |
|           | Staphylinidae | 1 |
| Coleoptera | Carabidae | 3 | 14 |
|           | 2 | 2 |
| Areneae   | Lycosidae | 1 | 16 |
|           | Clubionidae | 1 | 5 |
|           | Nephilidae | 1 | 6 |
|           | Araneidea | 1 | 1 |
|           | Hydropsychidae | 1 | 243 |
| Tot al    | 7 | 16 | 35 | 4 | 8 | 21 |
| Parasitoid | Ichneumonidae | 4 | 55 | Ichneumonidae | 4 | 20 |
|           | Braconidae | 4 | 54 | Braconidae | 3 | 40 |
|           | Torymidae | 1 | 1 | Eulopidae | 1 | 1 |
|           | Bethylidae | 1 | 1 | Sclionidae | 1 | 1 |
|           | Torimidae | 1 | 1 |
| Tot al    | 1 | 4 | 10 | 1 | 5 | 10 |

### 4. Conclusion
The composition and structure community of the arthropods in organic coffee plantation were higher than those of the conventional ones. In coffee plantations that are managed organically the number of orders and family of arthropod are far more than conventional ones, namely (10 orders, 65 families) and (7 orders, 31 families) respectively. On organic coffee, fields were found 7 orders, 20 families and 45 species of arthropod that were potential as natural enemies of insect pests, while in conventional land only 4 orders, 13 families and 32 species were found.
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