

The Diversity of Arthropods at the Arabica Coffee Plantation in Atang Jungket Village, Aceh Tengah District, Indonesia

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ABSTRACT

This research was conducted on an Arabica coffee plantation that was organically managed in Atang Jungket Village, Aceh Tengah District, Aceh Province. Sampling using a purposive sampling method with the 5-hectare land area at altitude 1400 m above sea level. The results showed that arthropods found in arabica coffee plantations consist of 2 classes, 12 orders, and 72 families. The order of Hymenoptera was the dominant order (39.72%), followed by Diptera (34.72%), Araneae (9.46%), Coleoptera (8.06%) and other orders (Hemiptera, Blatodea, Homoptera, Lepidoptera, Mantodea, Mecoptera, Orthoptera and Psocoptera) that is 8.05%. The high abundance of arthropods in an agro-ecosystem is related to the stability of the environment, where the food chain is still well-established.

Key Words: Araneae, Biodiversity, Coffee plant, Coleoptera, Diptera, Hymenoptera.

1. INTRODUCTION

The species diversity in a field is said to be high if a community is made up of many species, where the species abundance is identical or almost identical and Vice versa, if a land has few species and also with a few dominant species, thus the diversity of the species on the land is said to be low [1]. When species diversity is high, it indicates that a community has a high complexity because the occurring of high inter-species interaction within a community. Thus, in a community with high species diversity, there will be species interactions involving energy transfer (the food net), predation, competition, and theoretically very complex niche divisions [26].

Yusnita reported that in smallholder coffee farm in Karang Tengah Village, Bogor City, showed that the number of arthropods found in 12 observations was 20,117 individuals consisting of 6 classes including Arachnida, Chilopoda, Collembola, Diplopoda, Insecta, and Malacostraca. Predators commonly found including those in Family Araneidae, Linyphidae, Oxyopidae, Tetragnathidae, Thomisidae, Dolichopodidae, Reduvidae, Formicidae, Gryllidae, and Staphylinidae. The presence of predatory insects on coffee plantation land is determined by several factors such as feed sources, temperature, and humidity. All of these factors greatly affect the types of arthropods that exist in coffee plantations[13].

The use of broad-spectrum synthetic pesticides will exterminate all natural enemies and other organisms that are not targeted within the ecosystem [18]. The diversity of species is very important within one ecosystem because it simply proves that the ecosystem is still good and natural. Biodiversity has an important role within an ecosystem that affects agricultural ecosystems, human health, natural resources, and the development of other knowledge fields [14].

The abundance of arthropods in coffee plantations could be an indication of, either the presence or absence of contamination of harmful chemical compounds in coffee beans. Sustainable coffee agroecosystem (sustainable coffee) becomes an important issue in the world coffee trade with certification as one of its instruments.

Arthropods are the most dominant phylum among other animal phyla when it viewed from its diversity, distribution, and number of species. This success is associated with segmentation, a hard exoskeleton, and segmented legs. The body itself was covered with cuticles and exoskeleton. Arthropods are well known to be adaptable to the environment due to the presence of

well-developed sensory organs including the eyes, olfactory receptors for smell and the antenna for both, touching and smelling [20].

Based on the problem, it is necessary to study the diversity of arthropod in arabica coffee plantation agroecosystem in Aceh Tengah District to determine the quality of ecosystem.

2. MATERIAL AND METHODS

2.1 Determination of Sampling Location

The sampling location was conducted on the arabica semi-organic coffee plantation in Atang Jungket Village, Aceh Tengah District, Aceh Province. It located 1,400 m above sea level. The coffee plant used as the sample is the arabica coffee plant Gayo I varieties aged 20 years. In this cultivated land, the use of pesticides is relatively small where only selective herbicide types are used to control weeds which applied once per year. Coffee fruit waste is utilized as an organic fertilizer applied to the land by spreading it on the soil surface.

2.2 Sampling Method

Sampling was conducted by using purposive sampling method, four sample points on coffee plantation which managed semi-organically was selected. The sampling area is 5 Ha and divided into 5 sample blocks with 1 ha/block area. At each sample site, four sample points were determined by 4×4 m / sample point, then mounted a model trap device with a height of 1.5 m from the ground surface. Arthropod sampling was conducted every two weeks for three months.

In each trap was filled with methanol 100% as much as 10 ml and on the outside, the trap was smeared with a clear glue adhesive that serves to trap insects. Installation of traps organized in the morning (at 8:00). After 24 hours, the trap was released then the trapped arthropod was inserted into a 50 ml film bottle containing alcohol 70%. Next, they separated per individual and identified by using a binocular microscope (Swip type SM-80) up to family level. Identification was done using key identification according to Borror et al. [4].

3. RESULTS AND DISCUSSION

3.1 Composition and Abundance of Arthropods

Arthropods have an important role in an ecosystem, especially in terms of the food chain. The role of arthropods includes detritivore, herbivore, predator, and parasitoid. Detritivore arthropod is an organism which gaining energy by eating the remains of living things such as dead animals, dead plants, and deciduous leaves. Herbivore arthropods are an organism that utilizes plants as a food source. Predator arthropods are an arthropod which preys upon other arthropods, including prey on insect pests. Furthermore, explained that parasitoid arthropods are an organism that obtains food and spends some life cycle in the body of another organism (host) [9].

The life of arthropods depends heavily on the existence and density of the population. It is closely related to environmental factors, both abiotic and biotic. Arthropods play an important role in agricultural ecosystems, since they play a role in food webs, be it as herbivores, carnivores, and detritivores, for example, helping to decompose the soil in dissolving the larger substances into smaller sizes. In addition, arthropods could also become a detrimental and beneficial to human life [6]. Parasitoids are important natural enemies for most plant pests and acting as a key species in some ecosystems. Parasitoids are able to control pests specifically and their population in the field is relatively high [9]. Predators are specialized for hunting on other organisms that live freely in nature to meet the needs of life and could attack from the pre-adult phase to the adult phase. Predators need several preys during their lives so that they could be utilized in suppressing the number of pest populations in the field.

The results showed that there were 12 arthropod obtained from coffee plantations in Atang Jeungket Village. The abundance of arthropods varies widely, namely Hymenoptera (39.72%), Diptera (34.72%), Araneae (9.46%), Coleoptera (8.06%), while other orders only 8.05% are Blattodea, Hemiptera, Homoptera, Lepidoptera, Mantodea, Mecoptera, Orthoptera, and Psocoptera (Figure 1).

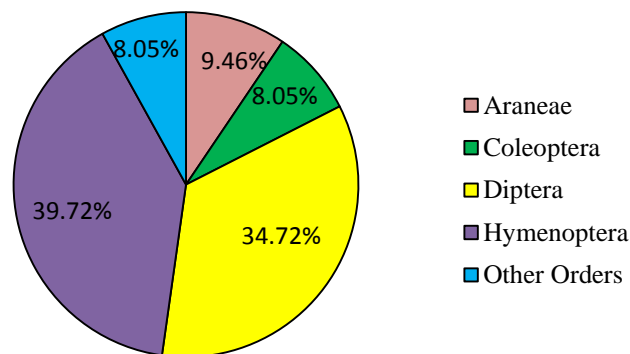


Figure1. Percentage of Arthropod Abundance Based on Order at Atang Jungket Village Coffee Plantation.

Figure 1 shows that the dominant arthropod is the Hymenoptera order of 39.72%, followed by Diptera (34.72%), Araneae (9.46%), Coleoptera (8.05%) and other orders 8.05 % consisting of Hemiptera, Homoptera, Blattodea, Lepidoptera, Mantodea, Orthoptera, Mecoptera, and Psocoptera. The high percentage of insects of the Hymenoptera order found to be associated with the role of these insects on coffee plantations besides acting as parasitoids, predators, pollinators and also including social insects. This is in accordance with the study results conducted by Perdana, the Hymenoptera order is one of the most dominant orders in insect classes, both in terms of species count and distribution in various habitats. Members of this order largely act as social insects and partly act as solitary insects that play an important role in human life such as helping pollination, parasitoids, and predators. This is instrumental in maintaining the balance of agroecosystems. Furthermore, Diptera is also have a high number of population and this is related to the condition of research land which has a high moisture level of soil and stored an amount of organic waste contained in the coffee planting land [23].

In this study the insects of the dominant Hymenoptera order were the Ichneumonidae (52.92%) and Formicidae (32.73%), followed by other families ie Apidae, Eulophidae, Braconidae, Diapriidae, Colletidae, Bethyidae, Platygasteridae, Tiphiidae, Megaspilidae, Aphelinidae, Apoidea and Tenthredinidae as many as 14.35% (Figure 2).

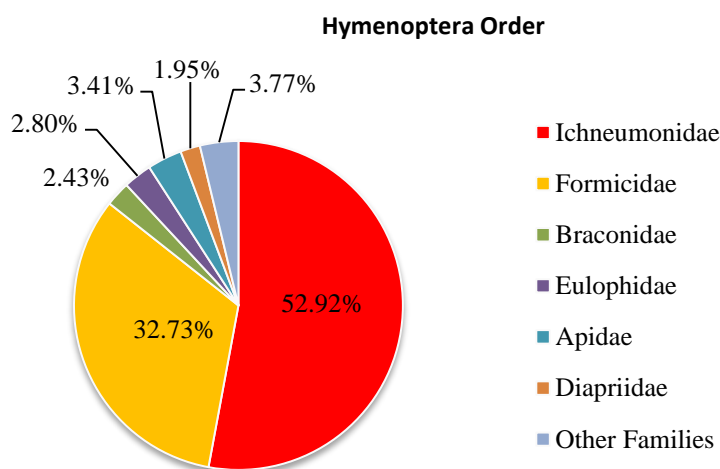


Figure 2. Percentage Abundance of Hymenoptera by Family in Atang Jungket Village Coffee Plantation.

The high percentage of trapped Ichneumonidae proves that the insects from this particular family are widespread in the arabica coffee plantation in Atang Jungket Village, Aceh Tengah District. Family Ichneumonidae are parasitoids that parasitize insect pests in coffee or other insects. Then followed by the family Formicidae which is a predator in several other insect pests. This is similar with the results of Hamdi et al. that the parasitoids of the Ichneumonidae family are the most dominant compared to other families, both in organic and inorganic coffee plantations [25]. Furthermore, Yusnita added that, on coffee plantations in Bogor, the Formicidae is quite dominant even though the population is still below the Ichneumonidae family [13]. This is in accordance with the opinion of Atkins, members of the family Formicidae found in many humid state areas and around the tropical rainforest [17]. Ant is to be included as a generalist predator and have a real influence on the ecosystem. Because of its ability to stabilize and regulate insect pest populations, the presence of these predators is indispensable in ecosystems [7]. Ants are widely found in clusters of coffee fruits and in primer branches of plants. In the primary branch (plagiotropic) plants, ant nests are

found in some plant samples. Ant needs for protein, carbohydrates, sugars, and other minerals can be found in parts of coffee plants such as on the leaves, flowers and fruit. Besides the available feed on the coffee tree canopy, generally, ants also get shelter space which made by combining some leaves or nesting on the sidelines of the fruit clusters. Another factor that affects the abundance of ants is that ants are attracted to honeydew released by Psyllidae [3]

Diptera is one of the largest orders of insects which have many roles in the environment, including the phytophage, entomophage and saprophage. In this study the insects of the Diptera are at most Muscidae (23.97%), followed by Sciaridae (21.06%), Tephritidae (15.47%), Dolichopodidae (9.74%), Drosophilidae (5.87%), Phoridae (5.59%) and other families (Stratiomidae, Scathophagidae, and Syrphidae) were 12.90% (Figure 3).

The high percentage of flies of the Muscidae family is related to the conditions in the coffee plantation area, such as the wet environment and considerable organic trashes on the coffee cultivation land, in accordance with the flies habitat for either laying eggs or feed availability for them. In accordance with the study conducted by Borrer et al., they revealed that generally flies from the Muscidae family could become pests for plants and also acted as a disease vector. Besides the high percentage of the population of the Muscidae family, Sciaridae family, and Tephritidae family, it is also suspected caused by the availability of fruits as its host like jackfruit and avocado are used as intercrops in the location of coffee plantations. At the time the study was conducted, the plant was in a fruitful condition, so it is suspected to be the cause of the many fruit flies which trapped, mostly come from Tephritidae Family. Flies from Tephritidae family are not a pest on coffee plants [4].

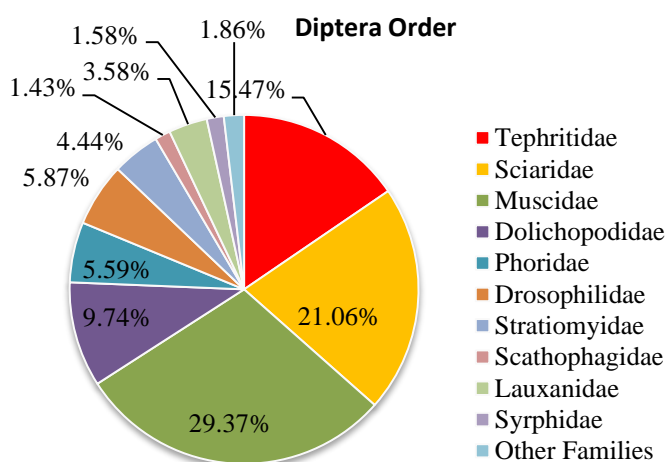


Figure 3. Percentage Abundance of Diptera by family in Atang Jungket Village Coffee Plantation.

Coleoptera order insects play an important role in the environment, either as a pollinator, predator, decomposer, or phytophage. In addition, the order of Coleoptera could also be a bioindicator in an environment. The bioindicator is a group of organisms that are sensitive to changes in the environment so that its existence can be used as a benchmark of an environment. In accordance with the opinion of Mc Geoch, which stated that the bioindicator or ecological indicator is a sensitive taxon or group of organisms and showed a response to environmental changes both due to human activities and due to the damage occurred to biotic systems [19]. Furthermore, Shahabuddin added that the group of insect which included as bioindicator comes from the Coleoptera order is Scarabidae, Carabidae and Cicindeliidae [24].

The type of insect from Coleoptera order in this study, which is often and mostly trapped was Scolytidae family (60.84%), followed by Scarabidae (6.02%), Curculionidae (4.82%), Carabidae (3.01%), Coccinellidae (1.81%) and other families (23.49%). The high population of Scolytidae family insects in this study is related to the main insect pests of coffee fruit borer, *Hypothenemus hampei* which exist in coffee plantation area (Figure 4). In addition, most insects from this family are herbivore type with a population density value of 0.02 individuals/m², while the resulting relative population density is 0.04%. This suggests that the insects are often present in the field of observation and the spread of these insects is widespread in the area of coffee cultivation. In accordance with Nainggolan research which states that the relative frequency indicates the presence of a type of insect in the habitat and can illustrate the spread of this type of insect [8]. Furthermore, Krebs added that the more heterogeneous physical environment, the more complex the flora and fauna community within an area and also the more diverse the insect types would become [16].

Within some ecosystem, spider has an important role as a predator, especially prey on insects so that it plays a role in controlling the population of insect pests. Spiders could be used as potential biological control agents for various insect pest species because they are polyphagous [15]. All spiders of Araneae order are predators and dispatch their prey by injecting toxins

into the body of their prey in different ways, depending on the species. Most spiders snare their prey in a web or cobweb. Some of these webs are covered by a very sticky small material and set as a place to trap a prey [4].

The results showed that the highest percentage of the Araneae order was the Salticidae family (53.37%), followed by Zodariidae (14.61%), Clubionidae (7.30%), Eutichuridae (6.18%) (as well as other families of 12.90%) (Figure 5). The existence of spider on coffee plantation proves that a condition of agro-ecosystem of coffee plant still stable and insect pest population still in general balanced position.

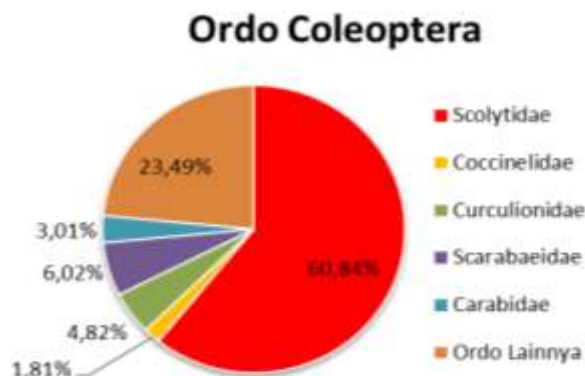


Figure 4. Percentage Abundance Coleoptera Order based on the family at Atang Jungket Village Coffee Plantation.

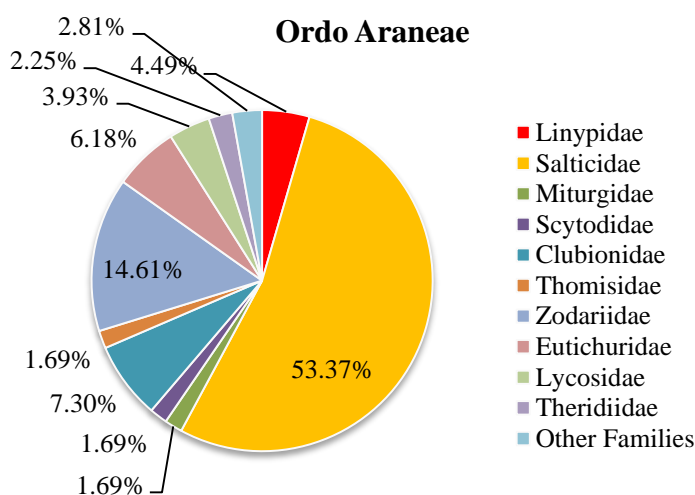


Figure 5. Percentage Abundance of Araneae based on family at Atang Jungket Village Coffee Plantation.

According to Suana, spider habitat is very abundant and diverse. Spiders will move from one habitat to another if the place they left behind is no longer habitable [10]. Suana & Haryanto added that the high abundance of spiders in a plantation may not necessarily be a natural enemy for pests [12]. Each of the spider species has different, both active times and prey types. The more diverse the species of spider, then the greater its potential in controlling various pests [11, 12].

The study results showed that the highest percentage of the population is the spider of the Salticidae family, the most adaptable as well as having a widespread. That result also have a similar conclusion from a study conducted by Peng et al. which displayed that 13% of all spiders in the world belong to the members of the Salticidae family [28]. Spiders from this family have no nest to trap their prey because this spider is a type of hunter which will stalk and strike on its prey by making use of the sense of sight and the ability to do long distance jump [5].

The Zodariidae family is the second highest population percentage within a family which including small spider hunters, known as antspiders, spider that resemble ants. The high percentage of this family is linked to the local ecosystem situation that is overgrown by annual plants so that the surface of the soil fulfilled with many fallen leaves which causing it enriched with high organic substances [22]. Pekar & Kral also revealed that the spiders of the Zodariidae family roaming actively on ground surface and keen to hide behind leaves litter to avoid predators as well as performing camouflage by using the form of small insects [27].

The distribution of arthropods in an ecosystem is strongly influenced by climatic conditions and the availability of hosts which present within the habitat. According to McPherson & Steck, the population generality of the insect species is influenced by

several factors including climate, host, and a high reproductive potency. Insect life is considered to be successful if supported by a factor of rapid adaptability to extreme environments and having a short life cycle [2]. Generally, the diversity and abundance of insects are determined by certain environmental factors such as temperature and humidity. The temperature will affect insect activity, geographical spread, and also its development, while the environmental moisture affects the body's water content, which has an effect on the choice of the habitat of its life [13, 21].

4. CONCLUSION

The level of arthropod diversity in coffee plantations in Atang Jungket Village of Bener Meriah District is high. The highest percentage of insects is the order of Hymenoptera as high as 39,72%.

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