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Arthropod Abundance in Different Vegetation in Nutmeg Plantation in Aceh Province

Muhammad Sayuthi[1*], Hasnah[2]

[1] *Study Program of Plant Protection, Faculty of Agriculture, Universitas Syiah Kuala, Aceh, Indonesia*
[2] *Study Program of Plant Protection, Faculty of Agriculture, Universitas Syiah Kuala, Aceh, Indonesia*

**Corresponding author: say_m2001@unsyiah.ac.id*

Abstract

Nutmeg (Myristica fragrans Hout) is a leading commodity from Aceh Province. The high yield of nutmeg oil and its distinctive aroma makes it in demand by the world market. The production of nutmeg plants is currently decreasing due to the disturbance of nuisance organisms so that nutmeg plants get sick and die. Appropriate agro eco-management of the nutmeg system is thought to overcome these problems. Such as by conserving the diversity of arthropod communities. Information regarding the presence of arthropods in nutmeg cultivation is very limited in South Aceh District. This study investigates the abundance of arthropods in nutmeg cultivation in different vegetation to detect the causes of the decline in nutmeg production in the South Aceh district. Sampling was carried out at 2 locations with different vegetation conditions, using the determining sub-samples. Each location consisted of 200 individual nutmeg plants, and at each location, several 20 individual nutmeg plants were assigned as samples. The results showed that the total collection of arthropod populations at the location I found nine orders, namely Araneae, Coleoptera, Dermaptera, Diptera, Homoptera, Hemiptera, Hymenoptera, Isoptera, and Orthoptera. Location II found 12 orders, namely Araneae, Blattodea, Coleoptera, Dermaptera, Diptera, Embioptera, Homoptera, Hemiptera, Hymenoptera, Isoptera, Orthoptera, and Phasmatodea). The class of insects and arachnids found at these two locations is part of the Phylum Arthropoda.

Keywords: diversity, arthropods, nutmeg plants, vegetation, abundance

Background

Indonesia is the largest nutmeg-producing country globally (Anwar, 2017). Nutmeg from Aceh produces high oil yields with a distinctive aroma. So that it becomes an advantage in reaching the world market (Drazat, 2007). Nutmeg cultivation is located in South Aceh Regency, owned by the people with a production level of 5,747 tons with more than 15,821 ha (Directorate General of Plantations, 2017). In recent years, nutmeg production has decreased by up to 50% due to attacks by Plant Pest Organisms, such as stem borer (Bactocera hercules) attacks (Triarko, 2018). Various ways have been done to overcome this problem. However, it has not solved its completion. Farmers have tried to replace sick nutmeg crops with healthy ones. However, pest and disease attacks still occur (Anwar, 2017).

The use of pesticides has a negative impact on the environment and can reduce the diversity and abundance of arthropod species in the location. Pesticides can also kill non-target insects in the nutmeg plantation area (Davis et al., 1998). Community diversity in an agricultural ecosystem consists of many types and each type can show its influence on the environment. In an agroecosystem, not all types of arthropods are harmful to plants, but some arthropods benefit plants in a cropping location (Odum, 1998).

Proper management of the nutmeg agroecosystem is thought to overcome the problem of pests and plant diseases in nutmeg plantations by conserving the diversity of the arthropod community to maintain a balance between flora and fauna in the agroecosystem so that everything runs according to its position and function. The hope is that environmental conditions can function normally again. Information on the diversity and abundance of arthropods in nutmeg cultivation is still very limited in South Aceh District, and it is necessary to explore the arthropod community, which is the first step in implementing management techniques by utilizing existing enemies.

Monitoring agroecosystem components, especially arthropods, needs to be equipped with information on the number of individuals, their role in an agroecosystem, and various factors that influence it.

This study aims to study the diversity of arthropods in nutmeg plantations with different vegetation in an effort to detect the causes of the decline in nutmeg production in South Aceh district.

Methods

This research was carried out on a nutmeg plantation in Batu Merah Village, Tapaktuan District, South Aceh Regency, and at the Plant Pest Laboratory of the Plant Protection Study Program, Faculty of Agriculture, Universitas Syiah Kuala, from November to June 2020. Ingredient the materials used in this study were plywood, used aqua glass (240 ml), transparent plastic bags, 100% methanol, wire, brown and black plastic bags, and waxed plastic (2.8x20 cm), double-sided tape, no clear glue, odors, stationery, label paper, edible oil, and 70% alcohol. While the tools used are a binocular microscope (Type Swift SM-80), spet (10 ml), knife, tweezers, sample bottle (20 ml), meter, scissors, thermometer, hygrometer, and magnifying glass. The sampling collection was carried out in the village of Batu Merah, Tapaktuan District, South Aceh Regency. Sampling was carried out at 2 locations with different criteria for each location. The location I with an area of 1 hectare and there are 200 individual nutmeg plants aged 15 years.

This location contains several types of plants such as mango, areca nut, kuwini, bay leaves, jamblang, coconut, rambutan, star fruit and lemon as well as various types of broadleaf weeds. Location II, with an area of 1 hectare and there are 200 individual nutmeg plants aged 30 years. Several types of plants are similar to location I. The types of plants found in location II are: kuwini, areca nut, bamboo and jackfruit as well as broad-leaved and narrow-leaf weeds. The following is the condition of nutmeg plants at locations I and II with different vegetation (Figure 1).

Figure 1. (a) Location-I: age of nutmeg plant 15 years. (b) Location-II: age of nutmeg plant 30 years

Location II is located at an altitude of ±110 m above sea level and the age of nutmeg plants growing at this location has reached 30 years. Nutmeg plant height is ±10 m and the average diameter is 64.8 cm. Apart from nutmeg, other types of plants were also found in this location, such as *Mangifera odorata, Areca catechu L., Bambuseae sp,* and jackfruit *Artocarpus heterophyllus,* as well as several types of weeds such as *Neprolepis biserrata, babadotan, Ageratum conyzoides, Chromolaena odorata* and *Melastoma affine*. The distance between location I and location II is ±0.5 km. The distance between nutmeg plants at locations I and II is 7 x 7 m.

a. Determination of Sub-Sample

Two hundred individual nutmeg plants were available at Location I (15 years old nutmeg plant) and II location (30 years old nutmeg plant). Only 20 individual nutmeg plants were used for each location. Sub-sampling was carried out using the diagonal slice method by setting five sub-

samples from both locations, and each sub-sampling used only four plants as representatives of each sub-sample.

b. Trapping and Sampling Arthropods

The trapping technique was carried out using the following Brown-Black Sticky Trap (BBST) and Plastic Panel Trap (PPT) methods:

BBST trap method. This method uses a plywood board measuring 25×25 cm covered with black and brown plastic mounted like a propeller and perpendicular. The surface is given a clear and odorless glue. The bottom surface of the plywood board is placed in a bottle that has been inserted in clear colored wax plastic and filled with 10 ml of 100% methanol which functions as an attractant. Next, the clear wax plastic bag that has been prepared is pierced first and done manually using a pin. The stabbing was carried out 10 times so that the aroma from the methanol would come out and the arthropods would approach the trap, which was hung on a nutmeg plant at the height of 1.5 m above the ground (Priawandiputra and Agus 2015).

PPT trap method. This method uses black plastic with a width of 60 cm and then wrapped into a nutmeg plant stem with a height of 1 m from the ground. After that, it was given a clear, odorless glue and sprayed with 100% methanol (Priawandiputra and Agus 2015). Installation of BBST and PPT traps was carried out at 08.00 WIB. The traps were set five times, and the interval for each repetition was one week (7 days).

c. Arthropod Sample Collection

Each arthropod trapped in BBST and PPT separately for each sample collection was put into a 20 ml bottle containing 70% alcohol. The arthropods were then identified in the laboratory

d. Identification of Trapped Arthropods

Each Arthropod collection was put into a bottle containing 70% alcohol, and taken to the Plant Pests laboratory to be identified at the family level. Identification was carried out using an introduction to the identification book of Insect Lessons Sixth Edition, written by Borror et al. (1996), the website www.bugguide.net which is managed by Isowa State University, Department of Entomology and www.barcodinglife.org which is managed by the University of Guelph.

e. Observed Variables

The variables observed in this study were as follows:

- **Arthropod diversity at location I and location II.** Observations were made by separating the arthropods from the order level, after which the number of orders, families and the number of individuals from each family was calculated.
- **Arthropod abundance at location I and location II.** Observations were made by separating arthropods from the family level, counting the number of families and tabulating them based on the sampling location.
- **Family similarity index between location I and location II.** The family similarity index was calculated using the Sorensen similar similarity index formula (Barbour et al., 1987) follows:

$$IS=2a/2a+b+c$$

Information:
IS = Sorensen similarity index
a = The same number of families are found at location I and location II
b = Number of families in location I
c = Number of families in location II

Arthropod Diversity Index between Location I and Location II calculated using the formula: Shannon-Wiener Diversity Index (Maguran, 1996), Where

$$Pi = ni/N$$

H = Shannon-Wiennner diversity index
Pi = Number of individuals in a family/total number of families
ni = Number of individuals in the i-th family
N = Total number of individuals

Results and Discussion

Arthropod Abundance at Location I and Location II

The observations related to the size of the arthropod population detected at the location I with the presence of a 15-year-old

nutmeg plant resulted in a collection of 850 arthropods. All of these individuals consist of two classes, namely Arachnida and Insects. The detected orders from the Phylum include nine orders, namely Araneae, Coleoptera, Dermaptera, Diptera, Homoptera, Hemiptera, Hymenoptera, Isoptera and Orthoptera. The order of arthropods after identification turned out to produce 125 families. Location II with a 30-year-old nutmeg plant resulted in a collection of 971 arthropods and 2 classes were detected, namely Arachnida and Insect. Araneae, Blattodea, Coleoptera, Dermaptera, Diptera, Embioptera, Homoptera, Hemiptera, Hymenoptera, Isoptera, Orthoptera and Phasmatodea. The order of Arthropods after identification turned out to have resulted in the findings of 135 families.

Location I has found nine orders of arthropods, including the order Hymenoptera which is the order with the highest population size, which produces 32%, followed by Coleoptera (31.4%), Diptera (18.6%) compared to the order Orthoptera which is the lowest population (0.2%). Location II found 12 orders of Arthropoda. The order Coleoptera produced the highest population size (33.9%), followed by Hymenoptera (24.6%), Diptera (20%), compared to the orders Embioptera and Phasmatodea which were the lowest population size (0.1%) (Figure 2).

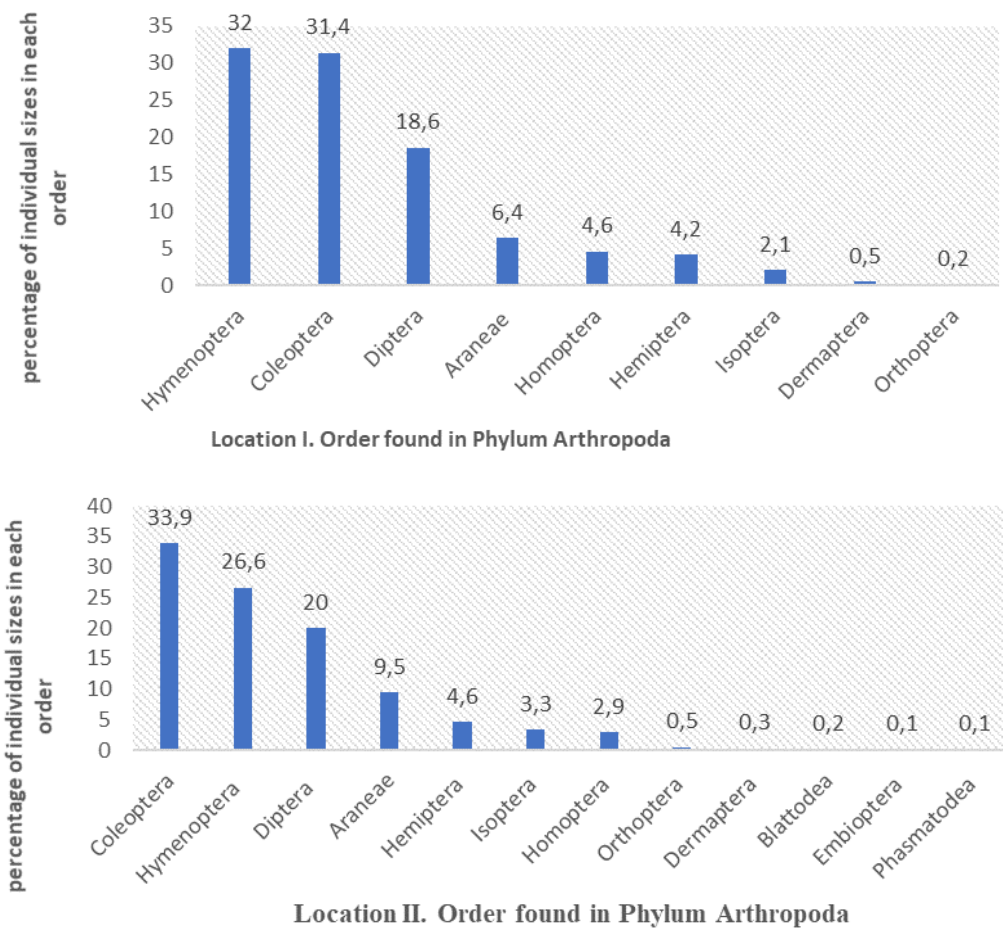

Figure 2. Percentage of arthropod orders at location I and location II

The high or low percentage of population size and arthropod diversity at the two locations is thought to be related to environmental conditions and the presence of vegetation around the nutmeg plant. Diversity of vegetation in the nutmeg plantation area (location I), such as mango, areca nut, kuwini, bay leaf, jamblang,

coconut, rambutan, star fruit, lemon and dominant broadleaf weeds, such as *Chromolaena odorata*, *Borreria leavis*, *Ageratum conyzoides* and grasses such as *Imperata cylindryca*, is a supporting factor related to the presence of insects in that location.

Location II also found several annual plants, such as areca nut, bamboo, jackfruit and broadleaf weeds including Neprolepis biserrata, kerinyu *Chromolaena odorata*, babandotan, *Ageratum conyzoides* and *Melastoma affine*. Insects of the Order Hymenoptera generally play a role in agroecosystems as predators, parasitoids and as pollinators. The presence of weeds and nutmeg at the two locations is thought to have an effect on the survival of the Order Hymenoptera, Coleoptera and Diptera or also known as alternative hosts. There are Coleoptera Orders that act as detrivores, herbivores and predators, while families from the Diptera Order have detrivores, herbivores and predators. In accordance with Yetno *et. al*. (2013) on coffee plantations, the Hymenoptera Order can act as predators and parasitoids. Furthermore, Tambunan *et. al.,* (2013) added that arthropods from the Order Hymenoptera also play a role in the process of pollinating nutmeg plants. The order Coleoptera can act as herbivores, predators and decomposers that are needed in the ecosystem (Heriza *et al*., 2016). Furthermore, according to Dennis (1994) that the Order Coleoptera has various habits such as its role in consuming nectar as food. According to Mulyani (2015) The order Diptera has a role as a pollinator.

In general, the Order Aranae (Spiders) act as pollinators but at the research location the percentage of their presence is low, this has something to do with the microclimate factor where they live with a temperature range of 26.30-28.40 °C and humidity of 89.20-92.80%, food and high rainfall at the time of the study so that it affects the population. In accordance with the opinion of Bukhari *et al*. (2012) environmental factors such as temperature, environmental relative humidity and rainfall affect the presence of a type of insect.

Arthropod Abundance at Location I and Location II

Abundance is the amount presented by each species from all individuals in the community (Campbell and Reece 2010). Arthropod abundance in an agroecosystem is strongly influenced by food sources and the environment. Factors that affect the presence of insects in an ecosystem are also influenced by population growth and species interactions. Population growth is strongly influenced by increases (immigrants and births) and decreases in population members (emigrants and deaths) (Krebs, 1989). The results of observations related to the abundance of arthropods at the two locations can be seen in Figure 3.

The highest family abundance of Arthropods was found in the Order Coleoptera 31% (42 Families), followed by the Order Hymenoptera 19% (26 Families), Diptera 18% (24 Families) and the lowest family found in the Order Orthoptera was 1% (2 Families) (Figure 3).

Figure 4 shows that the highest percentage of the abundance of the Arthropoda family is in the order Coleoptera 28% (35 families), followed by Diptera 19% (24 families), Hymenoptera and Aranea 14% (18 families) and the lowest is the order Embioptera and Plasmatodea, which is 1% (1 family). The abundance of families from each of these orders as detrivores, herbivores, predators, parasitoids and pollinators was higher than location II, which had families from orders at location 1 which were lower.

The occurrence of differences in the abundance of arthropod families at the two locations of nutmeg cultivation is thought to be related to differences in flora diversity that affect the presence of arthropods on the land. According to Poerwitasari (2013) that arthropods are more commonly found on land with a variety of vegetation. According to Yatno *et al*. (2013) the high and low population of arthropods in a land is closely related to the availability of food sources and microclimate factors in a land.

The highest population was found in the Formicidae family of the order Hymenoptera and the Coccinellidae family of the order Coleoptera. The high population of this family is thought to be related to the

role of insects from this family such as ants and beetles that act as predators. In addition, the availability of feed and living habitats is very optimal and effective.

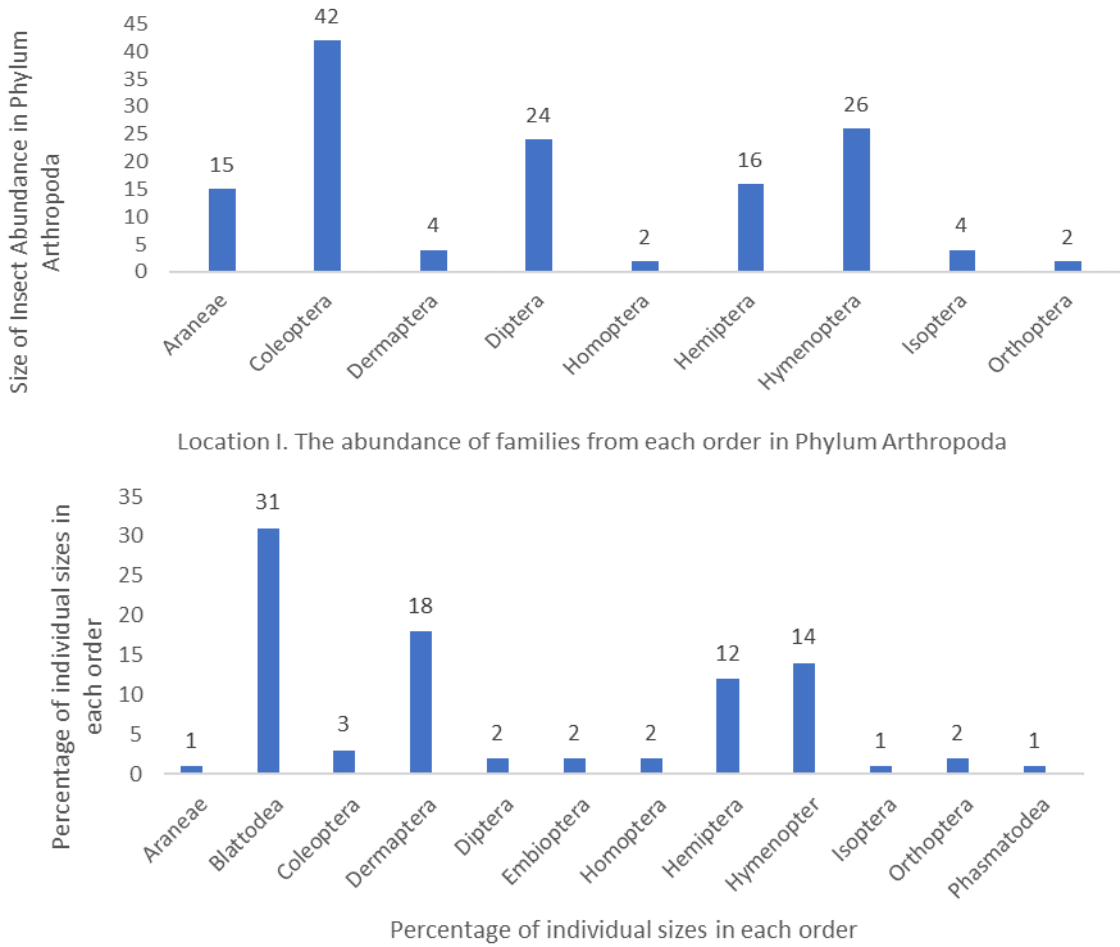

Figure 3. Percentage of family abundance of arthropods in each order (a) location I (15 years old nutmeg plant) and (b) location II (30 year old nutmeg plant).

Arthropod Family Similarity Index Between Location I and Location II

The similarity index value of the arthropod families trapped at location I and location II was categorized as low. The low level of similarity of the Arthropoda family at these two locations is thought to be related to the level of Arthropoda diversity at the two locations as well as differences in plant species, plant age, environmental conditions such as temperature and humidity. According to Haneda *et al*. (2013) the similarity value ranges from 0-1, if the similarity index value is close to 0, it indicates that a species becomes dominant in the community, but if the similarity index value is close to 1 then all species have the same level of similarity. The Sorensen arthropod similarity index value at the two locations was low. This shows that the family composition of the Arthropods that compose the community has a low level of similarity. Furthermore, according to Setiadi (2005), the smaller the similarity index for each combination of observation locations, the lower the similarity level. This is also due to variations in environmental conditions, both physical, chemical, and interactions between species that occur along the research site.

Arthropod Family Diversity Index between Location I and Location II

The results of the research conducted at the two locations showed differences in the two locations. This value can be seen in Table 1. The diversity index is a mathematical description of the level of diversity of insect species at the observation site (Tambunan *et al.*, 2013).

Table 1. The diversity index of arthropod family between location I and II

Location	Diversity index (H')	Community structure condition	Category	Scale
I	3,95	Very Stabil	Very good	5
II	3,71	Very stabil	Very good	5

These locations include conventional agro-ecosystems that lack modern technology input, such as the use of pesticides. According to Mahrub (1998), conventionally managed agricultural land without pesticides means that the even distribution of pests, predators, parasitoids, and insects is in a balanced condition. According to Heriza *et al*. (2016), the variation of vegetation in an agroecosystem will affect fauna diversity in that location. In addition, soil moisture, organic matter content and soil temperature can affect the population of soil fauna.

Conclusion

The location of nutmeg plantations in Batu Merah Village, Tapaktuan District, South Aceh Regency, is classified as organic so that the diversity of arthropods in the ecosystem is still high. Overall diversity and abundance of arthropods trapped at both locations were dominated by insects from the orders Coleoptera, Hymenoptera, and Diptera. The similarity index at the two locations of nutmeg cultivation was in a low category. The family diversity index between the two locations is still in a very stable community struct.

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