Arthropod Diversity on Forest Stands in South Sumatra, Indonesia

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Abstract. Arthropods have an important role in the forest ecosystem. Arthropods play a role in food webs as herbivores, carnivores, and detritivores. This study aims to analyze the diversity and abundance of arthropods in different forest stands, namely Pelawan (*Tristaniopsis merguensis*), Cajuput (*Melaleuca cajuputi*), and Sungkai (*Peronema canescens*). The research was carried out in the Forest Research Station of Kemampo belonging to the Environment and Forestry Research and Development Institute of Palembang, South Sumatra, Indonesia; through an observation approach with sweep nets, then taken to the laboratory for selection and identification. Research results showed that the levels of arthropod diversity in Pelawan, Cajuput, and Sungkai were relatively low. Those arthropods belong to 8 families with the highest number of the individual dominated by Pelawan stand, followed by Cajuput and Sungkai stands. Arthropod families consisted of Formicidae, Lycosidae, Elateridae, Scarabaeidae, Crabronidae, Chrysomelidae, Scolitidae, and Entomobryidae. The diversity index of arthropods under Pelawan, Cajuput, and Sungkai stands were 0.68; 0.31; and 0.3, respectively. The dominance index of arthropods on Cajuput stand was higher than in Pelawan, and Sungkai stands.

1. Introduction

The Kemampo Special Purpose Forest Area (Kawasan Hutan dengan Tujuan Khusus/KHDTK Kemampo) is one of the forest areas under the authority of the Center for Research and Development of Environment and Forestry of Palembang, which intended for research purposes, located in the Banyuasin District, South Sumatra Province. There are several types of forest plants found in KHDTK Kemampo, including Pelawan (*Tristaniopsis merguensis*), Cajuput (*Melaleuca cajuputi*), and Sungkai (*Peronema canescens*). Each of these three types of plants has many benefits. Pelawan has benefits as medicinal plants and energy wood. Cajuput is known for its oil from the distillation of leaves, which used as medicine. Sungkai is a type of carpentry wood which usually used for materials for building, furniture, handicrafts, and face on plywood.

The planting of these three types of plants was done in the monoculture method to stimulate the growth of Plant-Disturbing Organisms. The threat from pests and diseases assumed due to the abundant food, the suitable climate for breeding, and the lack of anticipation of pest attacks. The three types of forest plants, along with the vegetation contained below, can also be a place of life for arthropods both as a habitat, a place to get food, and a place to breed [1]. Vegetation is a shelter and alternative host and additional food for imago [2].
Arthropod's life is very dependent on the presence and density of its population. The existence and density of arthropods are very dependent on environmental factors, both biotic and abiotic. In general, arthropods play an important role in the ecosystem, both directly and indirectly [3]. Likewise, in forest ecosystems, arthropods play a role in food webs as herbivores, carnivores, and detritivores, and play another role in the process of organic soil decomposition. Arthropods play a role in the decomposition of soil organic matter for the nutrient supply [4].

Forest plant cultivation techniques generally reduce the number of individuals and diversity of soil fauna, including arthropods. Therefore, it is necessary to research to obtain information on the level of diversity and abundance of arthropods in forest plantations.

This research aimed to examine the diversity and abundance of arthropods under the stands of cajuput, sungkai, and pelawan trees in KHDTK Kemampo in Banyuasin District, South Sumatra Province.

2. Method

2.1. Materials

The tools used in this research are pitfall trap, sweep net, insect bottle, microscope, petri disk, and camera. The materials used in this research are a sample of arthropods, cajuput trees, sungkai trees, pelawan trees, alcohol 70%.

2.2. Procedure

2.2.1. Sampling of Arthropods

A sampling of arthropods was conducted in a Kemampo Special Purposes Forest Area (KHDTK Kemampo) in Banyuasin District, South Sumatra Province, from August 2018 to January 2019. The sampling of arthropods was conducted using a sweep net. This tool is made of lightweight and durable materials such as gauze, and is easy to swing, by which the captured arthropod can be seen. Sampling was carried out by swinging the net diagonally with monitoring intervals of 2 days and two observation periods with monitoring for two weeks. The capture was carried out in the morning around 07.00-09.00 a.m. and in the afternoon around 05.00-06.00 p.m. The captured insects were then collected and separated and then put into a sample bottle to identified in the laboratory.

2.2.2. Identification of Arthropods

All captured arthropods subsequently identified. The identification results tabulated and analyzed. The identification of arthropods captured from the field was done using the reference from Borror [5] and Bolton [6]. Identification was made by drying each type of the captured arthropods and putting them into cardboard by pricking with a needle. Then, the specimens were put into the specimen box and taken for documentation.

2.2.3. Data Analysis

The data on the composition of family, species, and number of individual arthropods were used to analyze the abundance and diversity of arthropods. The measurement of diversity used the Shannon diversity index value, the Berger-Parker species dominance index, and the Pielou species evenness index from Magurran's book [7]. The comparison of the similarity of arthropod communities between tree stands was conducted using the Sorensen index from Ludwig and Reynolds [8] book.

3. Result and discussion

3.1. The Diversity of Arthropods in Pelawan, Cajuput, and Sungkai Stands

Based on the identification, it is shown that there are two classes of arthropods found, namely the Insecta class (insect) and the Araneae class (spider) (Table 1). The number of insect orders found
under the Pelawan stands was higher than in the Cajuput, and Sungkai stands. Several types of insect orders found in all three types of forest stands, namely Hymenoptera, Coleoptera, Orthoptera, Collembola, and Ephemeroptera (Table 1). Several orders only found in one type of stand, including the order Ephemeroptera, which only found under the Sungkai stand.

There were eight families found under the Pelawan stands, namely Formicidae, Crabronidae, Elateridae, Scarabaeidae, Chrysomelidae, Scolitidae, Entomobryidae, and Lycosidae (Table 1), and four families found under the Cajuput stands, namely Formicidae, Acrididae, Grylidae, and Entomobryidae. Meanwhile, there were only two families found under the Sungkai stands, namely Formicidae and Caenidae. Formicidae is one of the most dominant insect families found active on the surface of the ground under the Pelawan, Cajuput, and Sungkai stands. Formicidae included in the order Hymenoptera, which is mostly predators. The family is a social arthropod that is generally non-destructive. Likewise, according to Suin [9], the movement of the Hymenoptera group is more flexible, and the animal group is a grass eater. The small number of families and the number of individuals from the Orthoptera order found under the Pelawan, Cajuput, and Sungkai stands are thought to be caused by inappropriate sampling time because it will affect the presence of arthropods found, in which the sample of this study was carried out during the dry season. Wallwork [10] reported that the presence of certain arthropods strongly influenced by seasons.

The number of species and individuals found under the Pelawan stands was higher than that of the Cajuput, and Sungkai stands. Meanwhile, the number of species and the number of individuals found under the Sungkai stand was the least, with two species and four individuals.

The difference in diversity and abundance of arthropods found under the forest stands is due to the influence of diversity and abundance of lower vegetation. The lower vegetation under the Pelawan stands more diverse and lusher than the Cajuput and Sungkai stands. Meanwhile, the type and density of vegetation under the Sungkai stand was the lowest compared to other stands (Table 2). The number of types of vegetation under the Pelawan, Cajuput, and Sungkai stands were 18, 15 and 10 species, respectively.

Table 1. The abundance of arthropods under forest stands in KHDTK Kemampo.

| Class, Ordo, and Family | Pelawan | | | Cajuput | | | Sungkai | | |
|-------------------------|---------|---|---|--------|---|---|--------|---|---|
|                         | NS  | NI | RD | NS  | NI | RD | NS  | NI | RD |
| Insecta                 |      |    |    |      |    |    |      |    |    |
| Hymenoptera             |      |    |    |      |    |    |      |    |    |
| Formicidae              | 2   | 22 | 52.38 | 2  | 24 | 80 | 1   | 2  | 50 |
| Crabronidae             | 1   | 2  | 4.76 | 0  | 0  | 0  | 0   | 0  |    |
| Coleoptera              |      |    |    |      |    |    |      |    |    |
| Elateridae              | 1   | 2  | 4.76 | 0  | 0  | 0  | 0   | 0  |    |
| Scarabaeidae            | 2   | 2  | 4.76 | 0  | 0  | 0  | 0   | 0  |    |
| Chrysomelidae           | 1   | 2  | 4.76 | 0  | 0  | 0  | 0   | 0  |    |
| Scolitidae              | 1   | 2  | 4.76 | 0  | 0  | 0  | 0   | 0  |    |
| Orthoptera              |      |    |    |      |    |    |      |    |    |
| Acrididae               | 0   | 0  | 0   | 1  | 2  | 6.67 | 0  | 0  |    |
| Grylidae                | 0   | 0  | 0   | 1  | 2  | 6.67 | 0  | 0  |    |
| Collembola              |      |    |    |      |    |    |      |    |    |
| Entomobryidae           | 1   | 6  | 14.29 | 1  | 2  | 6.67 | 0  | 0  |    |
| Ephemeroptera           |      |    |    |      |    |    |      |    |    |
| Caenidae                | 0   | 0  | 0   | 0  | 0  | 0  | 1   | 2  | 50 |
| Araneae                 |      |    |    |      |    |    |      |    |    |
| Arachnidae              |      |    |    |      |    |    |      |    |    |
| Lycosidae               | 2   | 4  | 9.52 | 0  | 0  | 0  | 0   | 0  |    |
| Total                   | 11  | 42 | 100 | 5   | 30 | 100 | 2   | 4  | 100 |

Note: NS = number of species, NI = number of individuals, RD = relative density.


Table 2. The diversity of types of low vegetations

| Undergrowth Vegetation | Pelawan | Cajuput | Sungkai |
|------------------------|---------|---------|---------|
| Borreria latifolia     | √       | √       | √       |
| Borreria laevis        | √       | √       | √       |
| Melastoma candidum     | √       | √       |          |
| Schima wallichi        | √       | √       | √       |
| Curattela americana    | √       | √       |          |
| Azystaria intrusa      | √       |          |          |
| Ageratum conyzoides    | √       |          |          |
| Chromolaena ordata     | √       |          |          |
| Cyperus rotundus       | √       |          |          |
| Lantana Camara         |          |          |          |
| Imperata cylindrica    |          |          |          |
| Cleome rutidosperma    |          |          |          |
| Clidemia hirta         |          |          |          |
| Adiantum aleutikum     |          |          |          |
| Duranta erecta         |          |          |          |
| Mikania micrantha      |          |          |          |
| Melastoma affine       |          |          |          |
| Scleria sumatrensis    |          |          |          |
| Total                  | 18      | 15      | 10      |

The lower vegetation in the form of wide-leaf weeds, grass, or ferns is a place of life for arthropods. Vegetation is a place to live for arthropods, both as habitat, a place to get food and a place to breed. The more varied the vegetation under the stands, the more the diversity and abundance of arthropods.

The abundance of arthropods that are active on the soil surface based on trophic level (Figure 1) shows that the number of predators, phytophagous, and decomposing arthropods under the Pelawan stands are higher than those under the Cajuput and Sungkai stands. The smaller number of predators and decomposing arthropods on the Sungkai stands due to the age of the older stem plants compared to the age of the Pelawan and Cajuput plants. The younger the plant's age, the more susceptible the plants to phytophagous insects/pests. Older plants have more stable physiological functions, including linkages with the formation of secondary metabolite compounds that function as a defense against insects. Bowers [11] and Schoonhoven et al. [12] reported that, in general, the concentrations of secondary metabolites in older plants were higher than those in younger plants. So, younger plants are more susceptible to phytophagous insects. The number of phytophagous insects that attack plants will result in an increasing number of predators. Wallwork [10] reported that vegetation could affect the diversity of animal species in individual plants. Besides, an animal population also influenced by water content, organic matter content, and soil temperature.

Figure 1. The abundance of predator, phytophagous and decomposing arthropods found on the soil surface understands: a) Pelawan, b) Cajuput, and c) Sungkai.
3.2. The Characteristics of Arthropods Community

The diversity index of arthropods that are active under the Pelawan stand is the highest (0.86) compared to the Cajuput (0.32), and Sungkai (0.30) stands (Figure 2). The high diversity index of arthropods that are active at the soil surface under the Pelawan stands is due to the more diverse and higher density of vegetation. Besides, the Pelawan plants are younger, so that the phytophagous insects found more than in the Cajuput and Sungkai stands. A decrease in individual distribution can cause a decrease in the value of diversity index species of arthropod species in the area.

![Figure 2. The Characteristics of arthropods community.](image)

The highest dominance index of arthropods that are active at the soil surface is under the Sungkai stands, followed by the Pelawan stand, and the lowest is under the Cajuput stand (Figure 2). The high level of dominance of arthropods that are active at the soil surface under the Pelawan stands shows a population imbalance between arthropod species. The high level of dominance in an ecosystem means that there is very high dominance by certain species compared to other species. The balance level of arthropod species that are active at the soil surface under the Sungkai stand is lower than that of Cajuput stand. The high level of dominance and low balance level of arthropod species in ecosystems also reported by Widiarta et al. [13].

3.3. Community Similarity

The arthropod communities that are active at soil surface under the Pelawan stands are the same as Cajuput stands with a value of 0.29. Whereas, the Sungkai stands have a higher similarity than the other two stand types (Table 3). Low abundance and diversity of arthropod species in ecosystems cause low levels of community similarity between habitats.

| Type of ecosystem | Pelawan | Cajuput | Sungkai |
|-------------------|---------|---------|---------|
| Pelawan           | 1.00    |         |         |
| Cajuput           | 0.29    | 1.00    |         |
| Sungkai           | 0.18    | 0.29    | 1.00    |
4. Conclusion
The levels of arthropod diversity in Pelawan, Cajuput, and Sungkai were relatively low. Meanwhile, the arthropods obtained, eight families with the highest number of an individual dominated by Pelawan stand, followed by Cajuput and Sungkai stands. Families belong to Formicidae, Lycosidae, Elateridae, Scarabaeidae, Crabronidae, Chrysomelidae, Scolitidae, and Entomobryidae. The diversity index of arthropods under Pelawan, Cajuput, and Sungkai stands were 0,68; 0,32; and 0,3, respectively. The dominance index of arthropods on Cajuput stand was highest than Pelawan and Sungkai stands.

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