Spread of Collembola at Different Altitudes and Their Response to the Environment at Gunung Halimun-Salak National Park

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Abstract. Collembola is a soil fauna that is beneficial for soil health. Collembola had a role in the food chain as one who helps in reshuffle organic matter. However, until now, the Collembola still not yet known widely in Indonesia. The aim of this study to assess the Collembola distribution based on height, besides that also study the influence of environmental factors like moisture, temperature, and soil fertility to the Collembola. The research was done at National Park in Mount Halimun Salak on seven altitudes. Those seven altitudes spread on five resorts, namely Koneng Mountain Resorts (500 m asl), Cimantaja Resort (700 - 900 m asl), Gunung Kencana Resort (1,100 masl) and Cikaniki Resort (1,300 – 1,700 masl). The method used the pitfall trap method. The results showed that the abundance of Collembola in all observation areas was 1,620 individuals, consisting of 3 orders and nine families. The abundance of Collembola shows a difference according to altitude. The highest abundance and diversity are at an altitude of 1,100 masl. Family Entomobryidae is predominantly found at seven altitudes but is more dominant at an altitude of 1,500 masl. The abundance of Collembola influenced by litter, total N, and C-organic.

1. Introduction

Collembola is the largest class from the filum of Arthropod [1]. Collembola has a body size between 0.25 and 8 mm [2], and some can reach 10 mm [3]. Collembola called Springtails because they have a jumping device called furcula or furca on the ventral part of the fourth abdomen. Collembola, in the world, is around 7,500 species of 581 known genera. Collembola in Indonesia are 124 genera, 225 species, plus 52 species that have not been described [3].

The role of Collembola in the ecosystem cannot be ignored, considering the enormous amount. Collembola plays a role in the food cycle as a remodel of organic matter or detritivore [1, 3, 4]. Besides, Collembola widely used as a biological indicator (bioindicator) or monitoring of an ecosystem [1].

Research on Collembola and its role has not been done much in Indonesia. Factors causing the lack of popularity of Collembola in Indonesia include the small body size, habitat in the soil, and the role that is not directly felt by humans. As a result, Collembola has become less well known for the diversity of species, habitats, distribution areas, and biological characteristics [5].

Research on Collembola at various heights has not been done much. Abiotic and biotic environmental factors influence the existence of soil fauna. Factors affecting environmental changes in mountainous areas can be predicted, such as temperature changes [6]. Temperature and evaporation...
can influence the presence of soil arthropods. Whitten et al. [7], explains that every change in altitude of 100 m, the temperature will drop by 0.5 - 0.6°C; due to changes in temperature, there is a change in habitat structure at each altitude [8]. In addition, mountainous areas are also vulnerable to environmental disturbances that occur, such as climate change [9].

Considering the large number of Collembola, and their role as bioindicators and monitoring of an ecosystem. It is exciting to research the Collembola community. Especially the surface collembo at Taman Nasional Gunung Halimun Salak (TNGHS or Mount Halimun Salak National Park. TNGHS has a rich diversity of flora and fauna and many have not yet been identified, including Collembola species that live in conservation areas. This study aims to analyze the attributes of Collembola and their responses to environmental parameters.

2. Method

2.1. Materials

The equipment used in this study consisted of three groups, namely field equipment, laboratory equipment, and supporting equipment. Field tools consist of shovels, knives, labels, and calico cloth. Laboratory equipment consisted of stereo microscopes, specimen bottles (vials), spray bottles, forceps, petri dishes, soil thermometers, air thermometers, scales, and soil testers. Supporting tools such as identification books, stationery, and cameras. Materials that would be used in this study included the collection of Arthropods, ethylene glycol, and 70% alcohol.

2.2. Procedure

2.2.1. Study area

The study conducted in Gunung Halimun Salak National Park in seven altitudes. The seven locations located in several resorts, namely Gunung Koneng Resort (500 m), Cimantaja Resort (700-900 m), Gunung Kencana Resort (1,100 m), and Cikaniki Resort (1,300-1,700 m) (Figure 1). Field data collection was carried out from September to December 2017. Identification was carried out in December 2017 to May 2018 at the Forest Entomology Laboratory, Faculty of Forestry, Bogor Agricultural University (IPB), Bogor, Indonesia.

![Map of study sites](image.png)

Figure 1. Study sites of Collembola study at Gunung Halimun Salak-National Park, western Java, Indonesia
2.2.2. Sampling

Another Sampling of soil arthropods was carried out using a pitfall trap method. The sampling conducted at seven locations with different altitudes. In each location, there were five subplots, each subplot having five plastic cups installed (Figure 2). So, in one plot, there were 25 plastic cups. The pitfall trap used was a plastic cup with a diameter of 6.5 cm, a base diameter of 4.5 cm and a height of 10 cm (Figure 1). Styrofoam with a diameter of 10 cm with a bamboo stick measuring 13 cm in length as its support was used as a roof of the pitfall trap to prevent rainwater from entering the cup. Habitat data collected were vegetation data, air temperature, humidity, soil temperature, the thickness of litter, light intensity, and chemical properties of soil.

Figure 2. Trap scheme in a plot of 20 m x 20 m

2.3. Data Analyses

The correlation between attributes of community and environmental parameters was analyzed using the Pearson correlation test with a confidence level of 95%. The correlation between Collembola and the location of the study was analyzed using Principal Component Analysis (PCA), which produced a biplot between component 1 and component 2.

3. Results and discussions

The total number of individuals observed in seven altitude habitats was 1,620 individuals, and there were three orders with 11 families. The following table shows the total abundance of Collembola individuals at all altitudes.

Table 1. Number of Collembola orders and families in seven sampling locations in the Mount Halimun Salak National Park

| Ordo       | Family          | 500  | 700  | 900  | 1,100 | 1,300 | 1,500 | 1,700 | Total |
|------------|-----------------|------|------|------|-------|-------|-------|-------|-------|
| Entomobryomorpha | Isotomidae    | 12   | 31   | 26   | 120   | 93    | 100   | 59    | 441   |
|             | Entomobryidae  | 21   | 23   | 58   | 121   | 170   | 134   | 15    | 542   |
|             | Cyphodoridae   | 0    | 3    | 0    | 0     | 1     | 0     | 6     | 10    |
|             | Paronellidae   | 0    | 1    | 2    | 0     | 9     | 2     | 0     | 14    |
|             | Tomoceridae    | 2    | 1    | 2    | 1     | 4     | 0     | 0     | 10    |
| Poduromorpha | Neanuridae     | 21   | 50   | 12   | 45    | 53    | 45    | 0     | 226   |
|             | Odontellidae   | 1    | 1    | 0    | 1     | 21    | 12    | 21    | 57    |
| Symphypleona | Hypogastruridae| 31   | 64   | 0    | 121   | 1     | 3     | 35    | 255   |
|             | Smirididae     | 8    | 2    | 0    | 2     | 0     | 1     | 0     | 13    |
|             | Dicyrtomidae   | 8    | 5    | 1    | 9     | 2     | 2     | 9     | 36    |
|             | Smirididae     | 2    | 3    | 3    | 0     | 7     | 1     | 0     | 16    |
| Total       |                 | 106  | 184  | 104  | 420   | 361   | 300   | 145   | 1,620 |

The highest abundance of Collembola individuals was at an altitude of 1,100 m asl, which was 420 individuals. The habitat condition at an altitude of 1,100 m asl was still good because it was far from
settlements, so there was very little interference from outside. In addition, the altitude of 1,100 meters above sea level had a high litter thickness value.

The Entomobryidae family (542 individuals) and the Isotomidae family (441) from the Entomobryomorpha order were more dominant than the other families. This result was following Agus [10] research, which stated that in the forest, there was Collembola from the most dominant Entomobryidae family. The abundance of Collembola in the forest could be influenced by the amount of litter that came from leaves and twigs that fell from trees and vegetation thereon. The following plot illustrates the spread of Collembola at seven altitudes. From the picture, it can be seen that the point (object) with its close position means that the object (habitat) has similar characteristics. The existence of an order is close to an altitude indicates a close relationship between the order with a certain altitude. Entomobryidae tends to be close to an altitude of 1,300 m asl, which means that this order is dominant at an altitude of 1,300 m asl. Figure 3 below shows the closeness of the order with the object (habitat).

![Figure 3. Distribution of the Collembola order at all altitudes](image)

Noted: Iso = Isotomidae, Ent = Entomobryidae, Cyp = Cyphoderidae, Par = Paronellidae, Tom = Tomoceridae, Nea = Neanuridae, Odo = Odontellidae, Smi = Sminthuridae, Smin = Sminthurididae, Dyc = Dicyrtomidae, Hyp = Hypogastruridae

Many orders that gather were at the midpoint. Objects that collected in the middle, such as Dicyrtomidae, Sminthuridae, Sminthurididae, Odontellidae, Cyphoderidae, Paronellidae, and Tomoceridae, meaning that the objects were not significantly dominant in a habitat. All biplot information could not be explained in detail because the biplot was only in two dimensions. So, there was some information that could not be explained by the biplot. In addition, the insignificant value of the number of individuals, different from one another, made the biplot unable to describe the relationship between objects in detail.

Environmental factors influence the life of living things [11]. The correlation test results using Pearson showed that habitat characteristics had values close to 1, meaning strong positive correlations, meaning that the greater the value of environmental variables, the Arthropod community value was also greater, or vice versa [12].
The correlation test results using Pearson indicated that habitat characteristics, which had positive values, indicated that the greater the value of environmental parameters, the greater the value of abundance at the observation site, or vice versa. The most influential environmental factor on the abundance of Collembola from the correlation data was litter thickness, with a value of $r = 0.69$. The results of the Collembola abundance correlation data, with some habitat characteristics, can be seen in Table 2.

| Environmental parameters | Abundance |
|--------------------------|-----------|
| Soil temperature ($^\circ$C) | -2.3 $^{**}$ |
| Litter thickness (cm) | 0.69 $^{**}$ |
| C-Org | 0.7 $^{**}$ |
| N-Tot | 0.59 $^{**}$ |

The high litter thickness positively correlated with the Collembola abundance ($r = 0.69$). This means that the higher the value of litter thickness, the Collembola individual abundance was increasing. Arief [13] mentioned the high presence of fauna in the availability of food sources. The higher the N-total value, the abundance of Collembola also increased ($r = 0.59$).

4. Conclusion
The highest abundance of Collembola individuals was at an altitude of 1,100m asl. The condition of the habitat of 1,100 m asl was still good because it was far from the settlement. Entomobryidae tended to be close to an altitude of 1,300 m asl. The most influential environmental factor on the Collembola abundance from correlation data was the litter thickness.

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