PRELIMINARY STUDY ON SOIL COLEMBOLA IN AN AREA ATTACKED BY PYROCLASTIC FLOW

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ABSTRACT


Study on soil collembo in an area attacked by pyroclastic flow was conducted at rocky riverbank. The attacked was on 22 November 1994, and the study was in March to October 1995.

The study area was divided into three habitats. They were the sandy habitat for serol solid material of the pyroclastic flow, the lower bank, relatively flat and formerly dominated by grasses and the upper bank, steep and formerly dominated by pine trees and broad leaf herbs.

Appreciably, soil collembo of Smirnithidae, Entomobryidae, and Bostrinidae were able to migrate to the sandy habitat, but they were not able to establish yet. Soil collembo in the lower and upper banks were able to rehabilitate. There was also an indication that there were individuals of Onychiuridae, and Hypogastruridae escape from the effect of pyroclastic flow. There was possibility that few individual of Smirnithidae, Entomobryidae, and Bostrinidae could survive. They were able to recolonize in the habitats.

Key words: collembo, pyroclastic flow.

INTISARI


Daerah pengamat-lidah menjadi tiga habitat. Ketiga habitat tersebut adalah areal pasir yang semula adalah matria pada awal panas, tebing kawah, yang dat...
STUDY SITE AND METHODS

Study site

On November 22, 1994, there was pyroclastic flow from Mt. Merapi, Yogyakarta Province. The pyroclastic materials flow down southward via Boyong River, destroyed the nearby forest ecosystem. Field observation on January 4, 1995 found that forest was burnt, the forest floor covered by sands and volcanic ash, and the Boyong River filled by solid materials of the pyroclastic flow. Hot air still came out from the sediment of the river with temperature up to 80°C. The study site was then decided at Boyong riverbank, located between feet of Turgo and Flawangan hills (Figure 1). The site was selected because it can be reached and still possible to get out hurriedly from the possibility of the danger from volcanic activities of Mt. Merapi.

The study area then divided into three habitats. The first was sandy habitat, formerly was solid materials of pyroclastic flow. The second was lower bank, relatively flat and formerly dominated by grasses. The last was upper bank, steep and formerly dominated by pine trees and broader leaf herbs. The last habitat was steep, with the steepness around 50°.

Sampling and observation

Sampling was conducted in March to October, 1995. From March to May the samplings were twice per month, and once per month thereafter.

Each sampling consisted of ten unit samples from each habitat, by the use of soil corer into 15 cm deep. Soil temperature was measured by thermistor thermometer (Digisense Thermometer, Cole Parmer Instr. Co.), and soil pH by soil tester pH (Takemura Electric Works Ltd.). Soil moisture was measured by the different of wet and dry weight of the soil samples, and expressed in percent. The drying of the soil sample was by putting in an oven with temperature of 100°C for three days.

INTRODUCTION

Pyroclastic flow is volcanic materials consist of solid materials and gases. Since the pyroclastic material is very hot, with temperature of 300°C to 700°C, some of the materials are melted. The pyroclastic materials flow down very rapidly (80 - 100 km per hour). The solid materials consist of stones of various sizes, gravels, sands, and volcanic ash. The gases consist of various volcanic gases (Bronto, 1995).

Report on vegetation study after the eruption of Mt. Krakatoa informed that the death of flora and fauna was partly by deeply buried, suffocation, high temperature, and toxic gases. The rehabilitation of vegetation was possible by mean of rhizomes, pollen, and seeds (Backer, 1929).

It was thought that the same effect could happened to soil collembola. Although there is still a possibility that some individuals survive and then flourish. There has been no study conducted yet on the effect of volcanic eruption on soil fauna, especially on soil collembola. Betsch and Betsch-Fi-not (1982) studied on the recolonization of collembola, but in a forest floor after clear-cutting and then burnt the litter. Vannier (1980a) reported his experiment on the effect of litter burning upon soil collembola.
RESULTS AND DISCUSSION

Environmental factors

Soil pH at study sites showed a range of neutral pH. Even though the sandy habitat consistently had the highest pH, then the lower bank, and finally the lowest was the upper bank (Table 1). Nevertheless, the soil pH was not the factor that caused the differences on the soil collembolan communities found in the three habitats.

Soil temperature of sandy habitat was also the highest, then the lower bank, and the lowest was the upper bank. The temperature fluctuated from 20.1° to 27.1° C.

This range is normal for the tropics.

Soil moisture showed a contrast different between sandy habitat and the other habitats. The lower and upper banks consistently showed higher soil moisture than the sandy habitat. It possible that the soil moisture might contribute to the differences of the soil collembolan communities in the area.

Soil collembola

In sandy habitat, collembola were found from March (the first sampling) to June 1995, and no collembola found thereafter. Besides the number of individuals was small, collembola found were

<table>
<thead>
<tr>
<th>Sampling date</th>
<th>Sandy habitat</th>
<th>Lower bank</th>
<th>Upper bank</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>temp</td>
<td>pH</td>
<td>moist</td>
</tr>
<tr>
<td>March 25</td>
<td>23.1</td>
<td>7</td>
<td>2.39</td>
</tr>
<tr>
<td>April 10</td>
<td>*</td>
<td>6.9</td>
<td>3.16</td>
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<tr>
<td>May 10</td>
<td>24.6</td>
<td>7</td>
<td>2.78</td>
</tr>
<tr>
<td>June 6</td>
<td>24.5</td>
<td>7</td>
<td>4.17</td>
</tr>
<tr>
<td>July 20</td>
<td>21.8</td>
<td>7</td>
<td>6.99</td>
</tr>
<tr>
<td>August 3</td>
<td>24.1</td>
<td>7</td>
<td>4.41</td>
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<tr>
<td>September 4</td>
<td>21.9</td>
<td>7</td>
<td>5.22</td>
</tr>
<tr>
<td>October 2</td>
<td>22.1</td>
<td>7</td>
<td>2.12</td>
</tr>
<tr>
<td>October 6</td>
<td>21.5</td>
<td>7</td>
<td>1.57</td>
</tr>
</tbody>
</table>

Note: *No data on soil temperature due to low battery.
only of Family Sminthuridae, Entomobryidae, and Isotomidae (Figure 2A).

In the lower bank, until June 1995, the number of individuals were very small, then increased and reached the peak in August and September. In October 1995, the number decreased drastically. However, the total numbers of individuals and families found were higher compared to the sandy habitat. Families found in the habitat were Sminthuridae, Entomobryidae, Isotomidae, Hypogastruridae, and Onychiuridae (Figure 2B).

The highest numbers of soil collembola were found in the upper bank. Until May 1995, in average was found 5-10 individuals per unit sample. In later months, it was found more than 10 individuals per unit sample. Peak of populations was in June 1995, and then decreased. In this habitat, there were five families found. The families were Sminthuridae, Entomobryidae, Isotomidae, Hypogastruridae, and Onychiuridae, as found in the lower bank (Figure 3).

There are three stages in the development of a fauna on a virgin land. They are immigration, population establishment, and population maintenance. In the first stage, only species with dispersal ability may reach the habitat. In the following stage, in order to be able to establish, the species should get appropriate habitat, food, and shelter. And finally, in the third stage, the established population must be able to cope seasonal and short-term variation in the environment (Green- slade & Majer, 1980).

The sandy habitat was a virgin habitat, since it was originally the solid materials of a pyroclastic flow, and formerly was very hot. Result of the observation showed that until October 1995, collembola have not able yet to settle on the habitat. Indeed, there were individuals of Sminthuridae, Entomobryidae, and Isotomidae dispersed and reached the habitat, but they were not able to establish. The three families which were able to reach the habitat were families with active movement and of soil surface inhabitants (epigean and peri-epigean) (Wallwork, 1975; Brown, 1980). The dispersion of them may be aided by water run-off and wind. The inability to establish on the habitat was caused by the low soil moisture, no shelter available, and direct exposure to sunlight. According to Vannier (1980), soil moisture less than 24% may cause an increase of collembolan activity, and move out. Beginning in July 1995, rainfall decreased drastically, temperature increased, and no collembola found in the sandy habitat. Apparently they were not able to cope the condition, and they died or moved out of the habitat.

Collembolan populations in the lower and upper banks at first were very low number, then increased slowly. This was an indicative that rehabilitation of soil collembola in that habitats did occur. Besides there were immigration to the habitats, few number of individuals might able to survive and then reestablished. This was supported by the fact that Onychiuridae and Hypogastruridae dominated the habitats (Figure 2B & 3). Onychiuridae and most species of Hypogastruridae are the true soil inhabitants (endops) and sluggish (Wallwork, 1975; Brown, 1980), therefore very small or no possibility for them to immigrate from other habitats. This was also supported by the fact that they were not found in the sandy habitat.

The number of individuals of collembola in the upper bank was consistently higher compared to the lower bank. This might indicate that higher number of individuals incidently escaped or sheltered from the danger of the pyroclastic flow. There were two possibilities: The first, cover growth on the habitat was broader leaf herbs and thick enough. The cover growth died when exposed to the pyroclastic materials. However, the death cover growth then formed a mat to cover the forest floor, and this might be a good shelter for soil fauna underneath. The second, former vegetation on the habitat consisted of pine trees. It is not uncommon that pine forest floor is covered by a thick layer of litter consisted of pine’s twigs and slowly decomposed. Therefore, the thick litter layer might protect soil fauna underneath, and more individuals survived. Furthermore, not only the true soil inhabitants might survive, there was still possibility few individuals of Sminthuridae, Entomobryidae, and Isotomidae which were litter inhabitants could also survive.
Figure 2. Fluctuation of soil Collembola
A: in Sandy Habitat; B: in Lower Bank

Figure 3. Fluctuation of Soil Collembola in Upper Bank
The decreased of soil collembolan populations in October 1995 was due to the soil moisture of the habitats. Beginning in August 1995 there was no rainfall, and the soil moisture decreased (Table 1). From September 1995, the study area was also disturbed by people collected woods. The human activities damaged the cover-growth, and exposed the soil directly to sunlight. This condition also affected the soil collembolan populations.

The study also revealed that the fluctuation of soil collembolan populations was parallel to the vegetation growth. The vegetation on the study area was not completely established and still unstable. Therefore the stability of microhabitats might not be reached, and this affected the soil fauna. According to Vannier (1980b), soil collembola may be used as an indicator for soil metabolic activity. Soil collembolan community in the study area was not in a stable condition yet, this was an indication that the soil metabolic activity was still unstable.

REFERENCES