

COLLEMBOLA DIVERSITY IN FORMER TRADITIONAL GOLD MINING IN SAMPOINIET DISTRICT, ACEH JAYA REGENCY

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ABSTRAK

Collembola berperan sebagai bioindikator kesuburan tanah, selain juga menjaga kestabilan unsur hara dan oksigen yang sangat bermanfaat bagi tumbuhan. Sayangnya, keragaman Collembola di habitatnya dapat terganggu akibat limbah misalnya limbah merkuri. Penelitian ini bertujuan untuk mengetahui keragaman jenis Collembola di kawasan bekas penampungan limbah merkuri dari penambangan emas tradisional di Desa Ligan Kecamatan Sampoiniet, Kabupaten Aceh Jaya. Penelitian ini dilakukan pada bulan Juni-Juli 2019 di 6 (enam) lokasi pada kawasan bekas penampungan limbah merkuri yang berada di Desa Ligan Kecamatan Sampoiniet, Kabupaten Aceh Jaya. Pengambilan sampel dilakukan dengan metode *purposive sampling* menggunakan perangkap jebak (*pitfall trap*). Data dianalisis dengan membandingkan karakteristik morfologi luar Collembola yang ditemukan dengan merujuk pada buku identifikasi Boror (1996) dan menentukan Indeks Keragaman Shanon Winner. Hasil penelitian menemukan 5 spesies Collembola dengan Indeks Keragaman $H' = 1,485323798$ yang tergolong dalam kategori keragaman sedang. Kadar merkuri rata-rata yang ditemukan di lokasi penelitian telah melampaui ambang konsentrasi krisis yaitu sebesar 0, 5111 mg/kg, yang diasumsikan mempengaruhi keragaman spesies Collembola pada habitatnya.

Kata Kunci: Keanekaragaman, Collembola, Penambangan Emas Tradisional, Sampoiniet.

ABSTRACT

Collembola functions as a bio-indicator of soil fertility, while maintaining the stability of nutrients and oxygen which are very beneficial for plants. However, the Collembola diversity in its habitat could be affected by mercury waste. This study aims to determine the diversity of Collembola species in the former mercury waste storage area of traditional gold mining in Ligan Village, Sampoiniet

District, Aceh Jaya Regency. This research was conducted in June-July 2019 in 6 (six) locations in the former mercury waste storage area in Ligan Village, Sampoiniet District, Aceh Jaya Regency. The sampling was done by purposive sampling method using pitfall trap. Data were collected by comparing the morphological characteristics of Collembola by referring to Boror's (1996) identification book and analyzed with Diversity Index of Shannon Winner. There are 5 Collembola species found in the research location with Diversity Index $H' = 1.485323798$ in the medium category. Mercury average levels found in the study site have exceeded the crisis concentration threshold with the value of 0.5111 mg/kg, which is assumed affecting the diversity of Collembola species in its habitat.

Keywords: Diversity, Collembola, Traditional Gold Mining, Sampoiniet

INTRODUCTION

One of the most dominant animal groups on earth is the Insects. The insects' existence in nature can be used as an environmental bio-indicator and plays a very important role in the food web. Insects that has the greatest influence as a soil fertility parameter is the Collembola sub-class, whose habitat depends directly on soil chemical and physical factors. According to Rusek (1998), Collembola is a soil arthropod found in almost all terrestrial ecosystems and usually lives in humid areas. Most of them live in the soil, soil surface, rotting litter, animal dung, animal nests, and holes [1]. The presence of Collembola in the ecosystem is strongly influenced by biotic and abiotic factors. Biotic factors that influence its existence include the ability to spread, predation, habitat selection and vegetation. Plants, for example, can increase soil moisture and produce litter which is preferred by soil insects [2]. Meanwhile, abiotic factors that influence the presence of soil insects include soil texture, soil structure, and chemical factors including pH, soil temperature, humidity and levels of organic matter and soil mineral elements [3]. One of the chemical factors that influence the presence of Collembola is the release of heavy metal waste.

The release of heavy metals into the environment causes harm to natural ecosystems. Metal types that have the potential to damage habitat stability include Hazardous Toxic

Materials (B3) in which various heavy metals are contained. Heavy metal is a metal element that has a density $> 5 \text{ g / cm}^3$, such as Cd, Hg, Pb, Zn, and Ni. Heavy metals such as Cd, Hg, and Pb are referred as non-essential metals and to some extent become toxic for organisms [5]. Mercury (Hg) is one of the most toxic metal ions which can affect soil biota presence in its habitat.

Conventional processing of gold ore can be bad for the surrounding environment. The mixture of mercury released into the environment causes a change of methylation potential to methyl mercury by microorganisms into the soil and water. The heavy metal waste then settles in the soil resulting in mercury pollution [4], that could affected the stability of nutrients and soil microorganisms. So it is important to do this research to obtain information about the presence of Collembola, especially related to its diversity.

RESEARCH METHOD

The data collection was carried out in six locations of ex-mining and gold processing in Ligan Village, Sampoiniet District, Aceh Jaya

Regency in June-July 2019. This study used the purposive sampling method to identify the presence of various types of Collembola in each location. The sampling location can be seen in the following image (Figure 1.)

Sampling was conducted using pitfall traps that were placed randomly at the six locations. The data found were identified in the Biology Laboratory, Faculty of Science and Technology UIN Ar-Raniry Banda Aceh, referring to the identification book of Boror, et.al (1996) [6] and Hopkin (1997) [7], as well as various reference sources from relevant journals.

The data found at the research location were analyzed qualitatively and quantitatively. Qualitative analysis is by describing environmental conditions related to the presence of Collembola. Quantitative analysis was carried out by calculating the diversity of Collembola with the Shannon-Wiener Diversity Index ($H' = -\sum p_i \ln p_i$), where: $p_i = \sum n_i / N$; p_i = number of individuals of a species divided by the total number of all species; n_i = number of individuals of species i ; and N = total number of

individuals. The criteria is that $H' < 1$ = Low diversity; $1 < H' < 3$ = moderate diversity; and $H' > 3$ = High diversity. The Mercury content was analyzed in the Banda Aceh Industrial Research and Development Agency (BARISTANS) laboratory.

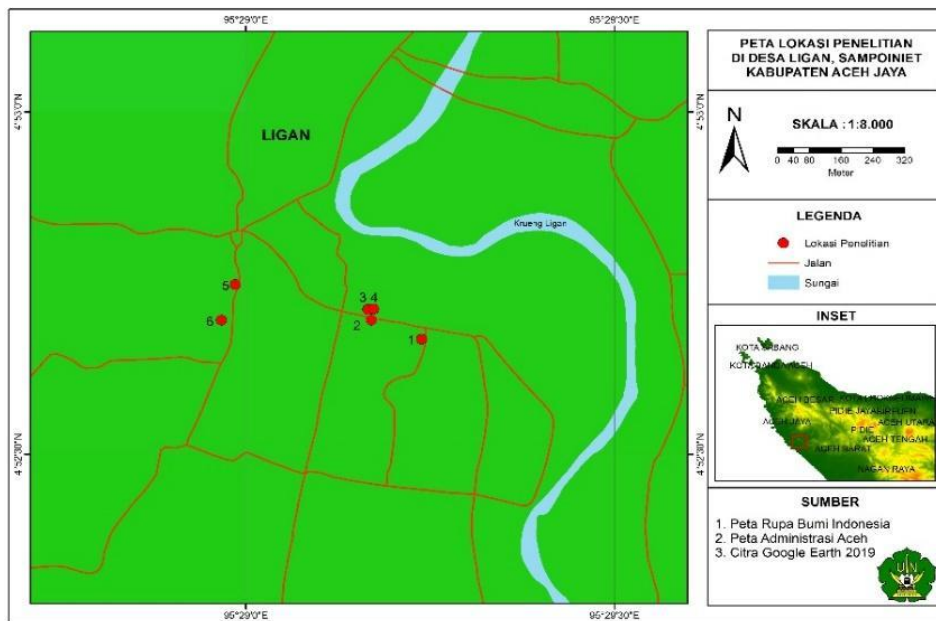


Figure 1. Map of Collembola Diversity Sampling Location in Ligan Village, Sampoiniet District, Aceh Jaya Regency.

RESULTS AND DISCUSSION

The study found 5 (five) individuals. The distribution of species Collembola species at six sampling locations i.e. *Isomiella* sp., *Entomobrya* sp., *Isotomurus* sp., *Vertagopus* sp. and *Tomocerus* sp. with a total of 108

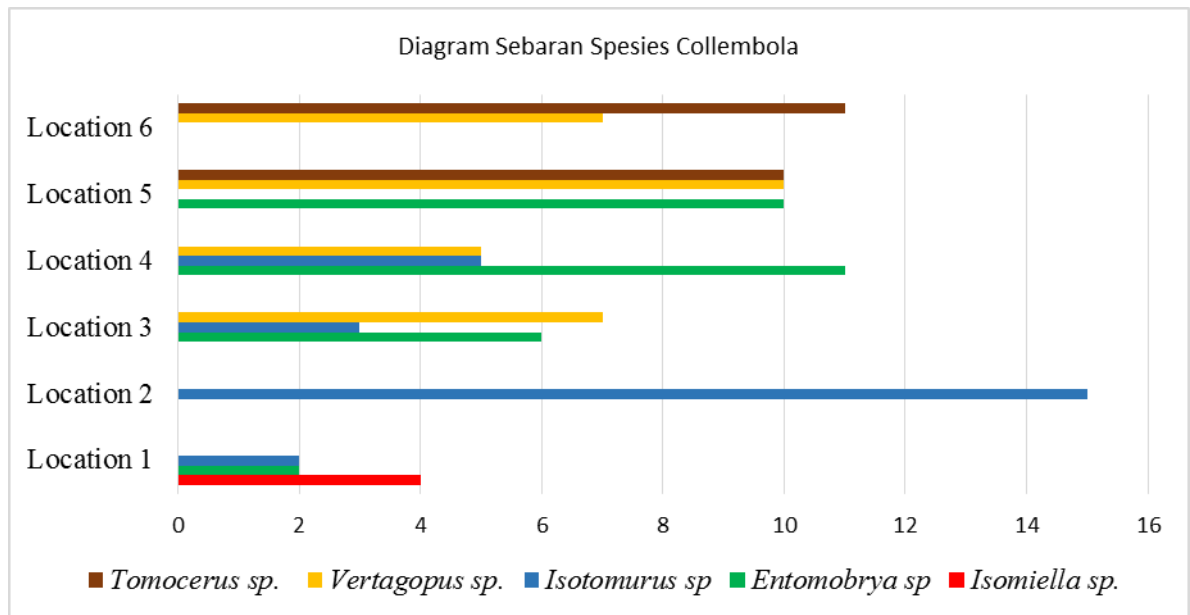


Figure 2. The Collembola Distribution Diagram in the Former Traditional Gold Mining Area in Ligan Village, Sampoiniet District, Aceh Jaya Regency.

Isotomorus sp. is the most numerous species found at the research location. This species has a wider distribution than other species because it is found in almost every location. This type is a cosmopolite and is generally often found in colonies. The location where the species was found has low contamination level, with various grass and shrub vegetation. Meanwhile, *Isomiella* sp. is the species that is found in the least number. It is assumed that there are huge differences in environmental conditions, especially at the discovery location. The condition

of the habitat that tends to be unstable can be seen from the damaged vegetation and dry soil structure due to the use of the location as a storage pool for gold mining waste disposal. This location (location 1) has the highest mercury content of 0.3814 mg / kg, which has exceeded the critical concentration threshold [8]. Litter thickness and the presence of canopy plants affect the presence of Collembola, while the type of vegetation affects the Collembola diversity [9].

Further data analyses showed that the diversity of Collembola species in the area of ex-gold mining waste disposal in Ligan Village, Sampoiniet District, Aceh Jaya District, Aceh Province is moderate, with an index of Shannon Wiener $H' = 1.485323798$. The diversity at each location is presented in table 1 below.

Table 1. Collembola Diversity at Each Location in the Former Traditional Gold Mining Area of Ligan Village, Sampoiniet District, Aceh Jaya, Aceh.

No	Family	Species	Total Number (Σ)	Diversity Index (H')
1	Isotomidae	<i>Isomiella</i> sp.	4	0,122068032
2	Entamobrydae	<i>Entomobrya</i> sp	29	0,353057653
3	Isotomidae	<i>Isotomurus</i> sp	25	0,338716528
4	Isotomidae	<i>Vertagopus</i> sp.	29	0,353057653
5	Tomoceridae	<i>Tomocerus</i> sp.	21	0,318423931
Total			108	1,485323798

Based on the observations at 6 (six) locations, the highest Collembola diversity index was found at locations 4, while the lowest diversity index was found at location 1. The locations that had the highest levels of mercury concentration were at locations 1. The level of Diversity Index at each location is influenced by biotic and abiotic factors. Various types of plants and the stability of soil nutrients in each location also determine the diversity of Collembola. The diversity of

vegetation in an area directly affects the diversity and abundance of insects in the area. Soil physic-chemical properties also affect Diversity Index at each location. Soil temperature is also one of the soil physics factors that determine the presence and abundance of soil organisms. The rate of decomposition of soil organic matter which is a source of nutrients for insect survival is greatly influenced by soil temperature itself [10]. The increase in soil temperature at the research location is assumed to

be due to the loss of several types of litter-producing shrubs due to contamination of the soil with mercury waste from traditional gold mining. Measurement of soil temperature parameters, soil pH, at location IV shows the average temperature value of 30.66 °C, and pH of 5.3. Aryoudi, et al. (2015) explained that the ability of soil insects to withstand environmental physical factors varies greatly depending on their species, where the range of tolerance changes with each type and stage of development [11].

The mercury levels in this area have exceeded the critical limit. This is because the disposal of mercury waste from traditional gold processing is not properly controlled. Overall diversity of soil insects in the area is classified into the medium category, which is also assumed to be influenced by the plant vegetation in the area. Vegetation will affect the production of humus which makes soil insects obtain food and ideal shelter [12]. The concentrations of mercury in the soil at research location have effect on the diversity of soil insects because the vegetation of plants that provide litter is lost due

to the accumulation of mercury. The average mercury concentration in the soil at the study location has exceeded the critical threshold (> 0.5 mg / kg). Moreover, the average soil moisture is also not suitable ($< 62\%$) for soil insect activity, especially Collembola. Krebs (1985) states that soil insects require high soil moisture that is appropriate for their development. Generally, this humidity can be obtained from the air and surrounding plants which produce a lot of water in its metabolism [13].

Each ecosystem has various characteristics that affect the structure of the soil insects' composition in it [14]. Measurement of parameters at each location has various results. These differences have direct impact on the diversity of soil insects in an area, because insects can still adapt to the environment even though these environmental parameters are different from one another, even if it affect insects' activity in the community [15].

CONCLUSION

There are 5 Collembola species found in the research location with Diversity Index $H' =$

1.485323798 in the medium category. Mercury average levels found in the study site have exceeded the crisis concentration threshold with the value of 0.5111 mg /kg, which is assumed

affecting the diversity of Collembola species in its habitat.

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