

## Original article

# Potential Study on Soil Arthropods Diversity as Vegetation Bioindicators at Puthuk Siwur and Mount Pundak Hiking Trails District of Mojokerto

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### Abstract

Puthuk Siwur and Mount Pundak located at Mojokerto Region. Soil arthropods having an important role in the ecosystem including vegetations. This study was aimed to understand the potential of soil arthropods diversity as a vegetation bioindicators. Based on the results some families having the potential to correlate with the vegetation on its habitat. Formicidae Family having potential as predators at a location that some of the vegetation producing fruits. Staphinilidae Family having potential for correlated with vegetation that produces leaf debris on the high amount. Entomobrydae family having potential for correlated with the decomposing activity of dying vegetation bodies at high altitude.

### INTRODUCTION

Indonesia is a country called mega biodiversity because it has a very diverse landscape, ranging from the ocean, land, hills, and mountains. Almost 25% of species on earth can be found in Indonesia with a variety of unique characteristics (Pelawi, 2009; Permana, 2015). Puthuk Siwur and Pundak are clusters of hills that are still part of the Arjuno Mountains and the Welirang Mountains. Puthuk Siwur is managed as ecotourism by Perum Perhutani, meanwhile, Gunung Pundak is managed by the Forestry Service as part of the *Taman Hutan Raya Raden Soerjo*.

Mountains are very potential landscapes and support the diversity of flora and fauna including soil arthropods (Ruslan, 2009). Soil arthropods have been around 350 million years ago with a total species of 1 million and there are still around 10 million species estimated to have not been identified (Borror, *et al.*, 1994).

Soil arthropods are insects that partly or wholly live in the soil or surface and play a very important role in the sustainability of the surrounding ecosystem; one of them as an indicator of stability in the ecosystem. Soil arthropods function in the process of destruction and overhaul of organic material and other minerals to be transformed in the form of nutrients that can support the stability of soil conditions, maintain soil structure and maintain the balance of organisms that live and thrive in the soil. Plant nutrients derived from various plant residues will go through the process of decomposition with the help of soil arthropods so that humus is formed as a source of soil nutrition for plants. Besides the role of soil arthropods as well as support for other plants such as pollinators (pollinators), predators to minimize species that are detrimental to the environment to as a bioindicator in an ecosystem (maintaining food chains in the soil), and pests (Fauziah, 2016; Ardillah, *et al.*, 2014; Soedijo and Pramudi, 2015; Afandhi, *et al.*, 2015).

Staphinilidae, Formicidae, and Entomobrydae are the common family at Mount Arjuno (Abdillah *et al.*, 2020). Staphinilidae are detritivores that easily found under the decaying leaf trees and rocks. Some of The Staphinilidae species such as *Paedurus* spp. are the predators in the rice field ecosystem (Fitriani, 2018). Formicidae are the most successful family in the world, they spread all over the continent on earth. Formicidae playing role as predators also detritivore, some of them are herbivore, carnivore, and omnivore (Hashimoto, 2003; Siriyah, 2017). The existence of Formicidae are the indicators of ecosystem stability because of its role in predation and maintain the food chain (Latumahina & Ismanto 2011). Entomobrydae is one of the family in Collembola group that is playing a role to decompose organic matter (decomposer) (Abdurrachman, 2013). The Collembola are suitable to live in abundant organic matter and humid environment. Ground pores and air circulation that affect on humidity influence the composition of Collembola species (Ganjari, 2012). Collembola species abundant helps the nutrient cycle in the soil, and otherwise describing the land productivity (Indriyanti & Wibowo 2008).

Puthuk Siwur and Mount Pundak have the same potential for Land Arthropods. The existence of soil arthropods makes it possible as a bioindicator of vegetation because of its role as a

detritivore, pollinator, pest predator, and also a pest for the vegetation itself. This study aims to examine the potential of soil arthropods as a bioindicator of vegetation in Puthuk Siwur and Gunung Pundak, Mojokerto Regency.

**MATERIAL AND METHODS**

This study was conducted in the Puthuk Siwur Climbing Path and Mount Pundak Mojokerto Regency, East Java Province. Puthuk Siwur is divided into three sampling points on the Hiking trail. Mount Pundak is taken one point around the Peak or Camp Site. The research map can be seen in Figure 1. The first observation was located at villager garden it dominated by fruit producing trees. The second observation was located at pine tree forest. The third Observation was located at heterogeneous vegetation forest. The last observation was located at the peak of Mount Pundak which dominated with Poaceae as e land cover.

The sample collection was carried out using the Pitfall trap method, which was spread by six in each location. Pitfall traps are installed for 24 hours on December 24-25, 2016. Obtained samples sorted and cleaned then preserved into 70% alcohol to be identified under the stereo microscope (Abdillah *et al.*, 2020).

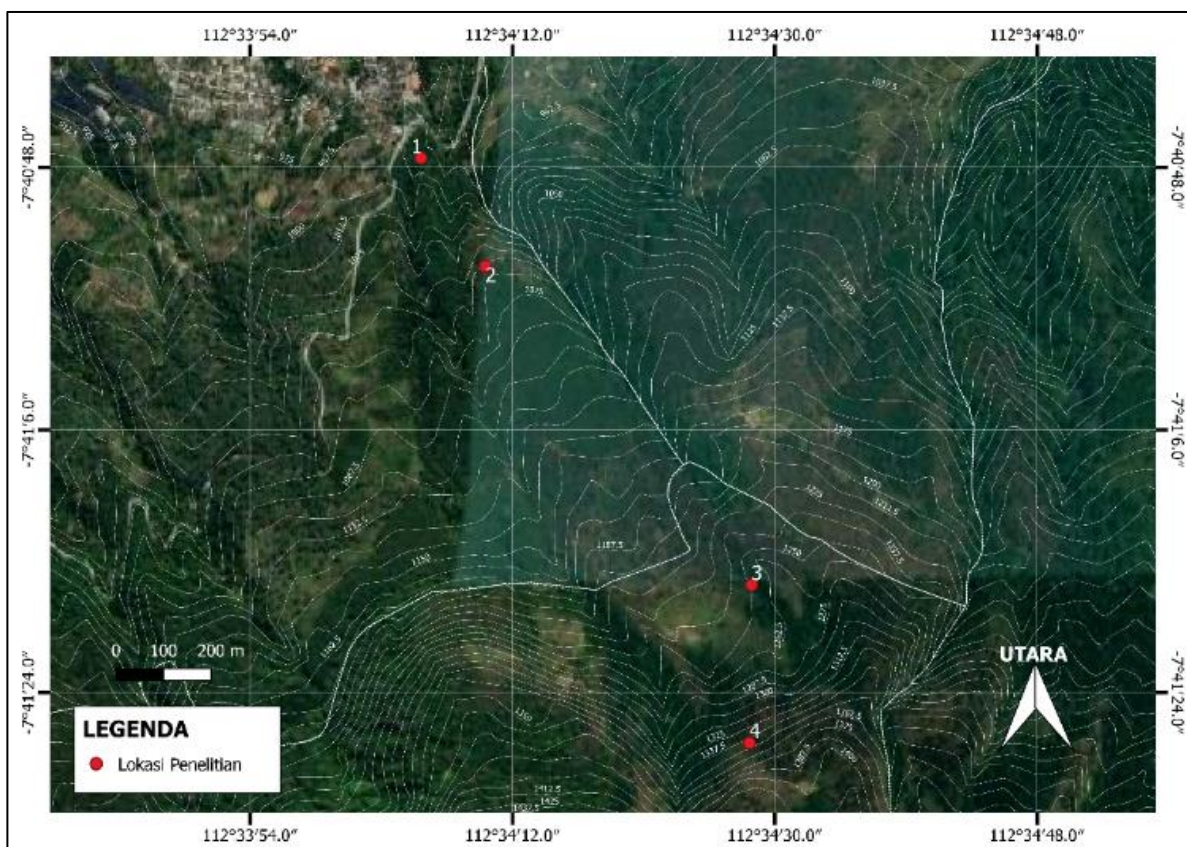


Figure 1. Research Map ( ● ) Observation Point

Samples are identified to the level of the family and then the data obtained are analyzed (Borror, et al., 1994). The data obtained were then analyzed using the Shannon-Wiener heterogeneity index with the following formula:

$$H' = -\sum Pi \ln Pi$$

Information:

H' = Index of heterogeneity

Pi = Number of individuals i / Total number of samples.

## RESULT AND DISCUSSION

The results showed that the total heterogeneity index was at the value of H'=1.43. This value indicates that the diversity of soil arthropods in this study approaches the diversity of soil arthropods on Mount Arjuno (H'=1.46) (Abdillah et al., 2020). The acquisition of these values can be obtained as a result of possible locations that are still the same in the Mount Arjuno. The results of the study can be seen in Table 1.

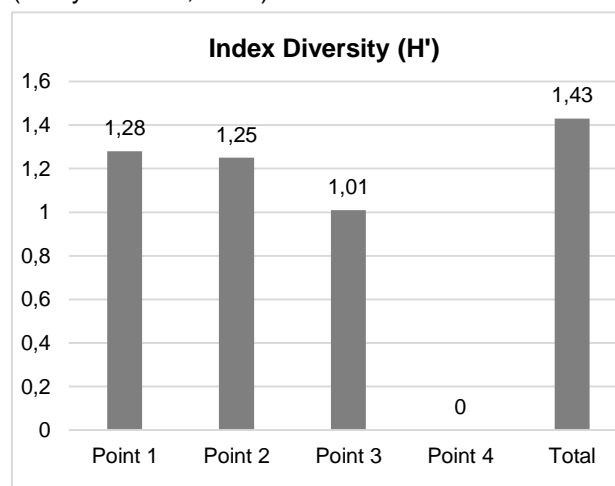
**Table 1.** The number of family of soil arthropods in Puthuk Siwur and Mount Pundak

Ordo	Famili	L1	L2	L3	L4	Total
Hymenoptera	Formicidae	33	30	10	0	73
Entomobryomorpha	Entomobryidae	6	2	18	4	30
	Haliplidae	5	0	3	0	8
Coleoptera	Amphizoidae	0	2	0	0	2
	Staphinilidae	6	8	0	0	14
Orthoptera	Trydactylidae	9	5	1	0	15
Blattaria	Blattidae	0	3	0	0	3
Total		59	50	32	4	145

Heterogeneity indexes at different locations have different results. The location of observation had a decreasing diversity index. The chosen location was based on differences in height from sea level and vegetation composition. The higher index value means that there was less ecosystem disturbance (Rahmadi & Suhardjono, 2003). Every height from sea level rises to 100 m, the temperature will drop ± 0.6°C (Ziello, et al., 2009). The average temperature that falls affects the physiological process of arthropods. The optimum temperature for arthropods is 25°C with a temperature range of 15°C – 45°C which is suitable for the physiology of arthropods (Rizali et al., 2002).

The first location had a heterogeneity index H'=1.28. The index is the highest value when compared to other locations in the study. The first location is close to the people's activities and there are some cultivars (such as bananas and jackfruit). Formicidae found in large numbers at this location have a role as predators for the ecosystem (Abidin, 2010). The existence of Formicidae here shows the existence of abundant food resources from the fruits and the other animals. Some of the Formicidae species are herbivores they ate fruits and some of them are carnivores that eats another insect larvae (Hasimoto, 2003). Some cultivars that produce fruit

with sweet taste will quickly invite other animals such as butterflies and moth whose larvae are one of the prey of Formicidae (Pierre & Idris, 2013). The Formicidae also predators for termites larvae and it can be used to control termite colony population (Musyafa et al., 2019).



**Figure 2.** Shannon-Wiener Index

The second location had a heterogeneity index value H'=1.25. The second location is located in an area with pine stands and the land surface is dominated by vegetation from the Family Poaceae. The second location has the largest population of

Staphinilidae families compared to other locations, although there are also still many populations of Formicidae Families. Staphinilidae which has a role as detritivore and commonly found under the decaying leaf debris or rocks (Borror *et al.*, 1994). The falling pine leaf will be decayed faster by the Staphinilidae existence. Staphinilidae destructs the falling pine leaf debris into a smaller size. Staphinilidae population amount is linear with leaf debris amount because the Staphinilidae uses them as food. The Poaceae are suitable for Staphinilidae because of some Staphinilidae such as *Paedurus* sp. commonly predators in the *Oryza sativa* field that also Poaceae (Fitriani, 2018).

The third location had a heterogeneity index  $H'=1.01$ . The Entomobrydae Family is found most in the third location. This location is located in a heterogeneous forest with a high diversity of vegetation. The high diversity of vegetation is also a habitat for some animals and will certainly produce feces which is one of the sources of food for the Entomobrydae Family. The higher altitude and denser canopies increase the humidity that is compatible habitat for the fungi. Entomobrydae in their habitat has the role of eating moderate or decaying plants, fungi, and feces (Borror, *et al.*, 1994). The denser canopies also inhibit for the Poaceae to grow. The absence of Poaceae are the main reason for the Staphinilidae absence.

The last location had a heterogeneity index value  $H'=0$ . In the fourth location, only the Entomobrydae Family is found which has the role of detritivore. The fourth location only has vegetation from the Poaceae Family. The height at the fourth location is  $\pm 1585$  masl at a very low temperature. At this temperature, dead vegetation will decompose more slowly without assistance from Entomobrydae. The Staphinilidae absence although the Poaceae presence here. The Staphinilidae absence may be caused by the temperature average that is under the suitable temperature range for the arthropods physiology  $\pm 10^\circ\text{C}$ . Entomobrydae are the part of Collembola Class, its population increased linearly by the higher altitude (Abdillah *et al.*, 2020).

Based on the results of the study, several families have the potential to have a relationship with vegetation. The Formicidae family acts as a predator found in locations with fruit-producing plant vegetation. The Staphinilidae family has the potential to be associated with stands whose land is covered by litter. Entomobrydae family has the potential to be associated with the decomposition of vegetation bodies in the highlands.

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