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SOIL ARTHROPOD DIVERSITY ON THE FOREST FLOOR AND EX-ROAD IN MANGGIS GADUNGAN NATURAL RESERVE KEDIRI REGENCY, INDONESIA

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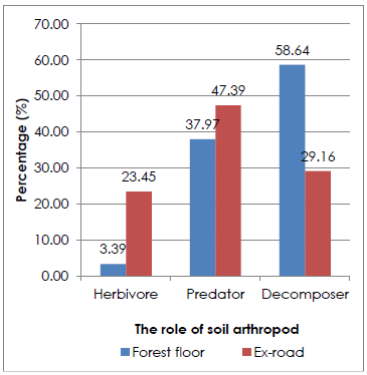
Graphical abstract



Abstract

Manggis Gadungan Natural Reserve is a biggest protected forest area in Kediri regency. There are many plants and animals conserved in the Natural Reserve. The main road crosses in the area was used as destination place. Since January 30, 2015 the road was unloaded. Soil arthropods have the ability to return to disturbed habitat. Soil arthropod diversity can illustrate the linkage of soil arthropod and ecosystem service. The research aims to compare abundance, composition and diversity of soil arthropod on the forest floor and ex-road in Manggis Gadungan Natural Reserve. The soil arthropods were collected by pitfall traps. The results show that there are 5 classes of soil arthropod i.e. Arachnida, Chilopoda, Collembola, Diplopoda and Insecta. The insect class has the highest taxa number of soil arthropods. The forest floor is characterized by the presence of Paronellidae 1, Entomobryidae 1 and Formicidae 5 while the ex-road is characterized by Paronellidae 2, Formicidae 1, Formicidae 7 and Gryllidae 1. The forest floor is dominated by decomposer while the ex-road is dominated by predator. Diversity of soil arthropod on the forest floor is higher than on the ex-road.

Keywords: Diversity, soil arthropod, natural reserve, forest floor, ex-road

1.0 INTRODUCTION

Natural reserve has an important role to support ecosystem sustainability and to maintain the existence of plants and animals in a conservation area. Manggis Gadungan Natural Reserve is a biggest protected forest area in Kediri regency. There are many plants and animals conserved in the area, but there is a main road that crosses in the natural reserve. The road connects villages in around the natural reserve [1]. There are many human activities in the Manggis Gadungan Natural Reserve, especially use the area as destination place. Human activities can cause environmental degradation that leads to decrease in the abundance of plant and animal communities. Base on the reason, since January 30, 2015 the road was unloaded.

Soil arthropods have the ability to return to disturbed habitat. Soil arthropods are critical in ecosystems as members of food webs and accelerators of nutrient cycling [2]. The richness of the soil arthropod is indicative of the maturity of the community of vegetation in the recovered area. After recovery of the soil, the process of secondary succession involves an increase in the diversity of the

structure and in the available ecosystem energy that facilitate the development of high trophic level [3]. Diversity of soil arthropod can be used to illustrate the linkage of soil arthropod and ecosystem service. The service is not only essential to ecosystem function but also a critical resource for the sustainable management of ecosystem [4]. Soil arthropod is an important reservoir of biodiversity and plays an essential role in several soil ecosystem functions. Soil arthropod is often used to provide soil quality indicators [3].

2.0 LITERATURE REVIEW

Diversity relate to the variety or number of species in a community. Diversity is discussed as a concept it will include measures of both species richness (the number of species) and diversity (the number and abundance of species) [5].

Soil arthropods are consumers and participate in the decomposition of plant debris as primary and secondary decomposers [6]. Soil arthropods affect primary productivity, organic matter turnover, ecological succession, biogeochemical cycling, carbon and energy fluxes and hydrology [7].

Diversity and community dynamic of arthropods are strongly correlated with ecosystem function. Arthropod community structure reflects habitat heterogeneity, as well as development and recovery of forest ecosystems after natural and anthropogenic disturbances. Arthropods are good indicator of the overall biodiversity and ecosystem integrity of forest and can be used for evaluating and designing sound ecosystem management plans [8]. Soil arthropod diversity in natural ecosystem is higher than disturbed ecosystem. The abundance and diversity of soil arthropod in Manggis Gadungan Natural Reserve are higher than in agroforestry system [9].

3.0 METHODOLOGY

3.1 Site Description

The study site was done at Manggis Gadungan Natural Reserve sub-district of Puncu, Kediri Regency, Indonesia (07o50'48.28"S 112o14'3.21"E) 100 m asl. The plants in natural reserve area are dominated by *Aleurites moluccana*, *Artocarpus elasticus*, *Pterospermum javanicum*, *Ficus globosa*, *F. retusa*, *F. variegata*, *Litsea glutinosa*, *Dysoxylum amoroides*, *Laportea stimulans*, *Acmena accuminatisima*, *Dysoxylum gaudichaudianum*, *Macaranga rhizinoides*, *Quercus sondaica*, *Streblus asper*, *Arenga pinnata*, *Calamus javensis*, *Aglaonema picta* and *Corymborchis veratrifolia* [1]. The long of ex-road is 700 m that crosses in the middle of natural reserve area. There is not yet vegetation in the area. Figure 1 shows the study site at Manggis Gadungan Natural Reserve Kediri Regency.

Figure 1 The study site at Manggis Gadungan Natural Reserve Kediri Regency

3.2 Sampling of Soil Arthropods

Soil arthropods sampling were conducted at rainy season between March until April 2015. Soil arthropods were collected by pitfall traps. There were 30 pitfall traps in every location that were installed systematically at 5 m intervals. The trap used plastic cup of about 10 cm mouth diameter that was filled with 10 ml 70 % ethanol and 5 drops of detergent solution. The traps were placed 24 hours in the ground. The trapped soil arthropods were stored in 70 % ethanol and observed under stereomicroscope for identification.

3.3 Data Analysis

The soil arthropods data were analyzed into Shannon's diversity index (H) and Principal Components Analysis (PCA). The data analysis used software Past 3.06.

4.0 RESULTS AND DISCUSSION

The soil arthropod samples that had collected from the study site were identified into class, order and family. The identification results show that there are 5 classes i.e. Arachnida, Chilopoda, Collembola, Diplopoda and Insecta (Table 1).

Generally, the taxa number on the forest floor in Manggis Gadungan Natural Reserve is higher than on the ex-road. The insect class has the highest taxa number of soil arthropods while the Arachnida class is the second. A rapid survey of invertebrate and vertebrate groups reveals that at least 1/4 of

described living species are strictly soil or litter dwellers. The main part of which is insects and arachnids [10].

Insects may dominate food chains and food webs in both volume and numbers. Feeding specializations of different insect groups include ingestion of detritus, rotting materials, living and dead wood [11].

Table 1 Comparison of soil arthropod taxa number on the forest floor (FF) and ex-road (ER)

Class	Order		Family	
	FF	ER	FF	ER
Arachnida	2	2	8	5
Chilopoda	2	1	2	1
Collembola	2	2	4	3
Diplopoda	2	1	2	1
Insecta	5	4	14	9
Total	13	10	30	19

The soil arthropods are very abundant in Manggis Gadungan Natural Reserve. Hypogastruridae and Paronellidae 2 are abundant in the both location while Formicidae 1, Formicidae 7 and Gryllidae 1 are only abundant in the ex-road (Table 2).

Result of Principal Components Analysis (Figure 2) shows that the forest floor in Manggis Gadungan Natural Reserve is characterized by the presence of Paronellidae 1, Entomobryidae 1 and Formicidae 5 while the ex-road is characterized by Paronellidae 2, Formicidae 1, Formicidae 7 and Gryllidae 1.

The Hypogastruridae, Paronellidae and Entomobryidae are member of Collembola class. The Collembola size is only 0.2-9 mm but their abundance make them play important role in decomposition processes [6]. Collembolans play a significant role in soil fertility maintenance as they influence key soil processes like organic matter decomposition and nutrient cycling. The reduction in collembolan abundance observed in the intensively managed systems may have important effects on organic matter decomposition and nutrient availability and consequently, on soil fertility [12].

Table 2 Soil arthropod abundance

Taxa	Forest Floor	Ex-road
Agelenidae	2	1
Agyrtidae	2	1
Araneidae	1	0
Atypidae 1	2	1
Atypidae 2	0	7
Blattidae 1	3	0
Blattidae 2	1	1
Carabidae 1	1	0
Carabidae 2	1	2
Carabidae 3	1	2
Carabidae 4	0	33
Coccinelidae	11	0
Corydiidae	3	0
Cryptopidae	4	0
Ectobiidae	2	5
Elateridae	3	0
Entomobryidae 1	38	13
Entomobryidae 2	18	21
Entomobryidae 3	1	0
Forficulidae	17	0
Formicidae 1	54	197
Formicidae 2	1	0
Formicidae 3	6	33
Formicidae 4	14	6
Formicidae 5	54	3
Formicidae 6	2	0
Formicidae 7	11	120
Gryllidae 1	11	192
Gryllidae 2	5	0
Gryllidae 3	7	50
Gryllidae 4	3	35
Gryllotalpidae	2	1
Hypogastruridae	357	290
Julidae	1	0
Lithobiidae	2	2
Lycosidae	2	5
Neanuridae	1	0
Oxyopidae	2	0
Paradoxosomatidae	2	2
Paronellidae 1	66	0
Paronellidae 2	109	154
Salticidae	1	8
Scarabaeidae	3	0
Staphylinidae 1	19	0
Staphylinidae 2	1	1
Tetrigidae	7	2
Thromisidae	1	2
Trombidiidae	1	0

Formicidae and Gryllidae are member of insect class. The Insect are essential to the ecosystem functions through nutrient recycling, via leaf-litter and wood degradation, maintenance of plant community composition and structure, via phytophagy, including seed feeding, maintenance of animal community structure, through transmission of diseases of large animals, and predation and parasitism of smaller ones [11].

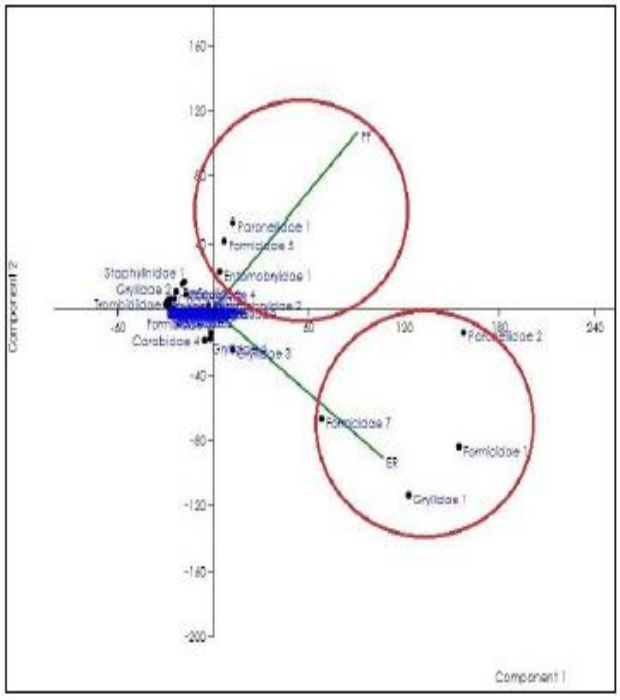


Figure 2 Principal Components Analysis (PCA) of soil arthropods on the forest floor (FF) and ex-road (ER

The role of soil arthropod on the forest floor in Manggis Gadungan Natural Reserve is dominated by decomposer (58.64 %). Decomposer community's are an important component in forest ecosystems. They role in the acceleration of organic matter decomposition. The decomposition process through breakdown of litter, digestion and stimulation of micro-organism activities [13]. Figure 3 shows the role of soil arthropod in Manggis Gadungan Natural Reserve Kediri Regency.

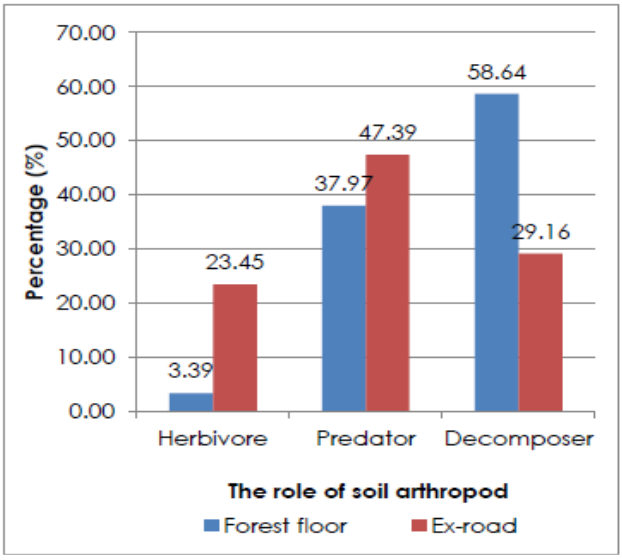


Figure 3 The role of soil arthropod in Manggis Gadungan Natural Reserve Kediri Regency

There is not yet plant on the ex-road in Manggis Gadungan Natural Reserve so this location is dominated by predator (47.39 %). A predator kills and consumes a number of prey animals during its life [11]. Predator and prey diversity change food web structure and predator-prey interactions affecting ecosystem function. Increasing predator diversity may increase the important predator species are included in the predator community [14]. Plants producing structural materials can be considered both as components of the ecosystem level food web and as ecosystem engineers in that stems, branches and roots create habitats for other organisms both aboveground and in the soil [15]. Among the described insects, 90% are members of orders including many herbivorous species. The hierarchy of feeding relationships in a community can then be regarded as a food chain, or food web, with linkages from plants to herbivores, to primary carnivores, to secondary carnivores and so on up the trophic system. Very simple communities may be more chain-like in structure, but usually web-like sets of interactions are observed, especially as predators tend to be more general feeders than herbivores and parasitoids [16].

Table 3 Community analysis of soil arthropod

	Forest Floor	Ex-road
Taxa number (S)	46	29
Individuals number (N)	856	1190
Shannon's index (H)	2.30	2.24

The taxa number and Shannon's diversity index of soil arthropod on the forest floor is higher than on the ex-road (Table 3). The rate of recovery of arthropod species after disturbance reflects the recovery of the habitat structure. After low-intensity cutting such as thinning, herbs and shrubs rapidly regenerate on the forest floor and create a suitable habitat that support height arthropod diversity [8].

Soil community diversity affects plant diversity, affects arthropod diversity which feeds back to affect plant diversity and thus affect soil community diversity [5]. Soil arthropod diversity ensures a multiplicity of functions under a variety of environmental conditions. High diversity guarantees a source of new species performing functions as environmental conditions change [17].

Under natural conditions, the interactions between the populations of organisms at the various trophic levels i.e. plants, herbivores, decomposers, predators and secondary predators result in a dynamic balance of population sizes. The total diversity is huge but any single population is only influenced by a relatively small number of interactions [18].

5.0 CONCLUSION

The conclusions for this research are as follows:
1. There are 5 classes of soil arthropod i.e. Arachnida, Chilopoda, Collembola, Diplopoda and Insecta in Manggis Gadungan Natural Reserve, where the insect class has the highest taxa number of soil arthropod.
2. The forest floor is characterized by the presence of Paronellidae 1, Entomobryidae 1 and Formicidae 5 while the ex-road is characterized by Paronellidae 2, Formicidae 1, Formicidae 7 and Gryllidae 1.
3. The forest floor is dominated by decomposer while the ex-road is dominated by predator.
4. The soil arthropod diversity on the forest floor is higher than on the ex-road.

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