Journal of Tropical Biodiversity and Biotechnology

journal homepage: http://jtbb.or.id

Diversity of Soil Macro Insect in Alas Purwo National Park, Banyuwangi, East Java, Indonesia

Astri Dwi Wulandari[1,*], Tutik Indrawati[1], Fitrahyanti Fiqqi Maghfirah[1], Eka Kartika Arum Puspita Sari[1], Shifa Fauziyah[1], Rosmanida[1,2]

[1]*Department of Biology, Faculty of Science and Technology, Airlangga University, Jl. Mulyorejo, Jawa Timur*
[2]*Institute of Tropical Disease, Airlangga University*
**Corresponding author, email: astridwi_wulandari@yahoo.co.id*

ARTICLE INFO

Article history:
Received 08/03/2018
Received in revised form 24/07/2018
Accepted 24/07/2018

Keywords:
Alas Purwo National Park
biodiversity
dominancy
soil/macro insect

DOI: 10.22146/jtbb.33773

ABSTRACT

Indonesia is the second largest mega biodiversity of the world. One of the forest resources are soil insects. Soil insects improved the soil physical properties, added organic material content, and used as bio-indicator of environmental conditions of conservation areas, forests, or mountains. The aim of this research was to get information about the diversity, dominance, and similarity index of soil macro insect in Alas Purwo National Park, Banyuwangi, East Java, Indonesia in 2017. Locations were selected based on purposive random sampling considering 2 habitat types; coastal forest path and tropical rain forest path. The method of this research was used pitfall trap. Insects were identified at Laboratory of Ecology, Biology Department, Faculty of Science and Technology, Airlangga University, Surabaya. The results showed that the diversity index of soil insects in the coastal forest path was 1.611 and in path of tropical rain forest was 0.855. It means that the diversity of soil macro insect in coastal forest path were medium and in path of tropical rain forest was low. The Dominancy index of coastal forest path was 0.334 and in path of tropical rain forest was 0.433. It means that the community was stable, there was no species domination. The similarity index of soil insects in both paths have a 58.8%, was a unity of the same community.

1. Introduction

Indonesia has many plants and animals, so Indonesia often called as the centre of megabiodiversity (Amir *et al,* 2008). Forest is natural resources that have high potency for supporting the diversity of flora and fauna. Alas Purwo National Park is a national park that located in Tegaldlimo and Purwoharjo sub-district, Banyuwangi district, East Java Province, Indonesia. Geographically Alas Purwo located in southeast of East Java, in coordinate point 8°26'45"-8°47'00"S and 114°20'16"114°20'16"114°36'00'' E.

Generally, Alas Purwo National Park has flat topography, sand-rubbery land. One of forest resources are soil insect. Soil insect is insect that lives in land (Suin, 1997). Rahmawaty (2000), stated there are some factors that can influence soil insect in forest, that is land structure influence their movement and penetration, land humidity, and the contain of its land can influence the development or the life cycle of soil insect, temperature can influence the place of breeding site, light and air influence soil insect's activity.

Soil insect that lives on the land has role as decomposer, repair physical characteristic of soil, containing of those organic matters can used as bioindicator of environmental condition of conservation area, forest, or mountain. Nowadays, using insect as bioindicator are important to show the relation between biotic factor and abiotic factor (Speight *et al,* 1999). Soil damage causes the type of insects on the soil surface or in the soil is reduced even disappear. Though insects play an important role in maintaining the balance of ecosystems. The role of insects soil one of them is to improve soil fertility, loss of soil fertility can affect the balance of ecosystem (Syaufina, 2007). Insects are very useful for several fields including agriculture, health, and natural resources. The loss of soil insects will affect the balance of the ecosystem.

2. Materials and Methods

2.1. Study sites

Alas Purwo is the one of the National Park in Banyuwangi, East Java, Indonesia. Average rainfall in Alas Purwo National Park is 100 - 1500 mm per year with temperature 22°-31° C, and the air humidity is about 40–85%. The research were conducted in February which has entered the rainy season. The western region of Alas Purwo National Park receives higher rainfall compared to the eastern region. The soil insect was taken in two location, beach forest (Pancur) and tropical rain forest (Sadengan). There are 3 locations, beach forest (Pancur), tropical rain forest (Sadengan), and triangulated beach. But we use 2 locations, beach forest and tropical rainforest, because it is easy to access and vegetation plants are abundant compared to the triangulated area. The higher humidity was located in beach forest (Pancur), it cause the location is more westward than tropical rainforest (Sadengan). Soil insects are collected from 300 meters down the path of beach forest (Pancur) and 300 meters down the path of tropical rainforest (Sadengan). Every paths has three observation sites and every sites has two traps mounted. From one station to the others is 100 meters apart. So, there are twelve total point observations (See Picture 1). Diversity of soil insect species was analysed using the Shannon-Wiener Index, the domination species was analysed using the Simpsons Diversity Index, and to comparing the similarity of two samples from different location was analysed using Sorensen's Similarity Index.

2.2. Materials

The materials used include leaf litter, rotten fruit, rotten fermented soybean, detergent and water. Meanwhile, the tools are GPS, hygrometer, gauge, string, medium basin container, spoon, small branch, cardboard, thermometer, thread, leaf litter, Styrofoam, plastic clip.

2.3. Methods

2.3.1. Sampling methods

This research use a pitfall trap. There are twelve total point observations using pitfall trap (Figure 1). According to Southwood (1978) in Suheriyanto (2013), the index of biodiversity is as follows:

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

Where, H' is Shannon Wiener's diversity index, p_i is the proportion of individuals found in species i. For a well-sampled community, we can estimate this proportion as $p_i = n_i/N$, where n_i is the number of individuals in species i and N is the total number of individuals in the community. According to Fitriana (2006) the index of diversity can be assessed by the value of H: 0 <H <1.0 = low diversity; 1.0 <H '<3.322 = medium diversity; H '> 3,322 = high diversity.

The domination species was analysed using the Simpsons Diversity Index (Junaidi, 2016). It is calculated in the following way:

$$C = \sum \left(\frac{n_i}{N}\right)^2$$

where C is Simpsons Diversity Index, n_i is the number of individuals in species i and N is the total number of individuals in the community. The dominant index ranges from 0-1. If C is close to or equal to 0 means no species dominate other species or community structures in a stable state; C is close to or equal to 1 means there are species that dominate other species, or unstable community structures because they occur ecologically.

The similarity of two samples from different location was analysed using Sorensen's Similarity Index (Ruslan, 2009), taking the following form:

$$IS = \frac{2C}{A+B} x100\%$$

Where IS is Sorensen's Similarity Index, A is number of genus of insects that exist only in the first habitat, B is the number of genus of insects that only exist in the second habitat, and C is number of genus of insects in both habitats. The trap by made a hole with the depth same as medium basin container. Then, filled by detergent. Detergent has function to decrease water surface pressure, it makes soil insect can be trapped. Rotten fruit and rotten fermented soybean were used to attract soil insect. Rotten fruit were covered by gauze that tied into cardboard/Styrofoam. Trap leaved for 24 hours¸ the trap results are collected every single day in the morning and also replace the material for 3 days.

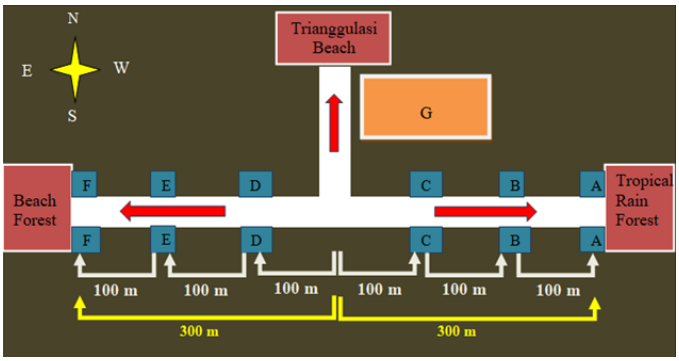

Figure 1. Map of pitfall distribution used in Alas Purwo. Tropical rain forest track: (A) pitfall III, (B) pitfall II, and (C) pitfall I; beach forest track: (D) pitfall I, (E) pitfall II, and (F) pitfall III; (G) homestay.

2.3.2. Collecting and identifying soil insect

Every soil insect that trapped, will be washed by

alcohol to clean from detergent, and then entered into plastic clip. After dry, sample will be saved in collection box and given chalk (Hardikastowo and Simanjuntak, 1996). Identifying of soil insect are doing in Ecology Laboratory, Department of Biology, Airlangga University.

3. Results and Discussion

A total of 221 soil insect has been identified, consist of 12 species from 9 family. From 221 individuals, 38% consist of *Foficula auricularia*, 34.84% consist of *Mrymecocystus mimicus*, 7.23% consist of *Camponotus pennsylvanicus*, 6.33% consist of *Parcoblatta pennsylvanica*, 4.52% consist of *Entomobria sicia*, 3.16% consist of *Neopnera villosa*, and others (Table 1, Figure 2).

Based on Shanon-Winner Index (H'), the value of H' in beach forest track was 1.61, meanwhile the value of H' in tropical rain forest was 0.85. It means that the diversity level, the distribution of species, and the stability in beach forest track was medium. Meanwhile, the diversity level, the distribution species, and the stability of tropical rain forest was low.

Based on Simpson Dominancy Index (C), the value of C in beach forest track was 0.33, and the value of C in tropical rain forest track was 0.43. It means the distribution of insect influenced by some geology and ecology factors, so there are some difference in the diversity of insect species. These difference caused by the difference of climate, season, latitude, and also kind of foods (Borror, 1998). From those sample, the value of Sorensen similarity index from two tracks was 58.8%, it means that both of tracks were in same unity. The value between 25-50% showed high similarity. Meanwhile, the value between 25% indicated two communities were different. There was no dominated species in both of track and the community structure is stable.

Variation of soil insect in homogenic and heterogenic forest stated by Ruslan (2009), consist of 8 order, 18 family, and 409 individuals from homogeny forest. Meanwhile, in heterogenic forest consisted of 8 order, 16 family, and 992 individuals. The mostly found order of soil insect were Coleoptera, Diptera, and Hymenoptera, because of their habitat's were in soil surface (Borror *et al*., 1992). The amount of soil insect influenced by the abiotic and biotic factor of their habitat (Suin, 1989). Variation of soil insect in heterogenic forest than in homogeny forest caused of the variation of vegetation in heterogenic forest. Organic matters are important nutrition for soil insect (Suhardjono *et al*., 1997). Another research come from Sari (2015) stated that order of soil insect in heterogenic forest are Formicidae, Vespidae, Gryllinae, Coleoptera and Diptera. Meanwhile, in homogenic forest orders of soil insect that found were Formicidae, Vespidae, Gryllinae, Diptera dan Siphonoptera. pH condition in heterogenic forest more acid than in homogeny forest (Wallwock, 1970).

Types of soil insect influenced by biotic factor and abiotic factor. Abiotic factor consist of soil, water, temperature, light, and atmosphere. Meanwhile, biotic factor consist of plant and animal around those area. The climate data of Alas Purwo National Park area was obtained from Banyuwangi Meteorology Station, according to the Schmidth and Ferguson classification system, the area around Alas Purwo National Park has climate type around D (slightly moist) to E (slightly dry). Average rainfall of 1000 - 1500 mm per year with temperature 22-31°C, and air humidity 40-85%.

Table 1. Composition of Soil Macro Insect from 2 tracks (Beach Forest and Tropical Rain Forest)

No.	Order	Family	Species	Track 01	Track 02	Total species	%
1.	Hymenoptera	Formicidae	*Myrmecocystus mimicus*	76	1	77	34.84
2.	Neuroptera	-	-	7	0	7	3.16
3.	Hymenoptera	Formicidae	*Solenopsis invicta*	1	0	1	0.45
4.	Hymenoptera	Formicidae	*Camponotus pennsylvanicus*	7	9	16	7.23
5.	Hymenoptera	Formicidae	*Ochetellus glaber*	1	0	1	0.45
6.	Dermaptera	Forficulidae	*Forficula auricularia*	38	46	84	38.00
7.	Blattodea	Ectobiidae	*Parcoblatta pennsylvanica*	3	11	14	6.33
8.	-	Unidentified	*Unidentified*	3	4	7	3.16
9.	Coleoptera	Mordellidae	*Mordellistena andreae*	0	1	1	0.45
10	Coleoptera	Staphylinidae	*Platydracus femoratus*	1	0	1	0.45
11.	Collembolla	Entomobrydae	*Entomobrya sicia*	10	0	10	4.52
12.	Coleoptera	Chrysomelidae	*Chrysolina auripennis*	2	0	2	0.90
Total				149	72	221	100

Note: Track 01 = Beach Forest; Track 02 = Tropical Rain Forest

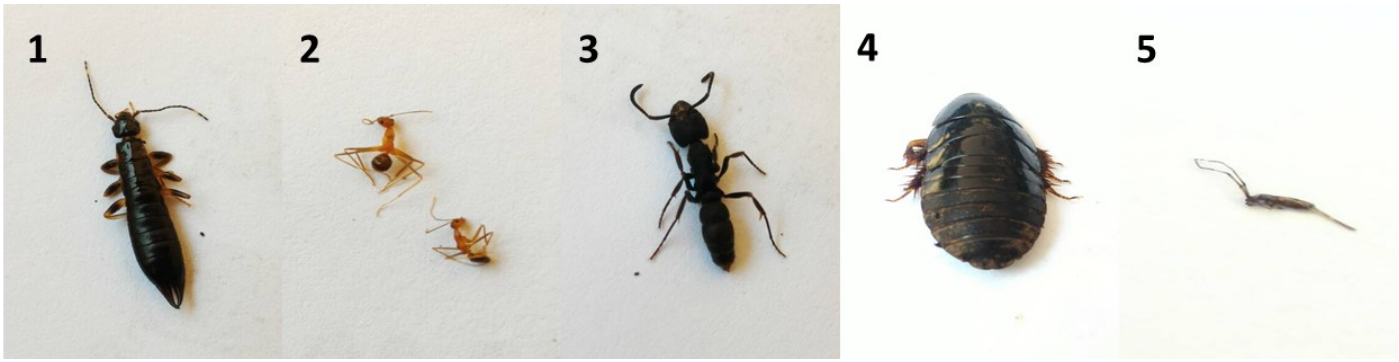

Figure 2. The higher soil macro insect. (1) *Foficula auricularia*, (2) *Mrymecocystus mimicus*, (3).*Camponotus pennsylvanicus*, (4) *Parcoblatta pennsylvanica*, and (5) *Entomobria sicia*

Ruslan (2009) stated that the enough presence of physics and chemistry factor can support the development and soil insect activity.

Based on the research that had been done by Suwondo *et al.* (2015) in Arboretum of Riau University, the composition of soil insect in Arboretum Riau University were 4 order and 11 species. Order Hymenoptera almost found in all station. Order Collembola was the second order that almost found in all station. Meanwhile, order Orthoptera, Coleoptera, and Diptera were found in little amount. Shanon-Winner index of soil insect in that arboretum classified as medium, with the value index between 1 until 3.

The role of insects in the environment as herbivores, carnivores, as well as detritivores in the food web, therefore insects are one component of biodiversity that plays an important role. In addition, insects are also very important for the balance of the ecosystem. Such as *Camponotus pennsylvanicus* is considered to be the most significant structure in forest areas. Because it colonizes trees and decaying wood, *Parcoblatta* is a wooden cockroach that lives in litter and junk in the forest, acting as an important decomposer for biological arrangements.

Soil insects are beneficial for soil fertility, especially short-lived insects. If the presence of soil insects is reduced then the soil will continue to experience a shortage of organic materials as a source of minerals and remove nutrients in the soil that negatively impact on vegetation (Syaufina, 2007). In every different place has different diversity of soil insects. Extreme environments lead to low community diversity, such as dry areas, poor soils, and high mountains. Whereas high diversity exists in areas with optimum environmental communities, such as fertile areas, rich soils, and mountainous areas (Sari, 2014)

Soil is a source of nutrients and energy for biota in the soil. Soil biota of which are the roots of plants, microbes, soil microfauna, soil mesofauna and soil macrofauna. Nutrient sources come from all soil components of soil minerals, soil organic matter, air and ground water (Makalew, 2001)

4. Conclusions

A total of 221 soil insects have been identified, consisting of 12 species from 9 families. Based on Shanon-Winner Index, the diversity of soil macro insect in beach forest track of Alas Purwo National Park classified as medium class. It means that the distribution of species and the stability of this community is medium. The diversity of soil macro insect in tropical rain forest of Alas Purwo National Park is low. It means the distribution species and the stability of this community is low. Based on Simpson Dominancy Index, there is no dominant species in both of track. The value of Sorensen similarity index from two tracks are 58.8%, it means the community structure is stable.

Acknowledgement

We thank to Alas Purwo National Park, Association of Biology Students Airlangga University who assisted this research.

References

Amir, M. W. A., Noerdjito and S. Kahono. 2008. *Insect in Halimun Mountain National Park, West* Java. Bogor. BCPJICA.

Borror, D. J., C. A. Triplehorn dan N. F. Johnson. 1992. *Introduction of Insect* Learning. 6th Edition. Soetiono Porto Soejono. Gajah Mada University Press. Yogyakarta.

Fitriana, Y. R. 2006. Keanekaragaman dan Kemelimpahan Makrozoo-bentos di Hutan Mangrove Hasil Rehabilitasi Taman Hutan Raya Ngurah Rai Bali. Jurnal Biodiversitas 7(1), 67-72.

Hadikastowo dan R. H. Simanjuntak. 1996. Mengumpulkan dan Mengawetkan Serangga. Penerbit Bhratara: Jakarta. i+89.

Junaidi, A. 2016. *Keanekaragaman serangga tanah pada lantai hutan & bekas jalan di cagar alam manggis gadungan kecamatan puncu kabupaten kediri*. Universitas Islam Negeri (UIN) Maulana Malik Ibrahim, Malang.

Makalew, A. D. N. 2001. The Diversity of Soil Biota at Agroecosystem without Tillage. Papers of Post Graduate Program. Bogor Agricultural University. Bogor. Http://www.hayati- ipb.com/users/rudyct/ indiv2001/afra-dnm.htm.

Rahmawaty. 2000. *The Diversity of Soil Insect and its Role on Rhizopora spp. Community and Ceriops Community Tagal in Rawa Aopa Watumohai National* Park. Thesis of Gradute Program Bogor Agricultural University . Bogor.

Ruslan, H. 2009. Composition and The Diversity of Soil Insect in Homogen and Heterogen Forest at Nature Conservation Center Bodogol, Sukabumi, West Java. VIS VITALIS Journal 2 (1), 1978-9513.

Syaufina, L. 2007. The Diversity of Soil Arthropods in Education Forest of Walat Mountain. Media Conservation Journal 12 (2), 57-66.

Sari, M. 2014. Identifikasi Serangga Dekomposer di Permukaan Tanah Hutan Tropis Dataran Rendah (Studi Kasus di Arboretum dan Komplek Kampus UNILAK dengan Luas 9,2 Ha). Bio-Lectura: Jurnal Pendidikan Biologi 2 (1), 63-72.

Suheriyanto, D. 2008. Ekologi Serangga. Malang, Indonesia: UIN Malang Press.

Suhardjono Y. R. 1997. *Serangga Serasah : Keanekaragaman Takson dan Perannya di Kebun Raya* Journal Biota 3 (1), 16-24.

Suin, N. M. 1989. *Ekologi Hewan Tanah*. Bumi Aksara. Jakarta.

Suwondo, E. Febrita, and A. Hendrizal. 2015. Composition and The Diversity of Soil Insect in Arboretum Riau University as Learning Source Through Inquiry Model. Biogenesis Journal 11(2), 93-98.

Wallwork, J. A. 1970. *Ecology of Soil Animals*. Mc Graw Hill. London.