DIVERSITY OF TOP-SOIL INSECTS ON TWO TYPE OF LAND USE PT. TIDAR KERINCI AGUNG, WEST SUMATERA, INDONESIA

Gita KOMONICI1*, Jabang NURDIN2, Henny HERWINA2, Muhammad Nazri JANRA2

1 Dept. of Biology, University of Andalas (Lima Manis, Pauh, Kota Padang 25163, West Sumatera, Indonesia)
E-mail: gkomonici22@gmail.com
2 Lecturer, Dept. of Biology, University of Andalas (Lima Manis, Pauh, Kota Padang 25163, West Sumatera, Indonesia)
E-mail: jabangnurdin@yahoo.com, hennyherwina@sci.unand.ac.id, mnjanra@sci.unand.ac.id

The research aimed to do the inventory and to reveal the diversity of top-soil insects related to the land utilization types in this company, i.e. conservation forest and oil-palm plantation. This study deployed survey method by collecting samples using pitfall traps. The result showed that the conservation forest and palm oil plantation were inhabited by 32 genera, 19 families, and 8 orders of top-soil insects. which mainly constituted of order Coleoptera, Hymenoptera, Collembola, Orthoptera, Diptera, Plecoptera, Hemiptera, and Dermaptera. The highest diversity (H' = 3.07) was observed on nocturnal soil insects at the conservation forest, while diurnal soil insects showed the lowest diversity (H' = 1.96) at the oil-palm plantation.

Key Words: diversity, top-soil insects, conservation forest, oil-palm plantation

1. INTRODUCTION

Top-soil insects consist of organisms that inhabit the top-soil layer of soil and significantly important in stabilizing the ecosystem13. Top-soil insects serve as decomposer of organic materials, hence, it can be used as bio-indicator of soil fertility13. The dynamics of top-soil insects are influenced by environmental factors, most of the time the micro- and macro-factors of the top-soil environment. Micro-factors, such as humus thickness, organic material components, density, and soil moisture, influence the life of soil insects. On the other hand, geology, climate, elevation, species of plants, and land utilization are considered to be the macro-factors3).

Currently, forest extraction for economic purposes has brought prominent impact on ecosystem structure. Forest conversion into oil-palm plantation has created fragmentation and decreased pristine natural habitat for many organisms. The life of soil insects is consequently impacted to be decreasing in its diversity.

PT. Tidar Kerinci Agung (PT. TKA) is a company that runs oil-palm plantation and processing in West Sumatera. In overall, this company occupies 28.029 ha of land that includes the plantation and conservation portion of the area. Since this company has run for a while, it is important to know the effect of its activities toward the diversity of top-soil insects at several of its land utilization types.

2. MATERIALS AND METHODS

(1) Time and Location

The study was undertaken between April 2017 until January 2018 at oil palm plantation and adjacent conservation forest within the territorial of PT. TKA in Solok Selatan Regency, West Sumatra province. Ecological data was analyzed at Ecology and Animal Taxonomy Laboratories, Andalas University, Padang. Verification on species identification was provided by Entomology Laboratories, Indonesian Institute of Science in Cibinong, Bogor, West Java.
(2) Data Collection
Sampling campaign used pitfall trap method that systematically set to randomly sampling the top-soil insects. The pitfall traps were evenly distributed into three stations, each at conservation forest and oil-palm plantation. The stations were set 100 meters apart from one to another, each contained six traps that set at 10 meter intervals. The traps were mounted and checked daily with two timing arrangements; first set at 17.00 and checked at 09.00 for trapping nocturnal insects and secondly set at 09.00 and checked at 17.00 for sampling diurnal insects. Trapped insects then collected, labelled and sorted according to their trapping time. Those collected within the first timing arrangement were labelled as nocturnal (active during night time), while those trapped during second arrangement grouped into diurnal (active during daytime) insects. Identification was assisted with appropriate reference. Measurement of chemical-physical factors of soil included soil temperature, soil moisture, soil pH, Nitrogen content, and soil C-Organic.

(3) Data Analysis
Some ecological indices were counted using following formulas:

Density (K) = \[ \frac{\text{Totals number of individual of genus } A}{\text{Totals of example unit (area/volume)}} \]

Relative Density (KR) = \[ \frac{K \text{ of genus } A}{\text{Totals } K \text{ of all genus}} \times 100 \% \]

Frequency of Attendance (FK) = \[ \frac{\text{Totals of all example unit where } \text{Genus } A \text{ found}}{\text{Totals of all example unit}} \times 100 \% \]

Shannon and Wiener’s Diversity Index
\[ H' = - \sum (pi \ln pi) \]
\[ pi = \frac{n_i}{N} \]

Where \( H' \) = Shannon and Wiener’s diversity index, \( n_i \) = individual number of taxon-i, \( N \): total individuals of entire sampled taxa, \( pi \): proportion of taxon-i population with the total individuals of the entire sampled taxa

Equitability Index (E): \[ E = \frac{H'}{H_{max}} \]

Where, \( H' \) = Shannon and Wiener’s diversity index, \( H_{max} = \ln s \), \( s \) = number of taxa

Simpson’s Dominance Index (C) = \[ \sum (pi)^2 \]

Where, \( PI = \frac{n_i}{N} \), \( n_i \) = individual number of taxon-i, \( N \): total individuals of entire sampled taxa

Sorensen’ Similarity Index (IS) = \[ \frac{2C}{A+B} \times 100\% \]

Where, \( C \) is number of taxa that equally present in both areas, \( A \) = number of taxa present in area A, \( B \) = number of taxa present in area B. If IS bigger than 0.50, then the two communities can be considered to be similar or composed by similar taxa.

3. RESULT AND DISCUSSION

(1) Composition of Top-soil Insect
From the study, it was known that both types of land utilization in PT. TKA were inhabited by 32 genera, 19 families and 8 orders of insect; all identified from 779 individuals of top-soil insects collected. Conservation forest recorded 29 genera from 17 families and 8 order, with 435 insect individuals collected. On the other hand, the oil palm plantation booked 19 genera from 12 families and 7 orders, with 344 insect individuals sampled.

There was difference in term of number of top-soil insect genera recorded at two types of land use (Fig. 1). It was presumably caused by the difference of land conditions and environmental factors (Table 1), which worked together with biotic factors that support the life of insects and food availability. Coleoptera and Hymenoptera became orders with the most genera recorded at conservation forest areas with respectively 11 and 10 genera observed. Meanwhile, at the oil-palm plantation, Hymenoptera (with 7 genera) and Diptera (with 5 genera) were the most prominent ones (Fig. 1). Hymenoptera found as the most genera at both types of land use, as it was thought that Hymenoptera well-adapt to different habitats and environmental conditions. Furthermore, Hymenoptera was included as insects with most members, positioned slightly below Coleoptera, Lepidoptera, and Diptera. It has evolved and diversified into various forms of morphology and ways of life.

(2) Ecological Indications of Top-soil Insects
Top-soil insect diversity varied according to the land-use type (Fig. 2). The diversity of top-soil insects seemed to decrease from conservation forest to oil palm plantation. The nocturnal insects at conservation forest showed the highest diversity (\( H' = 3.07 \)) among other criteria and habitat, particularly contributed by the sheer number of genera recorded in this area (26 genera). Meanwhile, the genera of top-soil insects were almost evenly distributed between land use types (\( E = 0.94 \)). Diversity of organism depends on number of species (in our case, genera) in that community and how abundant they are.

The evenness index can express the distribution of organism in a certain community. This index value, calculated in this study, indicated little to no dominance of certain organism in a particular location. Meanwhile, the domination index between two types of land use in PT. TKA ranged from 0.05 to 0.22. As this domination index was close to 0, implied that no genera dominated within the communities, despite several them were observed to
have numerous individuals.

(3) Environmental Factors of Top-soil Insect

Conservation forest showed slightly higher on most measured environmental factors than the oil palm plantation. Average soil temperature at conservation forest were lower than that at oil palm plantations (24.32°C compared to 26.33°C, Table 1). This directly related to the soil moisture, as it was measured slightly higher at conservation forest (20.12%) than at oil palm plantation (17.16%). Top-soil insects can tolerate a wide range pH, from 2 up to 9, while the pH at both study sites fell within this range. All of these conditions were arguably optimal to support the growth of ground vegetation and facilitate the presence of surface insects, as ground coverage affects soil moisture and in turn impacts the availability of food sources. Nitrogen levels in both two areas are moderate. C-Organic level at conservation forest was higher than at oil palm plantation, as decomposition process of organic matter worked better in area with well vegetation coverage.

4. CONCLUSIONS

The top-soil insects were observed to be more diverse at conservation forest than at oil palm plantation in PT. TKA. Conservation forest area recorded 29 genera (8 orders, 17 families, and 435 individuals), while the oil palm plantation observed 19 genera (7 orders, 12 families, and 344 individuals). The top-soil insects consisted of insect orders Hymenoptera, Coleoptera, Collembola, Diptera, Orthoptera, Plecoptera, Hemiptera, and Dermaptera.

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APPENDIX

![Fig. 1](image1.png)

Fig. 1 Number of top-soil insect genera at two land use type in PT. TKA

![Fig. 2](image2.png)

Fig. 2 Ecological aspects of top-soil insects at two land use types in PT. TKA. $H^*$ = Diversity Index, $E$ = Evenness Index, $C$ = Dominance Index
Table 1 Environmental factors of soil at two land use types in PT. TKA.

| No | Parameters             | Conservation Forest | Oil palm plantation |
|----|------------------------|---------------------|---------------------|
| 1  | Soil Temperature (°C)  | 24.38               | 26.33               |
| 2  | Soil Moisture (%)      | 20.12               | 17.16               |
| 3  | Soil pH                | 5.83                | 6.66                |
| 4  | N total (%)            | 0.43                | 0.37                |
| 5  | C-Organik (%)          | 5.95                | 4.05                |

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