Diversity and species composition of click beetles (Coleoptera: Elateridae) at different land-use types in Harapan Rainforest landscape, Jambi, Indonesia

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Abstract. Click beetles (Family Elateridae) are the largest family of beetles (Order Coleoptera) in superfamily Elateroidea that play an important role in the ecosystem, either as herbivores, predators and rhizophag. Land-use change can have a negative effect on diversity and abundance of click beetles. The aim of this research was to study the diversity and species composition of click beetles at different land-use types in Jambi. This research was carried out in Harapan Rainforest landscape that consists of 4 different land-use, i.e forest, jungle rubber, rubber plantation, and oil palm plantation. Click beetles were collected by fogging method in the morning and fogger directed toward the higher canopy for 20 min. The insect was collected in 16 traps that were installed under plant canopy, then the sample was sorted and identified in the laboratory. In a total of 2.042 individuals click beetles were collected, belonging to 7 subfamilies, 23 genera, and 59 morphospecies. Species richness and abundance of click beetles were higher in forest systems, while the lowest species richness was found in oil palm plantation and the lowest abundance was found in rubber plantation. Common click beetles species found in each land-use have consisted of morphospecies Melanoxanthus sp.01 (Elaterinae: Melanoxanthus). This research showed that different land-use types in Harapan Rainforest influenced the diversity, abundance, and species composition of click beetles. In conclusion, that habitat transformation has an impact on the loss of click beetles communities.

1. Introduction
Beetles provide essential ecological services with large effects on humans and used as an object in much scientific research [1]. Beetles play an important role in ecosystem function [2] and as indicators of environmental change [3]. Click beetles (Coleoptera: Elateridae) are a diverse group of beetles in the series Elateriformia with superfamily Elateroidea. Adults of click beetles species are phytophagous and live on flowers, under bark, or on vegetation [4], but larvae are found in soil, forest duff, or decaying plant materials especially wood. Wood inhabiting larvae are predaceous or saprophagous, meanwhile, soil-inhabiting larvae are generally phytophagous or some species are predaceous [5]. Some species of click beetles are very destructive and known as an agricultural pest, but in forest trees, click beetles does not cause serious damage [6].
Tropical rainforest conversion to plantation leads to major losses of biodiversity and associated ecosystem services and functions[7]. Indonesia is the second country globally in terms of loss forest area from 2010 to 2015 by land-use change for plantation [8]. Land-use change has a negative impact on the diversity and abundance of beetles. The results of research in Sulawesi showed that the ecosystem function of dung beetles was disrupted by land-use changes from natural forest to open agricultural area [9]. Another research also reported that land-use systems significantly affected ant species richness at 2 rainforests landscape in Jambi [10]. According to the results of research by [11], showed that different land-use types has no effect on species richness of ant, but has an effect on species composition of ant in Harapan Rainforest and Bukit Duabelas National Park, Jambi.

Harapan rainforest is one of the tropical lowland rainforests in Jambi Province which has undergone wide-scale changes due to habitat transformation that transformed into rubber and oil palm plantation [12]. The research of click beetles was poorly investigated in Indonesia, especially in the Harapan rainforest. Study about the effects of forest management on the diversity of click beetles is very important to do because many species have diverse habitat [6]. The aim of this research is to study the diversity and species composition of click beetles at different land-use types in the Harapan rainforest, Jambi Province.

2. Methods

2.1. Description of the study and locations
This research is a part of the CRC990-EFForTS project conducted in Jambi Province, Indonesia. Click beetle specimens used in this study are specimens collected by Jochen Drescher in the project of CRC990-EFForTS group Z02 that already in Biological Control laboratory, IPB University. The identification of click beetle specimens was carried out at the Biological Control laboratory of IPB University and Entomology laboratory of LIPI (Indonesian Institute of Sciences). Click beetle’s photos were taken by using LEICA digital microscope at Insect Biosystematics Laboratory, Department of Plant Protection, Faculty of Agriculture, IPB University.

This research was conducted in the Harapan rainforest at 4 different land-use, i.e. forest, jungle rubber, rubber plantations, and oil palm plantations in 2 seasons, which is the dry season (May to Oct 2013) and the rainy season (Nov 2013 to March 2014). Each land-use consists of 4 core plots with each core plot measures 50 m x 50 m and each core plot consists of 3 sub-plot. The total of core plots observed in 4 land-use types were 16 core plots, meanwhile, the total of sub-plots were 48 sub-plots.

2.2. Sampling methods and identification of click beetles
Based on Drescher et al., arboreal arthropods were sampled by the canopy fogging method that carried out in the morning started at 06.00 AM [13]. The fogging process used pyrethroid knockdown insecticides that already mixed with petroleum-based white oil in a ratio of 1:9 (insecticides: white oil) then directed towards the higher canopy for 20 min. After 2 hr of fogging, fallen arthropods were collected in 16 funnels which was installed under the tree canopy. On the tip of each funnel was installed plastic bottle containing 96% EtOH. After samples were collected, then taken to the laboratory for sorting and identification.

Click beetles specimens were identified based on several identification keys, i.e. Johnson [5], Dogger [14], Stibick [15], Calder [16], Chakraborty & Chakrabarti [17], and Lompe [18]. Click beetle specimens were also verified by reference to the specimen collection in the Entomology Laboratory of LIPI (Indonesian Institute of Sciences in Cibinong, Jakarta).

2.3. Data analysis
The database was tabulated in a pivot table using the software of Ms. Excel 2016. Then, the database was analyzed using R Statistic program version 3.6.1. Alpha diversity values of click beetles were obtained from Shannon-Wiener Index (H’), Evenness Index (E’), and Simpson Index (S’),
meanwhile species composition values of click beetles were obtained from Bray-Curtis Similarity Index. NMDS (non-metric multidimensional scaling) ordination used to show the similarity values of click beetles between 4 different land-use types. The season's database on this study was merged and not shown in these results.

3. Results and discussion
A total of 2042 individuals click beetles belonging to 7 subfamilies, 23 genera, and 59 morphospecies were collected in 4 land-use types (Table 1). The most species richness of click beetles was found in the forest (40 morphospecies) and the lowest in oil palm plantation (10 morphospecies). While the most abundant of click beetles were found in the forest (1397 individuals) and the lowest in rubber plantation (104 individuals).

| Land-use types | Σ Subfamily | Σ Genera | Σ Morphospecies | Σ Individual |
|----------------|-------------|----------|----------------|--------------|
| Forest         | 6           | 18       | 40             | 1397         |
| Jungle Rubber  | 5           | 17       | 36             | 427          |
| Oil Palm       | 3           | 7        | 10             | 114          |
| Rubber         | 4           | 10       | 20             | 104          |
| Total          | 7           | 23       | 59             | 2042         |

Based on Table 2, click beetles diversity in 4 different land-use types were in the lowest to medium category. Jungle rubber has the highest value in all diversity index (H’=2.45; E’=0.68; S’=0.86), while oil palm plantation has the lowest value (H’=0.69; E’=0.30; S’=0.26). ANOVA test showed that landuse has an effect on the abundance (F(3,12)=46.85; P=0.00, p>0.05) and also has an effect on the species richness of click beetles (F(3,12)=14.22; P=0.00, p>0.05).

The highest diversity of click beetles were in forest and jungle rubber compared with rubber and oil palm plantation. The result of research in the Harapan rainforest, Jambi showed that jungle rubber has the most diversity of Cerambycid beetles compared with other land-use types [19]. These might be affected by the vegetation in forest and jungle rubber were relatively polyculture and less disturbance compared to oil palm and rubber plantation. Moreover in forest and jungle rubber have dense of canopy cover than oil palm and rubber plantation.

| Land-use types   | Index Shannon-Wiener (H’) | Index Evenness (E’) | Index Simpson (S’) |
|------------------|---------------------------|---------------------|--------------------|
| Forest           | 1.40                      | 0.38                | 0.60               |
| Jungle Rubber    | 2.45                      | 0.68                | 0.86               |
| Oil Palm         | 0.69                      | 0.30                | 0.26               |
| Rubber           | 1.78                      | 0.59                | 0.65               |
| Total            | 1.98                      | 0.48                | 0.74               |

The value of the Bray-Curtis similarity index of click beetles between 4 land-use types ranged from 0.03 to 0.65 (Table 3). The highest species similarity of click beetles occurred between rubber (HR)
and oil palm plantation (HO) with NMDS ordination showed that both plot points were close together, it is indicated that they are similar (Fig. 1). Meanwhile, the highest dissimilarity occurred between oil palm plantation (HO) and forest (HF) that indicates click beetles species were distinct assemblages. ANOSIM test showed that species composition of the click beetles are significantly different among 4 land-use types (R=0.6797; P=0.001). These results are same as [20] who reported that there were significant differences in species composition of curculionid beetles at 4 different land-use types in the Harapan rainforest [20].

**Table 3.** Bray-Curtis similarity index of click beetle at 4 different land-use types.

|       | HF<sup>a</sup> | HJ | HO | HR |
|-------|---------------|----|----|----|
| HF<sup>a</sup> | 1.00          |    |    |    |
| HJ    | 0.28          | 1.00|    |    |
| HO    | 0.03          | 0.27| 1.00|    |
| HR    | 0.05          | 0.33| 0.65| 1.00|

<sup>a</sup>Notes are referenced to the first letter ‘H’ is a landscape type, namely Harapan rainforest, the second letter is a type of land-use with the letter code F= forest, J= jungle rubber, O= oil palm, and R= rubber.

**Figure 1.** NMDS ordination in different land-use types.

The most abundant species of click beetles that are found in 4 land-use types were *Melanoxanthus* sp.01 (232 individuals), followed by *Quasimus* sp.01 (67 individuals), *Agraeus* sp.03 (20 individuals), *Heteroderes* sp.02 (18 individuals), and *Agraeus* sp.05 (6 individuals) (Fig. 2). Click beetles with the
The genus *Melanoxanthus* is widespread throughout the Eastern Palaearctic, Oriental, Afrotropical, and Australian regions being particularly common throughout the topics [16].

Subfamily: Elaterinae  
Genera: *Melanoxanthus*  
Msp: *Melanoxanthus* sp.01

Subfamily: Negastriinae  
Genera: *Quasimus*  
Msp: *Quasimus* sp.01

Subfamily: Agrypninae  
Genera: *Agraeus*  
Msp: *Agraeus* sp.03

Subfamily: Agrypninae  
Genera: *Heteroderes*  
Msp: *Heteroderes* sp.02

Subfamily: Agrypninae  
Genera: *Agraeus*  
Msp: *Agraeus* sp.05

**Figure 2.** Morphospesies of click beetles that found in 4 land-use types.

### 4. Conclusion

In conclusion, forest and jungle rubber have a higher abundance and species richness of click beetles than oil palm and rubber plantation. *Melanoxanthus* sp.01 is the most common species that can be found in 4 land-use systems. The land-use changes of rainforest into oil palm and rubber plantation leads to substantial losses in diversity and species composition of click beetles. This results is important as it helps to understand the impact of habitat transformation and the strategy needed for conservation.

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