A COMPARATIVE STUDY OF COLEOPTERA DIVERSITY AND ABUNDANCE IN DISTURBED AND UNDISTURBED FOREST IN AMANI NATURE RESERVE

By

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Abstract

This study was conducted in disturbed and undisturbed forest of Eastern Usambara mountains in Amani Nature Reserve. We compared the relative abundance and diversity of Coleopteran families in both habitats. Three methods were used: Pit fall traps, leaf litter extractions and beating tray. Analyses were done using the G-statistic (test of independence) to determine significance of counts. Diversity was measured using Simpson's' index of diversity. The results showed that the undisturbed forest had higher abundance and diversity of Coleopteran families as compared to disturbed forest. However, it was also found that relative humidity and % shade did not affect the abundance and diversity of Coleoptera in both habitats.

1.0 INTRODUCTION

Insects are, by far, the most diverse group of organisms on earth, and must intrigue anyone with the slightest interest in the natural world. The Order Coleoptera belongs in the class Insecta. Coleoptera (Beetles) form the largest Order in the animal kingdom, with over one-third of a million described species. Beetles occur almost all part of the world, in terrestrial habitats from mountaintops to the intertidal shoreline, from the forest to the desert, in subterranean caverns and in freshwater habitats. (BOOTH et al.,1979.). Coleoptera are minute to very large insects, usually with strongly hardened bodies and the forewings modified into protective covers or elytra. Some species can be beneficial to mankind, such as those used in the biological control of arthropod pests and weeds, or those, which are crop pollinators. They also act in detrivores in the decomposer system; they help in breakdown of dead trees and other plants, animal remains, and dung, and so contribute to the recycling of nutrients essential for future production. Whereas, some have a negative impact by competing for food resources or damaging products.

The incentive for this study was to describe Coleopteran diversity and abundance in forests of Amani Nature Reserve.

Objectives

1. To determine the relative abundance of Coleopteran families in disturbed and undisturbed forests
2. To compare the species diversity of Coleopteran families in disturbed and undisturbed forests

Hypotheses

- Abundance of Coleoptera is less in disturbed forests than in undisturbed forests.
- Diversity of Coleoptera is less in disturbed forests than in undisturbed forests.

2 MATERIALS AND METHODS

2.1 Study area

Our study site was located in Amani Nature Reserve from 15th-27th September 2005. Amani Nature Reserve is located in the East Usambara mountains mountain at an altitude of about 910m above sea level. Mean rainfall of the area is 1918 mm; mean temperatures range from 20.6-24.6ºC and relative humidity is high (Hamilton 1989b). The East Usambara Mountains form part of the Eastern Arc Mountains, which are considered to be the oldest mountains in East Africa (Griswold, 1969 cited in Iddi 1998). Soil in Amani has been described as being highly leached, acid and infertile (Hamilton 1989b).

2.2 Methods

Site selection: Three transects were established in disturbed forests (around Amani Nature Reserve headquarters and undisturbed forests in the Monga forest). The start point for each transect was chosen using a random numbers (WHITE and ANN, 2000). We had 5- 6 collection sites on each transect separated by 10m. These collection sites were placed at right angles to the transect. There were 17 collection sites (12 pitfall and 5 leaf litter) for each habitat.

Data collection: Three techniques were used to collect data in the collection sites:

- Leaf litter quadrats
- Pitfall traps
- Beating tray samples

Leaf litter: In each of the 5X 1m^2 quadrats established, leaf litter was collected in to plastic bags and put in berlese funnels to dry. The insects move to collected tubes s for sorting and identification.

Pitfalls: In each of the 12 collection sites, 3 pitfall traps (8cm diameter and 6cm deep) were dug into the soil surface, totalling 36 traps per habitat. The traps were left for 2 days, and then another two days being emptied into sample bottles every 48 hours (Samways et al, 1996 and Heinonen et al, 1998) and then taken to the laboratory for sorting and identification.

Beating tray: Two transects were randomly selected along which ten collection sites were placed at an interval of 5 meters. Insects were obtained by beating plant leaves and branches, up to 1.5m height, on to the tray. Insects were collected with an aspirator for sorting and identification.

2.3 Data analysis

The abundance of Coleopteran families in disturbed and undisturbed forests (is given in the appendix)

Explanatory data analysis was carried out to determine abundance and diversity of Coleopteran families.

The abundance of Coleoptera in disturbed and undisturbed forests was analysed using G-statistic (a test of independence) to determine significance of counts in disturbed and undisturbed forests (Robert, 1981).

$$\begin{array}{ccc} & & \sum \\ a & b & a+b \\ c & d & c+d \\ \hline \sum\ a+c & b+d & a+b+c+d=n \end{array}$$

To show relationship between humidity, % shade and numbers of Coleopteran families a regression test was applied.

Diversity was measured using Simpson's' index of diversity (Charles, 1999).

$$\mathbf{D = \sum pi^2}$$

D= Simpson's index

pi: Proportion of species I in the community

1-D: Measure the probability that two individuals chosen random will be different species.

1/D: This is the number of equally common species required to produce the observed value of D

3. RESULTS

3.1 Sampling Methods

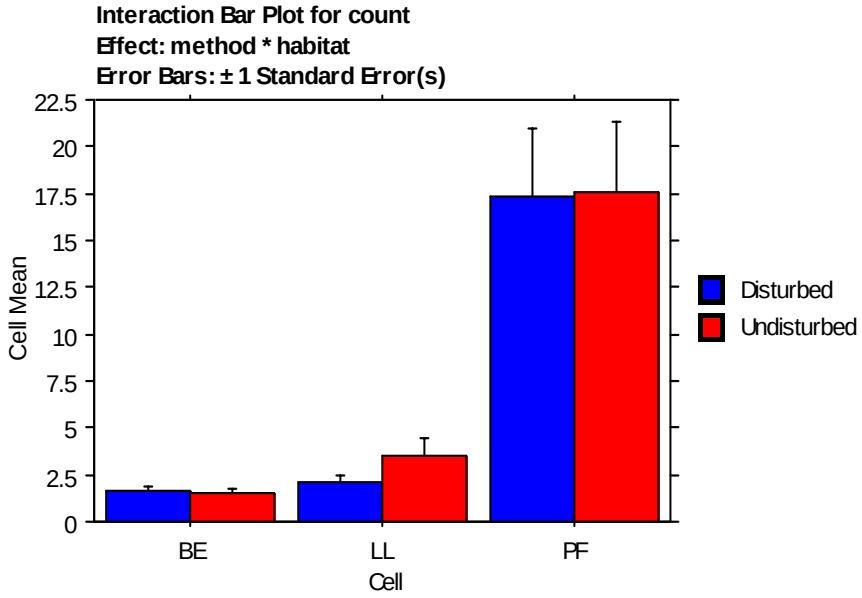

Fig1. Showing the numbers of Coleopteran families obtained form the three methods. Key: LL-leaf litter, PF-pitfall, BE-beating

Fisher's PLSD for count
Effect: method
Significance Level: 5 %

	Mean Diff.	Crit. Diff.	P-Value	
BE, LL	-1.126	2.305	.3355	
BE, PF	-15.850	2.458	<.0001	S
LL, PF	-14.724	2.962	<.0001	S

Fig.1 shows that there is no significant difference between BE ad LL methods. Whereas there is a significant difference between BE and PF, LL and PF methods. Also that the three sampling method are equally effective in sampling beetles in disturbed and undisturbed forest

3.2 Abundance

A total of 7 orders were collected in both habitats. 1007 individual insects were collected, of which 593 were from the Coleoptera

. Fig 2 shows the orders recorded.

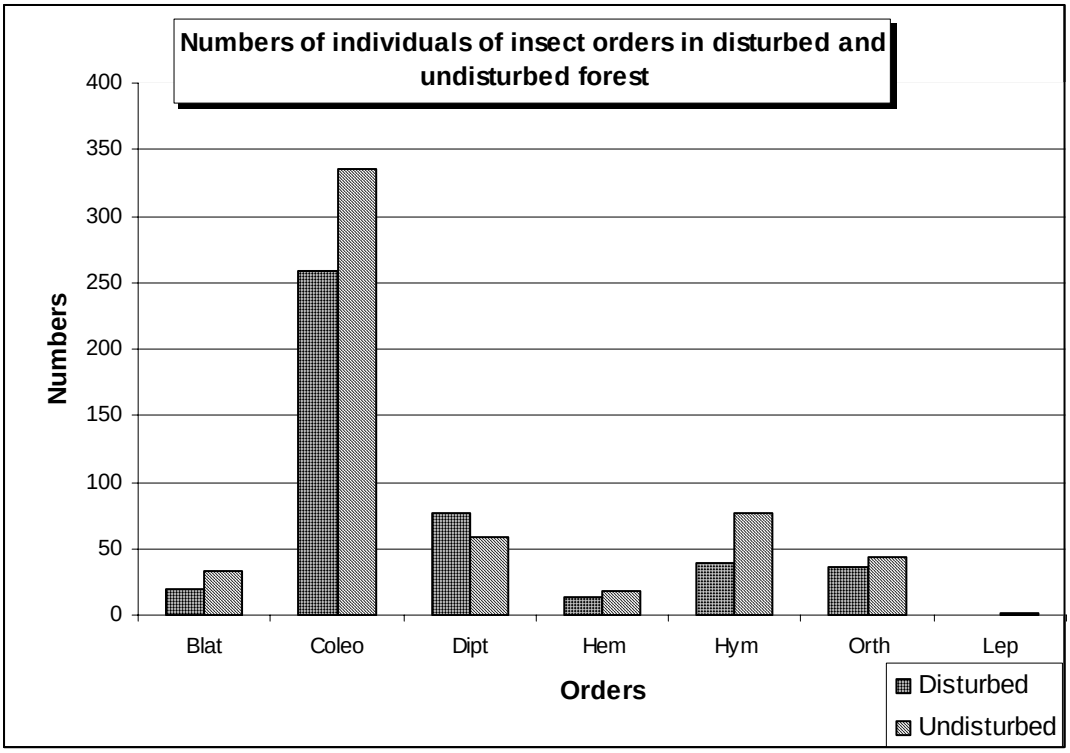

Fig2. Showing numbers of insect individuals against orders

Blat: Blattodea; Coleo: Coleoptera; Dipt: Diptera; Hem: Hemiptera:; Hym: Hymenoptera; Orth: Orthoptera; Lep: Lepidoptera

Figure 2 shows that the undisturbed forests had a higher abundance of insect orders as compared to the disturbed forests**.** A G –statistical test showed that there is a very large significant difference in orders between the disturbed and undisturbed forests.

G=9994.18; G tables at 95% df(5) is 11.7

A total of 19 different families were collected at the two collection site 9(Fig.3)

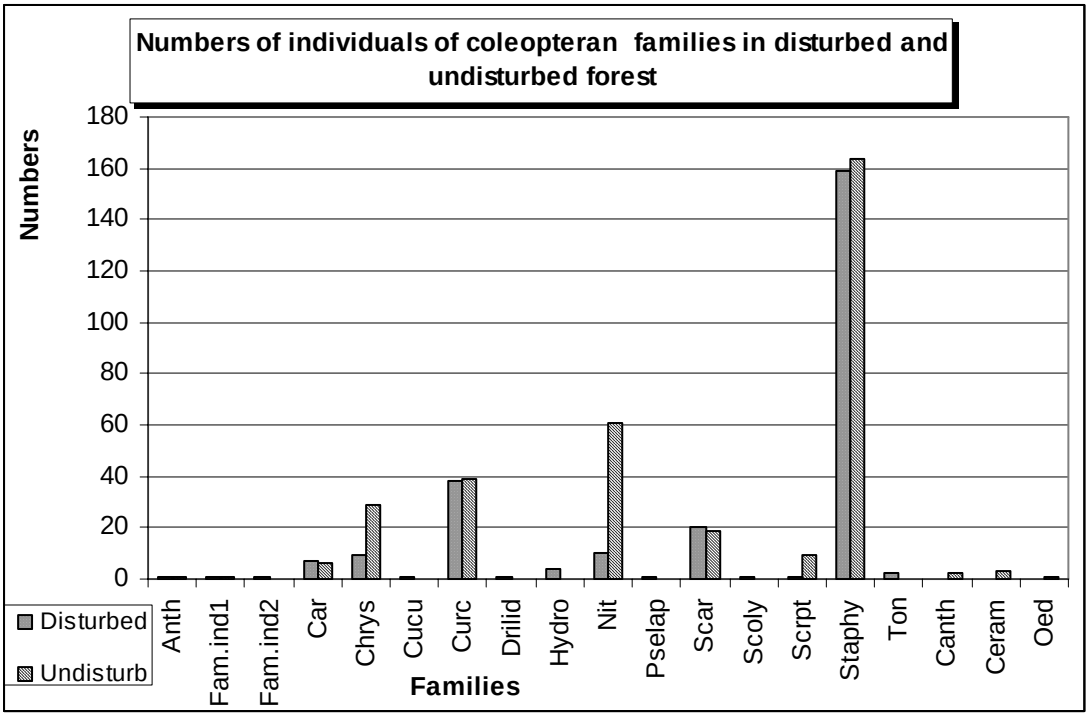

Fig 3. Showing the numbers of Coleoptera individuals against their respective families.

Anth:Anthicidae; Fam.ind1: Family unidentified 1; Car: Carabidae; Chrys: Chrysomelidae; Cucu: Cucujidae; Drilid: Drilidae; Nit: Nitidulidae; Pselap[1]: Pselaphidae; Scar: Scarabaeidae; Scoly: Scolytidae; Scrpt: Scraptiidae; Staphy: Staphylinidae; Ten:Tenebrionidae; Canth: Cantharidae; Ceram: Cerambycidae; Oed: Oedemeridae

[1] This species was on closer examination in the family Scydmaenidae

Figure 3 shows that the undisturbed forests had a higher abundance of Coleopteran families as compared to the disturbed forests**.**

G=4261.52; G table at 95% df(18) is 28.86

This shows that there is a high significant difference in abundance between the disturbed and undisturbed forests.

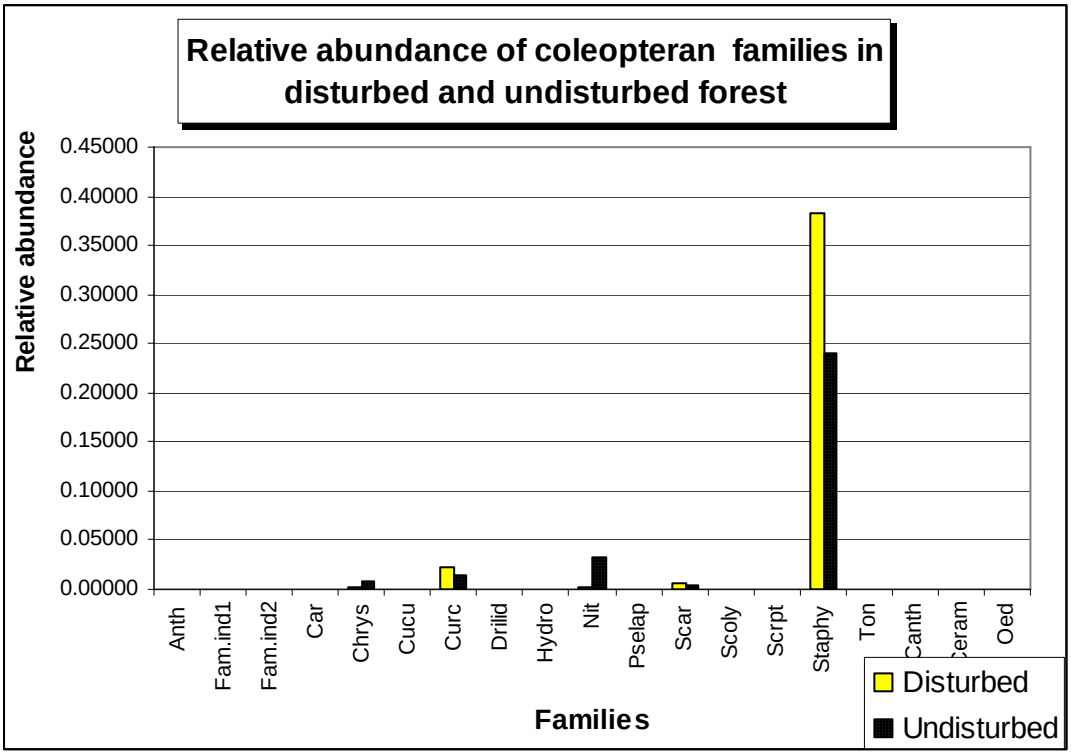

Fig 4. Showing relative abundance of Coleopteran families in disturbed and undisturbed forests.

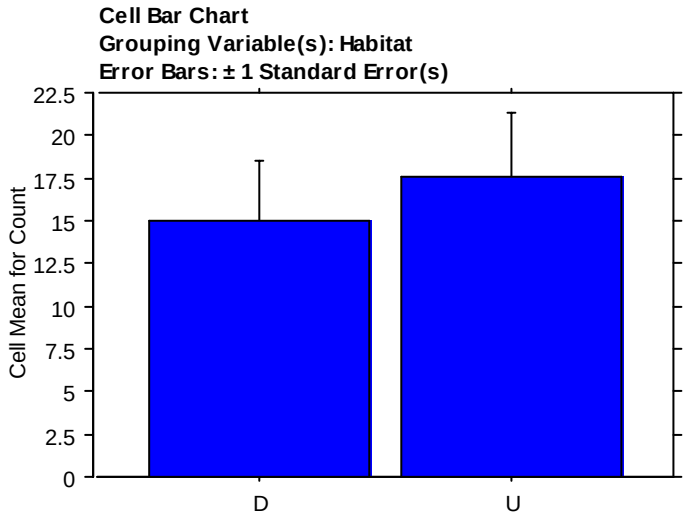

Figure 5. Showing average number of Coleopteran families in pit fall traps per collecting site in disturbed and undisturbed forest

D= Disturbed forest; U= Undisturbed forest

- **Regression between % relative humidity, % shade and numbers of Coleopteran families.**

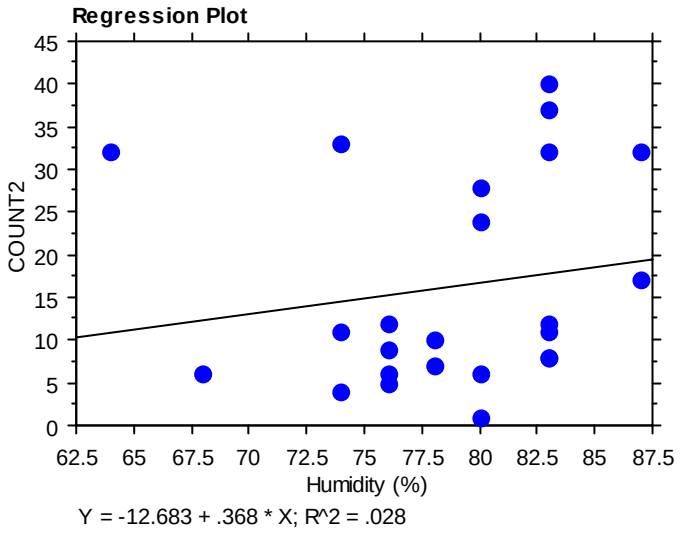

Fig 6. Showing regression of number of Coleopteran families against %humidity

The results show no significant relationship between %humidity and numbers of Coleopteran families (p. value =0.438, r2= 0.028)

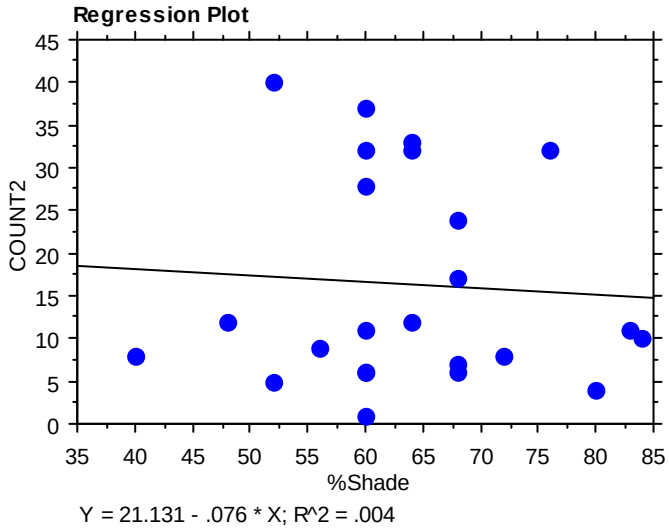

Fig 7. Regression of number of Coleopteran families against % shade

Fig 7 shows no significant relationship between % shade and numbers of Coleopteran families (p. value =0.759, r2= 0.004).

3.3 Diversity in Coleopteran families in disturbed and undisturbed forests

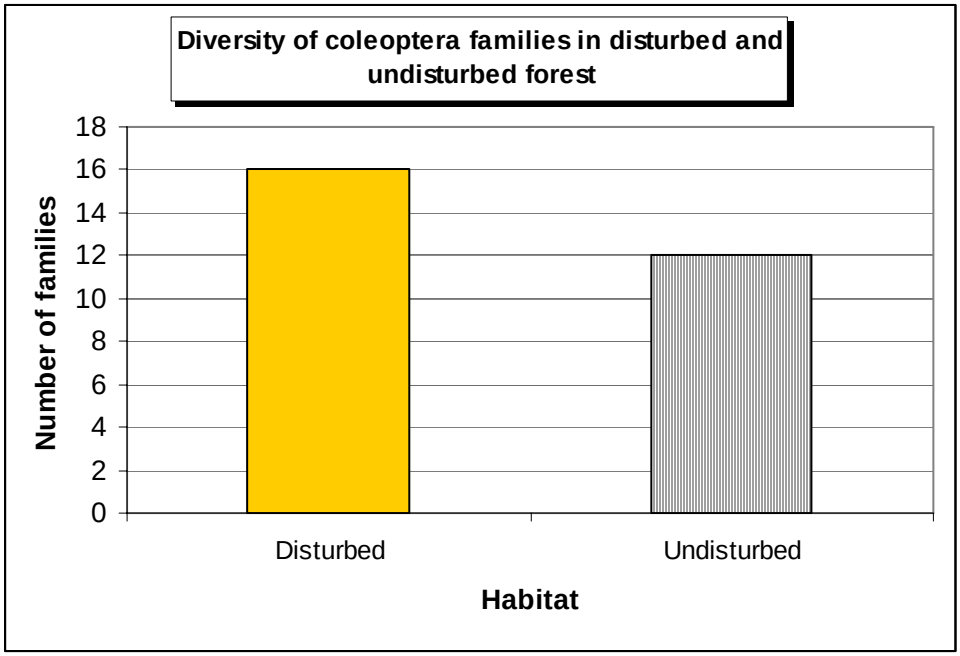

Figure 8. Shows that there are more Coleopteran families in disturbed forest as compared to undisturbed families.

However, from Simpson's diversity index, it noted that there are more Coleopteran families in undisturbed forest as compared to disturbed families.

Table 1: Showing Simpson's diversity index

	Disturbes	Undisturbed
D	0.41	0.30
1-D	0.59	0.70
1/D	2.41	3.35

D= Simpson's index

1-D: Measure the probability that two individuals chosen random will be different species.

1/D: This is the number of equally common species required to produce the observed value of D

4. DISCUSSION

Methods used

Three methods were used for collection of beetles and it was found that beetles were collected in approximately equal proportion in both disturbed and undisturbed forest by each of the methods. This confirms the relevance of three methods for beetle collection.

Slightly more litter beetles were collected in undisturbed forest probably due to more leaf litter being present, and this accounts for the slightly more beetle numbers.

Abundance

Coleoptera was the largest order collected in both disturbed and undisturbed forests. Staphylinidae was noted to have the largest number of individuals both in disturbed and undisturbed forest.

Nitidulidae and Chrysomelidae contribute to the relative abundance of Coleopteran specimens in the undisturbed as compared to the disturbed forest. The reason for this observation could probably be explained by a greater diversity of fruiting trees and understorey vegetation in the undisturbed forest (e.g. *Alanblackia* fruits in undisturbed forest as compared to the *Maesopsis* fruits with a very small edible part). As many Nitidulids feed on rotting fruit and Chrysomelids are generally leaf feeders.

Environment measure like relative humidity and % shade were observed not to influence abundance of beetles both in disturbed and undisturbed forest. Probably other factors can help to explain differences for example *Maesopsis* leaf litter-causing change in PH and other factors associated with the leaf litter in both habitat.

Diversity

Concerning diversity of Coleopteran families, our results show that there is more family diversity in the undisturbed forests as compared to the disturbed forests. (cfr Simpson's index). This could be attributed to the fact that in disturbed forests there may be a loss of diversity of native plant species, which have specialist species of insects feeding on them whereas the alien plant species have fewer specialist insects associated with them e.g. *Clidemia hirta* species. Another reason could be explained by the disturbance and logging in disturbed forest causing loss of microhabitats from insects associated with large fallen logs.

It's also known that the leaf litter of *Maesopsis eminii* causes changes in soil PH and other factors (Newmark 2002), but it's not known whether this has an effect on insects.

CONCLUSION

The undisturbed forest had higher abundance and diversity of Coleopteran families as compared to the disturbed forest.

RECOMMENDATION

The results show that disturbance affects beetle numbers; it's therefore recommended that further studies be carried out on food preference, logging and factors associated with the microhabitat.

AKNOWLEDGEMENTS

First of all, we would like to thank all organisers of this course especially Dr Rosie Trevelyn, Mark Othieno and Brigid Barry for their kind help and unlimited supervision. Thanks also to Dr Rowan for helping us identify Coleoptera and his encouragement and company from the field to data analysis. Big thanks to Dr Pauline and Dr Robert for statistical advice. The warm comradeship our TBA colleagues was constant source of inspiration and encouragement without which our stay in Amani could have been most dull and uninspiring.

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