



Assessment of Beetles Diversity and Abundance in Forest Edge and Grassland Ecosystems of Ngel-Nyaki Forest Reserve

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Abstract

This survey of beetles abundance and diversity was conducted at the Nigerian Montane Forest Project, Ngel-Nyaki Forest Reserve (NMFP). The study aimed to assess the abundance and diversity of beetles at the Ngel-Nyaki Forest Reserve located at Latitude 7°05' N and Longitude 11°04' E. It was carried out for one month from September to October 2021. Stratified sampling method was used to divide the study location into two major habitats; forest fragment and grassland and subsequently plots. A total of 200m line transect was established each on the selected habitat types. Pitfall traps were placed at 50m intervals along a 200m transect for the selected habitats. Hand-pick was adopted for beetle collection along the line transects. Sample collections were carried out in the morning and in the evening between the hours of 6 am and 8pm respectively. A total of 233 beetles were collected consisting of 24 species. The highest species diversity was recorded in the grassland ($H' = 2.65$). The relative Abundance is 0.69 and 0.3 from the 2 habitats. The Abundance of beetles in the forest reserve contributes to the ecosystem of the forest.

Key words: Assessment, Abundance, Beetle, Diversity, Forest, Ngel-Nyaki

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INTRODUCTION

Insects play a strategic role in the welfare of man through their activities (Garba *et al.*, 2023). Beetles constitute about two-thirds of all known insects, which comprise about one-third of all known animal species, invariably they participate in various activities, resulting in several changes in the ecosystems (Hussain *et al.*, 2020). Beetles are phytophagous and can enrich forest and savanna soils worldwide (Seymour and Joseph, 2019). The beetles like other

insects, often evolve and exist as components of communities of plants and other animals. Most of the species are terrestrial but some are aquatic (Losey and Vaghan, 2006).

Beetles are endopterygotes, they exhibit complete metamorphosis, involving a series of conspicuous and relatively abrupt changes in body structure between hatching and becoming adult after a relatively immobile pupal stage (Collados and Duane, 1999). They are classified under the order Coleoptera (Hunt *et al.*, 2007). Like all other insects, coleopterans are easily identified by two pair of wings, the front pair, and the elytra which is hardened and thickened into

sheath-like or Shell-like protection for their rear pair and for the rear parts of the beetle's body (Hunt *et al.*, 2007).

Beetles' Diversity

The extraordinary diversity of beetles has long fascinated evolutionary biologists. The strongly sclerotized front wings defining the order Coleoptera, which provide protection while retaining the ability of powered flight with the membranous hindwings, may be an evolutionary novelty that promoted extensive diversification of the order (Sheikh *et al.*, 2017).

To explain the great diversity of beetles is difficult. In most beetles, the elytra cover the membranous flight wings and the abdomen (Lawrence and Newton, 1982; Ferreira *et al.*, 2023; Goczał and Beutel, 2023). In this way, the elytra are thought to protect beetles against environmental stresses and predation (Sheikh *et al.*, 2017). The close historical association of some of the most diverse groups of beetles, such as weevils (Curculionidae), longhorn beetles (Cerambycidae), and leaf beetles (Chrysomelidae), with flowering plants during their own period of diversification is thought to be one of the main reasons explaining the beetles' great diversification (Okrikata and Yusuf, 2016; Ferreira *et al.*, 2023; Goczał and Beutel, 2023).

Beetles are important in most natural terrestrial and freshwater ecosystems. They have a great effect on agriculture and forestry, and are useful model organisms for many types of scientific experiments (Okrikata and Yusuf, 2016). A better understanding of beetle biodiversity will enhance our knowledge of the world and provide many practical applications.

Distribution and abundance

Beetles are by far the largest order of insects: the roughly 400,000 species make up about 40% of all insect species so far described, and about 25% of all animals (Rosenzweig, 1995). Study by Bussler *et al.* (2012) provided four independent estimates of the total number of beetle species. A mean estimate of about 1.5 million species were reported, spanning all four estimates from a minimum of 0.9 to a maximum of 2.1 million beetle species. (Maina and Maina, 2012).

Beetles are found in nearly all habitats, including freshwater and coastal habitats, wherever vegetative foliage is found, even inside plants in galls, in every plant tissue, including dead or decaying ones (Kakkar and Gupta, 2009). They can be found also in nearly all climates and latitudes (Noonan, 1999). Although many species occur in temperate environment, in general the number of species is greatest in the tropics (Stork *et al.*, 2015).

Individuals of more species are most abundant in the tropical region, Tropical Forest canopies have a large and diverse fauna of beetles, including Carabidae, Chrysomelidae, and Scarabaeidae (Salomão *et al.*, 2018; Kirmse and Chaboo, 2020). Beetles' distribution demonstrates an array of potentially interacting and competitive abilities as well as habitat preference (Gilliott, 1995).

There is little or no information documented so far on the diversity and abundance of Beetles in Ngel-Nyaki Montane Forest Reserve. Insect biodiversity studies conducted in Nigeria have largely been on those of other orders and/or species of insects. Beetles are of economic importance; this is because their very presence alone constitutes a nuisance.

They cause damage to stored food products and other household goods. They also have direct impact on agricultural food production by chewing the leaves of crop plants sucking out plants juice. Aside inadequate taxonomic knowledge, the ecological knowledge of beetles in Nigeria is not well understood as distribution and abundance of many insect species in the country are unknown and their ecosystem services mostly assumed (Kato *et al.*, 2000).

Due to scanty information on Coleopterans within Ngel-Nyaki Forest Reserve, this study was designed to document diversity and abundance of beetles in Ngel-Nyaki Forest Reserve by generating a check list of Beetles found within the forest reserve. This information will not only be useful for Agricultural, Medical and Veterinary purposes, but will

also probably give an insight into the beetle species richness of Ngel-Nyaki; an information that is very critical for management and conservation purposes.

MATERIALS AND METHODS

The Study Area

Ngel-Nyaki forest reserve is situated between Latitude 7°05' N and Longitude 11°04' E towards the western escarpment of the Mambilla Plateau, Sardauna Local Government Area of Taraba State, Nigeria.

It is made up of a main forest and three forest fragments separated by hills covered by montane grasslands. The Reserve occupies about 46km² area of land, with about 7.2km² of submontane to mid-altitude forest (Korndoerfer, 2010; Borokini *et al.*, 2012).

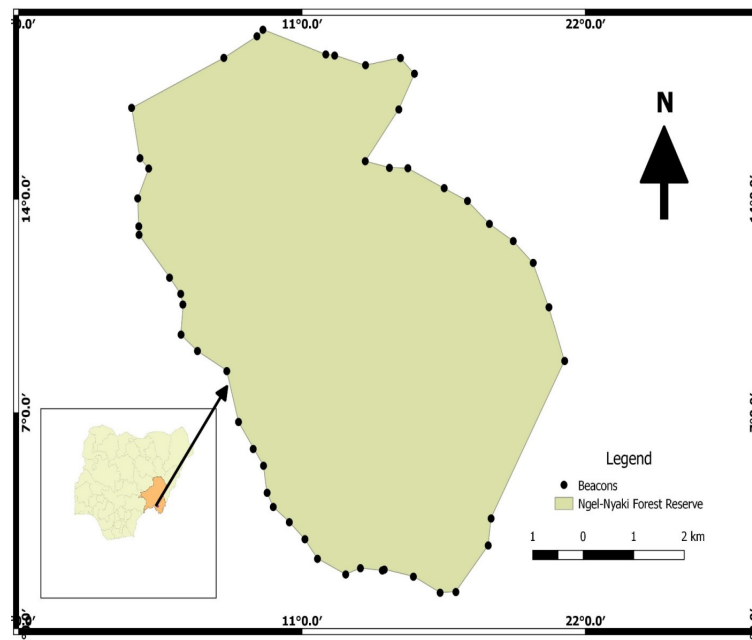


Figure 1: Map of Ngel-Nyaki Forest Reserve, Nigeria.

Sampling Techniques

Simple stratified sampling method was used to divide the study area into two major habitat niches; forest fragment and grassland. Sampling was conducted systematically using two methods. A total of 200m line transect was established each on the selected habitat types. Pitfall traps were placed at 50m intervals along a 200m transect for the selected habitats. Hand-pick was adopted for beetle collection along the line transects. Sampling was carried out in the morning and in the evening between the hours of 6 am and 8pm. The timing corresponds with when beetles emerge for their activities (Cornelis and Hermy, 2004; Fridman *et al.*, 2014).

Harvests from pitfall and handpicked were placed in appropriately labeled sample bottles for identification using beetle identification guide.

Data analyses

Shannon-wiener diversity index was used to calculate the diversity of beetles.

$$H' = -\sum P_i \ln i$$

Where H' = Shannon diversity index,

P_i = proportion of individual species,

$\ln i$ = Natural log of proportion of the individual.

A comparison of the relative abundance in the two different habitats was done.

RESULTS

Number and beetle species across two habitat types

A total of two hundred and thirty-three (233) beetles were sampled across the two habitat types, these comprised of twenty-four (24) species.

Table 1: Number and species of beetles across two habitat types

S/N	Common Name	Scientific Name	Forest edge	Grassland
1	Horn dung beetle	<i>Angrypnin sp</i>	2	4
2		<i>Calopteron discrepens</i>	12	16
3	Net wing beetle	<i>Calopteron terminale</i>	1	4
4	African jewel beetle	<i>Chlorocara Africana</i> <i>Compscephalus</i>	1	20
5	Flower chafers	<i>dimitriewe</i>	4	2
6	Dung beetle	<i>Copris fricator</i>	2	19
7	Dung beetle	<i>Copris luncri</i>	1	1
8	Horn dung beetle	<i>Copris sp</i>	1	1
9	Green June beetle	<i>Cotinis nitida</i>	3	25
10	Yellow spotted ground	<i>Craspendophorus bonvouloiri</i>	4	5
11	Lady bug beetle	<i>Harmonia axyridis</i>	12	7
12	Large dung beetle	<i>Helicopris dominus</i>	2	1
13	Darkling beetle	<i>Macradesmia sp</i> <i>Macyorhinia</i>	3	3
14	African fruit beetle	<i>polyphemus</i>	4	3
15	Blister beetle	<i>Mylabris pustulata</i>	6	16
16	Garden fruit chafer	<i>Pachnoda sinuate</i> <i>Proagoderus</i>	4	11
17	Autler beetle	<i>sexcornutus</i>	0	2
18	Leaf beetle	<i>Theopea sp</i>	8	15
19	Wasp beetles	<i>clytus arietus</i>	0	1
20	Cucumber beetle	<i>Acalymma vittatum</i>	0	1
21	Stripe bug	<i>Graphosoma tialicum</i>	0	1
22	Stripe orange	<i>Graphasoma halicum</i>	0	2
23	Carrion beetle	<i>Nicropohorus vespilo</i>	0	1
24	Click beetle	<i>Elateridae</i>	0	2
	Total		70	163

Table 2: Comparison of number, relative abundance and diversity across the habitat types

Habitat	Number	Relative Abundance	Diversity index (H')
Forest	70	0.3	2.53
Grassland	163	0.69	2.65

Relative Abundance and Diversity across the Habitat Types

The diversity and relative abundance across the grassland and the forest edge indicated that the grassland had the highest abundance and diversity of beetle species as indicated in Table 2.

DISCUSSIONS

The result of the study shows that grassland ecosystem of the forest reserve support abundant populations and diverse species beetles than forest edge. This is in agreement with Thomas, (2001), who suggested that grassland may harbour precious and rear ground beetles. The difference in numbers of the beetles between grassland and forest edge may be due to difference in microclimate and resources in each habitat type. It is widely understood that many beetle's species prefer a particular habitat type that provide suitable micro environmental conditions and food resources (Hunt *et al.*, 2007).

The difference in beetle's species abundance between the two habitats may be due to availability of resources, ecosystem stability, and microclimate of each habitat type (McGarvey *et al.*, 2013; Huang and D'Odorico, 2021). In grassland, there were plenty young green grasses and fewer disturbances compared to the forest fragments. It is widely understood that many Beetles species prefer a particular habitat type that provide suitable micro environmental conditions and food resources (Hunt *et al.*, 2007; Lawrence *et al.*, 2000).

There is a positive relationship between grassland area and beetles' assemblage unlike the surrounding of forest. Some highly abundant forest species move through the grassland than the forest edge. Fewer beetles occur in forest because of the environmental difference, there is more variable temperature, wind speed and sunlight which may produce a less favorable environment for the forest species (Barton *et al.*, 2013). The Larger the grassland the more difference the environmental conditions are from the forest environment leading to decrease edge effect.

Generally, grassland is considered a natural or mostly semi-natural vegetation type which is suitable for the production of animal feeds and for the production of fiber. For the grassland ecosystem in Ngel-Nyaki rich Beetles species was established.

It was observed that the forest edge may experience regular human activities such as fire wood collection which may cause the loss of habitat of the species and also ecological factor such as climate change that may cause disturbance to life of species.

The difference in beetles species abundance between the two habitats may also be due to food availability and ecosystem stability. In grassland, there were plenty young green grasses and fewer disturbances compared to the forest fragments.

Dung beetles were found to be the most abundant species in the study area. Dung beetles are important because of the role they play. They act as secondary seeds dispersal agents, thus protecting seeds and generating the forest (Chapman 1995, Anderson *et al.*, 2014). Dung Beetles are found where

livestock especially, cows and horses' forage. They feed mainly on the cow dung and the ecosystems support abundant populations of beetles with diversities varying according to the land use type. (Hanson *et al.*, 2016; Frank *et al.*, 2017; Tonelli, 2017). Habitat difference has also been shown to decrease edge effect on dung beetles in the tropics (Spector and Ayzama, 2003; Peyras *et al.*, 2013).

CONCLUSION

The research results showed that grassland ecosystems support more abundant populations of beetles and exhibit greater diversity compared to forest edges. This indicates that the grassland community has a greater potential to support beetle diversity than the forest edge. Additionally, the abundance of beetles in the reserve serves as a suitable indicator for monitoring environmental changes. Moreover, anthropogenic activities have impacted beetle abundance and diversity in the Ngel-Nyaki Forest Reserve..

RECOMMENDATIONS

- It is recommended that beetle habitats should be given conservation priority by management of the Nigerian Montane Forest Project so as to promote biodiversity of beetles within the forest.
- It is recommended that beetle specialists should put more effort to publish identification guides to benefit students and researchers.

There should be increase in the use of information technology to enhance research on beetles' abundance and diversity

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