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Influence of Land Use Systems on Diversity and Abundance of Insects in Akure Forest Reserve, Ondo State Nigeria.

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Abstract
The study was carried out to assess the effect of land use system on insect diversity and abundance. Three land used (fallow land, cocoa agroforestry land, and untouched forest land) were selected for field work within Akure forest reserve. An hectare block were centrally demarcated in each of the forest type. The block was divided into twenty plots of 20 m x 25 m in size. Ten plots where randomly selected where insect's collection and enumeration of tree took place. The enumeration entails identification of all woody plants with diameter at breast height (dbh) of at least 10 cm. Monthly collection of insects with sweep net and hand peaking were used in each selected plot.
A total of 13,578 insects were collected and identified from the three land use: 5,182 from fallow land, 5,884 from cocoa agro forestry land and 2,492 from untouched forest land. The identified insects belonged to a total of 30 families and are distributed among 15 orders. Within fallow land a total of 5,184 insects belonging to 8 orders and 46 families; while cocoa agro forestry land consist of 5,884 insect that are distributed within 10 0rders and 50 families; and untouched forest land contain of 2,490 insects distributed within 10 orders and 56 species. The families and order with highest number of individual insects are Lepidoptera (4,000) and Orthopetera (1,260). These insects are mainly defoliators. Shannon-weaver diversity index for insects species for the three land use system were 2.306, 2.448, and 3.622 for fallow land, cocoa agro forestry land and untouched forest respectively. There was a significant difference in tree species diversity in the habitats. The species with highest frequency in the study habitat per hectare is *Cordia platythrsa* (6) in fallow land, cocoa (50) in cocoa agroforestry land *Celtis zenkerii* in untouched forest land. A total of 14 26, and 41 species of tree were identified in the fallow land, cocoa agroforestry land and untouched forest respectively.

Key words: agroforestry, diversity, Insect, untouched

Introduction
Forests throughout Nigeria and the rest of tropical countries are diminishing at an alarming rate in land coverage over the past fifty years. The natural forests in Nigeria are increasingly being depleted through the indiscriminate extraction of economic trees and encroachment on forestland for other purposes like agriculture, urbanization and industries. Deforestation has been attributed to be the aftermath of various activities of man in the bid for economic development (Rapp, 1987). The over-exploitation of the existing tropical forest resources and the disappearance of economic and other important hardwood species is a threat to global biodiversity, conservation

and abundance of insect species and this is an issue of great current concern (Sutton and Collins, 1991). This study therefore examines the influence of land use systems on the diversity and abundance of insects in the study habitats.

Methodology

The study was carried out within the tropical rain forest of South-western Nigeria, specifically, Akure Forest Reserve (Aponmu), Ondo State which covers an area of 69.93 km^2. The three land uses selected for the study were within this area. Akure Forest reserve is managed by Department of Forestry, Ondo State, of Nigeria. The study site is situated along Ondo-Akure road at about 20 km south of Akure on Latitude 7^0 18'N and Longitude 5^0 02'E.

Untouched forest, Cocoa agro forestry, and Fallow land were in the same vicinity and similar in terms of forest type, altitude, and topography. In each habitat (site) 100 x 100 m^2 (Ha) were located and each plot were sub-divided in to plots of equal size of 20 x 25 m^2. The simple random sampling was used to allocate sample plots in every habitat (site). Fifty percent sampling intensity was adopted to select the number of sampling units.

Insect Collection

Ten sample plots were randomly selected in each study habitat and at centre of each plot five trees were tagged. The sampling protocol was targeted at insect foraging during the daytime on the tree nearest to the tagged sampling point. Sampling was carried out monthly for the period of 18 months. During each survey all the tagged trees were inspected once and the insects were collected alive with hand and sweep net.

Light traps were also used to sample nocturnal insect herbivores while hand pickings were as well used for crawling insects on the ground and on the trees. An insect Parataxonomist was employed. All insect species were classified into families and orders. The frequency was obtained to ascertain species abundance / richness and species evenness.

Tree Species Identification

The botanical name of trees encountered in the sample plots of each Land use system, which is larger than 10 cm dbh, was recorded. In cases where a tree's botanical name was not known, such tree was identified by their common name. Trees that could not be identified, were referred to as "Unknown' and parts of such trees (e.g. leaves, bark, fruits), were collected for identification.

Result and Discussion:

Result in Tables 1 show the level of insect species diversity, richness and distribution in the site selected for this study. A total of 56 species (15 Orders) were encountered in Untouched Forest, 50 species (8 Orders) in Cocoa Agroforestry and 47 species (8 Orders) in fallow land use system. On the whole a total of 6,874 species per hectare distributed among 9 orders were identified in the three land use systems. In Untouched forest area the species with highest number of individual/ha was *Hypolimnas dubius* (Order with a relative frequency of 7.71%). In lightly logged habitat its relative frequency was 4.49% while in heavily logged habitat it was 0.19%. In Cocoa agroforestry land, the species with highest number of individual per ha was *Anaphe venata* (Order which was found to be the pest of *Triplochition scleroxylon* (obeche) tree). It had a relative frequency of 51.22%. It was not encountered in unlogged habitat but its relative frequency in heavily logged habitat was also the highest value of 42.79%. The numbers of individual insects per hectare for all species were 2490, 5,884, and 3,184 in Untouched, cocoa Agroforestry land and Fallow land respectively. The Order with highest number of species in the study area was Lepidoptera with nineteen species in untouched, 21 species in Cocoa agroforestry land, and 21 in fallow land. Orthoptera had nine species in untouched forest, nine species in cocoa agroforestry and nine species were also present in fallow land. Likewise, Coleoptera had

eleven species in untouched forest land, seven species in cocoa agroforestry land, and three species in fallow land (Table 3). These findings suggest that other land use apart from untouched forest land had few number of insect species (low species richness), but large number of individuals (high species abundance) in contrast to many species (high species richness) in untouched forest land with few numbers of individuals (low species abundance).

The result of the Shannon-Weaver Index reveal that, insect diversity is higher in untouched forest land (H′=3.622) than what was obtained in cocoa agroforestry land (H′=2.448) and fallow land (H′= 2.306) though they do not have high variation in their species richness (56, 50, and 46 for untouched forest land, cocoa agroforestry land, and fallow land respectively). Shannon-Weaver Index of diversity of untouched forest land was one and half times higher (3.622 / 2.448 = 1.5) than what was obtained in cocoa agroforestry land, while it is almost the same value times higher (3.622 / 2.306 = 1.6) than what was obtained in heavily logged habitat. Shannon-Weaver Index of diversity of lightly logged habitat was almost the same value (2.448/2.306 =1.1) with what was obtainable in fallow land. (Table 2). Similarly, studies of Hill *et al* (1995) have demonstrated a reduction in diversity following more extreme forms of forest disturbance. The pattern of tree complexity in the three habitats used could have contributed to the nature of insect species diversity observed in this study which is similar to the findings of Novotany *et al* (2006) who reported that the greater the number of tree species in the tropics the higher the insect diversity. Untouched forest was observed to have closed canopy with three layers very pronounced while Cocoa Agroforestry land had some open areas despite the fact that they also have tree species scattered over the whole area. This allowed much regeneration of tree wildling and poles to grow in the open areas, which might have contributed greatly to the enhancements of insect diversity, encountered in study areas as more food are available for them.

Greater amount of coarse woody debris that was found in untouched forest habitat than Cocoa Agroforestry land and Fallowed land could have influenced the insect diversity observed in the study. This observation is supported by Lattin (1993), and Hutheson and Jones (1999) who noted that terrestrial arthropod diversity including that of Coleoptera could be influenced by coarse woody debris. This was found to be the critical component of structural diversity, and is greater in unlogged forest habitat, the habitat with the higher diversity, followed by lightly logged forest habitat.

Table. 1: Community Diversity of Insect Species in the Study Area

Site	Number of Order	Number of Species	Number of Individual Insect/Ha	H′ Index	Evenness (E)
Untouched forest	10	56	2492	3.622	0.8999
Cocoa agroforestry	10	50	5884	2.448	0.6393
Fallow land	8	46	5182	2.306	0.5894

H′ is Shannon-Weaver diversity index

The species encountered in fallow land was fourteen, which are distributed among eleven families (Table 2). The species with the highest frequency was *Cordia spp.,* with a relative frequency of 17.14%. This is followed by *Triplochition scleroxylon, celtis zenkerii milicia excelsa* with the same value of relative frequency of 11.43%. The least distributed species in heavily logged habitat is *Albizia zaygia, Ficus exaspirata, Brachystegia enrycoma and Mitragyna stipulosa.* Shannon-Weaver Diversity Index was calculated to be H′= 2.466

The values of Shannon-Weiner Diversity Index as it is presented showed that untouched forest land has the highest community tree diversity while fallow land has the least. The tree species diversity of an untouched habitat is about 1.1 times greater than the tree species diversity

in cocoa agroforestry land, while it is 1.3 times greater than the tree species diversity in fallow land. Likewise tree species diversity in cocoa agroforestry land is about 1.2 times greater than tree species diversity in fallow land.

Table. 2: Community Diversity of Tree Species in the Study Area

Site	Number of Species	Number of Trees / Ha	H′ Index	Evenness (E)
Untouched forest	41	342	3.215	0.8657
Cocoa agroforestry	26	126	2.957	0.8866
Fallow land	14	70	2.466	0.9294

H′ is Shannon-Weaver diversity index

Insect abundance was highly correlated (r=0.95) with number of trees present in the study area. Likewise the r^2 was very high (r^2=0.90) which means that the equation could be used to predict potential future insect abundance (Equation …….1)

Insect abundance = No. of tree spp. = $90.64x_1 + 7.49$ ……..Equation 1

(Where x_1 = Insect abundance, K=insect number, R=0.95, r^2=0.90)

Conclusions

- The higher the tree species diversity in the study area the higher the insects species diversity
- The higher the insect species diversity the lower the insects' abundance
- The higher the insects abundance the more such insects species becomes pest to the existing three species in such ecosystem.
- Agroforestry systems must be adopted in other to sustain insect biodiversity in area where there is human impact.

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