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Diversity and Abundance of Arthropods and Tree Species as Influenced by Different Forest Vegetation types in Ondo State, Nigeria

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Abstract This study was carried out to assess the abundance and diversity of tree species and arthropods in different forest vegetation types (mangrove, rainforest and derived savannah) of Ondo state, Nigeria. . Sample plots of (100 by 100 m^2) were demarcated in each of the selected sites, and were sub-divided into smaller unit of 25m by 25m, out of which five temporary sample plots were randomly selected in each vegetation types. Insects were collected with the aid of sweep net and by hand picking thrice in both dry and raining seasons from each of the study site. Tree species in each plot were numbered and identified. A total of 166 insects were collected and identified. Fifteen (15) were collected during dry season in mangrove swamp forest, 37 in rainforest and 18 in derived savannah. 27, 48 and 21 were collected during raining season in mangrove swamp forest, rainforest and derived savannah respectively. Shannon-wiener diversity index of insect's arthropods was 1.71 in mangrove swamp forest, 2.23 in rainforest and 1.95 in derived savannah respectively. Tree species were 13 in mangrove forest, 18 in rainforest and 7 in derived savannah. There is no significant difference in the abundance of insects in the study area ($P \leq 0.05$).

Keywords Assessment, Mangrove, Rainforest, Raining and Dry Seasons

1. Introduction

Arthropods are of ecological importance in the forest ecosystem and their abundance and diversity are of great interest to entomologists. The role played by arthropods in the decomposition processes and continuous release of nutrient to the forest soil is of great importance. Arthropods are the most successful member of the animal kingdom; more than 80% of the described living animal species are Arthropods[1]. They also include an incredibly diverse group of taxa such as insects, crustaceans, spiders, scorpions, and centipedes. There are far more species of arthropods than species in all other phyla combined. Coleman and Crossley [2] confirmed the significance of soil fauna in decomposition and litter transformation. The activities of micro organisms in forest soil are very significant because they decompose the plant residues and move them from one place to another. In forest soil ecosystem, macro organisms such as beetles and earthworm enhance nutrient cycling by burying animal dung in tiny tunnel that they excavate into the upper soil horizons. The abundance, biomass and diversity of soil and litters are influenced by a wide range of forest management practices which are used in forest and wildlife conservation ([3], [4]).

Also, several research works had been carried out on the abundance of arthropods in the various forest communities and forest ecosystems ([5], [6]and [7]), but not much have been done on the comparison of soil litter arthropods of mangrove forest, rainforest and derived savannah forest ecosystems in Ondo State. Therefore, the focus of this research work is to assess the diversity and abundance of arthropods and tree species in different forest ecosystems (mangrove, rainforest, and derived savannah) of Ondo State.

2. Methodology

2.1. Study Area

This study was carried out in Ondo State, which is one of the States in the defunct Western State of Nigeria. Based on the vegetation types present in Ondo State, the State were divided into three ecological zones, they are; mangrove forest, rainforest and derived savannah.

2.2. Description of Study Sites

Mangrove forest is located at Arogbo forest area in Ese-odo Local Government Area of Ondo state. It is on latitude $7^0$21'14'' N and longitude 5^o 02' 25''E. The climate of this area is cold with sea breeze and experiences a mean annual rainfall of about 400 mm to 450 mm which normally

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occurs between April to September and also has November to March as drying season. It has mean annual temperature of 28^0C and on 270m elevation.

The tropical rainforest is located within Akure Forest Reserve, in Ondo East Local Government Area of Ondo State. The Strict Nature Reserve portion of this reserve, popularly known as 'Queen's plot', is on longitude 5^o 03' 82'' E and latitude 7^o 27' 84'' N with an elevation of 252 m above the sea level with a mean annual rainfall of about 4000 mm and temperature range from about 20.6°C to 33.5°C The forest reserve covers an area of about 600 hectares; it's one of the Strict Nature Forest Reserves (SNR) in Nigeria.

The derived savannah extends from Oke-Agbe, Akoko North Local Government Area of Ondo State, Nigeria. It is located between longitude 5^0 77' 80'' E and latitude 7^0 65'96'' N with elevation of 260 m above the sea level. The mean annual rainfall is about 3500mm and temperature ranges from 26 ^{0}C to 39 ^{0}C

2.3. Arthropods Collection and Identification

Sample plots were selected in each of the three vegetation types for analysis. One hectare of land was centrally demarcated (100 m X 100 m) and sub-divided into temporary sample plots of (25 X 25 m). A sampling intensity of 30% was used. Therefore, five plots were randomly selected from each of the study area and from each plot; both the arthropods and tree species were collected for analysis.

Insects on the trees and forests floor were collected as well as those flying around. These flying insects were collected by means of sweep net while those on forest floor were handpicked. The insects were identified and classified into order and families and their occurrence were recorded to confirm their diversity and abundance.

2.4. Tree Species Classification and Computation of Diversity Indices

All tree species that were encountered in each of the three forest ecosystems were classified into families using [8] as a guide. Their frequencies of occurrence were also obtained to ascertain diversity of the tree species. The following biodiversity indices were computed.

(a) The Shannon–Wiener diversity index (H′). This was used to calculate ecosystems diversity index because it takes into account the richness and abundance of each species in the different ecosystems [9]. The equation that was used is (eqn. 1):

$$H = -\sum_{i=1}^{S_{obs}} p_i \log_e p \qquad (1)$$

H' = Shannon diversity index,

S = the total number of species in the habitat,

pi = proportion S (species in the family) made up of the ith species

ln = natural logarithm.

(b) Species evenness (E): This was calculated by adopting Shannon's equitability (EH) as stated by [10]

(eqn. 2): $E_H = H/\log(S)$. (2)

2.5. Data Analysis

The results were subjected to analysis of variance (ANOVA)

Table 1. Diversity and Abundance of Insects in the Study Area

FAMILY NAME	SPECIES	MF				RF				DS			
		D	R	T	H'	D	R	T	H'	D	R	T	H'
Lepidoptera	*Papilio rumanzovia*	0	4	4	-0.22	8	15	23	-0.35	0	4	4	-0.23
Lepidoptera	*Papilio palinurisweb*	2	3	5	-0.25	4	6	10	-0.25	1	2	3	-0.20
Lepidoptera	*Papilio rhamni*	0	2	2	-0.14	4	5	9	-0.24	0	2	2	-0.15
Orthoptera	*Hemicordulia tau*	8	10	18	-0.36	10	4	14	-0.30	1	2	3	-0.20
Orthoptera	*Tetracanthagyna plaagiata*	3	5	8	-0.32	3	0	3	-0.12	0	0	0	0.00
Hymenoptera	*Bombus nomadas*	0	0	0	0.00	2	1	3	-0.12	0	1	1	-0.09
Hymenoptera	*Xylocopa virginica*	0	0	0	0.00	1	0	1	-0.05	0	0	0	0.00
Dictyoptera	*Andreas hogus*	0	0	0	0.00	1	0	1	-0.05	0	0	0	0.00
Orthoptera	*Nomadracis septemfascsta*	1	1	2	-0.14	1	6	7	-0.21	5	2	7	-0.31
Orthoptera	*Grylus spp*	0	0	0	0.00	1	0	1	-0.05	1	1	2	-0.15
Coleoptera	*Diplotamis spp*	0	0	0	0.00	1	0	1	-0.05	0	1	1	-0.09
Hymenoptera	Wasp	0	1	1	-0.09	1	1	2	-0.09	0	0	0	0.00
Coleoptera	*Acatocephela terminalis*	0	0	0	0.00	0	2	2	-0.09	0	0	0	0.00
Orthoptera	*Coelifera spp*	1	0	1	-0.09	0	7	7	-0.21	0	2	2	-0.15
Orthoptera	Skirt and blouse	0	1	1	-0.09	0	1	1	-0.05	10	4	14	-0.37
	Abundance			42	-1.71			85	-2.23			39	-1.95
	Diversity				1.71				2.23				1.95

Where: MF = Mangrove forest, RF= Rain forest, DS= Derived savannah, D= Dry season, R= Raining season, T= Total, and H^1 = Diversity index respectively.

Table 2. Anova Table Showing Insect Abundance

Source of variation	Degree of freedom	Sum of square	mean squares	f-cal.
Block (Seasons)	1	0.014	0.014	1.27
Treatment (Vegetations)	2	0.19	0.97	8.70
Error	2	0.022	0.011	
Total	5	0.023		

Table 3. Diversity, Abundance and Evenness of Arthropod in the study area

Types of Forest	Abundance	H^{-}	Evenness
Mangrove Forest	42	1.71	0.62
Rainforest	85	2.23	0.62
Derived Savannah	39	1.95	0.70

Table 4. Abundance of Tree Species in the Study Area

S/NO	FAMILY NAME	BOTANICAL NAME	LOCAL NAME	MF	RF	DS
1	Ulmaceae	*Trema orientalis*	Afere	3	0	0
2	Caesalpiniaceae	*Anchonia cordifolia*	Ewe-ifa	5	6	0
3	Loganiaceae	*Anthocleista djalolensis,*	Sapo	3	4	0
4	Pynontidae	*Mussanga spp*	Umrella tree	4	0	0
5	Rhizophoraceae	*Rhizophora apiculate*	Red mangrove	11	0	0
6	Acanthaceae	*Avecinia spp*	Kokoro	7	0	0
7	Moraceae	*Ficusmusuco,*	Ula	6	0	0
8	Apocynaceae	*Alstonia congenesis*	Ahun	1	0	0
9	Caprifoliaceae	*Raffia nitida*	Raffia palm	5	0	0
10	Apocynaceae	*Zylopia spp*	Okilolou	3	0	0
11	Palmae	*Elias gunuensis*	Oil palm	2	1	2
12	Combretaceaes	*Hoppolomysia spp.*	Akoriko	1	0	0
13	Sterculiaceae	*Sterculia rhinopetala*	Aye/Kokoigbo	0	6	0
14	Euphorbiaceae	*Uapaca guineensis*	Ajegbe	0	5	0
15	Sapotaceae	*Chrysophyllum albidum*	Agbalumo	0	4	0
16	Leguminoceae	*Brachystegia nigerica*	Akolodo	0	1	0
17	Myristicaceae	*Pycnathus angolensis*	Akomu	0	3	0
18	Annonaceae	*Cleistopholis patens*	Apako	0	4	0
19	Sterculiaceae	*Triplochyton scleroxylon*	Arere/Obeche	0	5	0
20	Euphorbiaceae	*Drypetes paxii*	Ata-Igbo	0	3	2
21	Meliaceae	*Trichilia welwitschii*	Awe	0	2	3
22	Apocynaceae	*Alstonia boonei*	Ahun	3	5	1
23	Ebenaceae	*Diospyrus mesipiliformis*	Ebony	0	4	0
24	Lecythidaceae	*Largastonia speciosa*	Ekakieri	0	5	5
25	Leguminoceae	*Brachystegia eurycoma*	Eku	0	3	0
26	Euphorbiaceae	*Ricinodendron heudelotti*	Erinmado	0	1	0
27	Leguminosae	*Erythrophleum ivorense*	Eru	0	2	0
28	Combretaceae	*Anogeissus leiocarpus*	Ayin	0	0	2
29	Leguminosae	*Parkia biglobosa*	Igba	0	0	3
30	Sapotaceae	*Vitellaria paradoxa*	Emi	0	0	5
	TOTAL			54	64	23

Where: MF = Mangrove forest, RF= Rain forest, DS= Derived savannah

3. Results

Table 1 shows the results of insect abundance and diversity in the study areas. A total of 9 species and 42 individuals were recorded in the Mangrove forest. The most abundant species was *Hemicordulia tau* (with relative frequency of 21.4%). In the rainforest, a total of 15 species of insects and 85 individuals were recorded. The species, *Papilio rumanzovia* was the most abundant (with relative frequency of 27.1 %) while a total of 10 species and 39 individuals were recorded in the derived savannah zone. A species, *Paederus sabaeus* known locally as 'skirt and blouse' was the most abundant (with relative frequency of 35.9%). Highest species diversity was recorded at the rainforest zone with Shannon-Weiner index of 2.23 and an evenness index of 0.62. The Shannon and evenness indices obtained for the mangrove forest were 1.71 and 0.62 respectively. For the derived savannah, the Shannon index was 1.95 and the evenness was 0.70. The order, Orthoptera had the highest family occurrence (6) while Lepidoptera occurred 3 times. Hymenoptera occurred 3 times. Dictyoptera occurred once (1) and Coleoptera occurred twice (2 times). The following species were marked as species generalists *Papilio* species, *Hemicordulia tau, Nomadracis semptemfascsta, Coelifera spp,* and *Paederus sabaeus. Bombu*s species and wasp were species that was common to all ecological zones.

Table 2 shows the results of the Analysis of Variance (ANOVA) for the abundance of the collected insect species according to season. It shows that there were no significant differences at ($P \geq 0.05$) between drying and raining seasons. There was no significant difference ($P \geq 0.05$) in the abundance of the insects according to the vegetation types (Mangrove swamp forest, Rainforest and Derived savannah) in drying and raining seasons also.

Table 3 revealed the abundance and diversity of insects' species in the three study areas. Mangrove forest (H' =1.79 and Evenness =0.55), Rainforest (H'=2.23 and E = 0.65) and Derived savannah (H' =1.75 and E 0.53).

Table 5. Diversity, Abundance and Evenness of Tree Species in the Study Area

Type Of Forest	Abundance	H^1	Evenness
Mangrove Forest	54	2.22	0.55
Rainforest	64	2.77	0.67
Derived Savannah	23	1.7	0.50

Table 4 was on the tree species encountered in the study areas. Also, from Table 5, it was discovered that rainforest had the highest abundance with 64 individual/ha, diversity of 2.77 and evenness of 0.67. This was followed by Mangrove forest with 54 individual/ha, diversity 2.22 and evenness 0.55. The least was the Derived savannah with an abundance of 21, diversity of 1.83 and evenness of 0.6. *Alstonia species* and *Elias gunuiensis*, these tree species were common to all ecological zones. It was discovered that tree species in the rainforest had the highest diversity indices than the other two vegetations.

4. Discussion

The results of the analysis showed that the rainforest ecosystem has both the highest diversity and abundance of insect species as well as tree species compared to the Mangrove and Derived savannah. This could be attributed to the fact that there are more desirable tree species in the rainforest zone that could attract insects and the environmental condition is very conducive as insect habitats. The Shannon-Weiner diversity index showed the value of rainforest as H' = 2.23, followed by Mangrove forest as 1.79 and the least value (1.75) were obtained in the derived savannah. The highest evenness was also recorded for the rainforest (0.70). High species richness and distribution are the most important characteristics of tropical rainforest ecosystem. Regardless of plot size, the number of tree species is far greater in tropical rainforest than in any other forest community as in[11]. The result of this work is similar to Adeduntant[7] who reported that insects are generally more found where there are favourable environmental conditions and other factors like light, litter falls, food and rocky ground which also favours the abundance of the tree species in the rainforest ecosystems in this study. The nature of tree species enumerated could have contributed and influenced the abundance and diversity of insects in each of the ecosystems. This is also similar to the findings of[12] who noted that the greater the tree species in the tropics, the higher the insect diversity. Reference[13] reported that physical complexity of an environment could affect arthropods abundance and diversity.

Rainforest was also observed to have more closed canopy compared to the rest forest ecosystems. Coarse woody debris was also found in rainforest than mangrove forest and derived savannah which could have influence the diversity of insect in this study area. References ([14] and [15]) remarked that terrestrial arthropods diversity including that of coleoptera could be influenced by coarse woody debris.

5. Conclusions

The results this study showed that the higher the tree species diversity and abundance, the higher the diversity and abundance of insect species also. The vegetation that accommodates the highest life form (Plant and insect) is the rain forest. This was followed by savannah and derived savannah. The variation in insect diversity and abundance were not significant in dry and rain seasons in each of the ecological areas selected for this study.

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