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Abundance and Diversity of Arthropods in the Federal University of Agriculture, Abeokuta, Ogun State, Nigeria

Akinkunle V. Adeniyi[1]*, Adebayo R. Adeyemo[1,3], Grace I. Oyebode[1], Dorcas O. Alade[2,4], Shifau O. Ijaola[1], Oluwatosin E. Atobatele[5], and Iyabo V. Olatubi[5]

[1]Department of Pure and Applied Zoology, Federal University of Agriculture, Abeokuta, Nigeria
[2]Department of Pure and Applied Botany, Federal University of Agriculture, Abeokuta, Nigeria
[3]Department of Biological Sciences, Florida International University, Miami, Florida, USA
[4]Horticultural Sciences Department, Citrus Research and Education Center, University of Florida, Lake Alfred, Florida, USA
[5]Department of Biological Sciences, College of Agriculture, Engineering and Science, Bowen University, Iwo, Nigeria

*Corresponding Author: victorakinkunle@gmail.com

ABSTRACT

Seasonal variations affect the diversity and abundance of arthropods. Despite the extensive grasslands and woodlands at the Federal University of Agriculture, Abeokuta (FUNAAB), the composition of the arthropod community including its diversity, abundance, and species richness remains unexplored. This study examined dry and wet season insect populations at three locations (Forest Nursery [FN], Sports Center [SC], and Fadama) on the FUNAAB campus between December 2018 and August 2019. Insect samples were collected at 30-m distance from each other using a sweep net, pitfall traps, and a line transect. A total of 902 arthropods were collected, representing 8 orders, 18 families, and 21 species. Margalef's Index, Pielou's Index, and Shannon's indices of species richness and diversity analysis showed that the Fadama had the most species diversity. The FN had the maximum species diversity during the dry season (H = 2.895), while during the wet season, the SC had the least (H = 2.757). Fisher's alpha of diversity shows that the SC had the highest diversity (7.439) during the wet season, whereas the Fadama had the lowest (5.702) during the dry season. Pairwise diversity *t*-test revealed no significant differences between habitats and seasons ($p > 0.05$). This study brings to the fore the composition, abundance, and diversity of arthropods and some weeds in FUNAAB and underscores the need for more study.

Keywords: Fisher alpha, species richness, species diversity, line transect, FUNAAB

INTRODUCTION

Insect populations, the most diverse animal group on Earth in terms of species and ecological roles, are influenced by temperature, rainfall, biotic interactions, and primary productivity (Boyer et al., 2003; Molina et al., 1999). Yet, the escalating loss of biodiversity due to human activities urbanization, habitat modification, pollution, and illegal species trade presents a critical threat to these vital creatures and the ecosystems they inhabit (McIntyre 2000).

Although insects are adaptable to a wide range of habitats, the ocean remains a less-populated environment (Nandini & Murali, 2012; Okoro, 2015). Climatic factors, such as rainfall, temperature, wind, and humidity, significantly influence insect populations (Alarape et al. 2015; Khaliq et al. 2014). This is particularly evident in the tropics, where seasonal variations in insect abundance are common, especially in areas with alternating wet and dry seasons (Davis, 1945). The arrival of the rainy season often coincides with a dramatic increase in the populations of species that were present in low numbers during the dry period (Aydagnhum, 2007).

The goal of this study was to investigate dry and wet season species richness, species dominance, and species evenness of arthropod fauna in three habitats at the Federal University of Agriculture, Abeokuta (FUNAAB): the Forest Nursery (FN), the Sports Center (SC), and the Fadama.

MATERIALS AND METHODS

Description of the Study Area

The FUNAAB is geographically positioned along the Osiele Abeokuta Road, proximate to the Ogun-Osun River Basin Development Authority (OORBDA), and is situated approximately at latitude 7°30' N and longitude 3°54' E. The university lies within the ecological zone of the humid lowland rainforest, which is characterized by a bimodal seasonal pattern. The wet season typically spans from June to October, while the dry season extends from November to February. Rainfall during the wet season can be substantial and, at times, erosive, frequently accompanied by lightning and thunderstorms, particularly during the transitional periods at the start and end of the season. The mean monthly temperature varies from 22.9°C in August to 36.32°C in March. The relative humidity is high ranging from 75.52°C in February to 88.15°C in July (Aiboni 2001). The vegetation of the area comprises lowland forests but becomes secondary rainforests or forest regrowth because of the increase in land use and exposure. The vegetation has the characteristics of tropical rainforests such as high forests and growth of massive trees and twinning shrubs. Three distinct locations on the FUNAAB campus were selected for this study: the FN, the SC, and the Fadama (Figure 1). The dry-season sampling took place between December 2018 and February 2019, and the wet-season sampling took place between June and August 2019. The average relative humidity varied between 82% in June to August and approximately 60% in December and February 2019.

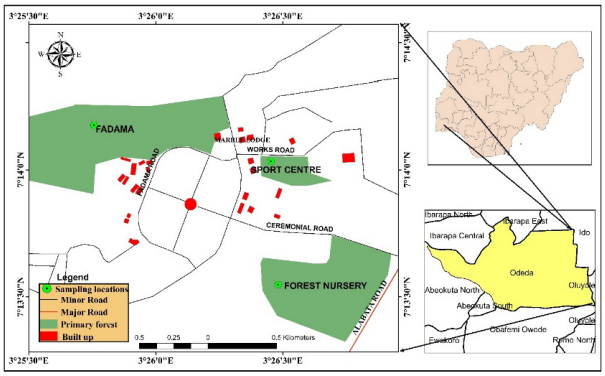

Figure 1. A map of the research area with sampling points highlighted (inset: maps of Ogun State and Nigeria showing the location of the study area).

Method of Data Collection

Monitoring (Line of Transect)

At each location, a 0.23-km line transect was established, and every insect sighted was captured; the method used was employed by Yager et al. (2017) and Alarape et al. (2015). Three transect walks were completed (i.e., one per habitat).

Sweep Net. Sampling was carried out across the habitats using a sweep net and the conventional method of sampling (Cooper & Whitmore, 1990; Gadagkar et al. 1990). The collection of insects was conducted twice a week, from 6 a.m. to 8 a.m. and from 5 p.m. to 7 p.m. along a planned transect. The insects were preserved in ethanol and temporarily stored in universal bottles before being sent to the laboratory for identification.

Pitfall Traps. In total, 12 wet pitfall traps (four of each type) were deployed across the sampling locations. Each trap consisted of a 100-mL plastic container (12.5-cm top diameter, 11.5-cm height) buried flush with the ground and filled with 2 cm of a dishwashing soap and water solution to prevent insect escape (Yager et al. 2017).

Inactivation and Preservation of Collected Insect Samples. Insects were collected into wide-mouthed jars with airtight lids and cotton wool bottoms saturated with ethyl acetate as a killing agent. Preservation methods included direct pinning and pickling. For pinned specimens, insects were removed from the killing jar and placed on a setting board. An entomological pin was inserted symmetrically through the thorax, with approximately three-quarters of the pin traversing the insect. Wings were spread and fixed at a 90° angle. This technique was effective for larger insects. Specimens were then placed on a standard setting board, with wings and legs extended horizontally and secured with setting tape. After two days of drying, pinned insects were mounted in insect boxes (Yager et al. 2017). Insects unsuitable for pinning were preserved in 50% ethanol. Identification was performed using established taxonomic keys (Bernard, 1982; Larsen, 2005; Riley, 1975; Tanwar et al. 2010; Terren et al. 2012; Youdeowei, 1974).

Data Analysis

Data generated from this research were analyzed using descriptive statistics. Identified insects were grouped into species, families, and orders. One-way analysis of variance was used to determine the difference in order, family, and species. Species diversity, species richness, and species evenness were computed using diversity indices such as Margalef's Index, Pielou's Index, and the Shannon–Wiener Index.

RESULTS AND DISCUSSION

Diversity, Distribution, and Abundance of Arthropods

The abundance and diversity of insects could vary between habitats. According to the findings of this study, the FUNAAB has a diverse arthropod population. The sampled habitats yielded a total of 902 arthropods, representing 21 species across 18 families and 8 orders (Table 1&2) during dry and wet season. Hymenoptera and Lepidoptera were the most abundant orders, each comprising 20.73% of the total insect composition (Figure 2). Hymenoptera and Lepidoptera were identified as the most dominant insect orders in the present study. Across all sampled habitats and seasons, Hymenoptera and Lepidoptera were the most prevalent arthropod orders, while Arachnida was the least represented. Arthropods, as integral components of complex ecosystems, are influenced by interactions with both biotic and abiotic factors (Hunter 2002). The prevalence of Hymenoptera is consistent with the findings of Nandini and Murali (2012) in Karnataka, India. However, this study's

results differ from those of Adeduntan and Olusola (2013), who reported Orthoptera as the dominant order in Ondo State's forest ecosystems. Subsequent abundance was observed in Orthoptera (18.29%), Diptera (16%), Odonata (8.87%), Blattodea (7.32%), Coleoptera (3.77%), Arachnida (3.44%), and Hemiptera (0.44%). Order Hemiptera was represented by the fewest individuals in both sampled habitats during both dry (Table 1&2) and wet seasons. This observation is inconsistent with the findings of Okrikata & Yusuf (2016), who reported a different pattern of Hemiptera abundance.

Order Diptera was distributed across the habitat in dry and wet seasons with Muscidae, Calliphoridae, Sarcophagidae, and Culicidae represented with only four species. Order Hymenoptera was also well distributed across the habitat with only family Formicidae represented with only three species in dry and wet seasons. The order Odonata has a total number of three species belonging to the families Libellulidae and Platycnemididae, with the two species with the highest numbers in the dry season and wet season, respectively, belonging to Platycnemididae. The order Arachnida was only represented with a single species belonging to family Araneidae across the habitats in dry and wet seasons. Order Orthoptera includes three families, that is, Pyrgomorphidae, Acrididae, and Gryllidae, which shared only one species across the season. For order Lepidoptera, family Nymphalidae had two species and Papilionidae had a single species across the seasons. The Lepidoptera species collected in the present study are typical of West African taxa, corroborating previous research. Specifically, the presence of Nymphalidae and Papilionidae families aligns with the findings of Nwosu and Iwu (2011), who documented these same families as characteristic components of the African Lepidoptera fauna. Furthermore, Lepidoptera emerged as the dominant order across all habitats and seasons in this study. This dominance may be attributed to the availability of a wide variety of plant, ornamental, and seedling species within the sampled areas. The order Coleoptera had two families, Coccinellidae and Lagriidae, which showed only one species each, and for order Blattidae, Periplaneta showed only one species; no species was recorded for Bellicosus in the dry season; however, in the wet season, two families were also recorded, that is, Periplaneta and Bellicosus representing only one species across the habitats. The greater arthropod abundance observed in the Fadama site during the dry season may be attributed to the increased exposure to direct sunlight, leading to higher temperatures and lower humidity. Conversely, the FN exhibited the highest arthropod abundance during the wet season, likely due to the greater structural complexity provided by the diverse tree species and vegetation cover. This observation supports the findings of Adeduntan (2009), who reported a correlation between tree diversity and insect diversity. Trees exert a significant influence on the microclimate, mitigating the intensity of solar radiation reaching the soil surface and thus creating more stable temperature and humidity conditions conducive to insect life.

Table 1. Diversity and Abundance of Insects in the Habitats Sampled During Dry Season

S/N	Insect Order	Family	Species	Habitats		
				Fadama	**Sport Center**	**Forest Nursery**
1	Diptera	Muscidae	*Musca domestica*	5	21	12
		Calliphoridae	*Chrysomya megacephala*	5	6	5
		Sarcophagidae	*Sarcophaga carnaria*	5	5	4
		Culicidae	*Culex*	5	4	2
2	Hymenoptera	Formicidae	*Oecophylla smaragdina*	10	10	15
			Lasius niger	25	12	10
			Formica rufa	15	2	10
3	Odonata	Libellulidae	*Orthetrum pruinosum*	5	7	3
		Platycnemididae	*Sympetrum flaveolum*	5	9	2
			Copera marginipes	5	10	5
4	Arachnida	Araneidae	*Araneus sp*	3	6	5
5	Orthoptera	Pyrgomorphidae	*Zonocerus variegatus*	29	12	10
6		Acrididae	*Locusta migratoria*	30	12	10
7		Gryllidae	*Acheta domesticus*	14	5	14
8	Lepidoptera	Nymphalidae	*Acraea egina Cram*	10	8	10
			Danaus chrysippus	10	10	12
		Papilionidae	*Danaus tethys*	20	10	12
9	Coleoptera	Coccinellidae	*Harmonia axyridis*	4	1	4
		Lagriidae	*Lagria villosa*	3	1	4
10	Blattodea	Blattidae	*Periplaneta americana*	10	5	7
		Termitidae	*Macrotermes sp*	0	0	0
Total				221	156	158

Note. S/N = serial number.

Table 2. Diversity and Abundance of Insects in the Habitats Sampled During Wet Season

S/N	Insect Order	Family	Species	Habitats		
				Fadama	**Sport Center**	**Forest Nursery**
1	Diptera	Muscidae	*Musca domestica*	1	7	12
		Calliphoridae	*Chrysomya megacephala*	7	9	10
		Sarcophagidae	*Sarcophaga carnaria*	5	4	5
		Culicidae	*Culex*	1	2	6
2	Hymenoptera	Formicidae	*Oecophylla smaragdina*	7	8	9
			Lasius niger	6	9	7
			Formica rufa	12	8	12
3	Odonata	Libellulidae	*Orthetrum pruinosum*	5	3	1
		Platycnemididae	*Sympetrum flaveolum*	3	7	3
			Copera marginipes	2	1	4
4	Arachnida	Araneidae	*Araneus sp*	5	6	6
5	Orthoptera	Pyrgomorphidae	*Zonocerus variegatus*	7	0	4
6		Acrididae	*Locusta migratoria*	5	1	4
7		Gryllidae	*Acheta domesticus*	1	1	5
8	Lepidoptera	Nymphalidae	*Acraea egina Cram*	10	9	7
			Danaus chrysippus	12	10	9
		Papilionidae	*Danaus tethys*	15	9	4
9	Coleoptera	Coccinellidae	*Harmonia axyridis*	2	1	1
		Lagriidae	*Lagria villosa*	5	1	7
10	Blattodea	Blattidae	*Periplaneta americana*	6	4	7
		Termitidae	*Macrotermes sp*	10	2	15
Total				127	102	138

Note. S/N = serial number.

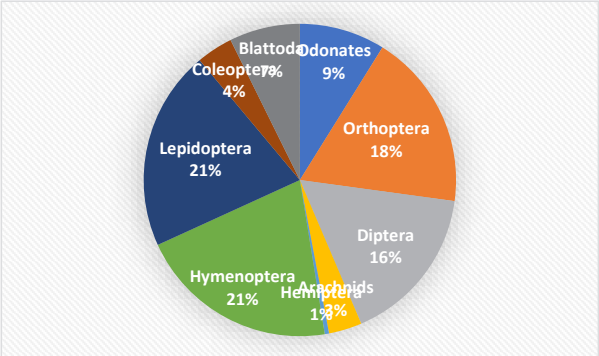

Figure 2. Proportion of arthropods taxa sampled in the study

Species Richness and Diversity of Arthropods in the Sampled Habitats

The overall species richness and diversity of insects collected in the sampled habitats are summarized in (Table 3). The highest species richness was in the Fadama in the dry season (221) and in the FN in the wet season (138), while the lowest species richness was recorded in the SC in the dry season (156) and in the wet season (102). The SC had the highest species richness with Margalef's Index in the dry season (3.951) while the Fadama had the highest in the wet season (4.129). The SC habitat had the highest value for insect diversity in the dry season (H' = 2.818) while the FN had the highest in the wet season (H' = 2.895). Evenness revealed that FN had the highest value for evenness in both dry (J' = 0.840) and wet (J' = 0.861) seasons. Fisher's alpha of diversity shows that the SC had the highest diversity (7.439) and the FN had the lowest (6.897) during the wet season, while the FN had the highest (6.499) and the Fadama had the lowest (5.702) in the dry season. Pairwise diversity *t*-test revealed no significant differences between habitats and seasons ($p > 0.05$). Despite the higher overall arthropod abundance in the Fadama site, the FN exhibited a higher Shannon–Wiener Diversity Index (H = 2.895), indicating that plant diversity and vegetation structure influence insect diversity and abundance (Cheng et al. 2007). Also, Alarape et al. (2015) revealed that diversity and the structure of habitat have been shown to correlate with animal and insect species diversity. The protected status of the FN, coupled with its established forest canopy, likely contributes to this observed dominance. The high butterfly diversity documented by Nwosu and Iwu (2011) in the Okwu Ogbaku forest reserve reinforces the association between forested environments and Lepidoptera abundance. The observed abundance of butterflies in the present study suggests a rich food resource base, potentially leading to increased caterpillar populations and subsequent defoliation. While the species composition of the Fadama and FN habitats was similar, no significant difference in species richness was detected between these two plant-dominated ecosystems. This lack of significant difference is consistent with the concept of plant–insect coevolution (Hougen & Rausher, 1994; Tscharntke & Brand 2004) and the consistent resource availability in both habitats, creating favorable breeding conditions (Adeduntan & Olusola, 2013; Samways, 2007).

Table 3. Species Diversity Indices of Insect Species Across the Habitats in Dry and Wet Seasons

	Dry			Wet		
	Fadama	**Forest Nursery**	**Sport Center**	**Fadama**	**Forest Nursery**	**Sport Center**
Taxa_S	21	21	20	21	21	20
Individuals	221	158	156	127	138	102
Dominance_D	0.077	0.062	0.067	0.066	0.061	0.071
Simpson_1-D	0.922	0.937	0.932	0.933	0.938	0.928
Shannon index	2.767	2.871	2.818	2.836	2.895	2.757
Evenness_e^H/S	0.757	0.840	0.837	0.812	0.861	0.787
Brillouin	2.596	2.648	2.603	2.58	2.648	2.473
Menhinick	1.413	1.671	1.601	1.863	1.788	1.98
Margalef's Index	3.705	3.951	3.762	4.129	4.059	4.108
Equitability_J	0.908	0.943	0.940	0.931	0.951	0.920
Fisher alpha	5.702	6.499	6.097	7.169	6.897	7.439
Berger-Parker	0.135	0.094	0.134	0.118	0.108	0.098
Chao-1	21	21	20.5	22	22	23.33

The physical parameters such as ambient temperature, rainfall, and relative humidity during the sampling period are shown in (Figure 3). The ambient temperature was highest (28–28.3°C) from December 2018–February 2019 during the dry season of the sampling period, while the lowest temperature (25.3–26.6**°C)** was recorded during the wet season in June–August 2019 (FUNAAB Meteorological Station 2019). Also, rainfall was highest at 161.8–221.1 mm in June–August 2019 during the rainy season, while it was lowest at 0.0–14.4 mm in December–February during the dry season. The relative humidity ranged from 55.5% to 65.7% from December to February during the dry season while it ranged from 76.3% to 80.3% from June to August during the wet season.

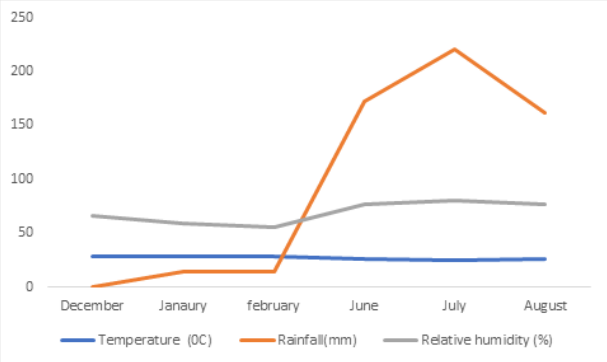

Figure 3. Mean monthly values of environmental variables monitored.

Weed plants collected during dry and wet season

Weed plant species such as *C. odorata* were dominantly present across the habitats during dry and wet seasons (Tables 4 & 5). The plants during the wet season were recorded to be most abundant at the Fadama and the least abundant in the SC. The study area is dominated by plant species like *Tridax procumbens, Sida acuta, Phyllanthus niruri,*

Chromolaena odorata, Helianthus annuus, Manihot esulenta, Gliricidia sepium, and other ornamental flowering plants which promoted the arthropods' richness. It is obvious that some of the tree species in the FN are attractive to the butterflies. This finding is similar to the finding of Alarape et al. (2015), who reported some species being attractive to butterflies in the botanical garden of the University of Ibadan.

Table 4. Abundance of Weed Plants in the Various Habitats Sampled During the Dry Season

Fadama	Forest Nursery	Sport Center
Phyllanthus niruri	*Chromolaena odorata*	*Sida acuta*
Chromolaena odorata	*Sida acuta*	*Tridax procumbens*
Pennisetum purpureum	*Helianthus annuus*	

Table 5. Abundance of Weed Plants in the Various Habitats Sampled During the Wet Season

Fadama	Forest Nursery	Sport Center
Phyllanthus niruri	*Chromolaena odorata*	*Sida acuta*
Chromolaena odorata	*Sida acuta*	*Tridax procumbens*
Pennisetum purpureum	*Helianthus annuus*	
Aspilia africana	Heteropogon contortus	
Manihot esculenta		
Gliricidia sepium		

CONCLUSION

This research investigated the insect species diversity and abundance within three distinct habitats at the FUNAAB: the FN, the SC, and the Fadama. The data generated provide valuable baseline information on the arthropod communities inhabiting these areas. The Fadama was notable for its diverse insect species composition. Based on these findings, we recommend enhanced conservation strategies for both plant and arthropod species throughout the FUNAAB campus.

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