



Research Article

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Estimation of Forest Insect Biodiversity in Akure, Ondo State, Nigeria

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Abstract

Insects play a crucial role in ecosystem functioning, acting as pollinators, decomposers, and bioindicators of environmental change. This study was conducted to investigate the diversity and abundance of insect species within the forest ecosystem of the Federal University of Technology, Akure (FUTA), and Nigeria. The research aimed to provide baseline data essential for biodiversity conservation and sustainable ecosystem management in the region. Insects were collected from three distinct zones within the forest using pitfall traps and sweep nets over a specified sampling period. Collected specimens were identified and classified into families and species using standard entomological keys. A total of 685 individual insects were collected, comprising 19 species across 16 families. *Macrotermes subhyalinus* (Family: Termitidae) recorded the highest abundance (180 individuals), followed by *Glenurus gratus* (Family: Myrmeleontidae) with 120 individuals, and *Lasius niger* (Family: Formicidae) with 95 individuals. Shannon-Wiener and Simpson's diversity indices revealed that Zone A had the highest diversity, suggesting relatively undisturbed habitat conditions. The species richness and evenness varied across zones, reflecting habitat heterogeneity and microclimatic differences. The dominance of termites, ants, and antlions indicates the ecological health and stability of the forest ecosystem, as these groups are vital for soil aeration, nutrient cycling, and food web dynamics. The presence of rare and moderately distributed species also underscores the forest's potential as a biodiversity hotspot. These findings provide important ecological information that could inform forest conservation strategies and serve as a reference point for future environmental monitoring. The study highlights the need for continued research and protection of forest habitats to preserve insect biodiversity in Nigeria.

Keywords

Forest, Insects, Biodiversity, Estimation

Introduction

Forests represent one of the richest and most complex ecosystems on Earth, harbouring an extraordinary diversity of life forms, among which insects constitute the most numerous and ecologically significant group (Yager, et al. 2018; Alafia, et al. 2023) [1,2]. Insects play vital roles in forest ecosystems, including pollination, decomposition, nutrient cycling, seed dispersal, and serving as food for higher trophic levels (Alafia, et al. 2023) [2]. As such, they are fundamental to the stability and functioning of forest environments. However, despite their importance, forest insect biodiversity remains underexplored, particularly in tropical and subtropical regions where species richness is highest and taxonomic information is often limited (Alafia, et al. 2023; Olatoye, et al. 2024) [2,3].

The estimation of insect biodiversity in forest ecosystems is essential for several reasons. First, it provides insight into ecosystem health, resilience, and the functioning of ecological processes (Olatoye, et al. 2024) [3]. Second, insect diversity can serve as a sensitive bioindicator for detecting environmental changes, habitat degradation, and climate impacts (Bakare, et al. 2024) [4]. Third, such studies offer valuable data for conservation planning and biodiversity

management, especially in regions experiencing rapid deforestation, habitat fragmentation, and anthropogenic disturbances (Alafia, et al. 2023; Olatoye, et al. 2024) [2,3].

Traditional biodiversity surveys have often focused on more conspicuous or economically significant species, overlooking the vast majority of forest insects due to their small size, high abundance, and taxonomic complexity (Alafia, et al. 2023) [2]. Recent advances in sampling techniques, such as the use of multiple complementary traps and biodiversity indices, have made it increasingly possible to obtain more accurate estimates of insect richness and abundance in forested habitats (Yager, et al. 2018) [1].

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Tropical forest ecosystems, such as those found in parts of Africa, South America, and Southeast Asia, are particularly important areas for such investigations, as they are believed to contain more than half of the world's insect species (Olatoye, et al. 2024) [3]. Nigeria's forests, for example, are under increasing pressure from logging, agricultural expansion, and urbanization, yet little is known about the insect communities they host (Olatoye, et al. 2024) [3].

This study aims to estimate insect biodiversity within a selected forest reserve using standardized sampling methods. The results are expected to provide baseline data on the diversity and composition of insect species in the area, contributing to ecological knowledge and informing strategies for sustainable forest conservation.

Methodology

Study area

The study was conducted in the forest area of the Federal University of Technology, Akure (FUTA), situated in Akure South Local Government Area of Ondo State, Nigeria. This forest ecosystem lies within the humid tropical rainforest zone of southwestern Nigeria, known for its high biological diversity and dense vegetation cover. The climate of the region is typically tropical, exhibiting distinct wet and dry seasons. The mean annual temperature is approximately 26°C, with minimum and maximum temperatures of 19°C and 34°C, respectively. Annual rainfall averages around 2000 mm and follows a bimodal distribution, with peaks occurring in July and September, and a short dry spell typically experienced in August. The vegetation of the area comprises a rich mix of trees, shrubs, herbs, and climbers, which together provide suitable microhabitats for various faunal groups, particularly insects.

Sampling design

To obtain a representative estimate of insect diversity within the forest, four sampling plots were demarcated in different sections of the FUTA forest. Each plot measured 10 m × 10 m (100 m²), and was carefully established using wooden pegs and measuring tapes. The selection of plot locations was guided by differences in ecological features such as canopy coverage, ground vegetation density, and proximity to footpaths or human activity. This approach ensured that the selected plots reflected the heterogeneity of microhabitats within the forest, which is crucial for capturing a broad spectrum of insect taxa.

Insect collection techniques

Insect sampling was carried out using a combination of active and passive collection methods to maximize the capture of various insect groups. Sweep netting was employed to target flying and foliage-dwelling insects such as butterflies, beetles, flies, and wasps. This involved sweeping the net horizontally and vertically across vegetation to dislodge and collect insects. Ground-dwelling and slow-moving insects, including ants and caterpillars, were manually collected through hand-picking from tree trunks, foliage, and the forest floor. Additionally, the beating tray method was used for canopy and foliage insects by placing a white tray

beneath branches and tapping them with a stick to dislodge hidden insects. Sampling was conducted during daylight hours, specifically between 8:00 AM and 12:00 PM, when insect activity is generally high. Each sampling session lasted a minimum of 30 minutes per plot to ensure sufficient coverage and specimen yield.

Specimen preservation and identification

Collected insects were carefully transferred into clean, labeled bottles containing cotton wool soaked in chloroform for euthanization and temporary preservation. In the laboratory, specimens were sorted and preserved based on body type. Hard-bodied insects were pinned and stored dry, while soft-bodied insects were preserved in 70% ethanol. Each specimen was examined and identified using standard entomological taxonomic keys and identification guides. Classification was based on observable morphological features such as antennae type, wing structure, mouthparts, and body segmentation. All identified insects were categorized into their respective orders and families for further analysis.

Data analysis

The analysis was conducted using Microsoft Excel and Paleontological Statistics (PAST) software version 4.03. Descriptive statistics were also employed to summarize the total number of insect species, individuals, and their distribution across the plots. PAST was used to calculate the biodiversity indices

Results

The insect composition and abundance in the various study zone is presented in [table 1](#). A total of 685 individual insects belonging to 19 different species and 16 families were recorded across the four study zones. *Macrotermes subhyalinus* (Rhinotermitidae) was the most abundant species with 158 individuals, representing 18.8% of the total count. This was followed by *Glenurus gratus* (Myrmeleontidae) with 90 individuals (10.7%) and *Lasius niger* (Formicidae) with 65 individuals (7.7%).

Among the zones, Zone B recorded the highest number of *Macrotermes subhyalinus* (65 individuals), while *Glenurus gratus* was most dominant in Zones A and D with 40 and 45 individuals, respectively. Other species with notable abundance included *Camponotus pennsylvanicus* (59 individuals, 7.0%), *Pyrgomorpha borealis* (38 individuals, 4.5%), and *Omocestus viridulus* (34 individuals, 4.0%). Less abundant species included *Neoconocephalus palustri* (1.3%), *Anax junius* (1.4%), and *Sphodromantis viridis* (1.7%). The least represented in terms of numbers was *Neoconocephalus palustri*, which occurred mainly in Zone B.

The family Formicidae had the highest representation, comprising three species (*Camponotus pennsylvanicus*, *Lasius niger*, and *Formica rufa*) with a combined total of 145 individuals (21.2%). In contrast, several families such as Syrphidae, Tabanidae, and Tipulidae were represented by single species with relatively low abundance. Overall, insect composition and abundance varied across the zones, indicating a diverse assemblage and possible differences in habitat conditions.

Table 1: Insect species composition and relative abundance in the study zones.

Insect Species	Common Name	Family	Zone A	Zone B	Zone C	Zone D	Total	%
<i>Nemobius sylvestri</i>	Wood Cricket	Rhaphidophoridae	6	0	5	15	26	3.1
<i>Neoconocephalus palustris</i>	Marsh Cone Head	Tettigoniidae	2	8	0	1	11	1.3
<i>Macrotermes subhyalinus</i>	Subterranean Termite	Rhinotermitidae	18	65	55	20	158	18.8
<i>Glenurus gratus</i>	Antlion	Myrmeleontidae	40	5	0	45	90	10.7
<i>Sphodromantis viridis</i>	Praying Mantis	Mantidae	1	7	6	0	14	1.7
<i>Omocestus viridulus</i>	Common Green Grasshopper	Acrididae	12	14	0	8	34	4.0
<i>Camponotus pennsylvanicus</i>	Carpenter Ant	Formicidae	4	40	15	0	59	7.0
<i>Lasius niger</i>	Black Ant	Formicidae	20	0	25	20	65	7.7
<i>Volucella zonaria</i>	Hornet's Bionic Hoverfly	Syrphidae	10	8	6	0	24	2.9
<i>Pyrgomorpha borealis</i>	Northern Grass Pyrgomorph	Pyrgomorphidae	15	18	0	5	38	4.5
<i>Gryllus campestris</i>	Field Cricket	Gryllidae	7	3	10	0	20	2.4
<i>Anax junius</i>	Green Darner Dragonfly	Aeshnidae	5	0	4	3	12	1.4
<i>Chrysoperla carnea</i>	Green Lacewing	Chrysopidae	3	10	10	0	23	2.7
<i>Tettigonia viridissima</i>	Great Green Bush-Cricket	Tettigoniidae	4	9	0	3	16	1.9
<i>Formica rufa</i>	Red Wood Ant	Formicidae	6	8	0	7	21	2.5
<i>Forficula auricularia</i>	European Earwig	Forficulidae	8	6	5	0	19	2.3
<i>Cicindela campestris</i>	Green Tiger Beetle	Cicindelidae	9	0	8	4	21	2.5
<i>Tabanus bovinus</i>	Horsefly	Tabanidae	3	7	6	0	16	1.9
<i>Tipula paludosa</i>	Marsh Crane Fly	Tipulidae	6	0	7	5	18	2.1

Table 2: Diversity of insects collected at the study zones.

	ZONE A	ZONE B	ZONE C	ZONE D
Taxa_S	19	14	13	12
Individuals	179	208	162	136
Simpson_1-D	0.9009	0.8408	0.8338	0.8244
Shannon_H	2.604	2.213	2.176	2.043
Evenness_e ^{H/S}	0.7117	0.6531	0.6777	0.643
Margalef	3.47	2.436	2.359	2.239
Equitability_J	0.8845	0.8386	0.8483	0.8223

The insect diversity across the different zone is presented in table 2. Zone A recorded 19 taxa and 179 individual insects. Zone B had 14 taxa and 208 individuals. In Zone C, 13 taxa and 162 individuals were recorded, while Zone D had 12 taxa and 136 individuals. The Simpson's Diversity Index (1-D) values were 0.9009 for Zone A, 0.8408 for Zone B, 0.8338 for Zone C, and 0.8244 for Zone D. Shannon's Diversity Index (H) was 2.604 in Zone A, 2.213 in Zone B, 2.176 in Zone C, and 2.043 in Zone D. Evenness values (e^{H/S}) were 0.7117, 0.6531, 0.6777, and 0.643 for Zones A, B, C, and D respectively. Margalef's index values were 3.47 for Zone A, 2.436 for Zone B, 2.359 for Zone C, and 2.239 for Zone D. Equitability (J) values were 0.8845 in Zone A, 0.8386 in Zone B, 0.8483 in Zone C, and 0.8223 in Zone D.

Discussion

The findings from this study demonstrate a relatively rich and diverse insect community within the forest zones surveyed. The detection of multiple insect species from a variety of families across the study areas indicates a healthy and functioning ecosystem. The dominance of species such as *Macrotermes subhyalinus* suggests that decomposer groups play a vital role in the ecological processes of the forest, particularly in organic matter recycling and soil nutrient enhancement. Similar patterns have been reported in other

forest biodiversity studies, where termites were often the most abundant taxa due to their ecological niche (Adeduntan & Owa, 2018) [5].

The variation in species composition and distribution across the different zones points to differences in microhabitat conditions and resource availability. Some zones exhibited higher species richness, while others were characterized by greater abundance but lower diversity. This trend aligns with the findings of Yusuf, et al. (2020) [6], who observed that certain areas within forest ecosystems tend to favour specific insect taxa depending on habitat structure, vegetation cover, and moisture levels. The presence of multiple ant species from the Formicidae family further reflects the forest's ecological balance, as ants are often indicators of environmental health due to their sensitivity to habitat disturbance (Bihn, et al. 2010) [7].

The overall evenness in species distribution suggests that, in some zones, insect populations were relatively well balanced rather than being dominated by a few species. This characteristic is often observed in undisturbed or semi-natural forest environments, where competition and predation promote diversity (Hill, et al. 2001) [8]. On the other hand, zones with slightly reduced diversity may be experiencing ecological stress or marginal disturbance, affecting the community structure.

Furthermore, the family-level representation indicates a wide range of ecological functions performed by the insects observed, ranging from pollination and herbivory to predation and decomposition. This functional diversity is essential for maintaining forest resilience and ecological integrity. Studies such as those by Umeh and Ugwumba (2021) [9] have emphasized the importance of insect biodiversity in tropical forests for ecosystem service provision and conservation planning.

Overall, the findings are consistent with previous research conducted in similar tropical forest environments, highlighting the importance of maintaining diverse and undisturbed forest habitats for sustaining insect biodiversity. Continued monitoring and conservation efforts are necessary to preserve these habitats in the face of increasing anthropogenic pressures.

Conclusion

This study has provided valuable insights into the diversity and abundance of insect species within the forest ecosystem of the Federal University of Technology, Akure. A total of 685 individuals representing 19 species across 16 families were documented, reflecting a relatively high level of insect biodiversity. The dominance of species such as *Macrotermes subhyalinus*, *Glenurus gratus*, and *Lasius niger* highlights the ecological significance of termites, antlions, and ants in this forest habitat. Diversity indices further revealed notable variations in species richness and evenness across the sampled zones, with Zone A exhibiting the highest biodiversity.

These findings underscore the ecological importance of preserving forested areas as reservoirs of insect diversity. The data serve as a baseline for future ecological monitoring and conservation planning in the region. Continued assessment of insect communities in this and similar ecosystems is essential, especially in the face of increasing anthropogenic pressures and environmental change, to safeguard biodiversity and maintain ecological balance.

Declaration

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analysed during the current study are available from corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

Samson Timilehin Oluyi, Elizabeth Oluwatomisin Ayodele, Kemi Josephine Fehintola, Opeyemi Eunice Oyekojo and Richard Olajide Owaseye carried out the field work and also compiled the manuscript together.

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