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Evaluation of Diversity and Abundance of Diptera, Hemiptera and Lepidoptera in Afuremo, Oye-EgboandFaalex Areas inOye-Ekiti, Ekiti State, Nigeria

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ABSTRACT: This study aimed at evaluating the diversity and abundance of Diptera, Hemiptera and Orthoptera in Afuremo, Oye- Egbo and Faalex areas in Oye- Ekiti, Ekiti State, Nigeria from January to April 2024 using a combination of Sweep net, Pitfall, jarring and Active hunting methods. Data obtained reveals, a total of 333 individuals belonging to 3 orders, 26 families and 40 species were identified from Afuremo, Oye- Egbo and Faalex. Diptera was the most dominant order across the three study areas with 164 individuals. Out of these numbers 96 individuals were obtained from Afuremo, 21 individuals were obtained from Oye-Egbo while 47 individuals were obtained from Faalex. In Afuremo, *Coniceratibialis* (Diptera: Phoridae) had the highest relative abundance of 31.25% while both *Aedesinfirmatus* (Diptera: Culicidae) and *Muscadomestica* (Diptera: Muscidae) had the lowest relative abundance of 1.04% respectively. However, in Oye-Egbo, *Cimexlectularius* (Hemiptera: Cimicidae) had the highest relative abundance of 64.29% while *Brassolissophorae (Lepidoptera: Nymphalidae), Plodiainterpunctella (Lepidoptera: Pyralidae) and Lymantriadispar (Lepidoptera: Erebidae)* had the lowest relative abundance of 9.09% respectively. In Faalex, *Eupeodesfumipennis (Diptera:* Syrphidae) had the highest relative abundance of 68.09% while *Limnellaquadrata*(Diptera: Ephydidae) had the lowest relative abundance of 2.13%. Oye- Egbo had the highest Shannon, Margalef and Evenness values (1.09, 0.47, 0.99) respectively while Faalex had the lowest Shannon and Evenness values (0.90, 0.82) respectively. The results suggest that Afuremo is a biodiversity hub and has favorable microclimatic condition that ensures the sustenance of Diptera, Lepidoptera and Hemiptera.

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Insects are essential for nutrient cycling, organic matter decomposition, pollination, and soil aeration in urban ecosystems (Li *et al*., 2023). Insects are essential for ecological functioning. They play a crucial role in plant pollination, seed dispersal, soil fertility maintenance and population control of other organisms, serving as a significant food source for other species (Verma *et al.*, 2023) and acting as parasites or disease vectors for other organisms, including humans. Hemiptera, sometimes known as true insects, comprise diverse species with various ecological functions. Their sharp-piercing mouthparts distinguish them and consist of aphids, cicadas, leafhoppers, and scale insects (Fent and Dursun, 2021). Hemipterans are important herbivores that feed on plant sap and have crucial functions in nitrogen cycling and interactions with plant diseases (Musaqaf *et al.*, 2022). Some animals act as predators or carriers of plant diseases, playing crucial roles in land ecosystems. Lepidoptera, the order comprising

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butterflies and moths, are well-known for their remarkable beauty and intriguing life cycles. With more than 180,000 identified species, they are one of the most varied insect orders (Park, 2023). They act as pollinators, herbivores, and significant markers of environmental health (Oyeniyi, 2018). Diptera is the order of actual flies, which includes a wide range of species such as mosquitoes, flies, gnats, and midges (Amao *et al*., 2018). Dipterans have various ecological functions, including pollination, decomposition, predation, and disease transmission. Their versatility, quick reproductive rates, and capacity to thrive in different settings have led to their ecological success (Ileke andAdesina, 2020).

Several studies have examined the insect composition and diversity in tropical areas (Ashton *et al*., 2014; Agavekar *et al*., 2018; Onyekwelu *et al*., 2021). Researchers have studied several tropical environments, including rainforests, savannahs, and mangroves, to analyze the types and quantities of insect species in these ecosystems. Different variables affect the insect species composition in distinct environments, determining their distribution and abundance. The attributes of a habitat, including plant type, structure, and complexity, greatly influence the makeup of insect species. Various insects have distinct environmental preferences and ecological roles (Sufi *et al*., 2017). The comparative study of insect species composition within the selected orders Diptera, Hemiptera and Lepidoptera in Afuremo, Oye-Egbo, and Faalex areas of Oye-Ekiti is vital for several reasons. Understanding the species composition and diversity within these orders can provide insights into the ecological health and biodiversity of the studied areas as well as identifying variations in ecological factors, habitat quality, and potential environmental pressures. Biodiversity assessments help identify areas of high conservation value and regions that may require targeted conservation efforts (Margules and Pressey, 2000). By documenting the species in Afuremo, Oye-Egbo, and Faalex, the research can contribute to developing strategies for preserving insect diversity and maintaining ecological balance. Therefore the objective of this paper is to evaluate the diversity and abundance of Diptera, Hemiptera and Lepidoptera in Afuremo, Oye-Egbo and Faalex areas in Oye-Ekiti, Ekiti State, Nigeria.

MATERIALS AND METHODS

Study area:The study area is characterized by a tropical wet and dry climate, with an average annual rainfall of 622 mm and temperatures averaging 29°C. Covering approximately 483 square kilometers, Oye-Ekiti is located between longitudes 5°10'-5°30' E and latitudes 7°35'-7°50' N. The dry season lasts from late November to early February. The driest month is December. The rainy season lasts from mid-February to mid-November. Afuremois located on Latitude N 07. 79355˚ and longitude: E 005.33617˚.Oye- Egbo is located on Latitude N 07.79189˚ and longitude E 005.33246˚ and Faalex is located on Latitude N 07.79404˚ and longitude E 005.33653˚ (Figure 1).

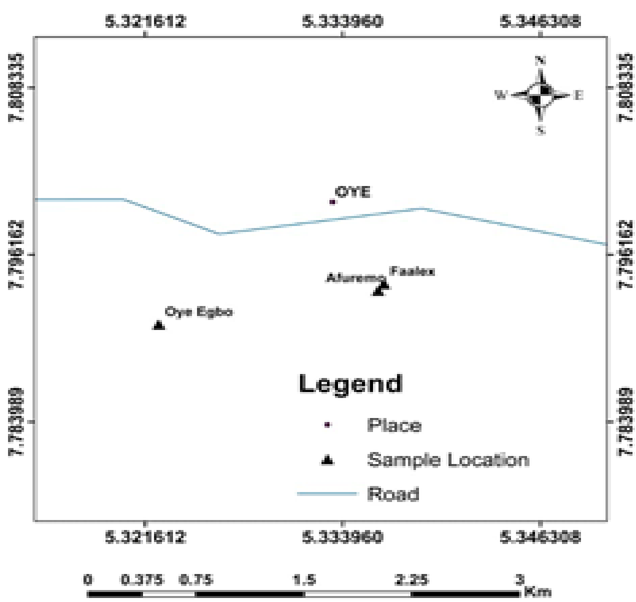

Fig. 1: Map of the study area

Insect Collection: Insect sampling was carried out bi-weekly through the months of January to April 2024 in Afuremo, Oye- Egbo and Faalex. A 100 m^2 per habitat was mapped out as the sampling area and subdivided into temporary sample plots of 25 m^2 per habitat. Random sampling technique was employed.

Sampling Techniques: Insect samples were collected from Afuremo, Oye- Egbo and Faalex using pitfall traps, sweep nets, jarring and active hunting methods.

Pitfall Trap: On each sampling occasion, eight pitfall traps (5 – 10 metres apart) made of plastic containers with mouth diameters of 12 cm and 13cm deep were set on each of the three study sites. The traps were set in such a way that their rims were made to flush with the soil surface and filled to one-fifth with 70% ethanol solution**.** The traps were collected after forty-eight hours and the insects were sorted, identified and counted in the laboratory of the Department of Animal and Environmental Biology, Federal University Oye- Ekiti.

Jarring: Jarring method involved shaking or striking vegetation to dislodge insects, which were then collected as they fell onto a piece of white cloth placed beneath the plants or shrubs. After dislodging the insects from the vegetation**,** Diptera**,** Hemiptera and Lepidoptera were sorted out from the insects and carefully transferred into collecting vials containing 70% ethanol and taken for counting and subsequent identification in the laboratory of the Departmentof Animal and Environmental Biology, Federal University Oye- Ekiti.

Active Hunting: This method involved direct capture of insects by hand. The insects were placed into well-labelled containers containing 70% ethanol and transported to the laboratory of the Department of Animal and Environmental Biology, Federal University Oye- Ekiti for sorting, counting and identification.

Sweep Net: Sweep net made into a bag and fitted into a circular rod of a mouth diameter of 30 cm, bag depth of 50 cm and a wooden handle of 1 m was used. On each sampling occasion ten sweeps were made across the vegetation and emptied on plain white cloth. The catches were carefully examined for flying insects after each sweep.

The insects caught were deposited into a well-labeled container containing 70 % ethanol and transported to the Department of Animal and Environmental Biology, Federal University Oye- Ekiti for sorting, counting and identification.

Insect Identification: The insects were identified to the species level using the taxonomic identification key (Zettler*et al.,* 2016; Packer, 2024).

Computation of Diversity Indices:The following biodiversity indices were computed:

$$N = \sum N_i \qquad (1)$$

Where: N_T = total number of individuals; Ni= Number of individuals in each sample

$$D = S - \frac{1}{\ln(N)} \quad (2)$$

Where D = Margalef diversity Index; S= total number of species; N= total number of individuals in the sample

$$(H') = \sum pi \ * \ln(pi) \ (3)$$

Where H'= Shannon Index; Σ=greek symbol that means sum; ln= natural log; pi= the proiportion of the entire community made up of species i

$$D = \sum n^{\,(n-1)} / N(N-1) \quad (4)$$

Where D= Simpson Index; n=total number of individuals of each species; N=total number of individuals of all species

$$J = {H'} / {\ln S} \qquad (5)$$

Where J= Evenness; H'=Shannon Weiner Diversity; S =total number of species in a sample across all species in a dataset

Data Analysis: All data collected were analyzed using SPSS 20.0 software. Abundance and relative abundance was determined. Descriptive Statistics was employed. Bar chart was also used to represent the abundance of Diptera, Lepidoptera and Hemiptera across the study sites.Percentage Composition of insect orders and spatial percentage composition were also estimated.

RESULTS AND DISCUSSION

Abundance and Relative Abundance of Insects: The abundance and relative abundance of Diptera, Lepidoptera and Hemiptera were recorded across the three study sites. The findings are summarized in Table 1. In this study, a total of 333 individuals belonging to 3 orders, 26 families and 40 species were identified from Afuremo, Oye- Egbo and Faalex (Table 1). Diptera was the most dominant order across the three study areas with 164 individuals (Table 1). Out of these numbers 96 individuals were obtained from Afuremo, 21 individuals were obtained from Oye-Egbo while 47 individuals were obtained from Faalex (Table 1). In Afuremo, *Conicera tibialis* (Diptera: Phoridae) had the highest relative abundance of 31.25% (Table 1) while both *Aedes infirmatus* (Diptera: Culicidae) and *Musca domestica* (Diptera: Muscidae) had the lowest relative abundance of 1.04% respectively. However, in Oye-Egbo, *Cimex lectularius* (Hemiptera: Cimicidae) had the highest relative abundance of 64.29% (Table 1) while *Brassolis sophorae(Lepidoptera: Nymphalidae, Plodia interpunctella (Lepidoptera: Pyralidae) and Lymantria dispar (Lepidoptera:Erebidae)* had the lowest relative abundance of 9.09% respectively (Table 1). In Faalex, *Eupeodes fumipennis (Diptera:* Syrphidae) had the highest relative abundance of 68.09% while *Limnella quadrata*(Diptera: Ephydidae) had the lowest relative abundance of 2.13%.

Table 1: Diversity, abundance and relative abundance of diptera, lepidoptera and hemiptera in afuremo, oye- egbo and faalex

			Site					
Order	**Family**	**Genus/Species**	**AF**	**RA**	**OE**	**RA**	**FA**	**RA**
Diptera	Ephydridae	*Limnella quadrata*	0.00	0.00	0.00	0.00	1.00	2.13
	Glossinidae	*Glossina sp.*	7.00	7.29	0.00	0.00	0.00	0.00
	Phoridae	*Conicera tibialis*	30.00	31.25	0.00	0.00	0.00	0.00
	Culicidae	*Aedes infirmatus*	1.00	1.04	0.00	0.00	0.00	0.00
	Culicidae	*Aedes aegypti*	5.00	5.21	0.00	0.00	7.00	14.89
	Stratiomyidae	*Hermetia illucens*	23.00	23.96	0.00	0.00	0.00	0.00
	Drosophilidae	*Drosophila melanogaster*	5.00	5.21	5.00	23.81	0.00	0.00
	Muscidae	*Musca domestica*	1.00	1.04	9.00	42.86	5.00	10.64
	Syrphidae	*Helophilus fasciatus*	13.00	13.54	0.00	0.00	0.00	0.00
	Syrphidae	*Eupeodes fumipennis*	5.00	5.21	0.00	0.00	32.00	68.09
	Sciaridae	*Bradysia sp.*	0.00	0.00	4.00	19.05	0.00	0.00
	Culicidae	*Anopheles gambiae*	1.00	1.04	3.00	14.29	2.00	4.26
	Tabanidae	*Tabanus nigrovittatus*	5.00	5.21	0.00	0.00	0.00	0.00
Lepidoptera	Notodontidae	*Pharyganidia californica*	10.00	19.61	0.00	0.00	0.00	0.00
	Tineidae	*Tineola bisselliella*	0.00	0.00	0.00	0.00	3.00	15.79
	Crambidae	*Elophila obliterculis*	15.00	29.41	0.00	0.00	0.00	0.00
	Nymphalidae	*Pareuptychia occirrhoe*	1.00	1.96	0.00	0.00	0.00	0.00
	Nymphalidae	*Euphaedra hollandi*	0.00	0.00	10.00	45.45	6.00	31.58
	Nymphalidae	*Actinote thalia*	0.00	0.00	0.00	0.00	7.00	36.84
	Nymphalidae	*Brassolis sophorae*	0.00	0.00	2.00	9.09	0.00	0.00
	Nymphalidae	*Papilio horta*	1.00	1.96	4.00	18.18	0.00	0.00
	Papilionidae	*Ornithoptera meridionalis*	0.00	0.00	2.00	9.09	0.00	0.00
	Lycaenidae	*Curetis acuta*	1.00	1.96	0.00	0.00	0.00	0.00
	Pyralidae	*Plodia interpunctella*	17.00	33.33	2.00	9.09	1.00	5.26
	Nymphalidae	*Maniola jurtina*	0.00	0.00	0.00	0.00	2.00	10.53
	Erebidae	*Lymantria dispar*	0.00	0.00	2.00	9.09	0.00	0.00
	Nymphalidae	*Junonia terea*	2.00	3.92	0.00	0.00	0.00	0.00
	Nymphalidae	*Acraea acuta*	4.00	7.84	0.00	0.00	0.00	0.00
Hemiptera	Reduviidae	*Triatoma infestans*	2.00	5.00	0.00	0.00	0.00	0.00
	Reduviidae	*Reduvius personatus*	3.00	7.50	0.00	0.00	0.00	0.00
	Nepidae	*Nepa cinera*	8.00	20.00	0.00	0.00	0.00	0.00
	Cimicidae	*Cimex lectularius*	0.00	0.00	18.00	64.29	0.00	0.00
	Pentatomidae	*Halyomorpha halys*	5.00	12.50	0.00	0.00	9.00	
	Pentatomidae	*Nezara viridula*	3.00	7.50	3.00	10.71	0.00	0.00
	Gerridae	*Gerris sp.*	11.00	27.50	0.00	0.00	0.00	0.00
	Membracidae	*Ceresa taurina*	3.00	7.50	0.00	0.00	0.00	0.00
	Cicadellidae	*Eurymeloides bicincta*	1.00	2.50	0.00	0.00	0.00	0.00
	Cicadidae	*Neotibicen linnei*	2.00	5.00	0.00	0.00	0.00	0.00
	Reduviidae	*Rhynocoris iracundus*	2.00	5.00	3.00	10.71	0.00	0.00
	Blissidae	*Blissus leucopterus*	0.00	0.00	4.00	14.29	0.00	0.00
	TOTAL ABUNDANCE							333

AF=Afuremo,RA=Relative Abundance,OE=Oye-Egbo,FA=Faalex

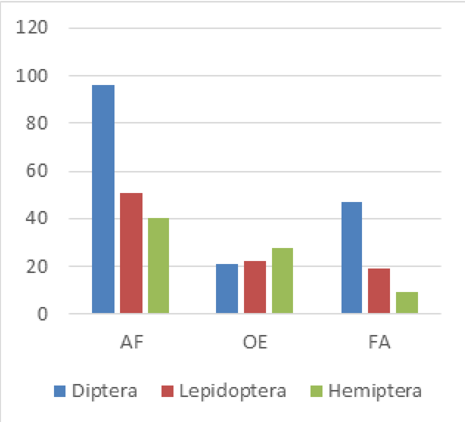

Fig. 2: abundance of diptera, lepidoptera and hemiptera in afuremo, oye-egbo and faalex

The Abundance of Diptera, Lepidoptera and Hemiptera in Afuremo, Oye-Egbo and Faalex is as presented in Fig. 2. In Afuremo and Faalex, Diptera had the highest abundance (95, 45) respectively. However, Hemiptera had the lowest abundance in Afuremo and Faalex (40, 10). (Fig. 2).

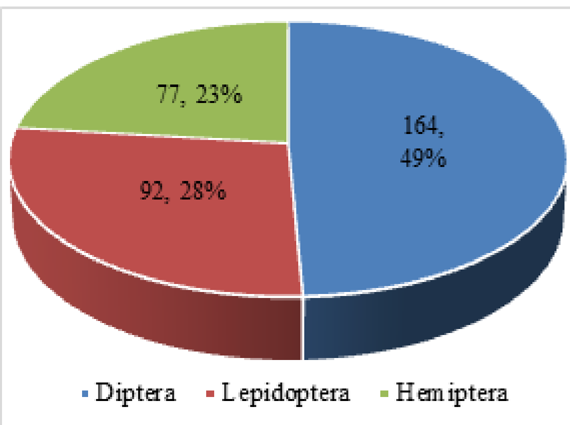

Fig. 3: percentage composition of insect orders

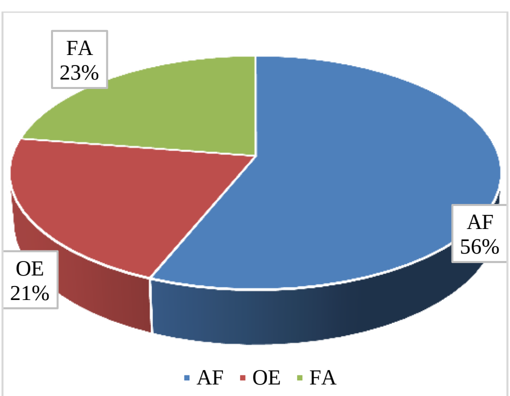

Fig. 4: spatial percentage composition

The percentage composition of Diptera, Lepidoptera and Hemipteara is as presented in Fig. 3. Diptera had the highest percentage composition 164(49%) while Hemiptera the lowest percentage composition 77(23%). The spatial percentage composition is as presented in Fig. 4. Afuremo had the highest percentage composition (56%) while Oye- Egbo had the lowest percentage composition (21%) (Fig. 4).

Table 2: Diversity Indices of Afuremo, 0ye- Egbo and Faalex

Indices	AF	OE	FA
Dominance_D	0.38	0.34	0.47
Simpson_1-D	0.62	0.66	0.53
Shannon_H	1.03	1.09	0.90
Evenness_e^H/S	0.93	0.99	0.82
Menhinick	0.22	0.36	0.35
Margalef	0.38	0.47	0.46
Equitability_J	0.93	0.99	0.81
Fisher_alpha	0.51	0.63	0.63
Berger-Parker	0.51	0.39	0.63

The diversity Indices of Afuremo, Oye- Egbo and Faalex is as presented in Table 2. Oye- Egbo had the highest Shannon, Margalef and Evenness values (1.09,0.47, 0.99) respectively. Faalex had the lowest Shannon and Evenness values (0.90, 0.82) respectively. The comparative study of insect species composition in Afuremo, Oye-Egbo, and Faalex within Oye-Ekiti, Nigeria, provides a comprehensive overview of the diversity and distribution of Diptera, Lepidoptera, and Hemiptera in these different habitats. This research illuminates the ecological dynamics and the effects of human activity on insect communities in these areas. The results reveal notable differences in insect abundance and diversity among the three study sites. Diptera emerged as the most dominant order across the sites, reflecting its adaptability and the variety of ecological niches it occupies. The highest abundance of Diptera was recorded in Afuremo (96 individuals), followed by Faalex (47 individuals) and Oye-Egbo (21 individuals). This trend indicates that Afuremo, with its minimally impacted environment, provides favorable conditions for Diptera, likely due to its proximity to a river and the less disturbed nature of its habitat (Assefa *et al.*, 2020). On the other hand, Faalex, characterized by high population density and urbanization, showed a significant presence of *Eupeodes fumipennis* (Diptera: Syrphidae) with a relative abundance of 68.09%, suggesting that urban areas can support a specialized subset of Diptera adapted to such environments (Dyer and Taylor, 2003). The abundance of Lepidoptera and Hemiptera was also variable across the sites. Afuremo's high abundance of Lepidoptera, particularly *Elophila obliterculis* and *Plodia interpunctella*, aligns with its more stable and less disturbed environment, which likely supports a rich variety of plant species and, consequently, herbivorous insects like Lepidoptera (Prazak*et al.,* 2014). In contrast, Oye-Egbo exhibited high relative abundance of *Cimex lectularius* (Hemiptera: *Cimicidae*) with 64.29%, suggesting that this site may have conditions favorable for bed bugs, possibly due to the presence of a nearby dump site (Southwood and Henderson, 2000).

The spatial distribution of insects highlights the influence of habitat type on insect diversity. Afuremo, with its higher percentage composition of 56%, suggests that less human interference and proximity to natural water sources contribute to higher insect diversity (Woodcock, 2005). Conversely, Oye-Egbo's lower percentage composition (21%) and high dominance of *Cimex lectularius* reflect the ecological pressures exerted by nearby human activity and waste, which can skew species composition towards those resilient to such conditions (Southwood and Henderson, 2000). Faalex's high abundance of *Eupeodes fumipennis* amidst urban and agricultural activities signifies that certain species have adapted to or even thrive in disturbed environments, a pattern supported by urban ecology studies (Dyer and Taylor, 2003). The diversity indices further support these findings. Oye-Egbo exhibited the highest Shannon (1.09) and Margalef (0.47) indices, indicating greater species diversity and richness compared to Afuremo and Faalex. This suggests that despite moderate human activity, Oye-Egbo maintains a more balanced and diverse insect community. In contrast, Faalex had lower diversity indices, reflecting a more dominant presence of fewer species and lower overall diversity, likely due to the intense human activity and habitat disturbance (Assefa *et al.,* 2020). The evenness values, which measure the distribution of individuals among species, were highest in Oye-Egbo (0.99), suggesting a more even distribution of species. This is in contrast with Faalex, where the evenness value was lower (0.82), reflecting a more uneven distribution and dominance by a few species (Prazak *et al.,* 2014). Such patterns align with ecological theories suggesting that increased disturbance often leads to decreased evenness and higher dominance by a few adaptable species.

Overall, the study underscores the importance of habitat type and human activity in shaping insect communities. The varying insect abundance and diversity across Afuremo, Oye-Egbo, and Faalex reflect the impact of environmental conditions and human influences on these ecosystems. The findings are consistent with other studies indicating that less disturbed and more natural habitats support higher insect diversity and evenness, while urbanized and disturbed areas tend to have lower diversity and higher dominance by a few adaptable species (Woodcock, 2005; Southwood and Henderson, 2000).

Conclusion: In conclusion, the evaluation of diversity and abundance of Diptera, Hemiptera and Lepidoptera in selected areas in Oye- Ekiti reveals significant impacts into how environmental factors and human activities influence human activities. This study contributes valuable data to our understanding of insect ecology and highlights the need for continued monitoring and conservation efforts to preserve biodiversity in varying habitat types. By comparing insect communities, we can understand the factors that influence species richness, abundance and ecological interaction. Oye-Egbo showed the highest diversity and richness indicating a more balanced and diverse insect community than Afuremo and Faalex. Future research could focus on more detailed investigations into how specific environmental factors and human activities interact to shape insect communities, as well as exploring the ecological roles of these insect species within their respective habitats.

Declaration of Conflict of Interest: The authors declare no conflict of interest

Data Availability Statement: Data are available upon request from the corresponding author

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