https://dx.doi.org/10.4314/dujopas.v10i3c.24
ISSN (Print): 2476-8316
ISSN (Online): 2635-3490
Dutse Journal of Pure and Applied Sciences (DUJOPAS), *Vol. 10 No. 3c September 2024*

Evaluation of the Diversity and Abundance of Selected Insect Orders (Orthoptera, Hymenoptera and Coleoptera) in a Wetland in Federal University Oye-Ekiti, Nigeria

Akinmuleya C.B[1], Oluwabiyi O. O.[1], Ayindero,A.B[1], Ayodele , O.[2]

[1]Soil Ecology and Entomology Unit,
Department of Animal and Environmental Biology,
Federal University Oye- Ekiti.

[2]Laboratory of Animal and Environmental Biology,
Federal University Oye- Ekiti.

Email: catherine.afolayan@fuoye.edu.ng

Abstract

This study assessed the diversity and abundance of selected insect orders (Orthoptera, Hymenoptera and Coleoptera) in a wetland at Federal University Oye-Ekiti. Insects were collected from February to April, 2022 using a combination of pitfall traps, sweep nets and active hunting methods. Arthropods were identified up to the generic level and counted monthly. A total of 3654 individuals belonging to 3 orders, 21 families and 54 species were recorded from the studied habitat. The highest relative abundance of 19.37603% was found in Odontomachus monticola (Hymenoptera: Formicidae). In this study, Hymenoptera was the most dominant order while Orthoptera was the least dominant order. The active hunting method collected the highest number of insects while the sweep net method collected the lowest number of insects. Results of the percentage distribution of insect species and individual insects revealed that for both active hunting and pitfall trap methods, the Order Hymenoptera had the highest percentage distribution while the Order Coleoptera had the lowest percentage distribution. Results of the diversity index across the collection methods revealed that the Sweep net method had the highest insect diversity and evenness (H'=2.492, 0.4317) while the Pitfall method had the lowest insect diversity and evenness (H'=1.818, 0.126). Results of one- way ANOVA showed no significant difference in species composition across habitats at a 5% probability level. This study has shown that the etlandd at Federal University Oye- Ekiti is rich in insect species with the Order Hymenoptera being the most abundant.

Keywords: diversity, abundance, relative abundance, percentage distribution, evenness

INTRODUCTION

Orthoptera are hemimetabolous insects, with nymphs resembling adult forms in their general appearance but lacking fully developed wings and reproductive organs. They are insects typically recognized by their enlarged hind legs. They are often seen jumping away when disturbed or heard singing at night (Capinera *et al.*,2004). Orthopterans are extremely diverse in their food preference and feeding (Ringcards, 2009). Most Orthopteran species are phytophagous, feeding on the foliage of higher plants. A number of them feed on roots and others on fungi. Many species are predaceous, while others are omnivorous.

Author for Correspondence

Hymenoptera contains some of the most economically important insects. The mouthparts of Hymenoptera are adapted primarily for biting and often for sucking. There are two pairs of membranous wings joined by hooks on the anterior border of the hind wing joined with a groove on the posterior border of the forewing. The hind wings are smaller. Hymenoptera are remarkable for their great specialization of structure, for their varying degrees of social organization and for the highly developed condition that parasitism has reached. (Libersalt, 2018). The highly complex social organization in the bees, ants and wasps, in which caste development is of prime importance, is foreshadowed in the interesting behavior of solitary wasps and bees.

Coleoptera is the largest order of insects, representing about 40 percent of all known insect species. Globally, it is the largest order among insects in terms of described species diversity (Foottit and Adler, 2009). Most of the individuals belonging to this order (Coleoptera) have strongly sclerotized bodies and are characterized by the fore (mesothoracic) wings which are hardened to form rigid elytra which meet along the middle line. (Arakane, 2012).

Studies of beetle communities in restricted areas such as oceanic islands (Peck 2005), large administrative units (Sikes 2004, Carlton and Bayless 2007), or specific habitat types (Anderson and Ashe 2000) can provide important data on biodiversity at finer scales. Comprehensive species lists from well-defined areas or habitat types are useful not only because they give insights about current ecosystem health and function, but also because they can be compared to lists generated at other periods to monitor changes over time (Howden and Howden 2001). Analysis of changes in species composition allows us to better understand human effects on ecosystems and provides evidence to guide land use and conservation decisions.

The main goal of this study is to investigate the diversity and abundance of Orthoptera, Hymenoptera and Coleoptera in a wetland at Federal University Oye- Ekiti as well as to examine variation in species composition of Orthoptera, Hymenoptera and Coleoptera in the study site. This study provides the first documented evidence of diversity and abundance of orders Orthoptera, Hymenoptera and Coleoptera in a wetland at Federal University Oye-Ekiti, hence it will provide a valid species list of the selected insect orders in the wetland of Federal University Oye- Ekiti as well as provide baseline information for future researchers.

MATERIALS AND METHODS

Description of the study site

The study site is a wetland situated close to the University Library in phase three, Federal University Oye-Ekiti. The wetland is located on coordinates latitude N 07. 77836^{o} and longitude E 005. 31250^{o} (Figure 1). The area has a bimodal rainfall pattern with an average of 1514mm.The type of soil in the study site is loamy soil. The site is surrounded by two rivers on both sides. The area is humid and the prominent trees in the study sites include palm trees and Raffia. The prominent grasses in the study site included Elephant grass (*Cynodon spp*) and *Tridax procumbens*. The palm trees formed a plantation which provided shadow and a favorable climate for the arthropods. Epiphytes were seen on the palm trees and the presence of hydrophytes growing on the water body are a notable feature of the physiognomy of the wetland.

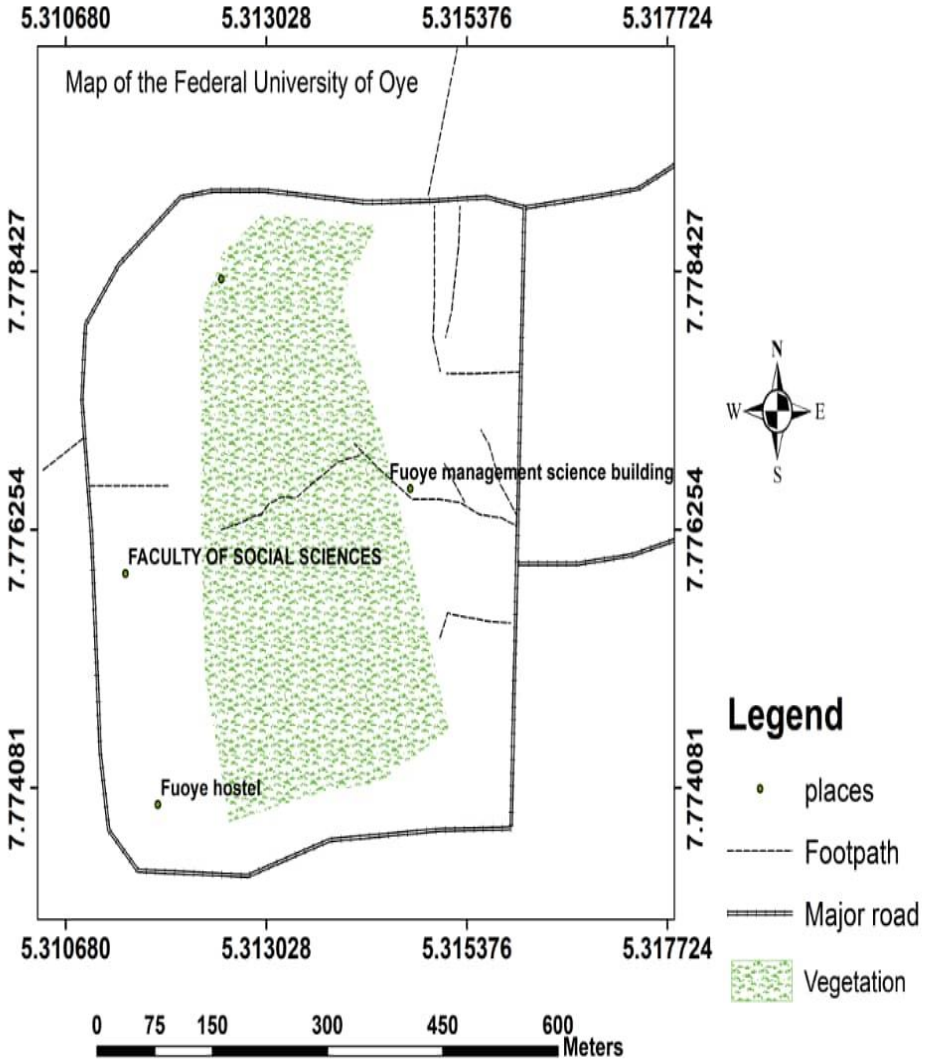

Figure 1: Map of the study Area

Sampling and Trapping Techniques

Sampling was done twice a week using a combination of pitfall traps, sweep nets and active hunting. All categories of traps or methods ran concurrently for three months.

Pitfall traps

Sampling was done twice a week for three months. Sampling started in February and ended in April 2022.The area of the study site was 25m^2 and a random sampling method was employed. Ten pitfall traps were set at the experimental site. The traps were set in such a way that their rims were at the same level as the soil level. Each trap was filled to a depth of 3cm with 70% ethanol solution and left in place for forty - eight hours so as to monitor the number of species of Orthoptera, Hymenoptera and Coleoptera in the area.

Sweep Net

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

Active Hunting

Active Hunting was used to sample insects that are usually found in clusters on the soil surface, foliage or around decaying logs. Here, the insects were manually handpicked from the soil, foliage and around decaying logs. All categories of traps or methods ran concurrently for a period of three months.

Sorting, Counting and Identification

Arthropods collected from the sweep net and active hunting were transported to the Animal and Environmental Biology Laboratory, Federal University Oye- Ekiti. Thereafter, Insects were sorted from the other arthropods using a spatula and a magnifying lens and those belonging to the orders Orthoptera, Hymenoptera and Coleoptera were counted and preserved in 70% ethanol. Similarly, in the laboratory, the content of each pitfall trap was poured into a Petridish for identification, counting and sorting of Orthoptera, Hymenoptera and Coleoptera from other trapped arthropods using a dissecting microscope. Further identification was done to the species level using a combination of standard keys and description (Orkin, 2001, Nolan, 2024).

RESULT AND DISCUSSION

Diversity and Abundance of insects in the Study Site

Table 1 shows the diversity and abundance of insect species identified in the Wetland. A total number of 3,654 individual insects were collected during the study period belonging to 3 orders, 21 families and 54 species (Table 1). *Formica rufa* (Hymenoptera: Formicidae) had the highest abundance of 610 individuals. This was followed by *Camponotus atriceps* (Hymenoptera: Formicidae) with an abundance of 462 individuals (Table 1). Across the sampling months, the active hunting method collected the highest number of insects with a total of 1851 individuals. This was followed by the Pitfall trap which collected a total of 1709 individuals whereas the sweep net collected the least number of insects with 94 insects (Table 1).

Table 1: Diversity and Abundance of Hymenoptera, Orthoptera and Coleoptera obtained from Wetland in Federal University Oye-Ekiti, Nigeria.

S/N	ORDER	FAMILY	SCIENTIFIC NAME	METHHOD OF COLLECTION								
				FEB 2022			MAR 2022			APR 2022		
				SN	PF	AH	SN	PF	AH	SN	PF	AH
1	Hymenoptera	Apidae	*Apis mellifera*	0	0	0	1	0	0	2	0	0
			Xylocopa sonorina	1	0	0	1	0	0	0	0	0
			Xylocopa violacea	0	0	0	1	0	0	0	0	0
		Bethylidae	*Sierola gilbertae*	0	1	0	0	0	0	0	0	0
		Formicidae	*Brachymrymex aphidicola*	0	0	0	0	0	8	0	0	2
				0	51	0	0	0	1	305	0	0
			Camponotus atriceps	0	462	0	0	0	0	0	0	16
				0	2	0	0	0	58	0	0	0
			Camponotus pennsylavanicus	0	1	168	0	1	0	0	1	0
				0	0	0	0	165	198	0	1	0
			Camponotus japonicas	0	0	0	0	0	0	0	1	42
				0	0	0	0	1	0	0	0	0
			Camponotus vagus	0	610	92	1	2	0	0	0	3
			Dorymrymex bicolor	0	0	0	0	0	203	0	0	6
				0	0	235	0	185	372	0	2	12
			Formica rufa	0	0	0	0	0	2	0	0	0
			Harpegnathos venator	0	0	0	0	0	66	0	125	0
				0	0	0	0	1	0	0	35	0
			Odontomachus monticola	0	0	0	0	0	0	0	1	2
		Ichneumonidae		0	0	0	0	0	1	0	0	1
		Vespidae	*Pheidole pallidula*	0	0	0	1	1	1	0	0	1
			Soleonopsis invicta	0	0	0	0	1	0	0	0	0
		Braconidae	*Trachymerymex septentrionalis*	0	0	0	0	0	1	0	1	0
				0	0	0	0	1	0	1	0	0
		Sphecidae	*Camponotus fellah*	0	1	0	0	0	0	0	0	0
			Lasius niger	0	1	0	0	0	0	0	2	0
		Evaniidae	*Lissopimpla exclesa*	0	0	0	0	1	0	0	1	0
			Polistes canadensis	0	0	0	0	0	0	0	1	0
		Megachilidae	*Synoeca septentrionalis*									
			Bracon brevicornis									
			Atanycolus sp									
			Sceliphron curvatum									
			Ammophila procera									
			Eremnophila aurenotata									
			Evania appendigaster									
			Anthidium manicatum									
2.	Orthoptera	Prgomorphidae	*Zonocerus variegates*	0	5	1	1	0	5	0	0	0
				0	1	2	3	3	1	0	0	0
		Acrididae	*Sphenarium purpurascens*	1	0	2	15	2	5	0	0	9
				0	0	0	1	0	0	0	0	0
			Prygomorpha conica	8	1	1	5	4	1	26	3	0
				0	8	3	2	0	9	0	0	0
			Calliptamus italicus	1	0	1	2	1	0	0	0	0
			Cantatops humeralis	0	0	0	1	0	0	0	0	0
				0	0	1	4	3	1	0	0	0
			Chorthippus brunneus	0	0	0	6	1	0	0	0	0
		Gryllidae		0	1	0	1	2	1	0	0	0
		Trigonidiidae	*Gomphocerripus rufus*	0	0	0	1	0	0	0	0	0
				0	0	0	0	0	1	0	0	0
			Leptysma marginicollis									

			Schistocerca Americana *Melanoplus differentialis* *Xenogryllus mamoratus* *Teleogryllus commodus* *Anaxipha Saussure*									
3.	Coleoptera	Cerambycidae Chrysomelidae Coccindelidae Nitidulidae Lycidae Buprestidae Geotrupidae Carbidae	*Dendrobias mandibularis* *Knulliana cincta* *Charidotella bicolor* *Charidotella sexpunctata* *Chrysolina fastuosa* *Epilachna varivestis* *Calviaquatuor decimguttata* *Conninella magnifica* *Aethina tumida* *Calopteron reticulatum* *Buprestis octoguttatus* *Geotrupes egeriei* *Brachinus sclopeta*	0 0 0 0 0 0 0 0 0 0 0 0 0	0 1 0 0 0 0 1 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 4 0 0 0 0 0 0 0 0 0 0	1 1 0 1 0 1 2 0 2 0 0 0 6	0 1 1 1 0 1 2 0 3 1 0 0 0	0 0 0 0 0 0 0 1 0 0 1 1 0	0 0 0 0 2 1 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0
	Total			11	1147	506	51	388	1248	32	174	97

Relative Abundance of the insect species identified across the methods

Table 2 shows the relative abundance of species identified across the methods. The highest relative abundance was found in *Odontomachus monticola (*19.37603%). Thirteen (13) families had the lowest relative abundance of 0.027367%. The families include: *Xylocopa violacea, Sierola gilbertae, Harpegnathos venator, Bracon brevicornis, Ammophila procera, Anthidium manicatum, Prygomorpha conica, Gomphocerippus rufus, Xenogryllus mamoratus, Teleogryllus commodus, Anaxipha saussure, Calopteron reticulatum and Buprestis octoguttata respectively* (Table 2).

Table 2: Relative abundance of the species identified across the methods

S/N	ORDER	Scientific Name	RA		Scientific Name	RA		Scientific Name	RA
1.	Hymenoptera	*Apis mellifera*	0.082102	Orthoptera	*Zonocerus variegates*	0.328407	Coleoptera	*Dendrobias mandibularis*	0.054735
		Xylocopa sonorina	0.054735		*Sphenarium purpurascens*	0.930487		*Knulliana cincta*	0.164204
		Xylocopa violacea	0.027367		*Pryogomorpha conica*	0.027367		*Charidotella bicolor*	0.027367
		Sierola gilbertae	0.027367		*Calliptamus italicus*	1.304996		*Charidotella sexpunctata*	0.054735
		Brachymyrmex aphidicola	0.273673		*Catantops humeralis*	0.602080		*Chrysolina fastuosa*	0.109469
		Camponotus atriceps	9.77015		*Chorthippus brunneus*	0.136836		*Epilachna varivestis*	0.054735
		Camponotus pensylvanicus	13.08155		*Gomphocerippus rufus*	0.027367		*Calviaquatuor decimguttata*	0.109469
		Camponotus japonicus	1.642036		*Lepystma marginicollis*	0.246305		*Conninella magnifa*	0.082102
		Camponotus vagus	4.679803		*Schistocerca Americana*	0.191571		*Aethina tumida*	0
		Dorymyrmex bicolor	9.961686		*Melanoplus differentialis*	0.136836		*Calopteron reticulatum*	0.027367

		Formica rufa	1.176793		*Xenogryllus mamoratus*	0.027367		*Buprestis octoguttata*	0.027367
		Harpegnathos venator	0.027367		*Teleogryllus commodus*	0.027367		*Geotrupes egeriei*	0.164204
		Odontomachus monticola	19.37603		*Anaxipha Saussure*	0.027367		*Brachimus sclopeta*	0.273673
		Pheiodole pallidula	5.719759		*Zonocerus variegates*	0.328407			
		Solenpsis invicta	22.05802						
		Trachymyrmex septentrionalis	0.054735						
		Camponotus fellah	5.227148						
		Lasius niger	0.985222						
		Lissopimpla exclesa	0.082102						
		Polistes canadensis	0.054735						
		Synoeca septentrionalis	0.109469						
		Bracon brevicornis	0.027367						
		Atanycolus sp.	0.054735						
		Sceliphron curvatum	0.054735						
		Ammophila procera	0.027367						
		Eremnophila aureonotata	0.082102						
		Evania appendigaster	0.054735						
		Anthidium manicatum	0.027367						

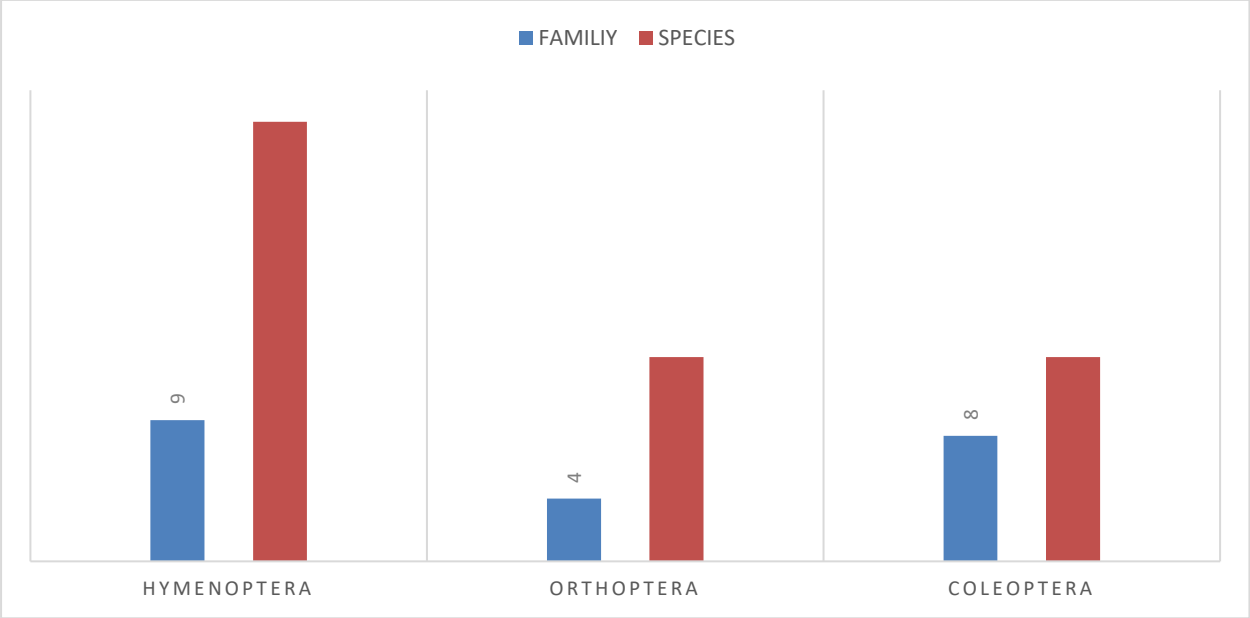

Figure 2: Family and insect species abundance based on the insect order.

Figure 2 shows the Family and insect species abundance based on the insect order. It revealed that according to the total number of species, the dominant order was Hymenoptera with 9 families and 28 species, followed by Coleoptera with 8 families and 13 species, and the least was Orthoptera with 4 families and 13 species (Figure 2).

Percentage distribution of individual insects (Frequency) and the species based on Order for the three methods of collection.

Table 3 revealed the Percentage distribution of individual insects and insect species in the wetland based on the order for the three methods of collection. For the insect species, in the pitfall method and active hunting methods respectively, out of the 50 and 47 species collected,

the order Hymenoptera had the highest percentage distribution of 60% and 48.94% respectively. The order Coleoptera had the lowest percentage distribution of 14% and 17.02% respectively (Table 3). However, for the sweep net method, out of the 28 species collected, the order Orthoptera had the highest percentage distribution (57.14%) and the order Coleoptera had the lowest percentage distribution (14.29%).

However, for the individual insect species, out of the 94 individual insects obtained by sweep net, Order Orthoptera had the highest percentage distribution of 82.98% while the lowest was Order Coleoptera with 7.45% (Table 3). In the pitfall method, out of the 1709 individual insects obtained, Order Hymenoptera had the highest percentage distribution of 97.13% while the lowest was Order Coleoptera with 0.82%. For the Active Hunting method, out of the 1851 individual insects obtained, Order Hymenoptera had the highest percentage distribution of 96.97% while the lowest was Order Coleoptera with 0.65% (Table 3).

Table 3: Percentage distribution of individual insects (Frequency) and the species based on Order for the three methods of collections.

S/N	Order		Species		Individual	
Methods	**SN**	**PF**	**AH**	**SN**	**PF**	**AH**
Hymenoptera	8(28.57)	30(60)	23(48.94)	9(9.60)	1660(97.13)	1795(96.97)
Orthoptera	16(57.14)	13(26)	16(34.04)	78(82.98)	35(2.04)	44(2.38)
Coleoptera	4(14.29)	7(14)	8(17.02)	7(7.45)	14(0.82)	12(0.6
Total	28(100)	50 (100)	47(100)	94(100)	1709(100)	1851(100)

Note: SN- Sweep net, PF- Pitfall, AH- Active Hunting

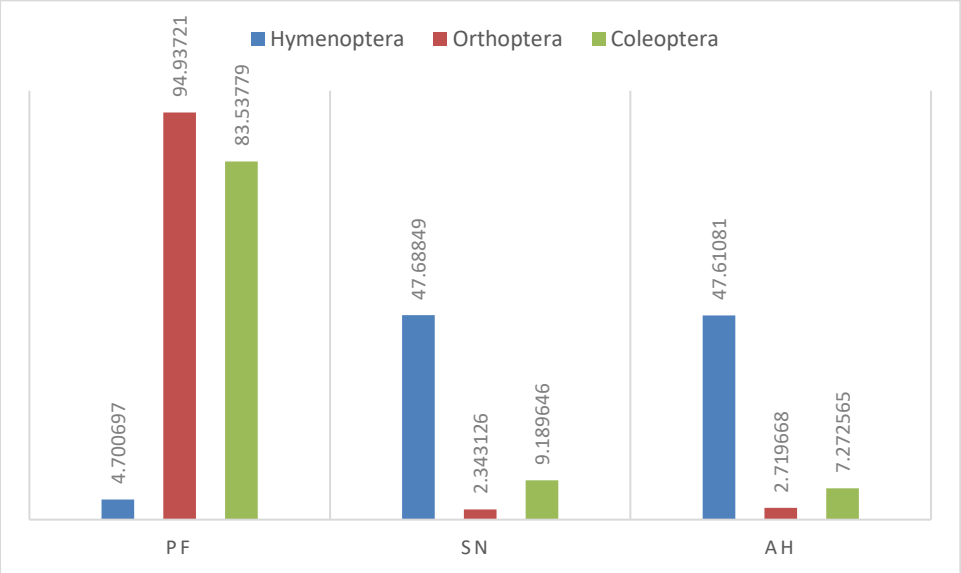

Figure 3: The abundance of the insect order across the three methods

Figure 3 revealed the abundance of the insect order across the three methods**.** The abundance of the insect order across the three methods shows that for the pitfall method, the order Orthoptera had the highest abundance of 94.93721 while the order Hymenoptera had the least abundance of 4.700679 (Figure 3). For the Sweep net and active hunting methods respectively, the order Hymenoptera had the highest abundance of 47.68849 and 47.61081 while Orthoptera had the least abundance of 2.343126 and 2.719668 respectively (Figure 3).

The Diversity indices of insects collected in the study site across the three methods are presented in Table 4. Sweep net had the highest insect diversity (H' = 2.492) and the least was

observed in pitfall (H' =1.818) (Table 4). The highest species evenness was observed in the Sweep net (0.4317), and the least was observed in the pitfall trap (0.126). However, pitfall trap had the highest dominance (D=0-2278) and species richness (6.583) (Table 4).

Table 4: Diversity indices of insects collected in the study site across the three methods

Variables	Methods		
	SN	PF	AH
Number of species	28	50	47
Individuals	94	1709	1851
Shannon_H	2.492	1.818	2.391
Dominance_D	0.1146	0.2278	0.1204
Species eveness	0.4317	0.1264	0.2324
Margalef index	5.943	6.583	6.114

The result of one-way ANOVA launched from SPSS revealed in Table 5 that there was no significant difference in species composition or richness across the orders at probability level of 5%.

Table 5: One-way ANOVA for the differences in species composition across the habitats

Variables	SumofSqrs	df	Mean Square	F	p(same)
Betweengroups:	11760.2 2	5880.08	2.724 0.06661		
Withingroups:	1.04254E06	483	2158.47	Permutation p(n=99999)	
Total:	1.0543E06	485			0.05353

Note: No significant difference at probability level of 5%

DISCUSSION

This study evaluated the diversity and abundance of Orthoptera, Hymenoptera and Coleoptera in a wetland at Federal University Oye- Ekiti. Results indicate that diversity and abundance were highest in the Order Hymenoptera followed by the Order Orthoptera and it was lowest in Order Coleoptera. This is in consonance with the report of Akinmuleya and Oso, 2022 and Nandini and Murali (2012) who obtained similar results as well as the findings of Forbes *et al*., 2018 who found Hymenoptera to be the most dominant order. It is however contrary to the work of Yager *et al.* (2017) who reported Hemiptera in their study of insect abundance at the Federal University of Makurdi, Benue State. It also negates the study of Aina-Oduntan *et al.,* (2021) who found Lepidoptera to be the most dominating order in their research on Spatial Distribution of Insect Diversity in Selected Locations within the Forestry Research Institute of Nigeria, Ibadan, Nigeria. The highest number of Hymenopteran species obtained in this study may probably be a result of the fact that Hymenoptera have diversified into a variety of morphological forms and ways of life (Austin and Dowton 2000). Several studies have shown that they may be the most abundant order of insects as they rank second or third after the Coleoptera and Lepidoptera (Stork 1997). Hymenoptera have biting mouthparts that they use for feeding, capturing prey, building nests, or, when necessary, defense (Krenn, 2019) and their ecological importance in honey production (Chamberlain and Schlising, 2008) and pollination (Ahmad *et al.,* 2023) makes them a commercially important group. Furthermore, many hymenopterans have been successfully used in biological control programmes (Morales- Ramos *et al.,* 2023). Similarly, the high abundance of Hymenoptera, mostly members of the family Formicidae is similar to the work of Frouz and Ali (2004). It could probably be linked to their burrowing habits, foraging and feeding habits (Hickman *et al.,* 2001). *Solenopsis invicta,* the most abundant species recorded in this study is an omnivore that exhibits aggressive behavior, its high abundance in this study is hardly surprising as it is polymorphic (Araujo and Tschinkel 2010).

Orthoptera, the second most abundant group recorded in the present study are a highly abundant group of insects (Lopin and Karr, 2005) suitable for use as indicators in open habitats (Adu- Acheampong *et al.,* 2016). Grasshoppers play a role in the herbivory process in the ecosystem and are known to be a good source of protein for other animals such as small reptiles, birds and other mammals. Factors, such as host plant availability and nutritional value, have also been reported to affect grasshopper abundance and distribution Gebeyehu and Samways 2006). Studies have shown that scarcity of Orthopterans may hinder the trophic structure in an ecosystem (Solioman *et al.,* 2014). Despite the fact that Coloptera has been found to be the largest order of insects, the present study have shown that the order Coleoptera had the least insect abundance, perhaps the condition of the wetland environment at the time of the research was not too favourable for the insects, hence the least abundance. The lower species richness of Coleoptera may also probably be as a result of the fact that although more species of beetles (> 350,000) have been described than any other order of animal or insect (Bouchard *et al.,* 2009), this does not reflect their actual diversity relative to other insects. Historical biases in beetle collecting and an associated accumulation of taxonomic resources for the Coleoptera may have had an outsized influence on our perception of diversity. Out of the three methods used, the order Hymenoptera had the highest abundance in two (pitfall trap and active hunting methods). This lends credence to the fact that hymenoptera are an extremely species- rich group of insects (Forbes *et al.,* 2018; Huber, 2017) that are largely represented in biodiversity assessments because of their ability to colonize a variety of habitats. In this study eleven phytophagous families, nine predaceous families and one detritivorous family were identified.

Wetlands are considered among the most biologically diverse of all ecosystems, serving as home to a wide range of plant and animal species (Semwal, 2021). Being rich reservoirs of biodiversity, they provide various ecosystem services (Cherry, 2011), hence the study site is suitable. Furthermore, the diversity indices of insects in the study site show that the highest insect diversity and species evenness were observed in the sweep net method. This indicates that the wetland environment harbored many different types of organisms and species which explains the relevance and ability of the sweep net to collect relatively dispersed insect species on top of the vegetation, however this method is biased towards flying insects. Hence, the high insect diversity in the study site. The species evenness also indicated that all insects observed in the sweep net method have similar distribution (Roberts, 2019) which gives an indication of the stability of an ecosystem. The result of one-way ANOVA revealed that there was no significant difference in species composition or richness across the three orders at a probability level of 5%. High p-values may indicate that the evidence provided is not strong enough to suggest an effect exists in the population. An effect might exist but it's possible that the effect size is too small, the sample size is too small, or there is too much variability for the hypothesis test to detect such effect. However, this does not mean that the hypothesis will be rejected.

The results suggest that the wetland of Federal University Oye- Ekiti is a biodiversity hub and contains a high diversity of Hymenoptera, Orthoptera and Coleoptera.

CONCLUSION

The study site (Wetland) is relatively high in insect diversity and abundance. This provides baseline information on the insect species for documentation and for more research purposes. The study area is surrounded by vegetation where all these insects were located and which also served as their habitats. Therefore, according to the results obtained in this research, the Order Hymenoptera was the highest dominant order due to the highest occurrence of the Family Formicidae, followed by Order Orthoptera (Family Acrididae) and the least was

recorded in Order Coleoptera. One of the most prominent abiotic factors that can affect the diversity and abundance of insects is temperature. Thus, it is essential to know the optimal time of day during which sampling of target species should be done to allow accurate arthropod biodiversity studies.

REFERENCES

Adu-Acheampong, S., Bazelet, C.S., and Samways, M.J. (2016). Extent to which an agricultural mosaic supports endemic species-rich grasshopper assemblages in the Cape Floristic Region biodiversity hotspot. *Agric Ecosyst Environ.* 227:52–60. https://doi.org/10.1016/j.agee.2016.04.019.

Aina-Oduntan, O.A., Onilude, Q.A., George-Onaho, J.A., Woghiren, A.I. and Jeminiwa, O.R. (2021). Spatial distribution of insect diversity in selected locations within Forestry Research Institute of Nigeria, Ibadan, Nigeria. *Journal of Applied Science and Environmental Management.* Vol. 25(7). Pp. 1249-1255.

Ahmad, F., Mohd, J., Gaurav, K, Shafkat, M (2023). "Importance of Hymenopteran Insects in Pollination". In: Advances in Agricultural Entomology Volume 22 (pp.140) AkiNik Publications. DOI: 10.22271/ed.book.2051. ISBN: 978-93-5570-572-3.

Akinmuleya, C.B and Oso, A.F. (2022). Diversity and Abundance of Insects in Farmland, Forest and Wetland Habitats of the Federal University, Oye-Ekiti Nigeria. *FUOYE Journal of Pure and Applied Sciences.* Vol 7(2). ISSN: 2616-1419. DOI: 10.55518/fjpas.POAM5571.Pp73-83.

Anderson, R. S. and J. S. Ashe. (2000). Leaf litter inhabiting beetles as surrogates for establishing priorities for conservation of selected tropical montane cloud forests in Honduras, Central America (Coleoptera; Staphylinidae, Curculionidae). *Biodiversity and Conservation*. 9: 617–653.

Arakane, Y., Lomakin, J., Gehrke, S.H., Hiromasa, Y., Tomich, J.M. *et al.,* (2012).Formation of rigid, non-flight forewings (elytra) of a beetle requires two major cuticular proteins. *PLoS Genet.* 8(4):e1002682. doi: 10.1371/journal.pgen.1002682.

Austin, D., and Dowton, M (2000). '*Hymenoptera: Evolution, Biodiversity and Biological Control'.* CSIRO Publishing. Doi: 10.1071/97080643090088, ISBN (Electronic):978-0-643-09910-4.

Araujo, M.B., and Tschinkel, W.R. (2010). Worker allometry in relation to colony size and social form in the fire ant *Solenopsis invicta. J Insect Sci* **10:**94. doi:10.1673/031.010.9401.

Bouchard, P., Grebennikov, V.V., Smith, A.B.T, and Douglas, H. (2009). Biodiversity of Coleoptera. In: Foottit RG, Adler PH, editors. "*Insect biodiversity: science and society*". Oxford: Wiley-Blackwell; p. 265–301.

Capinera, J. L., Scott, R.D., and T. J. Walker (2004). Field guide to grasshoppers, katydids, and crickets of the United States. Cornell University Press, Ithaca, NY. 249 pp.

Carlton, C. E. and V. M. Bayless. (2007). Documenting beetle (Arthropoda: Insecta: Coleoptera) diversity in Great Smoky Mountains National Park; beyond the halfway point. *Southeastern Naturalist* 6 (Special Issue 1): 183–192.

Chamberlain, S.A and Schlising R.A (2008). Role of honey bees (Hymenoptera: Apidae) in the pollination biology of a California native plant, *Triteleia laxa* (Asparagales: Themidaceae). *Environ Entomol*. 37(3):808-16. doi: 10.1603/0046-225x(2008)37[808:rohbha]2.0.co;2. PMID: 18559188.

Cherry, J. A. (2011). Ecology of Wetland Ecosystems: Water, Substrate, and Life. *Nature Education Knowledge* 3(10):16.

Foottit, R.G. and Adler, P.H. (2009).Insect Biodiversity: Science and Society. JohnWiley and Sons. ISBN 9781444308228. https://books.google.com.ng/books?id=vFSGcTbASg4C. pp 656.

Forbes, A.A., Bagley, R.K., Beer, M.A., Hipee, A.C and Widmayer, H,A (2018). Quantifying the unquantifiable: why Hymenoptera, not Coleoptera, is the most speciose animal order. *BMC Ecol* **18**, 21. https://doi.org/10.1186/s12898-018-0176-x.

Frouz, Jan and Ali, A.. (2004). Soil macroinvertebrates along a successional gradient in central Florida. *Florida Entomologist*. 87. 386-390.

Gebeyehu, Solomon and Samways, Michael. (2006). Topographic Heterogeneity Plays a Crucial Role for Grasshopper Diversity in a Southern African Megabiodiversity Hotspot. *Biodiversity and Conservation*. 15. 231-244. 10.1007/s10531-004-7065-7.

Huber, J.T. (2017). Biodiversity of Hymenoptera. In Insect Biodiversity: Science and Scociety (wilwy- Blackwell, Oxford).

Krenn, H. 2019 Insect Mouthparts Form, Function, Development and Performance: Form, Function, Development and Performance**.** DOI:10.1007/978-3-030-29654-4 ISBN: 978-3-030-29653-7.

Lopin, B and Karr, T.L (2005). Reproduction and Development. In Comprehensive Molecular Insect Science. Vol. 1:213-236. https://doi.org/10-1016/BO-44-451924-6/00001-6.

Morales- Ramos J.A., Goolsby, J.A., Geden, C., Rojas, G.M, García-Cancino, M.D., *et al.,* (2023). Production of hymenopteran parasitoids. In: Mass Production of Beneficial Organisms (pp.101-155). DOI:10.1016/B978-0-12-822106-8.00016-6.

Nandini, V.B. and Murali, J. (2012). A preliminary study on abundance and diversity of insect fauna in Gulbarga District, Karnataka, India. *International Journal of Science and Research*, 3(12), 64-70.

Nolan, J. (2024). Types of Black bugs (with pictures) and identification guide. *Leafy place*. https://leafyplace.com.

Orkin, (2001).The Insect Identification guide. Orkin Insect Zoo. http://www.orkin.com.pp1-24.

Peck, S. B. (2005). A checklist of the beetles of Cuba with data on distributions and bionomics (Insecta: Coleoptera). Arthropods of Florida and Neighboring Areas 18: 1–241.

Roberts, F.S. (2019). Measurement of Biodiversity: Richness and Evenness. In: Kaper, H., Roberts, F. (eds) Mathematics of Planet Earth. *Mathematics of Planet Earth,* vol 5. Springer, Cham. https://doi.org/10.1007/978-3-030-22044-0_8.

Semwal, A., Tewari, H., Trakroo, M.D., Mishra, A. and Pathak. Y. (2021) Wetland Conservation and Management. *Agri-India Today.* Article ID : 01/IV/06/0421. Vol. 1:4. Pp 24-28.

Sikes, D. S. (2004). The beetle fauna of Rhode Island. An annotated checklist. The Biota of Rhode Island. Volume 3. Rhode Island Natural History Survey, Kingston, Rhode Island. vi + 295 pp.

Stork N. E., Adis, J., and Didham, R. K.(1997). Canopy Arthropods. London, Chapman & Hall, 584 pp.

Yager, G.O., Agbidye, F.S. and Adma, E.S. (2017). Insect species diversity and abundance in and around Federal University of Agriculture, Makurdi Forestry Nursery, Benue State, Nigeria. *Asian Journal of Biology*. Vol. 4(4). Pp. 1-11.