



## Diversity of Wasp (Hymenoptera) in Obafemi Awolowo University, Ile-Ife, Osun State, Nigeria

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### Abstract

The inventory of wasp species and distribution within Obafemi Awolowo University (O. A. U.), Ile-Ife campus was investigated with the view of updating the checklist of the insect species found in the habitats. The research was carried out between the month of May 2021 and April 2022. Wasp's species were collected from six selected habitats on the campus using active/direct method of collection which involves the use of sweep net and indirect/passive method of setting of traps with baits. The collected wasp specimens were pinned, dried in an automated oven at the Museum of Natural History, O. A. U., Ile-Ife then stored in insect boxes containing naphthalene flakes (camphor). Identification was made using identification keys for Afrotropical Hymenoptera. Data collected were analyzed using descriptive (tables) and inferential statistics. Paleontological Statistics (PAST) (version 16) was used for analysis of wasps Diversity Indices with level of significant ( $p=0.05$ ). Twenty eight species of wasps were collected which belongs to six Families from the selected habitats, comprising of Families Crabronidae, Evaniidae, Ichneumonidae, Pompilidae, Sphecidae, Vespidae. Opa Reservoir habitats have the most diverse of the species with eleven (11) species (Shannon index of 1.464) while the hills have the least (1) (Shannon index of 0). The Family Vespidae has the highest numbers of genera (13) while the genus *Belonogaster* has the highest numbers of species (3). There are many more wasp species yet to be discovered in Nigeria as some wasp species are predatory in nature; some are pollinator of flowers, some do lay their eggs in the nest of other wasps, while most of the solitary wasps are parasitic in nature and feed on almost every pest, an attribute qualifying them as good bio-control agents (O'Neill and Kevin. 2001).

**Key words:** Family, description, habitat, species,

### INTRODUCTION

Wasp belongs to the order Hymenoptera, sub-order Apocrita. They are neither bees nor ant and are different from the sawflies (symphyta) as distinguished by a wasp-waist, or petiole, a constriction that lies between the first and second abdominal segments. Only about 20,000 of the 154 000 estimated Hymenoptera species worldwide are known to exist in the Afrotropical region (van Noort, 2022). Hymenoptera numbers have been estimated by Aguiar *et al.* (2013) and Huber (2017). According to a conservative extrapolated estimate, the Afrotropical region alone may contain up to 100,000 species, with the possibility that the number could reach 500,000 (van Noort, 2022). The two most widely

recognized wasps in the world are yellow jackets and hornets, both of which are members of the Vespidae Family. The Vespidae Family of wasps exhibits a gregarious behavior, as they live in cooperative groups consisting of a single female (queen), multiple reproductively active males, and non-breeding individuals who collaborate to maintain, safeguard, and nourish the group. But the majority of wasp species lead independent (solitary) lives. A typical female wasp has an ovipositor for egg laying, some like the Aculeata have their ovipositor modified into an organ of defense and prey capturing through stinging. Some wasp species are predatory in nature; some are pollinator of flowers, some do lay their eggs in the nest of other wasps, the process known as Kleptoparasitism. The presence of the host and the quantity and kind of flowering vegetation that serves as a food source for adult parasitoids affect the diversity

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of hymenopteran parasitoid wasps (Aldinas *et al.*, 2022).

Social wasps (family Vespidae) feed on other insects which cause damages to valuable plants, thereby making them good agents of pest control (De Souza *et al.*, 2012; Brügger *et al.*, 2019). They are used as bio-control agents preying on pest insect like beetles, butterflies, weevils, houseflies and moths. However, some members of this species cause damages to fruits or valuable plants, they likewise cause nuisance to the environment, making it necessary to periodically remove their nests (Brügger *et al.*, 2011; 2017). Environmentalist use social wasps interaction in ecosystem as an assessment of environmental impact and conservation in forest fragments because they do show adaptation to environmental changes (Elpino-Campos *et al.*, 2007). Social wasps use plant materials, mud and their secretions to construct nest; the citing of their nest and the process of formation varies from group of species to the other. Some wasps species such as *Dolichovespula media* and *D. sylvestris* know as Yellow jacket build their nest on the shrubs or tree; *Protopolybia exigua* attaches their nest to the branches of trees or underside of the leaves while others such as *Polistes erythrocephalus* prefers location close to water or aquatic environment (Carlos, *et al.*, 1986). Species of [Agelaia multipicta](#) and [Vespula germanica](#) prefer nesting in crevices in ground and houses. Species such as [Apoica flavissima](#) have their nest arranged in a multiple comb-like form (Sôichi *et al.*, 2009). Species of *Polistes erythrocephalus* react to changes in temperature which affect their breeding durations as it could be elongated than usual (Ross and Kenneth, 1991). Subfamilies Vespinae and Polistinae (family Vespidae) are the only social species of wasp with black colour with yellow stripes or markings (Prezoto *et al.*, 2005; Richter, 2000; Torezan-Silingardi, 2011).

Godfray (1994) and O'Neill (2001) reported that most wasps' species are solitary; female social wasps live independently of the male, after mating, it build its nest solely for its young ones. The nest of the solitary species may be in colony of the same species but independent of each other except error of breeding or foraging in other nest could happen. Division of labour is an exception in solitary wasp's species. High percentages of solitary wasp burrows under the ground (O'Neill and Kevin, 2001) while some

solitary wasps build cells with mud or sands in protected or covered places (Houston and Terry, 2013). Specie of [Potter wasps](#) are another set of solitary wasps which constructs with mud vase-like nests usually with many cells attached to the slender branches of trees or against walls (Grissell, 2007). Another group of solitary wasps are the Kleptoparasites wasp of the family Chrysidae that uses the nests of their host which are of unrelated species as egg laying abode. Their eggs are being laid with that of other unrelated specie or in their nest likewise could be feed on after being stung (O'Neill and Kevin, 2001).

Wasp diversity in Nigeria has not received much attention; the little studies available are on fig wasps (Yadok and Geogina, 2009) and Nigerian solitary wasp (Sceliphron) Ighere *et al.*, (2014). Large number of Wasps species is yet to be discovered in Nigeria, van Noort (2022). Dolphin *et al.* (2001) reported that wasps are in global decline due to environmental changes. This study aimed at creating awareness, appreciation of the diversity and value of wasps at all levels of society which is low and also gives the knowledge of species in the study area.

## MATERIALS AND METHODS

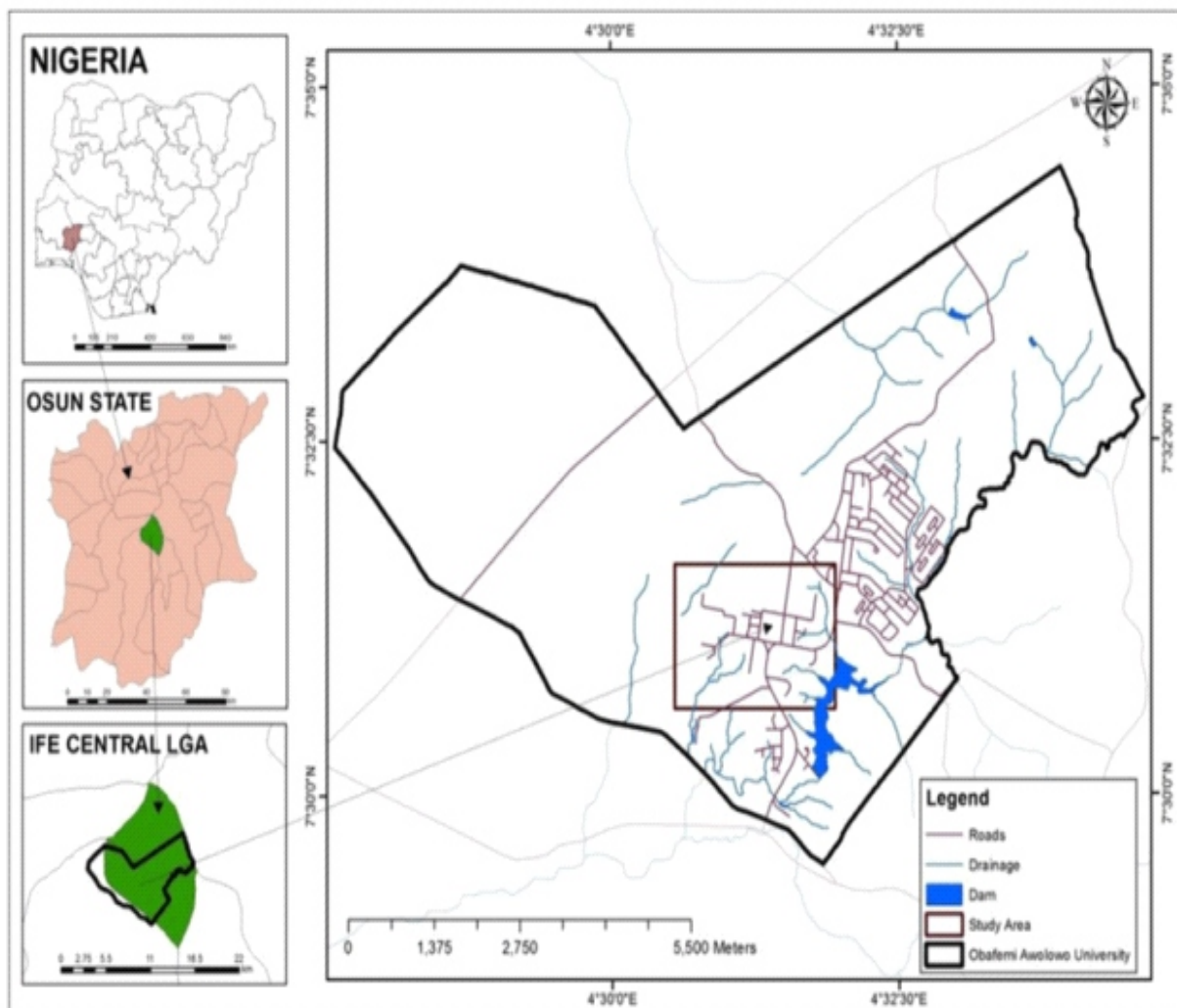
### Experimental Site

The location of this study is between latitudes 7° 30' to 7° 35' North and longitudes 4° 30' to 4° 32' East at Obafemi Awolowo University, Ile-Ife, Nigeria. On the campus, six particular habitats were chosen, and they are as follows: Opa Reservoir, which symbolizes the campus's aquatic environment, is situated between 7° 30' 7" N and 4° 31' 47" E. The Dam was created in 1978 with a length of 2.5 and width of 0.8km respectively. The Reservoir is surrounded with a sparsely uncultivated farmland and trees which serves as a nesting place for insects like wasps. Likewise, it's made up of both open and closed vegetation, different shape of trees with leaves arrangements or pattern and other plant structures that could be selected by some insect species. It was selected in order to determine aquatic species. The biological garden, which is made up of mature woodland and wild plants with relatively tall trees and open understorey, is situated between 7° 31' 27" N and 4° 31' 30" E. It also includes the animal habitation. The botanical section of the garden has various plant species for horticultural use and is located between 7° 31' 22" N and 4° 31' 22" E. This area has a mixture of vegetation, including

ornamental plants close to buildings, secondary forest regrowth, and natural forest. Some areas have natural plantations, while the remaining portion is mostly covered in shrubs and sparse grassland (Amusan, *et al.*, 2014). The location was selected to determine wasp that feed on animals and plants.

Teaching and Research farm was selected to determine wasp species that are related to crops. The location is made up both cultivated farmland and offices with equipment for farming activities which could serves as a nesting sites for various insect especially wasps. It is located at  $7^{\circ} 33' 16''$  N and  $4^{\circ} 33' 22''$  E of the campus comprises of different agricultural sections like the animal section, farm section, nursery section, offices and some abandon structures which could house some of the wasp species. It's made up of open vegetation with a moderate temperature, Parks

and garden was also selected to determine wasp species that are related to ornamental plants especially pollinators of ornamentals. It is located on  $7^{\circ} 31' 22''$  N and  $4^{\circ} 31' 47''$  E and covered in a mixture of grassland, shrubs, and ornamental plants and includes both cultivated and uncultivated areas, with the southern portion of the garden being traversed by a stream. The area is approximately 10 hectares, with an average elevation of 291 meters above sea level and a canopy cover of roughly 60% (Amusan *et al.*, 2014). Residential area was also selected to determine those that co-habits with humans and the hills to determine wasp species in elevated places. Some parts of the hills were cultivated and others were uncultivated with rocks. Hills 1 and 2 has elevation of 350m and hill 3 have elevation of 410m above ground.



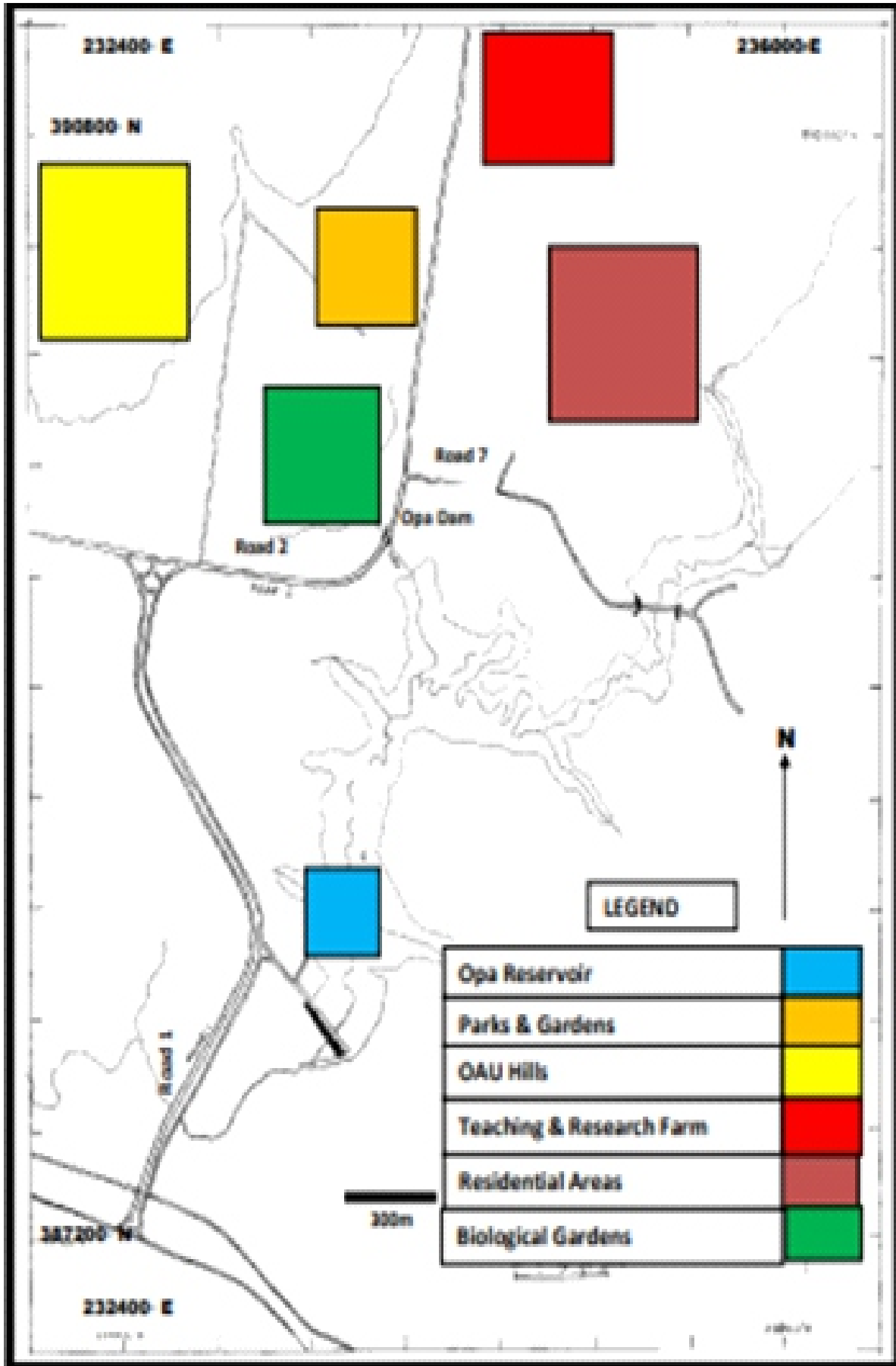


Fig1: Map of Obafemi Awolowo University, Ile-Ife indicating the selected habitats.

### Traps and Trapping

Trapping was done from May 2021-April 2022 using two methods namely; Active method: This method involves active participation of the researchers with the aid of sweep nets and killing jar. Searching actively every trees (leaves and branches), crevices and corners of houses within the selected areas and capturing the wasps with the sweep net, then transferring then into the killing jar. This method is the widely used methods during this research as most wasps' species are encountered flying and having their nest hiding and passive method which make use of traps for insects' collection. Traps like yellow pan traps are set on the ground, filled with water mixed with soap to reduce the surface tension, while bottle traps, container were filled with juice then attached to trees at selected habitat (baits like banana, pineapple and juices (like fruit juice, drinks) of which can attracts the insects of interest and left over a certain period of 24hrs before checking. Malaise trap was also used for the insect collection; it was set in an undisturbed spots within the selected habitat and does not require the active participation of the researcher.

### Wasp's identification

Wasps collected were taking to the museum of natural history for morphological identification using afrotropical Hymenoptera keys (van Noort, 2022)

### Statistical Analysis

Descriptive statistics (tables) and inferential statistics were used to analyze the data. The Diversity indices (Dominance, Shannon's Wiener, and Evenness) of wasps were analyzed using Paleontological Statistics (PAST) version 16. The six locations' diversity indices and abundance were tested for significant differences using a one-way ANOVA.

$$\text{Shannon's Wiener } (H) = -\sum p_i * \ln(p_i)$$

Where:

- $\Sigma$ : sum total of all organisms
- $\ln$ : Natural log
- $p_i$ : total number of species  $i$

The greater the value of H, the more varied the species are within a given community. The diversity decreases with a decreasing value of H. There is only one species present in a community when H=0.

$$\text{Evenness } (E_H) = H / \ln(S)$$

Where:

- $H$ : The Shannon Diversity Index
- $S$ : The total number of individual species

## RESULTS

### Diversity of species

A total of twenty eight species of wasps belonging to six families were recorded in the study area

(Table 1). Opa Reservoir had the highest number of wasps species with 11 species belonging to 4 families out of the six families recorded in the six Habitats. Eight species of wasps were present in Teaching and Research farm indicating that wasps in this Habitats is less diverse when compared with Opa Reservoir in terms of the number of species recorded. Five were recorded in both the Biological garden and Residential areas each when compared with Opa Reservoir. Four wasps species were recorded from the Parks and garden, the lowest was recorded from the Hills with one specie (Table 1)

Table 2 shows the Diversity indices between the various Habitats, indicating that there is no significant differences ( $P < 0.05$ ) in the abundance and distribution of the wasps in Obafemi Awolowo University, Ile-Ife using analysis of variance (ANOVA) which all gives a p-value greater than 0.05.

Table 3 shows the result of paired comparison of the wasps family using non-parametric t-test. There is significant differences ( $P < 0.05$ ) between location F and other locations. The comparisons between other locations were not significantly different.

**Table 1:** Wasps in different habitats at Obafemi Awolowo University, Ile-Ife

FAMILY	SPECIES	HABITATS					
		Opa Reservio ur	Bio. Garde n	Teachi ng and resecar ch farm	Par ks and gar den	Resi denti al area	hill
CRABRONIDAE	<i>Liris subtessellatus</i>	-	-	-	-	X	-
	<i>Trypoxylon chirindense</i>	-	-	X	-	-	-
	Sub Total	0	0	1	0	1	0
EVANIIDAE	<i>Evania appendigaster</i>	X	-	-	-	-	-
	Sub Total	1	0	0	0	0	0
ICHNEUMONIDAE	<i>Charops annulipes</i>	X	-	-	-	-	-
	<i>Enicospilus bicoloratus</i>	X	-	X	-	-	-
	<i>Netelia infractor</i>	X	X	-	-	-	-
	<i>Ophion angularis</i>	-	X	X	-	-	-
	<i>Xanthopimpla punctata</i>	X	-	-	-	-	-
	<i>Xanthopimpla stemmator</i>	-	-	X	-	-	-
	Sub Total	4	2	3	0	0	0
POMPILIDAE	<i>Auplopus carbonarius</i>	X	-	-	-	-	-
	<i>Auplopus mellipes</i>	X	-	-	-	-	-
	<i>Deuteraenia ossarium</i>	X	-	-	-	-	-
	<i>Hemipepsis ochropus</i>	X	-	X	-	-	-
	Sub Total	4	0	1	0	0	0
SPHECIDAE	<i>Sceliphron spirifex</i>	-	-	-	X	X	-
	<i>sphex lucae</i>	-	-	X	X	-	-
	Sub Total	0	0	1	2	1	0
VESPIDAE	<i>Afreumenes aethiopicus</i>	-	X	-	-	-	-
	<i>Afreumenes violaceus</i>	-	X	-	-	-	-
	<i>Anterhynchium synagroide</i>	-	-	-	-	X	-
	<i>Belonogaster dubia</i>	-	-	-	-	X	-
	<i>Belonogaster facialis</i>	-	-	-	-	-	X
	<i>Belonogaster juncea</i>	X	-	-	-	-	-
	<i>Eumenes fraternus</i>	-	X	-	-	-	-
	<i>Polistes fuscatus</i>	X	-	-	-	-	-
	<i>Polybioides tabidus</i>	-	-	-	X	-	-
	<i>Rhynchium marginellum</i>	-	-	-	-	X	-
	<i>Ropalidia fraternal</i>	-	-	-	X	-	-
	<i>Ropalidia malaise</i>	-	-	X	-	-	-
	<i>Synagris spiniventris</i>	-	-	X	-	-	-

**Table 2:** Diversity indices among the Habitats

Diversity indices	Opa reservoir	Biological garden	Teaching and research farm	Parks and garden	Residential areas	Hill
Dominance_D	0.3058	0.52	0.25	0.5	0.44	1
Shannon_H	1.464	0.673	1.294	0.6931	0.9503	0
Evenness_e <sup>^</sup> H/S	0.8846	0.9801	0.8911	1	0.8621	1

**Table 3:** Paired comparisons of wasps' families in different habitats

	<b>Opa Reservoir</b>	<b>Biological Garden</b>	<b>Teaching and Research Farm</b>	<b>Parks and Garden</b>	<b>Residential Areas</b>	<b>Hill</b>
<b>Opa Reservoir</b>		0.43	0.24	0.49	0.56	0.93
<b>Biological Garden</b>	0.39		0.06	0.44	0.18	0.056
<b>Teaching and Research Farm</b>	0.56	0.77		0.81	0.67	0.54
<b>Parks and garden</b>	0.35	0.38	0.12		0.07	0.17
<b>Residential Areas</b>	0.29	0.62	0.22	0.77		0.012*
<b>Hill</b>	0.044*	0.79	0.31	0.63	0.90	

### DISCUSSION

A total of twenty eight species of wasps belonging to six families were documented at Nigeria's Obafemi Awolowo University in Ile-Ife. Wasps species distribution and habitat preference was high in Habitat A (Opa Reservoir) (Table 1). The lowest degree of distribution and habitat preference was in Habitat F (The Hills) this could be that Wasps are ectothermic animal reason why most are found in cooler environments and crevices as supported by Ribeiro *et al.* (2019). This agrees with the work of Ribeiro *et al.* (2019), Svensson *et al.* (2000) and Herrera *et al.*, (2020). Improving the quality of the measures of needed resources increased the abundance of all cavity-nesting insects by improving resource availability and flower diversity (Beyer *et al.*, 2023). When resources are concentrated, biodiversity rises (Myers *et al.*, 2000). Because temperature, other habitat factors that are strongly correlated with elevation, and the density of bamboo, lianas, epiphytes, small trees, and herbs also strongly predict changes in the pimpline community, the composition of the community varies with elevation (Flinte *et al.*, 2023). Some species are not equally distributed in the chosen habitat because there aren't many differences between them, according to Table 2 diversity indices for the various habitats. A significant number of

species showed a preference for their respective environmental conditions, which corresponded with the differences in the habitats that wasps exploited. This suggests that for a particular group of animals, the quantity of such species may act as a bio-indicator of environmental quality (Oertli *et al.*, 2005; Szczepko *et al.*, 2012). Since human activity has a negative impact on insect fauna (Tommasi *et al.*, 2004), it's possible that human activity has disrupted some habitats on the campus of Obafemi Awolowo University (Westrich, 1996). Additionally, food, nesting substrates, and minimal disturbance are necessary for the majority of wasp species to coexist in their natural habitat. These requirements align with the landscapes of the Obafemi Awolowo University campus under investigation, as corroborated by McKinney (2006).

When compared to other habitats as shown in Table 3, the habitat F (hills) exhibits a significant difference. This difference may be attributed to a number of factors, including a decrease in the total and partial pressure of all atmospheric gases (mostly carbon dioxide and oxygen), a decrease in atmospheric temperature and its implications for ambient humidity, an increase in radiation under a cloudless sky, a decrease in atmospheric turbidity, and a higher fraction of radiation reaching the hills at any given time (Körner, 2007). By drawing

conclusions from the "Rapoport Rule" proposed by Sanders (2002) and Stevens (1989, 1992), which states that diversity decreases in response to rising ground level, one can explain why there is less species diversity at higher elevations. The high level of degradation in the forest environments caused by rocks and human interventions could be another factor contributing to the low species diversity (Noll and Gomes, 2009). This is true in the marine environment, where biodiversity is more prevalent in the middle latitudes of waters and the areas with the highest sea surface temperatures (Tittensor *et al.*, 2010). Biodiversity increases in response to high concentration of resources (Myers *et al.*, 2000), which will increase over time (McPeck *et al.*, 2007) until those resources are utilized or exhausted which could result into competition, immigration and eventually reduction in species distribution (Robosky, 2009).

#### CONCLUSION

Twenty eight species of wasps were collected and identified to species level. Six families from the selected habitats, comprising of families Crabronidae, Evaniidae, Ichneumonidae, Pompilidae, Sphecidae, Opa Reservoir Habitats has the most diverse of the species with eleven (11) species while the hills have the least (1). The family Vespidae has the highest numbers of genera (13) while the genus *Belonogaster* has the highest numbers of species (3). Insects of the wasp family are very significant from an economic and conservative perspective. Bees and wasps are significant pollinators that are essential to the upkeep and evolution of floral species richness as well as the functioning of ecosystems. It is therefore possible that some of the wasp species found in this study were not previously found in Obafemi Awolowo University, Ile-Ife, Nigeria, or throughout Africa.

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