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AN APPRAISAL OF INSECT SPECIES VISITING SOME ORNAMENTAL PLANTS IN ZARIA, NIGERIA: A CASE STUDY OF AHMADU BELLO UNIVERSITY ZARIA-NIGERIA

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ABSTRACT
This study was carried out in Ahmadu Bello University, Zaria, Main-campus, Samaru. The study area was divided into four units, the units were surveyed two times, the first survey was in May, 2015 and the second was in July, 2015. On each survey, insects were collected using sweep net from associated ornamental plants in a research unit of a study area independently. Eight species of ornamental plants were surveyed and a total number of ninety insects were collected from the plants and identified. The area of study showed significant difference ($p<0.05$) in the abundance of insects and may account for good plant species richness.

Keywords: *Insects, Pollinators, Ornamental plants, Biodiversity*

INTRODUCTION

Understanding plant-insects interactions is vital, as insects play a key role in flowering plants reproduction. Approximately 87% of flowering plants species globally are entomophilous (Ollerton *et al.* 2011). Ornamental plants depend greatly on insects for pollination and so the diversity and abundance of the insects will affect their reproduction. Factors like nectar secretion flower and insect morphology affect insect visitation to plants (Corbet *et al.* 2001).

There is clear evidence of recent declines in domesticated and wild pollinator populations, both of which might be affected by a range of environmental changes, including the loss of floral and nesting resources (Potts *et al*., 2010). However, this declination may be effects of fragmentation and can also be indirect, through the disruption of plant–animal interaction, and particularly of plant–pollinator interactions (Harris and Johnson, 2004; Aguilar *et al*., 2006; Biesmeijer *et al*., 2006; Fontaine *et al*., 2006).With many insect pollinator populations in decline (e.g. Potts *et al*. 2010) and a heavy dependency on a small number of pollinator species for crop pollination (Kleijn *et al*. 2015), a deeper quantitative insight into insect-flower visitors is essential. Consequently, this study sets out to produce more information into the relationship between insects and flowering plants.

Little academic research has been conducted linking ornamental plants and insect pollinators; there is also a lack of long term or definitive population studies that can be used as a baseline for native pollinators (National Research Council, 2007). Several European nations have conducted pollinator surveys and results have shown that native pollinator populations are in decline (National Research Council, 2007), the same research is needed in most tropical climates.

Despite the importance of biotic pollination, many obscurities about plant-pollinator interactions still need to be solved (Mayer *et al*. 2011). For example, the terms "flower visitor" and "pollinator" are often used synonymously, without actual proof of pollen transfer (Ne'eman *et al*. 2010). In this study, our objectives include identification and analysis of the differences in abundance of insect-flower-visitors of ornamental plants species in Zaria, Nigeria.

MATERIAL AND METHODS

Study Area

The study was carried out at four units in Ahmadu Bello University, Zaria (main campus). Zaria was located at 11º 04'54.91" N and 7º 42'57.44E. Unit 1 is Area A, Unit 2 is Faculties of Pharmacy and Veterinary medicine, Unit 3 is Faculties of Engineering and Environmental design, and then Unit 4 is Faculty of Sciences (Table 1).

Table 1: Study Areas and their location in the Campus

Units	Location in the campus
Unit 1	Area A
Unit 2	Faculties of Pharmacy and Veterinary Medicine
Unit 3	Faculties of Engineering and Environmental Design
Unit 4	Faculty of Sciences

Plant shoot sections of observed ornamental plants were collected at the study areas and taken to herbarium unit of Department of Botany, Ahmadu Bello University, Zaria, for identification.

Collection of insects

The insects were collected from each ornamental plant visited using a sweep net (Gibb *et al*., 2006). The insects collected were quickly placed inside a prepared killing jar containing ethylacetate for killing the insects collected before preserving them. The killing jar was made by adding ethylacetate into a container. Thereafter, cotton wool was then placed inside the container to absorb the solvent. A plain-white sheet of paper was also placed on the cotton wool inside the container on which the insects caught were put and the container was then tightly covered. It is important to kill the insects before preserving them, because, some insects such as bees and tsetse flies can easily sting the collector. Also, some insects like the butterfly can easily fly away and escape in the process if not firstly killed. The insects were preserved using "liquid preservation" in a container containing 70% ethanol, the container is labelled with respect to the ornamental plants from which the insects are collected. The insects were then taken to Department of Crop Protection museum at the Institute of Agricultural Research, Samaru, Zaria, for identification.

Statistical analyses

One way Anova was used to compare if there is a significant difference in the abundance of insect-flower-visitors between the study areas.

RESULTS

Eight species of ornamental plants were visited in this study (Table 2)

Table 2: Ornamental plants species visited during this study from which the insect pollinators were collected.

SN	Plant accession number*	Plant family	Plant Species
1.	A	Nyctaginaceae	*Boungavaellea glabra*
2.	B	Fabaceae	*Caesalpinia pulcherrima*
3.	C	Fabaceae	*Delonix regia*
4.	D	Verbenaceae	*Duranta repens*
5.	E	Rubiaceae	*Ixora coccinea*
6.	F	Rubiaceae	*Ixora foliosa*
7.	G	Apocynaceae	*Thevetia neriifolia*
8.	H	Apocynaceae	*Voacanga africana*

***plant accession number will represent the species name of the plants in this study**

Thirty species of insects pollinators were identified in this study (Table 3), belonging to six orders and twenty families. The Order Hymenoptera and the Order diptera have the highest insect species with eleven species each, followed by Lepidoptera and Coleoptera with three species of insect pollinators each. Orders with least insect species are Homoptera and Hemiptera represented with only one species each. The family Formicidae has the highest number of species of insect pollinators represented in this study with six species of insects, the family Formicidae is followed by the Families Chloropidae and Muscidae with three species each, and Apidae is with two species. The remaining sixteen Families are represented in this study with only one species each.

Table 3: Species of insect pollinators collected on ornamental plants.

SN	Order	Family	Species of insects
1.	Hymenoptera	Formicidae	*Abbalomba sp*
2.	Lepidoptera	Acraeidae	*Acraea eponina*. Cr.
3.	Hymenoptera	Apidae	*Apis mellifera* L.
4.	Hymenoptera	Apidae	*Anthophora* sp
5.	Hymenoptera	Vespidae	*Antodynerus bellatulus*. Sauss.
6.	Hymenoptera	Chalcididae	*Brachymeria* sp
7.	Coleoptera	Bruchidae	*Bruchidiussp*
8.	Hymenoptera	Formicidae	*Camponotus acvapimensis* Mayr.
9.	Hymenoptera	Formicidae	*Camponotus maculatus*. Fab.
10.	Hymenoptera	Formicidae	*Camponotus sp. Nr. Perrisi*. For
11.	Hymenoptera	Braconidae	*Chelonus sp.*
12.	Diptera	Calliphoridae	*Chrsomyia chloropyga.* Wied.
13.	Diptera	Culicidae	*Culex poicilipes.* Theob.
14.	Homoptera	Psyllidae	*Diaphorina sp*.
15.	Diptera	Pteromalidae	*Dinarmus sp*
16.	Hemiptera	Pentatomidae	*Dorycoris sp.* (Nymph)
17.	Diptera	Tephritidae	*Eutretosoma sp.*
18.	Lepidoptera	Pieridae	*f. pyrene.* Siv.
19.	Diptera	Chloropidae	*Globiops litoralis*. Deeming.
20.	Lepidoptera	Nymphalidae	*Hypolimnas misippus.* L.
21.	Hymenoptera	Formicidae	*Megaponera foetens*. Fab.
22.	Diptera	Muscidae	*Musca domestica L.*
23.	Diptera	Muscidae	*Musca confiscata.* Speiser.
24.	Diptera	Muscidae	*Musca sp.*
25.	Diptera	Chloropidae	*Pachylophus inornatus*. Loew.
26.	Diptera	Chloropidae	*Pachylophus sp.*
27.	Hymenoptera	Formicidae	*Pheidole sp.*
28.	Diptera	Drosophilidae	*Phortica sp.*
29.	Coleoptera	Scarabaeidae	*Rhyssemus sp.*
30.	Coleoptera	Coccinellidae	*Scymnus sp.*

Study areas and ornamental plants surveyed from their respected areas were shown on Table 4. Four species of ornamental plants were visited in Unit 1, these plants are; *Boungavaellea glabra, Caesalpina pulcherima, Ixora foliosa* and *Thevetia neriifolia*. Five plants were surveyed in Unit 2, which are; *Delonix regia, Duranta repens, Ixora coccinea, Thevetia neriifolia, Voacanga africana*. Five plants were surveyed in Unit 3, which are; *Boungavaellea glabra, Delonix regia, Duranta repens, Ixora foliosa, Thevetia neriifolia*. In Unit 4, four plants were surveyed, which are; *Delonix regia, Ixora coccinea, Ixora foliosa, Voacanga africana.*

Table 4: Area Units and ornamental plants visited

Plant Species	Unit 1	Unit 2	Unit 3	Unit 4
Boungavaellea glabra	+	_	+	_
Caesalpinia pulcher-	+	_	_	_
rima	_	+	+	+
Delonix regia	_	+	+	_
Duranta repens	_	+	_	+
Ixora coccinea	+	_	+	+
Ixora foliosa	+	+	+	_
Thevetia neriifolia	_	+	_	+
Voacanga Africana				

Keys: + Plant surveyed, - Plant absent

F. pyrene siv has the highest occurrence, occurs on seven ornamental plants absent only on *Thevetia neriifolia*, In terms of occurrence *F. pyrene* Siv. was followed by species of *Apis mellifera* L. and *Pheidole sp* which were found on five species of ornamental plants each. *Pheidole sp* occurs on *Caesalpina pulcherima, Delonix regia, Duranta repens* and *Ixora foliosa*, but absent on *Boungavaellea glabra, Ixora coccinea, Voacanga africana. Apis mellifera* L species are found on *Delonix regia, Duranta repens, Ixora coccinea, Ixora foliosa, Thevetia* neriifolia, and absent on *Boungavaellea glabra, Caesalpina pulcherrima* and *Voacanga africana*. Insect pollinators species with least occurrence are; *Musca sp, Rhyssemus sp, Pachylopus inornatus* Loew, *Eutretosoma sp, Brachymeria sp*, each are found once on all the vornamental plants surveyed in this study (see Table 5).

Table 5: The occurrence of insect pollinators on ornamental plants

SN	Species	A	B	C	D	E	F	G	H	Total
1.	*Abbalomba sp*	_	_	+	_	+	+	_	_	3
2.	*Acraea eponina*. Cr.	_	_	+	+	_	_	_	_	2
3.	*Apis mellifera* L.	_	_	+	+	+	+	+	_	5
4.	*Anthophora* sp	_	_	+	+	_	_	_	_	2
5.	*Antodynerus bellatulus*. Sauss.	_	+	_	_	_	_	+	_	2
6.	*Brachymeria* sp	_	_	_	_	_	_	+	_	1
7.	*Bruchidiussp*	_	_	_	_	_	+	_	_	1
8.	*Camponotus acvapimensis.* Mayr.	_	_	+	_	+	_	+	_	3
9.	*Camponotus maculatus*. Fab.	_	_	_	_	+	+	+	_	3
10.	*Camponotus sp. Nr. Perrisi*. For	+	_	_	_	_	_	+	_	2
11.	*Chelonus sp*.	_	_	_	_	+	+	_	_	2
12.	*Chrsomyia chloropyga*. Wied.	_	_	_	_	+	_	+	_	2
13.	*Culex poicilipes.* Theob.	+	+	_	_	+	_	_	_	3
14.	*Diaphorina sp*.	+	_	_	_	+	_	_	_	2
15.	*Dinarmus sp*	_	_	_	_	+	_	+	_	2
16.	*Dorycoris sp.* (Nymph)	_	_	_	_	_	+	_	_	1
17.	*Eutretosoma sp.*	_	_	+	_	_	+	_	_	2
18.	*f. pyrene.* Siv. ?	+	+	+	+	+	+	_	+	7
19.	*Globiops litoralis*. Deeming.	+	_	+	_	+	+	_	_	4
20.	*Hypolimnas misippus.* L.	_	_	+	_	+	+	_	_	3
21.	*Megaponera foetens*. Fab.	+	_	+	_	+	_	_	_	3
22.	*Musca confiscata*. Speiser.	_	_	_	_	+	_	+	_	2
23.	*Musca domestica. L.*	_	_	_	+	+	_	+	_	3
24.	*Musca sp*.	_	_	+	_	_	_	_	_	1
25.	*Pachylophus inornatus*. Loew.	_	_	_	_	_	_	+	_	1
26.	*Pachylophus sp*	+	_	_	_	_	+	_	_	2
27.	*Pheidole sp*.	_	+	+	+	_	+	+	_	5
28.	*Phortica sp.*	_	_	_	_	+	_	_	+	2
29.	*Rhyssemus sp*.	_	_	_	_	+	_	_	_	1
30.	*Scymnus sp.*	_	_	_	_	_	+	_	+	2
Total:		**6**	**3**	**9**	**4**	**15**	**10**	**12**	**2**	**73**

Key: + present, - absent

A total number of ninety insect pollinators were collected in this study, the frequency of their occurrence, percentage frequency and their abundance was on table 6 below. *Pheidole sp* has the highest abundance, represented in this study with fourteen individuals, followed by *Apis mellifera* L. with eleven individuals. Species with the least abundance are; *Rhyssemus sp, Musca confiscata* and *Brachymeria sp* represented in this study with one individual each.

Table 6: Frequency of occurrence, percentage frequency, and Abundance of insect species

Insect Species	Frequency	Percentage Frequency (%)	Abun-dance
1. *Abbalomba sp*	2	2.86	2
2. *Acraea eponina*. Cr.	2	2.86	?
3. *Apis mellifera* L.	7	10.00	11
4. *Anthophora* sp	1	1.43	2
5. *Antodynerus bellatulus*. Sauss.	1	1.43	1
6. *Brachymeria* sp	1	1.43	1
7. *Bruchidiussp*	1	1.43	2
8. *Camponotus acvapimensis* Mayr.	4	5.71	5
9. *Camponotus maculatus*. Fab.	4	5.71	4
10. *Camponotus sp. Nr. Perrisi*. For	1	1.43	1
11. *Chelonus sp*.	2	2.86	6
12. *Chrsomyia chloropyga*. Wied.	3	4.29	3
13. *Culex poicilipes*. Theob.	3	4.29	4
14. *Diaphorina sp*.	1	1.43	1
15. *Dinarmus sp*	1	1.43	6
16. *Dorycoris sp.* (Nymph)	1	1.43	1
17. *Eutretosoma sp.*	1	1.43	1
18. *f. pyrene*. Siv. ?	7	7.00	?
19. *Globiops litoralis*. Deeming.	2	2.86	5
20. *Hypolimnas misippus*. L.	3	4.29	?
21. *Megaponera foetens*. Fab.	1	1.43	1
22. *Musca domestica L.*	3	4.29	3
23. *Musca confiscata*. Speiser.	1	1.43	1
24. *Musca sp*.	1	1.43	1
25. *Pachylophus inornatus*. Loew.	1	1.43	1
26. *Pachylophus sp.*	2	2.86	2
27. *Pheidole sp.*	8	11.43	14
28. *Phortica sp.*	2	2.86	6
29. *Rhyssemus sp*.	1	1.43	1
30. *Scymnus sp*.	2	2.86	4
	Total frequency= 70	Approx. 97.05%	90

The mean difference in insect-flower-visitors abundance in the study areas is significant ($p<0.05$) when subjected to one way ANOVA (Table 7)

Table 7: Mean differences in species abundance between the study areas

Unit 1	Unit 2	Unit 3	Unit 4
$17.00 \pm 1^{c*}$	$36 \pm 1^{a*}$	$16 \pm 1^{d*}$	$23 \pm 1^{b*}$

1. Data presented as mean ± Standard deviation
2. (*) Shows significant differences at 0.05 level
3. Superscripts are used to indicates how the means differ (a is the highest followed by b,c, and d).

DISCUSSION

In an earlier study of the same area, John (2009) collected and identified 561 species of insects. This author reported that order Hymenoptera has highest number of insects' species than any other insects order in Ahmadu Bello University Zaria; his result is very relevant to this study in that eleven species of the insects identified belong to the order Hymenoptera among which is *Pheidole sp*.

Another important group of insect-flower-visitors were Dipterans represented in this study with eleven species of insects, same in terms of number of species but second in species abundance to hymenopterans. A study shows that Dipterans are one of the three largest and most diverse animal groups in the world, comprising of over 160,000 named species in about 150 families (Evenhuis *et al*. 2008). According to the Gifford *et al*. (2011) *Apis mellifera* which is diptera is the most widespread pollinator in the world.

Nuru *et al*. (2016) reported Fabaceae as one of the most represented bee plant species. In this work, the most represented bee species were *Thevetia neriifolia* belonging to the family Apocynaceae and *Ixora coccinea* of the family Rubiaceae on

which three bee individuals were bserved. According to the Mallick (2000) this is due to the time of their peak nectar secretion between 12noon-2pm, and that bee's forage is stimulated during this time because of high light intensity. Nyctaginaceae represented in this study by *Bougainvillea glabra* has no bee collected from the plant probably due to morphological hindrance, nectar secretion (Mallick, 2000) or it may occur by chance.

The significant differences ($p<0.05$) observed on the abundance of insect-flower-visitors may be due to differences in vegetation density because some plants attract more insects than others (Kaisa *et al*, 2001). The highest number of insects in unit 2 may be attributed to the highly dense vegetation of the area when compared to other areas of the study. The least Unit in species abundance in this study was Unit 3, and this may be as a result of heavy human activities of tree trimming with consequence of flower removal and thus reduced insect attraction in the area. It was also observed that the area is sparsely vegetated with ornamental plants.

CONCLUSION

Ninety insects were identified, thirty of which are of the same species. Plant species of *T. neriifolia* has the highest insect visitation. Generally, the study areas showed significant differences in abundance of insect-flower-visitation and may account for good plant species richness. It is also observed that good forestry management practices should be in place to safeguard the pollinator diversity in the main campus of Ahmadu Bello University, Zaria, Nigeria. Achieving this would not only ensure greening landscape but ensuring rich biodiversity for research and ecosystem services.

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