

## Resource Partitioning in the Sunbird Species Found in Federal College of Forestry, Jos, Plateau State

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### ABSTRACT

Competition occurs when individuals or different species are vying for the same resource which is in limited supply. Two complete competitors cannot coexist indefinitely, therefore competitors must differ to some degree in their resource use. The research was carried to investigate how resources are partitioned among the species of sunbirds found in Federal College of Forestry, Jos. Opportunistic sightings along a 200m transect was used for observation. Sunbirds were observed using binoculars between 6:30 – 8am and by 4:30 – 6pm. Six transects were purposively selected in the study area. Sightings along a 200m transect was used to observe; species of sunbird, sex of individual sunbird species, species of flowering plant visited by the sunbird species, activity or behaviour performed by the sunbird (probing, insect hunting, roosting, perching etc.) and duration of activity. Descriptive statistics, ANOVA and post hoc test was used to analyse the data obtained. Results showed that forty-three (43) plant species were utilised by the four (4) sunbird species found in the study site with *Corymbia torelliana* and *Hamelia patens* having the highest number of visit. These four sunbird species observed were; Scarlet-chested sunbird, Variable sunbird, Green-headed sunbird and the Copper sunbird. Mean number of plants visited shows that Green-headed sunbird visited more plants than the other three species (28.89) which was highly significant ( $p=0.001$ ). Copper sunbird spent the highest foraging time (67.71) which showed no variation with the other species ( $p=0.516$ ). Females of the sunbird species visit more plants species and spent more time foraging as compared to the males although there was no variation ( $p=0.984$  and  $p=0.906$  respectively). The activities of the males (perching, hovering, probing, feeding) was higher than that of females and had a high level of significance ( $p=0.001$ ). *Callistemon citrinus*, *Corymbia torelliana*, *Eucalyptus camaldulensis*, *Hamelia patens*, *Parkia biglobosa* and *Ziziphus mucronata* were utilised by all the sunbird species. Scarlet-chested sunbirds spent more time probing which aids pollination of plants in the study site and hence ecologically important to the plants found in the study site.

**Keywords:** Sun bird, Resource, Partitioning, Community, Plant

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## Introduction

The coexistence of sympatric species is made possible by the differential utilisation of resources and niches (Fossette *et al.*, 2017). The most important limiting resources are space and food (Chapin *et al.*, 2000) as these are the necessities for an organism to survive, grow and reproduce. Coexistence of sympatric bird species can be made possible by the partitioning of a shared habitat (Carstensen *et al.*, 2011), the type of resource used (Beaulieu and Sockman, 2012), foraging strategy employed (Oyugi *et al.*, 2012) or specialisation on a particular resource (Craig, 1990). Resource partitioning can result from three pressures, competition, predation and physiological constraints (Toft, 1985) and the outcome is an alleviation of the pressures of competition. If two species occupy the same ecological niche, one would eventually dominate, out-competing the weaker competitor (Griffin and Silliman, 2011). The negative effects of interspecific competition may be mitigated by species reducing the degree of overlap in their ecological niches and using resources in different ways (Ricklefs, 2007).

As food resources vary in quality, often dominant species will utilise more valuable resources, forcing subordinate species to use poorer quality resources (Abrahamczyk and Kessler, 2015). Ecological theory shows that interspecific competition will be less likely to result in competitive exclusion if it is weaker than intraspecific competition (Chesson, 2008). Resource partitioning can result in consuming slightly different forms of a limiting resource or using the same limiting resource at a different place or time, individuals of different species compete less within one another (interspecific competition) than individuals of the same species (intraspecific competition). Species therefore, limit their own population growth more than they limit that of potential competitors and resource partitioning acts to promote the large long-term coexistence (Griffin

and Silliman, 2011). Floral nectar is an important food resource for many birds. Nectarivores, which often are energy limited, tend to aggregate at major blooms of certain flowers to feed and gain energy (Botes *et al.*, 2008). Productive flowers assure these birds of stable resource sites that can be revisited repeatedly during the day for several weeks or longer. The principle that similar organisms require similar niche make competition evident. Sunbirds species are also involved in competing for limited resources such as, food, cover and mate. Lara *et al.* (2015) reported that species show a differential of resources in the face of interspecific competition as a fundamental manner of achieving species coexistence. In order to avoid or limit competition they often rely on resource partitioning. Sunbirds (Nectariniidae) are small bird with long curved beaks. There are many species of sunbirds and they are one of the two major groups of pollinating (flower-visiting) birds in Africa. Constantly on the move, they feed on nectar and insects and can hover around briefly (Franshawe and Stevenson, 2002).

There is no documented record on the sunbird's species found in the Federal College of Forestry Jos. The aim of this study is to determine the plant species visited by sunbird species and understand how these resources are partitioned among them. Sunbirds are recognized as very active pollinators of plants with bird pollinated flowers (Wolf *et al.*, 2001). A vast number of experiments show that species extinction on average reduces the level of eco-system processes (Cardinale, 2006), resource partitioning is thought to play an important role in causing this effect, although ecologists are just beginning to directly test this (Griffin *et al.*, 2008; Finke and Sander, 2008) by considering the degree of resource partitioning amongst species, scientists may be able to predict those ecosystems that are most vulnerable to the loss of species.

## Materials and Methods

### Study Area

The study was conducted in the Federal College of Forestry Jos located on Latitude 9°57'N and Longitude 8°54'E on the altitude of about 1180 above sea level with mean annual rainfall of about 1250mm and mean temperature of 23.5 degree (University of Jos meteorological station, 2010).

### Data Collection

Sunbirds were observed using binoculars between 6:30 – 8am and by 4:30 – 6pm. Six transects were purposively selected in the study area. Sightings along a 200m transect was used to observe; species of sunbird, sex of individual sunbird species, species of flowering plant visited by the sunbird species, activity or behaviour performed by the sunbird (probing, roosting, perching etc.) and duration of activity. Birds were identified with the aid of a Bird field guide (Borrow and Demey, 2004).

### Statistical Analysis

Data was analysed using Statistical Package for the Social Sciences SPSS. Descriptive statistics such as bar-chart, tables and graphs were used to illustrate patterns and trends of visits to plant species. Analysis of variance (ANOVA) was used to test aspect of behaviour and visitation and their respective level of variation. Post hoc test was used to compare the level of significance between each species.

## Q2 Results

The result in figure 1 shows the mean number of plants visited by the sunbird species with green-headed sunbird having the highest number (24.89) while copper sunbird had the least number (12.43) of visit to plants.

Figure 2 shows the mean number of plant visited by male and female sunbird (that is, irrespective of the different sunbird species); the females had the highest number (19.07) of plant visited while the

males had the least number (19.04) of visit to plants.

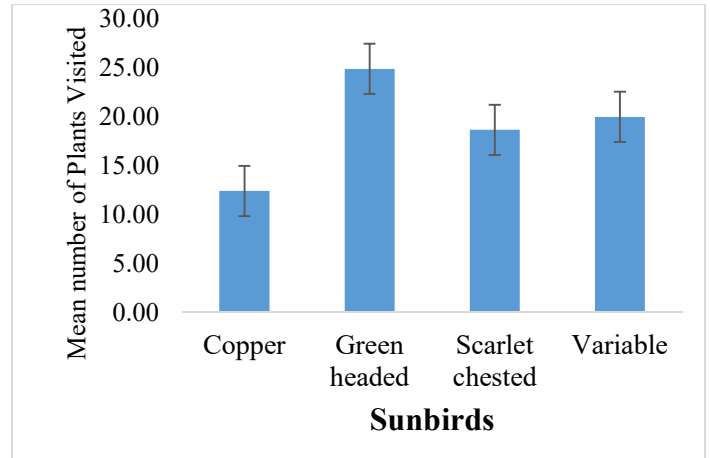


Figure 1: Mean number of plants visited by sunbird species

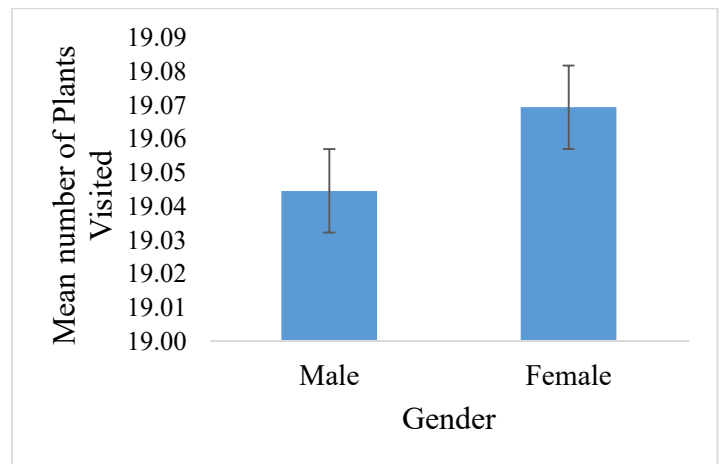


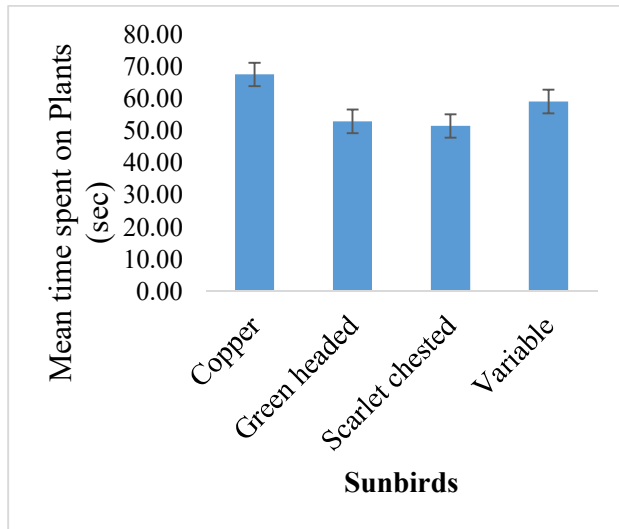
Figure 2: Mean number of plants visited by male and female sunbird

From Table 1, there was a high significant difference ( $p = 0.001$ ) between sunbird species visiting different plant species but there was no variation in the gender of sunbird species visiting plants ( $p = 0.984$ ).

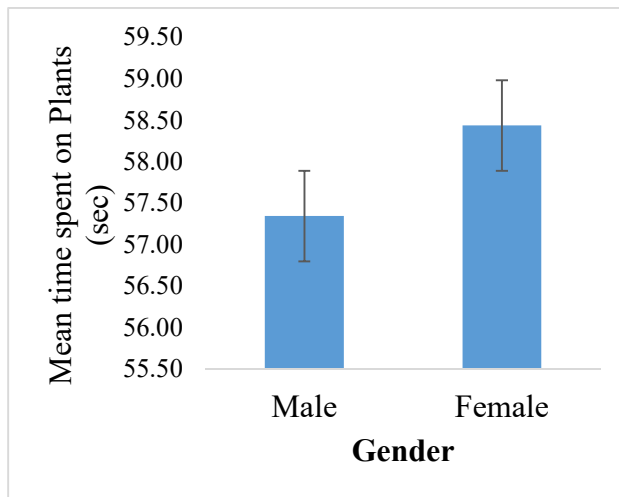
Table 2 shows that the green-headed sunbird had the highest number of visit (24.89) which was significant and the least being copper sunbird which had the lowest frequency of visit (12.43).

Figure 3 shows the mean time spent on the plants visited by sunbird species, results shows that copper sunbird spent the longest time (67.71) and lastly the scarlet-chested sunbird (51.62) which spent the least duration of time while visiting plants.

Figure 4 shows the mean time spent feeding on plants by male and female sunbird irrespective of the different species of sunbirds. The females spent the longest (58.44) while the males spent the shortest time (57.34) foraging.



**Figure 3: Mean time spent on plants by sunbird species.**



**Figure 4: Mean time spent on plants by male and female sunbird**

Table 3 shows that there was no variation between sunbird species visiting different plant species ( $p=0.516$ ) and the gender of sunbird species visiting plants ( $p= 0.906$ ), thus the interaction between the sunbird species and gender also had no variation ( $p = 0.921$ ).

Table 4 shows that the copper sunbird had the highest number of visit (67.71) followed by the variable sunbird (59.23), then the green headed sunbird (51.62) and lastly the Scarlet-chested sunbird (51.62). All the species of sunbird had no significant difference in the amount of time spent foraging.

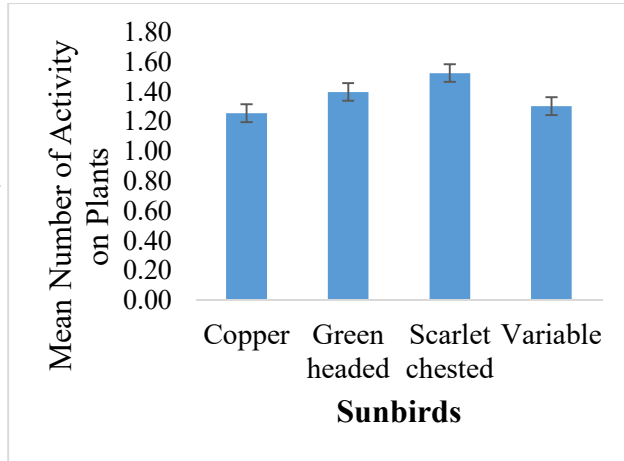
Figure 5 denotes the mean number of activities on plants by species with scarlet chested sunbird having the highest number of activities (1.53), while copper sunbird had the least number of activities (1.26).

Figure 6 shows the mean number of activities on plants by male and female sunbird irrespective of the species indicating the females having a greater number of activities compared to the males.

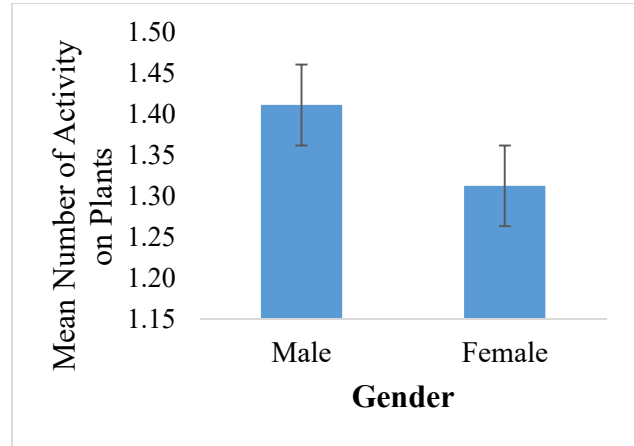
Table 5 shows the plants species highly utilised by sunbird species, with *Corymbia torelliana* and *Hamelia patens* having the highest visits (175 and 148 respectively).

Table 6 shows that more male sunbirds were encountered than females with a number of 690 and 558 respectively during the study.

Table 7 shows the number of activities by the sunbird species in the study area. Probing is the activity with the highest occurrence of seven hundred and eighty-seven sunbirds (787) while feeding had the least occurrence of one sunbird (1). Probing is an activity of searching for nectar, probing and feeding on nectar was observed mostly by Scarlet-chested sunbird.



**Figure 5:** Mean number of activities on plants by sunbird species.



**Figure 6:** Mean number of activities on plants by male and female

**Table 1:** Analysis of Variance (ANOVA) on species and sex of sunbirds visitors on plant species

Source	Sum of Squares	Df	Mean Square	F	Sig.
Sunbirds	8845.73	3	2948.58	19.659	0.001*
Gender	0.06	1	0.06	0.000	0.984 <sup>ns</sup>
SB * Gender	1197.58	3	399.19	2.661	0.047*
Error	185834.52	1239	149.99		
Total	195582.98	1246			

\*significant ns: not significant

**Table 2:** Post hoc on mean number of plant visited by sunbird species

Sunbirds	Mean Number of trees visited
Copper SB	12.43±8.8 <sup>c</sup>
Green-headed SB	24.89±12.4 <sup>a</sup>
Scarlet-chested SB	18.66±12.8 <sup>b</sup>
Variable SB	19.98±11.7 <sup>b</sup>

Means (±SD) in the same column having the same superscript are not significantly significant ( $p \geq 0.05$ )

**Table 3:** Analysis of Variance on the Effects of Sunbirds Visit in relation to Time spent on plants (Seconds)

Source	Sum of Squares	df	Mean Square	F	Sig.
Sunbirds	20085.66	3	6695.22	0.760	0.516 <sup>ns</sup>
Gender	122.85	1	122.85	0.014	0.906 <sup>ns</sup>
SB * Gender	4303.10	3	1434.37	0.163	0.921 <sup>ns</sup>
Error	10910522.76	1239	8805.91		
Total	10935900.38	1246			

**Table 4:** Post hoc on mean time spent on plants by sunbird species

Sunbirds	Mean Time Spent (Secs)
Copper SB	67.71±52.4 <sup>a</sup>
Green headed SB	53.05±47.2 <sup>a</sup>
Scarlet chested SB	51.62±123.6 <sup>a</sup>
Variable SB	59.23±55.5 <sup>a</sup>

Means (±SD) in the same column having the same superscript are not significantly significant ( $p \geq 0.05$ ).

**Table 5: Plant Species visited by Sunbird species in the Study Location**

S/N	Plants Species	Common Names	Copper sunbird	Green Headed sunbird	Scarlet-chested sunbird	Variable sunbird	Total
1	<i>Albizia lebeck</i>	Siris Tree, Woman's Tongue, East Indian Walnut	2	0	8	1	11
2	<i>Anacardium occidentale</i>	Cashew, Caju	4	0	3	11	18
3	<i>Bauhinia purpurea</i>	Purple Orchid Tree; Butterfly Tree	0	3	10	5	18
4	<i>Caesalpinia pulcherrima</i>	Peacock Flower, Pride of Barbados, Dwarf Poinciana	0	1	1	31	33
5	<i>Callistemon citrinus</i>	Scarlet Bottlebrush, Lemon Bottlebrush, Red Bottlebrush	2	1	81	20	104
6	<i>Canna indica</i>	English Indian Shot; Wild Canna Lily	0	6	4	0	10
7	<i>Corymbia terolliana</i>	Cadaga, Blood-Leaf Gum	4	36	130	5	175
8	<i>Delonix regia</i>	Flamboyant, Royal Poinciana	0	0	6	0	6
9	<i>Erythrophleum suaveolens</i>	English Ordeal Tree, Red Water Tree, Sassawood Tree	0	1	0	0	1
10	<i>Eucalyptus camaldulensis</i>	Red River Gum	1	18	21	3	43
11	<i>Ficus benjamina</i>	Weeping Fig, Benjamin Fig Or Ficus Tree	0	0	3	1	4
12	<i>Caryota urens</i>	Fishtail Palm	0	0	0	1	1
13	<i>Gmelina arborea</i>	Gumhar, Gamhar	0	0	8	5	13
14	<i>Hamelia patens</i>	Firebush, Hummingbird Bush, Scarlet Bush, And Redhead.	18	2	16	112	148
15	<i>Jacaranda mimosifolia</i>	Blue Jacaranda, Fern Tree	0	2	15	10	27
16	<i>Jatropha curcas</i>	Purging Nut, Barbados Nut Or Physic Nut	0	0	1	5	6
17	<i>Canna indica</i>	Indian Shot, African Arrowroot	0	1	1	0	2
18	<i>Khaya grandifolia</i>	Broad-Leaved Mahogany, Benin Mahogany, Benin Wood	0	0	0	2	2
19	<i>Khaya ivorensis</i>	Lagos Mahogany, Lagos Wood, Red Mahogany	0	1	9	1	11
20	<i>Khaya senegalensis</i>	Senegal Mahogany, Dry Zone Mahogany	0	1	11	6	18
21	<i>Lantana camara</i>	Lantana Weed, Wild Sage	0	0	3	3	6
22	<i>Leucaena leucocephala</i>	Leucaena, Lead Tree, White Tamarind	1	1	9	16	27
23	<i>Zea mays</i>	Maize	0	10	19	8	37
24	<i>Mangifera indica</i>	Mango	0	0	4	0	4
25	<i>Maranthus polyandra</i>	Maranthes	0	0	11	32	43
26	<i>Moringa oleifera</i>	Drumstick Tree, Miracle Tree, Horseradish Tree, Benzolive Tree.	0	0	2	0	2
27	<i>Parkia biglobosa</i>	African Locust Bean	1	13	80	4	98
28	<i>Pavetta spp.</i>	Bride's Bush, Christmas Bush	0	0	0	3	3
29	<i>Pinus caribea</i>	Black Pine	0	0	0	7	7
30	<i>Polyalthia longifolia</i>	Cemetery Tree, Indian Fir, Mast Tree	0	0	3	3	6
31	<i>Saba comorensis</i>	Rubber Vine	0	0	7	13	20
32	<i>Senna siamea</i>	Cassod Tree, Siamese Cassia, Blackwood, Iron Wood, Yellow Cassia	0	0	1	0	1
33	<i>Spathodea campanulata</i>	African Tulip Tree	1	90	34	4	129
34	<i>Stenolobium stans</i>	Yellow Elder, Yellow-Trumpet Flower, Trumpet Bush	0	1	11	32	44
35	<i>Tectona grandis</i>	Teak	0	0	3	0	3
36	<i>Terminalia mentaly</i>	Madagascar Almond	0	0	21	11	32
37	<i>Terminalia catappa</i>	Country Almond, Indian Almond, Malabar Almond, Sea Almond, Tropical Almond, Beach Almond	0	0	0	1	1
38	<i>Terminalia superba</i>	Afara, White Afara	0	0	5	1	6
39	<i>Thevetia peruviana</i>	Yellow Oleander, Lucky Nut	0	29	33	15	77
40	<i>Thuja plicata</i>	Western Red Cedar	0	0	0	5	5
41	<i>Vitellaria paradoxa</i>	Shea Tree, Sheabutter Tree.	0	0	0	2	2
42	<i>Vitex doniana</i>	Black Plum.	0	0	16	5	21
43	<i>Ziziphus mucronata</i>	Buffalo Thorn; Cape Thorn	1	3	9	10	23
	<b>Total</b>		<b>35</b>	<b>220</b>	<b>599</b>	<b>394</b>	<b>1248</b>

**Table 6:** Gender Distribution of the Sunbirds

Gender	Frequency
Male	690
Female	558
Total	1248

**Table 7:** Sunbird species activities on the individual plant's species

Activity on Plant	Sunbirds				Total
	Copper	Green-headed	Scarlet-chested	Variable	
Probing	26	136	337	288	787
Perching	9	82	235	99	425
Feeding	0	0	1	0	1
Hovering	0	2	26	7	35
Total	35	220	599	394	1248

## Discussion

At the completion of the research, four sunbird species were found in the study site (Scarlet-chested, Green-headed, Variable and Copper sunbird). The identified plant species visited by the sunbirds in the study area were about forty-three (43). *Hamelia patens* had the highest visitation rate, Variable sunbird had the highest frequency of visit (112) to *Hamelia patens* while Green-headed sunbird has its highest visit to *Spathodea campanulata* and Scarlet-chested has its highest visit to *Corymbia terolliana* (90 and 130 respectively). Only six (6) plant species were visited by all the sunbird species found in the study site (table 6) which includes; *Callistemon citrinus*, *Corymbia torelliana*, *Eucalyptus camaldulensis*, *Parkia biglobosa*, *Hamelia patens* and *Ziziphus mucronata*. Scarlet-chested sunbird visited the first three plant species more than other sunbirds species while the variable sunbird visited the last two plant species more frequently.

According to Wilmer (2011), flowers differ in their morphology in several ways (tube-like structure to narrow tubes spiral shapes funnel-like, brush-like, among others), colour and floral structure including nectar production structure are some of the main factor determining the types of bird visitor that patronizes a flower. Plants may

invest more in to floral structure in other to attract one particular bird visitor more than another (Stiles, 1978; Wilmer, 2011). Thus, it has been observed that different floral structure attracts different type of bird visitor which may suggest the reason why the studied sunbird species frequently visited/preferred visiting different flowers. The sunbirds visited different plant species or the same plants at the same time interval by utilizing different parts of the plants, sometimes if a particular species is probing for nectar the other species will be seen perching on other parts of the tree, which indicates that some species can coexist by having different niches on a particular food resource (tree) which must not overlap to avoid competition, as it was observed that copper sunbird and variable sunbird visited *Hamelia patens* same time but while the copper probe the variable sunbird perches or hover around it. This result agrees with Gaus (1934) who stated that “two complete competitors cannot coexist indefinitely therefore competitors must differ to some extent in their resource use”. Furthermore, the result obtained in this study shows that each of the sunbird species in the study area visit a particular plant species more often than others for instance, the Variable sunbird visited *Hamelia patens* (table 6) more often than any other species and also spent the longest time

during its visit. It was also observed that, Variable sunbird spent the second highest time foraging and visited frequently (Figure 1) as compared to other sunbird species. This may be due to the fact that it needs more energy requirement more than other species and perhaps the nectar quality or quantity of the plant may be low so it needs to spend a longer time foraging to meet its diet requirement. This is in line with the statement that 'When the nutrient or energy content of a food source is low, animals ingest larger amount, which is commonly known as compensatory feeding, and can be observed in various animal's taxa' (Karasov and Martinez Del Rio, 2007). Animals also increase their food intake after a period of deprivation to compensate for an energy deficit. The widespread distribution of the compensatory feeding response demonstrates the importance of the regulation of energy intake for animal survival and fitness. The energy that animals gain from their food however is determined not only by their foraging decision, but also by the digestive process of food. The macro nutrients (carbohydrate, protein and lipids) present in ingested food need to be broken down into their smallest components, a process that involves numerous enzymatic pathways. The breakdown products are subsequently absorbed by the epithelium of the gastrointestinal tract, either passively by diffusion or actively via carrier-mediated mechanism (Karasov and Martinez Del Rio, 2007).

Green-headed sunbird was observed to be highly territorial; it chases away any other sunbird species that utilises the same tree. Scarlet-chested sunbird also, chases away variable sunbird. This is in line with the finding by Schemer (1994) who stated that the coexistence of sympatric species is made possible by the differential utilization of resources and niches.

Mean number of plant visited by species from the result obtained shows that Green headed sunbird visits more plants than the other three species

which was highly significant ( $p=0.001$ ) as shown in figure 1 and table 1 above. This may be due to the fact that different birds have different nectar requirement as nectar varies in sugar concentration and viscosity. Plants pollinated by birds are expected to produce higher volumes of more diluted nectar than plants pollinated by insects (Bolten and Feinsinger, 1998; Nicolson and Fleming, 2003; Goldblatt and Manning, 2008).

Female sunbird species visited more plants and spent more time foraging than the males (Figure 4) which could be due to the fact that females go out to look for food and feed the fledglings (young birds) while the males watch over at home and protect their territories. Another reason may be to avoid competition as males are known to be more aggressive. The principle that similar organisms require similar niche makes competition evident, sunbirds are not exception to this; hence in event of competition different species devise different means or strategy to cope with competition for limiting resources. Lara *et al.* (2015) reported that species show a differential use of resources in the face of competition as a fundamental manner of achieving species coexistence. It was also observed that male sunbird species conduct more activities such as probing, hovering, etc. than the females, which may be due to factors such as mating and territoriality by the male sunbird species. Also, the males of the sunbird species had a higher level of occurrence as compared to the females in the study site (figure 6) with the level of occurrence of the females being 558 while the male was 690.

It was also observed that Green-headed sunbird visited more plants but doesn't spend much time foraging while copper sunbird visits a very few number of plants but spends the highest time foraging after which it hides (roosts) as it had the lowest number of activity recorded as compared to other sunbird species. Variable sunbird also visits numerous numbers of plants and also spends



much time foraging as it had the second highest in both, which may be due to the fact that it needs a great amount of energy to survive. Lastly, the Scarlet-chested sunbird does not visit numerous plants and spent the least amount of time foraging as compared to other sunbird species (Figure 1,3, and 5), but was observed to have the greatest level of activities (probing, feeding, hovering and perching) and the highest level of occurrence which is highly significant as compared to other sunbird species. The level of occurrence may be the reason why they do not need to spent much time feeding on numerous plants as their numbers as high they can easily share their resources as they were observed to be the most-friendly species that are not territorial, although there may be high predation risk if they are known to be very active. Scarlet-chested sunbird was observed to probe plants more frequently than other sunbird species which is very important in pollination (self and cross), hence it is a vital species (keystone species) in the study site.

### Conclusion

Four (4) sunbird species; Scarlet-chested sunbird, Green-headed sunbird, Variable sunbird and Copper sunbird were found in the study site. These species utilised resources in different ways so that they can coexist, some species fed on numerous plants within a short time to avoid predation pressure while other feed on less plant species within a short time because they have a high population that can withstand predation. The activities of sunbird species on a plant at the same time vary with each species having its niche. Scarlet-chested sunbirds were observed to probe more plants which was highly significant and of great ecological value, in both self and cross pollination. Plants species frequently utilised by the sunbird species had colourful and attractive flowers such as; *Corymbia terroliana*, *Hamelia patens* and *Spathodea campanulata*. There is need to plant more of these so that the species of

sunbirds which are excellent pollinators can be conserved.

### Competing interests

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