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POPULATION DENSITY AND DISTRIBUTION OF SQUIRRELS (*Sciurus spp*) IN UNIVERSITY OF IBADAN BOTANICAL GARDEN, SOUTHWESTERN NIGERIA

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ABSTRACT

The population status of squirrels at the Botanical Garden of the University of Ibadan (UIBG) in Southwestern Nigeria was assessed in this study. Total Count (TC) and Fixed Line transects were employed to collect data; GPS was used to establish five 0.4 km transects that were censured for squirrel species using standard technique. The information was analyzed using descriptive statistics. Eighty-seven squirrels belonging to 3 species: Funisciurus anerythrus (48.7%, 20.5/km), Heliosciurus gambianus (33.3%, 1.5/km) and Xerus erythropus (18.4%, 8.5/km) were recorded for abundance and density across sites respectively. Squirrels were sighted in clusters of one (73.6%), two (23.0%), three (2.3%) and four (1.1%) respectively. Encounter rate of squirrels was high (≥0.5) across all transects. 26 species of trees were identified belonging to 14 families of which Fabaceae and Moraceae had the highest occurrence (35.71%), while a total of 75 trees was recorded in squirrel habitat, Albizia lebbeck **have the highest** ***(13.33%) abundance,*** **followed by** ***Elaeis guineensis*** **(9.33%).** ***The habitat was dominated by litter (45.0 – 57.5%) and grasses (35.0 – 40.0%). The presence of these squirrel species and the density may be an implication of the habitat quality in terms of food availability, sleeping sites, level of disturbance and general management of the garden. Therefore, proper management should be guaranteed.***

Keywords: University of Ibadan Botanical Garden, Squirrel, Conservation, Population

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INTRODUCTION

Squirrels are small or medium size (Nowak, 1991) rodents from the family Sciuridae. Some live predominantly on the ground such as the ground squirrels while others on trees (tree squirrels). There are other types like the flying squirrels, prairie dogs, chipmunks amongst other rodents. They are naturally found in virtually all continents except in Australia where it was introduced by humans (Thorington *et al.*, 2005). They live in almost every habitat, from tropical rainforest to semiarid desert, avoiding only the high Polar Regions and the driest of deserts. They are predominantly herbivorous, subsisting on seeds and nuts, but many will eat insects and even small vertebrates.

Squirrels are important preys for a vast array of predators including predators that are threatened or endangered. Squirrels are also essential in the regeneration of forests around the world through their seed dispersal activities. They also serve as host to a number of parasites such as fleas, mites and ticks. These parasites are known for causing the transfer of a number of diseases, which are of economic importance (Gurnell, 1987; Thorington and Ferrell, 2006). Apart from in-situ locations like the National Park, Game reserves and other similar in-situ locations, Botanical gardens are some of the habitat where squirrels can be found in an urban setting. Botanic Gardens Conservation International (BGCI, 2016) defined botanical garden as an establishment that houses

documented collections of living plants for conservation, display, teaching, and scientific research. They are sometimes referred to as parks, but they are well-kept parks with a diverse range of plants that are appropriately labeled with scientific names for simple identification (Onefeli, 2019). There are around 480 Botanical Gardens globally that house/accommodate major tree and animal species (Hawkins, 2008), whereas there are approximately 16 Botanical Gardens in Nigeria that contain various living plants and taxa (Anon, 2018).

As a result, population studies are an important tool for quickly tracking the progress level of species decline in their respective habitat. When past and present survey results are compared, it can be used to determine management effectiveness as well as for record keeping to ensure proper species management. Even though the primary goal of botanical gardens is to conserve flora species, the flora species also serve as a home for a variety of wildlife, including insects, reptiles, birds, rodents, and a variety of other small and medium-sized fauna; all of this, when combined, contributes to the urban ecosystem, as most of these gardens are located in urban areas. Efforts to checkmate their population from time to time would show the habitat quality. Squirrels are very important in the ecosystem and their population have been reported to decline due to factors like poor habitat management, land use change, habitat fragmentation and deforestation (Hoffmann *et al.*, 2003; Anak, M., *et al*., 2013; Baltag E. S., 2014 and Hegyeli, Z., 2021), unfortunately, this species has been given little attention. Lack of accurate or adequate information on population status of this species may limit their proper management which is an important factor in sciurid conservation.

MATERIALS AND METHODS

This research was conducted in the University of Ibadan Botanical Garden in Ibadan, Oyo State in southwest Nigeria. It is located on North-South on latitude 7.458778°N and longitude 3.89615°N and Latitude 7.455388°N and Longitude 3.8966774°N on an elevation range of 277m above sea level, site covers an area of 100 acres in the northern end of the University of Ibadan. It is bounded by Ajibode-Apete river and Ajibode residential community, a fast-growing semi-urban settlement to the north. The dry season occurs between November and March (Alarape *et al.*, 2015). The garden covers a land area of about 40 hectares out of which only about 70% (28 Hectares) have been developed. The developed area consists of smaller gardens operating as sections (Alarape *et al.*, 2015).

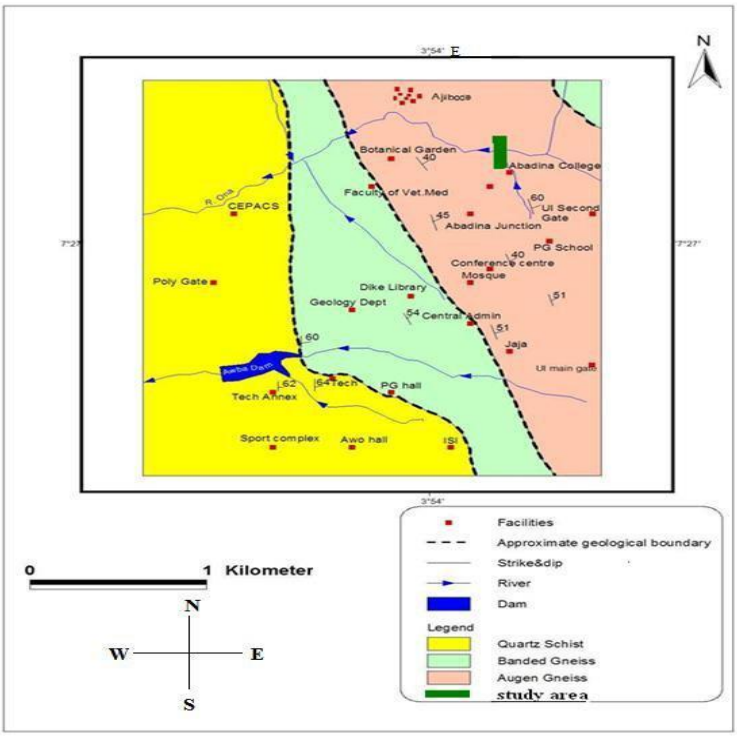

Figure 1: Map Showing Location of U.I Botanical Garden

All squirrels sighted and heard at interval within each line transect were documented, that is the number of groups, number of individuals, sighting distance, perpendicular distance and activities when observed. Each transect was visited twice a day, once in the morning (between 0730hrs and 1000hrs) and evening (between 1630hrs and 1900hrs), six times a week for eight (8) weeks. The number of each individual counted within each transect is recorded and averaged.
Population size can then be estimated using the formula:

$N = (A/a) \times n$ …… (1)

Where:
N = the estimated total population size
A = the total study area
a = the area of the transect
n = the number of organisms per transect

Population Density of Squirrels
The density of squirrels in the botanical garden was calculated using the Minimum Number Alive (MNA). This method provides an estimate of the number of individuals thought to be present at a given transect session.
Population density were estimated as follows:

$$D = \frac{n}{(2al)} \quad \text{……. (2)}$$

Where D = animal density, n = number of animals, l = length of transect and a = half the strip width.

Distribution of Squirrels
The distribution of squirrels in botanical garden were observed with the habitat types present, encounter rates were calculated as the ratio of the total number of individuals sighted to the total effort (km) during the survey period.

$$ER = \frac{\text{Total number of individual squirrels sighted}}{\text{Total Effort (km)}} \quad \text{…… ..(3)}$$

Where: ER = Encounter Rate
In comparing the habitat preference of squirrels, encounter rates from the five transects were pooled together and analysed.

Vegetation Survey

For the vegetation survey, all trees along habitats where squirrels were encountered were enumerated sampling with laid out quadrants' plots on a distance of 50m with reference to each marked point count. Metre tape was used to take measurement of habitat. In each round quadrant, the extent of canopy cover, ground cover and litter cover were determined in percentages. All the tree species within the quadrants were identified up to the species level with the assistance of a plant taxonomist. Herb composition was assessed using the Line Intercept method, identifying the marked object/point on the field, viz: grasses, litter, burnt vegetation, herbs/forbs, bare ground etc.

RESULTS
Abundance, Population Density and Distribution of Squirrels
A total of 87 squirrels were counted with 64 (73.6%) sighted individually, 20 (23%) in cluster of two, 2 (2.3%) in cluster of three and 1 (1.1%) in cluster of four, respectively, across transects (Table 1).

Table 2 presented the sighting index across the transects which are 17.24%, 21.84%, 19.3%, 18.39 and 22.98% for Transect of 1,2,3,4 and 5 respectively. Transect 5 (22.98%) had the highest sighting index, followed by Transect 2 (21.84%). The least is Transect 1 (17.24%.

Table 3 presented the abundance of each species across the transects in UIBG. Three species of Squirrels were identified viz: Thomas' rope squirrel with the highest mean (8.2), followed by Gambian sun squirrel (5.8) and Striped ground squirrel with the least mean (3.4). T1 has the highest abundance of Thomas' rope squirrel (13) while striped ground squirrel is the least also in T1.

A total of eighty-seven (87) squirrels belonging to three species *Funisciurus anerythrus* (48.7%) *Heliosciurus gambianus* (33.3%) and *Xerus erythropus* (18.4%) were found across the study site (Table 3). *Funisciurus anerythrus* (48.7%) was the highest number sighted and *Heliosciurus gambianus* (33.3%) followed (fig 2).

Table 1: Abundance and size of Squirrel group in UIBG

S/No	Numbers of group or individual sighting	Abundance	Percentage
1	1	64	73.6
2	2	20	23.0
3	3	2	2.3
4	4	1	1.1
TOTAL		**87**	

Table 2: Number of Squirrel across the study site

S/No.	Transect No	Abundance	Sighting Index (%)
1	1	15	17.24
2	2	19	21.84
3	3	17	19.54
4	4	16	18.39
5	5	20	22.98
TOTAL		87	100

Table 3: Species of Squirrels and their abundance in Universityof Ibadan Botanical Garden (UIBG)

S/No	Common Name	Scientific name	TI	T2	T3	T4	T5	Total	Mean size
1	Thomas' rope squirrel	*Funiscurus anerythrus*	13	9	8	3	8	41	8.2
2	Gambian sun squirrel	*Heiosciurus gambianus*	4	8	4	4	9	29	5.8
3	Striped ground squirrel	*Xerus erythropus*	1	3	5	2	6	17	3.4
	TOTAL		**18**	**20**	**17**	**9**	**23**		

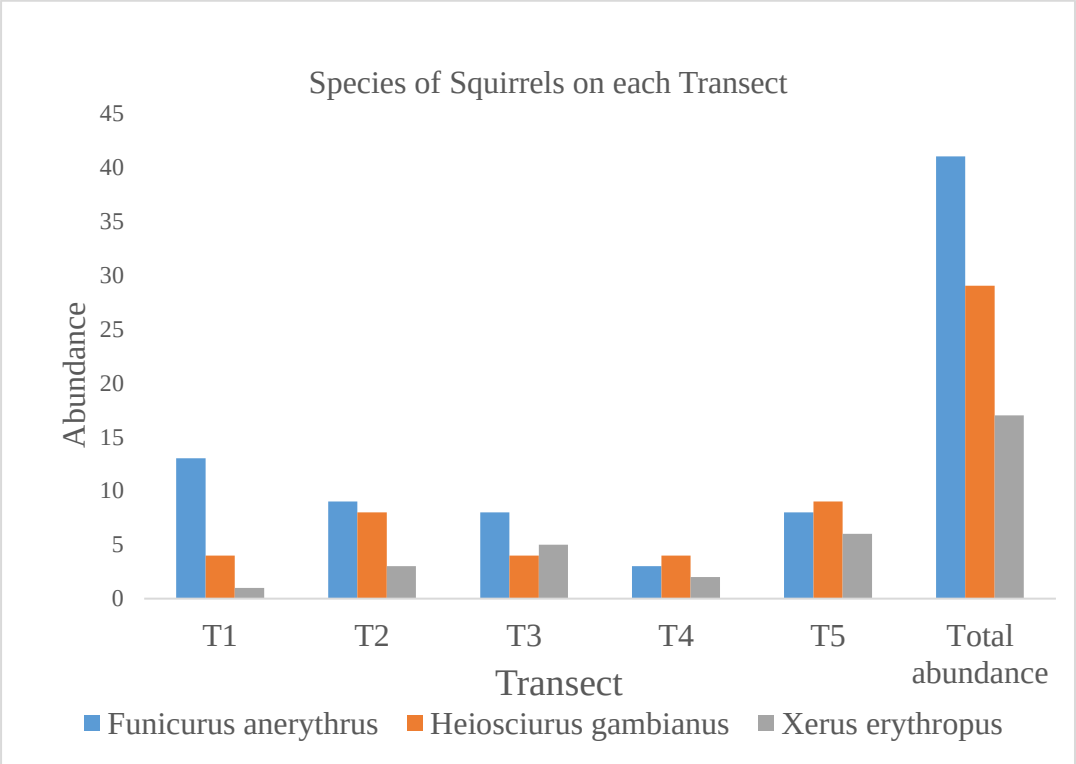

Figure 2: Species abundance of Squirrel in the University of Ibadan Botanical Garden
Density and Encounter rate of Squirrel in the study site

Table 4 showed that *Funiscurus anerythrus* had the highest density per hectare (20.5), followed by *Heiosciurus gambianus* (14.5), and *Xerus erythropus* (8.5). Encounter rate of squirrels in University of Ibadan Botanical Garden was high (≥0.5) across the transects (Table 5).

Table 4: Density of Squirrel in the University of Ibadan Botanical Garden

S/No	Scientific name	Abundance	Density/Ha	Relative density
1	*Funiscurus anerythrus*	41	20.5	47.13
2	*Heiosciurus gambianus*	29	14.5	33.33
3	*Xerus erythropus*	17	8.5	19.54
	TOTAL	87	43.5	100

Area = Transect = 400m by 50m = 100m by100m / 400m by 50m = 0.5ha

Table 5: Encounter rate of squirrel and their mean size in University of Ibadan Botanical Garden

Transect	Size	Effort (km)	Encounter Rate	Mean size
1	15	28.8	0.52	6.0
2	19	28.8	0.66	6.7
3	17	28.8	0.59	5.7
4	16	28.8	0.56	3.0
5	20	28.8	0.69	7.7

Vegetation

Table 6 shows tree species that squirrels are found carrying out their daily activities. A total of 26 different species of trees were recorded, giving a total abundance of 75 trees with *Albizia lebbeck* having the highest *(13.33%) abundance*, followed by *Elaeis guineensis* (9.33%), *Cocos nucifera* (6.67%), *Mangifera indica* (6.67%), *Milicia excelsa* (6.67%), and *Terminalia superba* (6.67%), respectively. *Ceiba pentandra, Celtis broconii, Fiscus exasperate, Khaya senegalensis, Nauclea diderichii, Rauvolvic vomitoria*, and *Senna siamea has the least (1.13%)* abundance, respectively.

Figure 3 revealed that 14 families were present with Fabaceae and Moraceae having the highest occurrence (35.71%) each, followed by Malvaceae, Meliaceae, and Combretaceae (14.28%) each while the least represented families were only 7.14% that is, Ocalidaceae, Cannabaceae, Arecaceae, Palmae, Laminaceae, Anacardiaceae, Rubiaceae and Pinaceae.

Herb Stratum

Assessing the herb stratum composition in the study site, it was observed that all the transects were dominated by litter with highest in T5 (57.5%) and least in TI (45.0); followed by grasses with the highest in T2 and T4 (42.5% each) and least in T3 (7.5%). Burnt vegetation was not recorded in this study while the bare ground encountered was relatively higher than forb/herb across the transects 5.0% and 0.0% respectively (Table 7).

Table 6: Tree species where Squirrels were spotted

S/No	Tree Species	Family	Abundance	Percentage
1.	*Albizia lebbeck*	Fabaceae	10	13.33
2.	*Alstonia boonei*	Apocynaceae	1	1.33
3.	*Artocarpus heterophylus*	Moraceae	2	2.67
4.	*Averrhoa carambola*	Ocalidaceae	2	2.67
5.	*Bombax buonopozence*	Malvaceae	1	1.33
6.	*Cedrela odorata*	Meliaceae	3	4.00
7.	*Ceiba pentandra*	Malvaceae	1	1.13
8.	*Celtis broconii*	Cannabaceae	1	1.13
9.	*Cocos nucifera*	Arecaceae	5	6.67
10.	*Dalbergia latifolia*	Fabaceae	2	2.67
11.	*Elaeis guineensis*	Palmae	7	9.33
12.	*Ficus exasperate*	Moraceae	1	1.13
13	*Ficus lutea*	Moraceae	2	2.67
14.	*Gmelina arborea*	Laminaceae	4	5.33
15	*Khaya senegalensis*	Meliaceae	1	1.13
16.	*Mangifera indica*	Anacardiaceae	5	6.67
17	*Milicia excels*	Moraceae	5	6.67
18.	*Morus mesoxygia*	Moraceae	2	2.67
19.	*Nauclea diderichii*	Rubiaceae	1	1.13
20.	*Pentaclethra macroloba*	Fabaceae	2	2.67
21.	*Pinus caribea*	Pinaceae	2	2.67
22.	*Rauvolvia vomitoria*	Apocynaceae	1	1.13
23.	*Senna siamea*	Fabaceae	1	1.13
24.	*Terminalia catapa*	Combretaceae	4	5.33
25.	*Terminalia superba*	Combretaceae	5	6.67
26	*Tetrapleura tetraptera*	Fabaceae	4	5.33
	Total		**75**	**100**

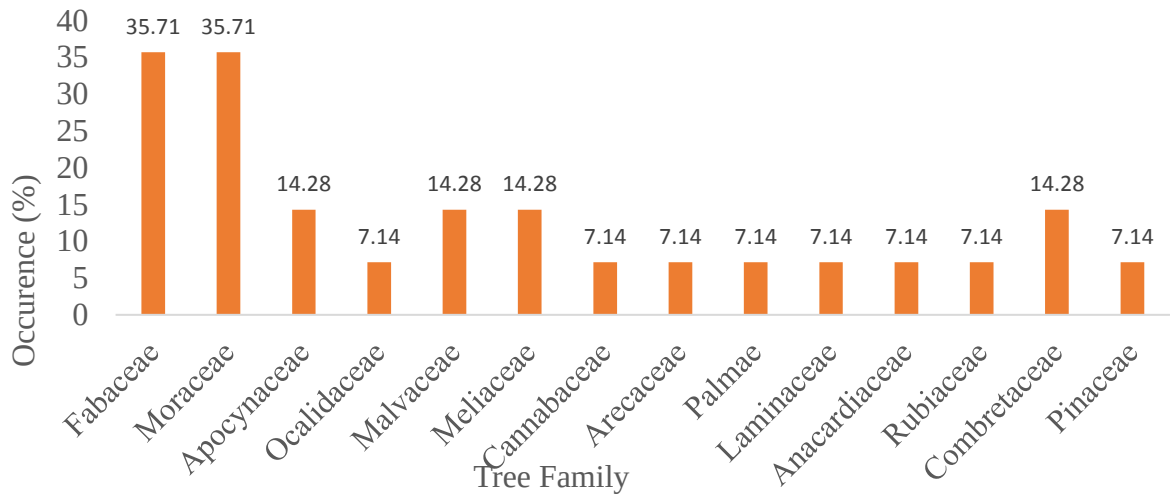

Figure 3: Occurrence (%) of Tree Families in UIBG

Table 7: Herb stratum composition of Squirrel habitat in UIBG

Transect	Litter (%)	Bare ground (%)	Grass (%)	Forb/Herb (%)	Burnt vegetation (%)
T1.	45.0	10.0	40.0	5.0	-
T2.	47.5	10.0	42.5	-	-
T3.	50.0	35.0	7.5	7.5	-
T4.	47.5	5.0	42.5	5.0	-
T5.	57.5	5.0	35.0	2.5	-

DISCUSSION

The diversity of squirrel in the garden is quite low as only three species were recorded. As stated by Koprowski, (2005), diversity of squirrels and its continued persistence are influenced by forestry practices, exotic species, and fire. Hence, it could be as a result of the predominant trees and plant species present in the garden or management practice. Forest destruction, urbanization and other kinds of anthropogenic environmental disturbance can affect species diversity and distribution. Squirrels have been reported to be disturbed by deforestation because of development (Farzaneh *et al.*, 2018), and the study of Onafeli (2019) discovered that there was reduced tree species diversity within the garden due to certain part of the garden that was converted to road and other development within the university. Hence, the reason for the population density of squirrels in the garden. A large proportion of plants depend upon animals for seed dispersal (Herrera and Pellmyr, 2009). However, with a decreasing animal population, the ecosystem would suffer a loss. Likewise, the tree squirrels are also recognized as indicators of forest health condition in rainforests because of their strict dependence on mature trees within the rainforest. Thus, increase or decline in tree cover of the botanical garden will have huge impact on the squirrel population.

Squirrels were observed to carry out their daily activity in group which corroborates the study of McKinney and Fiedler, (2009) who reported that species of tree squirrel resides and carries out their metabolic activities either as individual or in group by depending upon forest trees for seed, food, protection from predators, nesting sites, cover and microclimate for their food storage in the rainforest. Koprowski, (2005) reported that though the diversity and composition of squirrel as well as other small mammals may vary both spatially and temporally, the persistence of squirrel diversity in remnant forests as botanical garden is dependent on the prudent management of the site. Anthropogenic pressures can also have a significant influence: for example, land conversion and defaunation caused by deforestation. Hanski, (1998) reported that squirrels in managed forest are capable of using several tree types, sizes, species including young forest stands, as foraging and moving areas and are able to move across semi-open, clear-cut areas in the course of their metabolic activities. But (Gurnell 1987; Steele and Koprowski 2001) argue that Squirrels mostly rely on mature forests that produce quantities of seed, shaded microclimates, seed storage, and nest cavities. In this case, the Squirrels are found across varying species and sizes of trees which tends to indicate their adaptation to the ecosystem of the Botanical Garden over time.

Squirrels occupy two types of homes, including a permanent tree den as well as a nest of leaves and twigs on a tree crotch above the ground. Large number of Squirrels were found around the litter stratum which has lots of insects, nuts from trees and other food materials, supporting the report by Koprowski (2005), which opined that Squirrels are generally omnivores and feeds on nuts, flowers, leaves seeds, grains, fruit, fungi, buds and Insects especially by juveniles. *Funiscurus species* had the highest population density, distribution and encounter rate. The presence of certain species of animals in any habitat most times can be used to describe the habitat. In Nigeria, *Funiscurus species* has been reported to be found in secondary forests associated with undergrowth of shrubs and creepers, characterized with moderate-sized trees (Linn and Key, 1996; Kingdon *et al.*, 2013). The next in line was the *Heliosciurus species*, which are commonly seen inhabiting wooded savanna and other

grassland with scattered trees and cultivated areas (Grubb and Ekue, 2008). *Xerus erythropus* which had the least density and encounter rate as been reported to inhabit open or disturbed forests and savannah areas, often near cultivated land. The presence of these squirrel species and the density may be an implication of the habitat quality in terms of food availability, sleeping sites, level of disturbance and general management of the garden. Therefore, proper management should be guaranteed.

CONCLUSION

Three species of squirrels belonging to the scuridae family were identified. *Funiscurus spp* had the highest density and encounter rate, followed by *Heliosciurus spp* and *Xerus spp*, with *Xerus spp* having the lowest density and encounter rate. This could be due to a habitat trait or a management component in the garden. It is crucial to emphasize, however, that a considerable proportion of plants rely on animals for seed dispersal, and this is an important part of the plant's biological cycle and a key function for maintaining tropical forest biodiversity at various scales. To improve the conservation status of the Scruidae, it is proposed that this study be carried out on a larger scale, comparing species and populations at different land use types in the University.

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