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The Influence of Fruiting Plants on the Distribution of Tantalus Monkey (*Chlorocebus tantalus tantalus*) of Ngel Nyaki Forest Reserve, Taraba State, Nigeria

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Abstract

This study investigates the influence of fruiting plants on the distribution of Tantalus monkeys (Chlorocebus tantalus tantalus) in the Ngel Nyaki Forest Reserve, Taraba State, Nigeria. The research aims to determine the diversity, abundance, and distribution of fruiting tree species and their relationship with the spatial patterns of Tantalus monkeys across different habitat types. Data were collected over an eight-month period, covering both dry and wet seasons, using direct field observations and ecological survey methods to assess the availability of fruiting trees, primate feeding preferences, and monkey distribution. Results indicate that the presence and abundance of specific fruiting species significantly affect the distribution patterns of Tantalus monkeys, with seasonal fluctuations in fruit availability influencing primate movement and habitat utilization. This study highlights the critical role of fruiting plants in primate ecology and underscores the importance of conserving fruit-bearing tree species to support sustainable primate populations. The findings provide valuable insights for biodiversity conservation efforts and management strategies in montane forest ecosystems.

Keywords: Fruiting, Plant, Distribution, Tantalus, Monkey, Ngel-Nyaki, Forest

INTRODUCTION

The ancestors of primates lived in the trees of rainforests. Many behaviors represent adaptations to life in a complex three-dimensional environment (Groves, 2005). Africa is a continent where animal conservation is of particular importance for several reasons. First, it has a high diversity of primates, with at least 64 recognized primate species: 15 prosimian species, 46 monkey species and 3 ape species (International Union for Conservation of Nature (IUCN, 1996), i.e. primate genera, Nigeria, Equatorial Guinea and Central African Republic (Colin *et al.*, 2006). Historically African forests especially (Ngel Nyaki Forest Forest Reserve, Taraba State) have been highly dynamic, experiencing several cycles of expansion, and in many regions, Forests are always fragmented (Hamilton and Taylor, 1991). Major historical processes such as speciation, extinction and dispersal are important in shaping the current distribution patterns of primates across the continent (Lawes and Eeley, 2000).

Distribution of food species in habitat is important to ensuring the long-term conservation of primates. For primary consumers (mostly primates), the availability and abundance of plant foods are considered the main drivers of population growth, as these changes affect humans in the process of the geographic extent of the distribution area. The dependence of primates on plant foods may lead them to find spatial patterns that reflect the distribution (often in groups) of their preferred foods most especially ripe fruits and little proportion of leaves (van Schaik *et al.,* 1993; Zimmermann *et al.,* 2007; Hopkins, 2016). This dependence explains why seasonal changes in fruit availability are more associated with the distribution of Ateles belzebuth than with the distribution of the frugivorous *Cebus olivaceus* and *Alouatta macconnelli n* (Mourthe, 2014). However, indirect estimates of food availability, such as plant species richness, vegetation type and basal area of preferred food sources, are often used for testing how within-site spatio-temporal differences in habitat influence primate distribution, group size which not be be necessarily be food availability (Thomas, 1991; Anzures-Dadda and Manson, 2007; Gomez-Posada *et al.,* 2011). The ability to assess how spatial and temporal differences in habitat affect the spatial distribution and richness of primates is limited because these measure probabilities are not necessarily indicative of actual food availability. The animal's range is spread across different altitudes. For example, white rhinoceroses are found at 4,700 m in the Hengduan Mountains (Colin *et al.,* 2006), *Beringei beringei* gorillas are found at an altitude of 4,200m in the Ngel Nyaki forest reserve and baboons are found at 5,000m in the Ethiopian Plateau. Species diversity is often

influenced by historical events and the past history of clades. Current conditions associated with high levels of species richness can be traced to environmental factors that determine the distribution and differentiation of that clade. Furthermore, current conditions and events, such as changes in habitat and climate, continue to influence species diversity by removing species from some areas and other areas (Hamilton and Taylor, 1991). Primates constitute 25% to 40% of forest fruit eaters (by weight) and play an important role in the community by dispersing seeds of various tree species. Africa is a continent of particular interest for the conservation of world's animals for different reasons (Grubb *et al.,* 2003). Primate populations around the world are heavily impacted by logging, deforestation, hunting and other activities. Chinese primates are being killed. Therefore, studies using direct estimates of food availability (Wallace, 2008; Marshall *et al.,* 2009; Hanya and Chapman, 2013; Hopkins, 2016) are needed to address this issue. This study used direct and indirect estimates to test the hypothesis that plant species availability and tree abundance affect the habitat of a common primate (*Chlorocebus tantalus tantalus*) in Ngel Nyaki Forest Reserve. Based on the difference in plant food availability and primate dependence on seasonal plants (Chaves and Bicca-Marques, 2013, 2016), particularly those rich in energy and/or protein (Lambert, 2011; Lambert and Rothman, 2015); Righini *et al.,* 2015), we predict that the presence of fruit (especially ripe fruit and young leaves) will drive the dispersal of the monkey group. We also assume that there is no relationship between the presence of mature leaves and red distribution because this product is a poor food source (Marshall *et al.,* 2009; Lambert, 2011). The seasonality of fruit production in the forest and the distribution of fruit trees across the landscape lead to changes in the distribution of frugivorous primates (Ricklefs, 1990). The difference between food availability and forage availability affects primate products, with the likelihood of some species taking fruits or small leaves being increased as the landscape becomes richer.

Geographical and temporal variations can occur in distribution and phenology (van Schaik *et al.,* 1993; Chapman et al., 2005; Zimmerman *et al.,* 2007). Strong environmental factors of phenological patterns in plant growth and reproduction include precipitation, photoperiod, and extreme weather events (such as hurricanes and El Nino oscillations). Such seasonal or unanticipated changes can modify food availability for large consumers (van Schaik *et al.,* 1993; Chapman *et al.,* 2005), potentially changing plant-animal interactions and contributing to the migration of animals into various locations. To find biogeographic patterns, conduct surveys over wide (or vast) geographical scales. Occasionally, this involves comparing

isolated populations that are thousands or even hundreds of kilometers away. At this scale, vertebrate richness (Kay *et al.,* 1997) and density (Janson and Chapman, 1999; Chapman *et al.,* 2004; Marshall *et al.,* 2009) are primarily determined by the availability of food and the number of plants in tropical forests. The aim of this study is to assess the influence of fruiting plants on the distribution of Tantalus monkey (*Chlorocebus tantalus tantalus*)of Ngel Nyaki Forest Reserve, Taraba State, Nigeria

METHODS

Description of Study Area

Figures 1, 2, and 3 illustrate the location of Taraba State, Nigeria's Ngel Nyaki Forest Reserve (7°30N, 11°30E) on the western slopes of the Mambilla Plateau (Chapman *et al.,* 2004). Chapman *et al.* (2004) and Beck and Chapman (2008) discuss how yearly fires and cow grazing alter the coastal forest patches within the grassland matrix. Located at an elevation of 1,400–1,600 meters, the 5.3 square kilometer Ngel Nyaki montane forest. The Nigerian Mountain Forest Programme (NMFP) provides climate data that indicates the forest is of a dry type with an average annual rainfall of 1,800 mm, with the majority of the rainfall occurring during the rainy season between mid- and late-April. Akinsoji (1994). According to NMFP meteorological statistics, the monthly average temperature does not rise above 30 °C. One of Nigeria's most varied woods, Ngel Nyaki Forest is home to a wide variety of plant species, some of which are listed on the IUCN Red List (Chapman *et al.* 2004). These include the following: *Eriocaulon asteroids, Eriocaulon bamendae, Prunus africana, Polygala tenuicaulis, Dombeya cf. ledermanii, Pouteria altissima, Chassalia laikomensis, Carex preusii, Puttynose monkeys, Black and white Colobus monkeys,* and *Tantalus monkeys.*

Fig 1: Map of Nigeria showing Taraba State

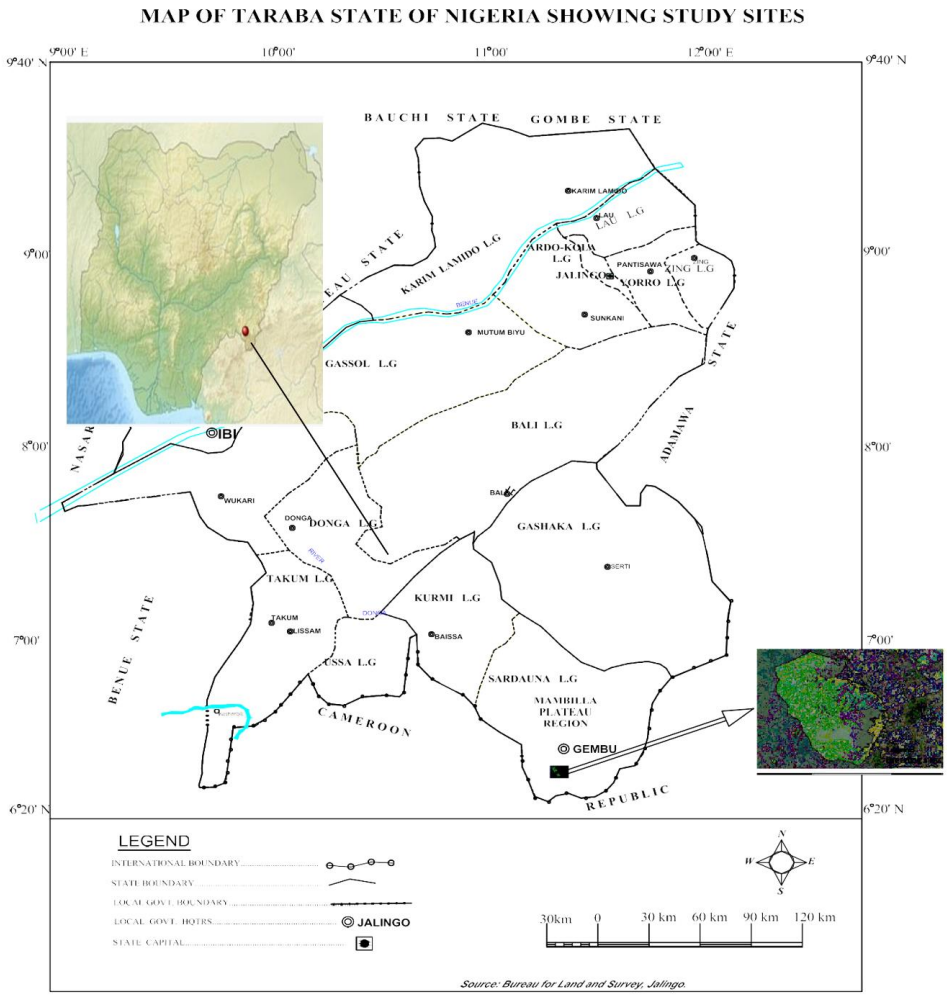

Fig 2: Map of Taraba State showing Ngel Nyaki Forest Reserve

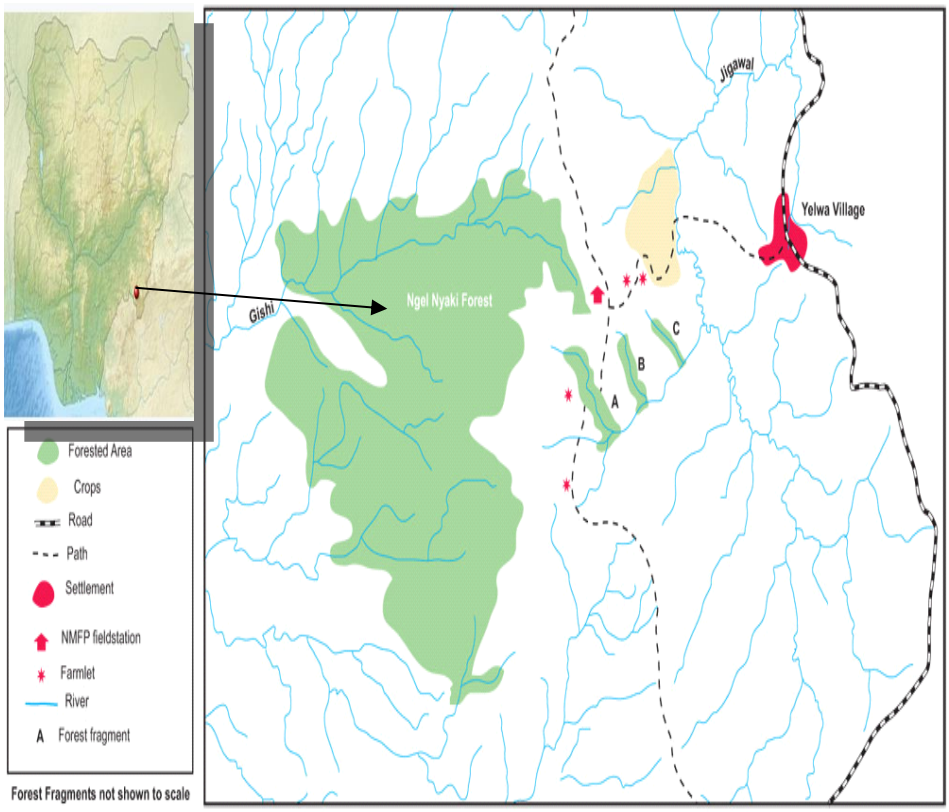

Fig 3: Map of Central Taraba State showing Ngel Nyaki Forest Reserve

Methods of Data Collection

Identification and Enumeration of Fruit Trees

To gain an insight into the fruit tree species composition of the three (3) selected sites (Forest edge, Forest fragment and Grassland), five (5) plots of 20m x 20m was measured on each line transect (700m) established taking into consideration the landscape configuration (Peres, 1999). All fruit trees were identified to species level and counted using direct observation while moving on foot throughout the whole study sites. Fruit tree species were identified using Keay *et al.* (1989).

Studies on the phenological survey to investigate spatial and temporal patterns of leaves, immature and mature fruit availability and how this may affect pattern of habitat use by Tantalus monkeys using a standardized protocols were used (Peres, 1999).

Enumeration of Tantalus Monkey

Line transect is the most commonly used method in forest primate abundance studies (Chapman and Lambert, 2000). The Tantalus Monkeys present at the various sites and the number of individuals encountered was recorded for each respective habitat.

Data collection was aided by direct observations, telescope and binocular. Tantalus monkey (*Chlorocebus tantalus tantalus*) in the area were counted by dividing or partitioning the forest reserve into 3 (three) sites/habitat (Forest edge, Forest fragment and Grassland) and each of the habitat were monitored using a line transect of 700m to estimate their population.

Statistical Analysis

(SPSS) version 25.0 was used to analyze the data collected during the survey. Chi- square test was used to test association between fruiting plant and distribution of Tantalus monkey while Student t-test was used whether the fruiting plants contribute to the distribution of primate (Tantalus monkey) in Ngel Nyaki Forest Reserve. One-way ANOVA was used to compare the relative abundance and distribution of Tantalus monkey in each habitat at 5% level of significance.

Shannon-Wiener index (H') which is given in the following formula was used to compare fruiting trees diversity and similarity among habitats types and seasons (Krebs, 1987; Gonfa *et al*., 2015).

$$H' = -\sum P_i \times \ln(P_i)$$

Where;

H'denotes the diversity indices and pi = number of individuals of species/total number of samples = number of species or species richness. Relative abundance is calculated by dividing the number of individuals of a species by the total number of individuals of all species, while, Pearson's correlation coefficient was used on the data to determine significant relationships between distributions of Tantalus monkey within the reserve with respect to fruiting trees abundance.

RESULTS

Fruiting Tree Species Checklist of Ngel Nyaki Forest Reserve

According to Table 1, forty-two (42) fruit tree species in twenty-three (23) families were recorded across the habitat types; thirty (30) were recorded at the Forest Edge, twenty-four (24) at the Forest Fragment and twenty-two (22) in the Grassland. Rubiaceae (6) (*Psychotria peduncularis*, *Psychotria succulent*, *Canthium sp.*, *Oxyanthus speciosus*, *Psychotria* sp. and *Gaertnera paniculata*) recorded the highest number of fruiting tree species followed by Phyllanthaceae (*Antidesma venosum*, *Margaritari discoidea*, *Bridelia speciosa*, *Antidesma sp., and Hymenocardia acida*) recording five (5) species, Myrtaceae (*Syzygium guineense*, *Eugenia gilgii*, *Syzygium macrocarpa*, *Maesa lanceolata*) recorded four (4) species each, then Guttiferae, Araliaceae, Combretaceae, Leguminosae-Mimsoideae, Clusiaceae, Apocynaceae and Sapindaceae recording two (2) species each and the least were Buddlejaceae, Moraceae, Leeaceae, Meliaceae, Leguminosae-Caesalphinoideae, Rutaceae, Ebenaceae, Rosaceae, Euphorbiaceae, Annonaceae, Monimiaceae, Anacardiaceae and Verbenaceae ecah recording one (1) species.

The following plants were recorded across the three (3) habitat types: *Syzygium guineense, Psorospermum aurantiacum, Maesa lanceolata, Albizia gummifera, Psychotria peduncularis, Psychotria succulent, Bridelia speciosa, Antidesma venosum,Cronton macrostachyus, Ficus sp.,* and*Anthonotha noldeae*; two (2) habitat types (*Polyscias fulva, Combretum molle, Harungana madagascariensis, Canthium sp.***,** *Eugenia gilgii, Leae guineensis*, *Garcinia smeathmannii*, *Clausena anisata, Gaertnera paniculata, Entada abyssinica, Isolona deightonii, Deinbollia onanae*) and one (1) habitat type (*Nuxzia congesta,Carapa oreophyla, Symphonia globulifera, Diospyros monbutensis, Psychotria sp. Prunus africana, Antidesma venosum, Landolphia, Rauvolfia vomitoria, Xymalos monospora, Allophylus africanus, Margaritaria discoidea, Terminaella ivorense, Lannea sp., Vitex doniana, Hymenocardia acida, Syzygium macrocarpa, Oxyanthus speciosus, Polycias*).

Table 2 shows the Shannon-Weiner Diversity Index for fruit tree species at Ngel Nyaki Forest Reserve recording (H' = 2.87589) and 792 individual fruit tree species.

In terms of overall abundance, *Garcinia smeathmannii* (143) in Clusiaceae Family took the lead, followed by *Psychotria peduncularis* (126) in Rubiaceae Family then *Psorospemum aurantiacum* (82) in Guttiferae Family and *Bridelia speciosa* (76) in Phyllanthaceae Family.

Table 1: Composition of fruit tree Species Checklist of Ngel Nyaki Forest Reserve

Family	Species	Forest Edge	Forest Fragment	Grassland
Myrtaceae	*Syzygium guineensis*	+	+	+
	Eugenia gilgie	+	+	-
	Maesa lanceolata	+	+	+
	Syzygium macrocarpa	-	-	+
Araliaceae	*Polyscias fulva*	+	+	-
	Polycias sp.	-	-	+
Buddlejaceae	*Nuxzia congesta*	+	-	-
Guttiferae	*Psorospermum aurantiacum*	+	+	+
	Harungana madagascariense	+	-	+
Leguminosae-Mimsoideae	*Albizia gummifera*	+	+	+
	Entada abyssinica	+	-	+
Rubiaceae	*Psychotria peduncularis*	+	+	+
	Psychotria succulent	+	+	+
	Canthium sp.	+	+	-
	Oxyanthus speciosus	-	-	+
	Psychotria sp.	+	-	-
	Gaertnera paniculata	+	+	-
Euphorbiaceae	*Croton macrostachyus*	+	+	+
Phyllanthaceae	*Bridelia speciosa*	+	+	+
	Antidesma venosum	+	+	+
	Antidesma sp.	+	-	-
	Margaritaria discoidea	-	+	-
	Hymenocardia acida	-	-	+
Combretaceae	*Combretum molle*	+	-	+
	Terminaella ivorense	-	-	+
Moraceae	*Ficus sp.*	+	+	+
Leeaceae	*Leea guineensis*	+	+	-
Meliaceae	*Carapa oreophila*	+	-	-
Clusiaceae	*Garcinia smeathmannii*	+	+	-
	Symphonia globulifera	+	-	-
Leguminosae-Caesalphinoideae	*Anthonoda noldeae*	+	+	+

Rutaceae	*Clausena anisate*	+	+	-
Ebenaceae	*Diospyros monbuttensis*	+	-	-
Rosaceae	*Prunus Africana*	+	-	-
Apocynaceae	*Landolphia*	+	-	-
	Rauvolfia vomitoria	-	+	-
Annonaceae	*Isolona heinsenii*	+	+	-
Monimiaceae	*Xymalos monospora*	-	+	-
Sapindaceae	*Allophylus africanus*	-	+	-
	Deinbollia pinnata	-	+	+
Anacardiaceae	*Lannea sp.*	-	-	+
Verbenaceae	*Vitex doniana*	-	-	+

Where

+ = Plant species present

– = Plant species absent

Table 2: Shannon-Weiner Diversity Index for Fruit Trees Sp.

S/N	Species	Abundance	P_i	$\ln(P_i)$	$\ln(P_i)$
1	*Bridelia speciose*	76	0.087558	-2.43546	-0.21324
2	*Canthium vulgare*	7	0.008065	-4.82028	-0.03887
3	*Albizia gummifera*	12	0.013825	-4.28129	-0.05919
4	*Ficus sp*	19	0.021889	-3.82175	-0.08366
5	*Maesa lanceolate*	18	0.020737	-3.87582	-0.08037
6	*Psorospermum aurantiacum*	82	0.09447	-2.35947	-0.2229
7	*Syzygium guineensis*	61	0.070276	-2.65532	-0.18661
8	*Cluasena anisate*	2	0.002304	-6.07304	-0.01399
9	*Rauvolfia vomitoria*	8	0.009217	-4.68675	-0.0432
10	*Garcinia smeathmannii*	143	0.164747	-1.80335	-0.2971
11	*Xymalos monospora*	1	0.001152	-6.76619	-0.0078
12	*Anthonotha noldeae*	18	0.020737	-3.87582	-0.08037
13	*Eugenia gilgie*	9	0.010369	-4.56897	-0.04737
14	*Leea guineeense*	17	0.019585	-3.93298	-0.07703
15	*Antidesma venosum*	5	0.00576	-5.15675	-0.0297
15	*Allophylus africanus*	7	0.008065	-4.82028	-0.03887
16	*Psychotria succulent*	36	0.041475	-3.18267	-0.132
17	*Psychotria peduncularis*	126	0.145161	-1.92991	-0.28015

18	*Gaertnera paniculata*	2	0.002304	-6.07304	-0.01399
19	*Ficus lutea*	2	0.002304	-6.07304	-0.01399
20	*Margaritaria discoidea*	1	0.001152	-6.76619	-0.0078
21	*Deinbollia onanae*	6	0.006912	-4.97443	-0.03439
22	*Nuxzia congesta*	20	0.023041	-3.77046	-0.08688
23	*Croton macrostachys sp.*	9	0.010369	-4.56897	-0.04737
24	*Isolona heinsenii*	2	0.002304	-6.07304	-0.01399
25	*Clausena anisata*	20	0.023041	-3.77046	-0.08688
26	*Polyscias fulva*	3	0.003456	-5.66758	-0.01959
27	*Combretum molle*	3	0.003456	-5.66758	-0.01959
28	*Harungana madagascariense*	50	0.057604	-2.85417	-0.16441
29	*Carapa oreophila*	63	0.072581	-2.62306	-0.19038
30	*Symphonia globulifera*	3	0.003456	-5.66758	-0.01959
31	*Diospyros monbuttensis*	3	0.003456	-5.66758	-0.01959
32	*Psychotria sp.*	10	0.011521	-4.46361	-0.05142
33	*Prunus Africana*	2	0.002304	-6.07304	-0.01399
34	*Antidesma venosum*	6	0.006912	-4.97443	-0.03439
35	*Entada abyssinica*	7	0.008065	-4.82028	-0.03887
36	*Landolphia*	3	0.003456	-5.66758	-0.01959
37	*Terminaella ivorense*	1	0.001152	-6.76619	-0.0078
38	*Lannea sp.*	1	0.001152	-6.76619	-0.0078
39	*Vitex doniana*	1	0.001152	-6.76619	-0.0078
40	*Hymenocardia acida*	1	0.001152	-6.76619	-0.0078
41	*Syzygium macrocarpa*	1	0.001152	-6.76619	-0.0078
42	*Oxyanthus speciosus*	1	0.001152	-6.76619	-0.0078
		792			**-2.87589**

H'=2.87589

Diversity of Fruiting Trees Species of Ngel Nyaki Forest Reserve

At the Forest Edge, Shannon-Weiner Diversity Index recorded (H'=2.62) fruit tree species with a composition of 411 species; the most abundant fruit tree species was *Psychotria peduncularis* (91) followed by *Carapa oreophila* (63) then *Garcinia smeathmannii* (55) while the least abundant species were; *Gartiera paniculata* (1) *Entada abyssinica* (1)and *Isolona heinsenii* (1) (Table 3)

According to Table 4, Shannon-Weiner Diversity Index recorded (H'=2.44) fruit tree species with a composition of 254 species, the most abundant fruit tree species was *Garcinia smeathmanni* (88) followed by *Psychotria peduncularis* (30) then *Syzygium guineense* (17); the least recorded one (1) species each, they are: *Polyscias fulva, Gaertnera paniculata, Isolona heinsenii, Xymalos monospora,* and *Margaritaria discoidea.*

At the Grassland,Shannon-Weiner Diversity Index was (H'=2.11), fruit tree species with a composition of 204 species, the most abundant fruit tree species was *Bridelia speciosa* (60) followed by *Harungana madagascariense* (45) then *Syzygium guineensis* (31); the least were *Albizia gummifera, Antidesma venosum, Combretum molle, Ficus sp., Terminaella ivorense, Deinbollia onanae, Lannea sp., Vitex doniana, Syzygium macrocarpa, Oxyanthus speciosus, Polycias fulva and Hymenocardia acida* recording one (1) fruit tree species each (Table 5).

According to Table 6, Forest Edge was statistically significant (P<0.05) at 2.225778 while Forest Fragment and Grassland were not statistically significant (P>0.5) at 0.172127 and 1.536135 respectively.

Table 3: Abundance of fruit tree Species at Forest Edge

S/N	Species	Abundance	P_i	$\ln(P_i)$	$\ln(P_i)$
1	*Syzygium guineensis*	13	0.029279	-3.53088	-0.10338
2	*Polyscias fulva*	2	0.004505	-5.40268	-0.02434
3	*Nuxzia congesta*	19	0.042793	-3.15139	-0.13486
4	*Psorospermum aurantiacum*	48	0.108108	-2.22462	-0.2405
5	*Maesa lanceolata*	12	0.027027	-3.61092	-0.09759
6	*Albizia gummifera*	8	0.018018	-4.01638	-0.07237
7	*Psychotria pendicularis*	91	0.204955	-1.58497	-0.32485
8	*Psychotria succulent*	15	0.033784	-3.38777	-0.11445
9	*Bridelia speciosa*	10	0.022523	-3.79324	-0.08543
10	*Antidesma venosum*	3	0.006757	-4.99721	-0.03376
11	*Combretum molle*	2	0.004505	-5.40268	-0.02434
12	*Harungana madagascariense*	5	0.011261	-4.48639	-0.05052
13	*Canthium*	3	0.006757	-4.99721	-0.03376
14	*Eugenia gilgii*	6	0.013514	-4.30407	-0.05816
15	*Croton macrostachyus*	2	0.004505	-5.40268	-0.02434
16	*Ficus sp.*	6	0.013514	-4.30407	-0.05816
17	*Leea guineensis*	7	0.015766	-4.14991	-0.06543

18	*Carapa oreophila*	63	0.141892	-1.95269	-0.27707
19	*Garcinia smeathmannii*	55	0.248869	-1.39083	-0.34613
20	*Anthonotha noldeae*	5	0.011261	-4.48639	-0.05052
21	*Symphonia globulifera*	3	0.006757	-4.99721	-0.03376
22	*Clausena anisata*	7	0.015766	-4.14991	-0.06543
23	*Diospyros monbuttensis*	3	0.006757	-4.99721	-0.03376
24	*Gaertnera paniculata*	1	0.002252	-6.09582	-0.01373
25	*Psychotria sp.*	10	0.022523	-3.79324	-0.08543
26	*Prunus Africana*	2	0.004505	-5.40268	-0.02434
27	*Antidesma venosum*	5	0.011261	-4.48639	-0.05052
28	*Entada abyssinica*	1	0.002252	-6.09582	-0.01373
29	*Landolphia*	3	0.006757	-4.99721	-0.03376
30	*Isolona heinsenii*	1	0.002252	-6.09582	-0.01373
		411			**-2.62**

H'=2.62

Table 4: Abundance of fruit tree Species at Forest Fragment

S/N	Species	Abundance	P_i	$\ln(P_i)$	$\ln(P_i)$
1	*Syzygium guineensis*	17	0.076923	-2.56495	-0.1973
2	*Polyscias fulva*	1	0.004525	-5.39816	-0.02443
3	*Psorospermum aurantiacum*	14	0.063348	-2.75911	-0.17478
4	*Maesa lanceolata*	4	0.0181	-4.01187	-0.07261
5	*Albizia gummifera*	3	0.013575	-4.29955	-0.05836
6	*Psychotria peduncularis*	30	0.135747	-1.99697	-0.27108
7	*Psychotria succulent*	6	0.027149	-3.6064	-0.09791
8	*Bridelia speciosa*	7	0.031674	-3.45225	-0.10935
9	*Antidesma venosum*	2	0.00905	-4.70502	-0.04258
10	*Canthium*	4	0.0181	-4.01187	-0.07261
11	*Eugenia gilgii*	3	0.013575	-4.29955	-0.05836
12	*Cronton macrostachyus*	3	0.013575	-4.29955	-0.05836
13	*Ficus sp.*	14	0.063348	-2.75911	-0.17478
14	*Leea guineensis*	10	0.045249	-3.09558	-0.14007
15	*Garcinia smeathmannii*	88	0.198198	-1.61849	-0.32078
16	*Anthonotha noldeae*	9	0.040724	-3.20094	-0.13035
17	*Clausena anisata*	15	0.067873	-2.69011	-0.18259

18	*Gartiera paniculata*	1	0.004525	-5.39816	-0.02443
19	*Isolona heinsenii*	1	0.004525	-5.39816	-0.02443
20	*Rauvolfia vomitoria*	8	0.036199	-3.31872	-0.12013
21	*Xymalos monospora*	1	0.004525	-5.39816	-0.02443
22	*Allophylus africanus*	7	0.031674	-3.45225	-0.10935
23	*Margaritaria discoidea*	1	0.004525	-5.39816	-0.02443
24	*Deinbollia onanae*	5	0.022624	-3.78872	-0.08572
		254			**-2.44**

Table 5: Abundance of fruit tree Species at Grassland

S/N	Species	Abundance	P_i	$\ln(P_i)$	$\ln(P_i)$
1	*Syzygium guineensis*	31	0.151961	-1.88413	-0.28631
2	*Psorospermum aurantiacum*	20	0.098039	-2.32239	-0.22769
3	*Maesa lanceolata*	2	0.009804	-4.62497	-0.04534
4	*Albizia gummifera*	1	0.004902	-5.31812	-0.02607
5	*Psychotria peduncularis*	5	0.02451	-3.70868	-0.0909
6	*Psychotria succulent*	15	0.073529	-2.61007	-0.19192
7	*Bridelia speciosa*	60	0.294118	-1.22378	-0.35993
8	*Antidesma venosum*	1	0.004902	-5.31812	-0.02607
9	*Combretum molle*	1	0.004902	-5.31812	-0.02607
10	*Harungana madagascariense*	45	0.220588	-1.51146	-0.33341
11	*Cronton macrostachyus*	4	0.019608	-3.93183	-0.07709
12	*Ficus sp.*	1	0.004902	-5.31812	-0.02607
13	*Anthonotha noldeae*	4	0.019608	-3.93183	-0.07709
14	*Entada abyssinica*	6	0.029412	-3.52636	-0.10372
15	*Deinbollia onanae*	1	0.004902	-5.31812	-0.02607
16	*Terminaella ivorense*	1	0.004902	-5.31812	-0.02607
17	*Lannea sp.*	1	0.004902	-5.31812	-0.02607
18	*Vitex doniana*	1	0.004902	-5.31812	-0.02607
19	*Hymenocardia acida*	1	0.004902	-5.31812	-0.02607
20	*Syzygium macrocarpa*	1	0.004902	-5.31812	-0.02607
21	*Oxyanthus speciosus*	1	0.004902	-5.31812	-0.02607
22	*Polycias fulva*	1	0.004902	-5.31812	-0.02607
	Total	**204**			**2.11**

Table 6: t-test for Fruit Tree Species Identified in Each Habitat

	Forest Edge	Forest Fragment	Grassland
Mean	10.57143	5.261905	10.57143
Variance	465.2753	100.9785	465.2753
Pearson Correlation	0.754894	0.092514	0.071753
t-Stat	2.225778	0.172127	1.536135
P(T<=t) one-tail	0.015794	0.432092	0.066094
Observations	**411**	**254**	**204**

The Abundance and Distribution of Tantalus Monkey Across Each Habitat.

According to Table 7, Forest Fragment (472; 49.9%) recorded the highest number of sighted individuals, followed by Forest Edge (363; 38.3%) and the least was grassland (112; 11.8%). Table 7 also indicate that, of the (472) individuals counted in the forest fragment, (257) were found feeding on fruits, (199) fed on leaves while (16) fed on flowers; also, of the (363) individuals of Tantalus monkeys counted at the Forest edge, (222) fed on fruits, (122) on leaves while (19) on flowers and of the (112) individuals found in the grassland, (61) fed on fruits, (51) on leaves and none on flowers.

Figure 4 shows the monthly abundance of Tantalus monkeys recorded across each habitat: forest edge recorded the highest value of (30) in the month of January followed by grassland (25) while forest fragment had the least value of (20). In the month of February, forest edge had the highest value of (54), followed by forest fragment (33) while the grassland recorded the least value of (25). In the month of March, forest fragment recorded the highest value of (92), followed by forest edge (70) while grassland (24) recorded the least. In the month of April, forest fragment recorded the highest value of (74), followed by forest edge (23) while grassland (4) recorded the least. In the month of May, forest fragment recorded the highest value of (46), followed by forest edge (27) while grassland (2) recorded the least.Forest edge recorded the highest value of (70) in the month of June, followed by forest fragment (34) while grassland (4) recorded the least. In the month of July, forest fragment recorded the highest value of (97), followed by forest edge (36) while grassland recorded the least value of (13). In the month of August, forest fragment recorded the highest value of (76), while forest edge recorded (53) and grassland recorded the least value of (15).

Table 8 shows the one-way ANOVA for estimated *Chlorocebus tantalus tantalus* abundance in each habitat type which has a significant difference for all variables since their p-value is

less than 0.05, hence there is a significant difference in the abundance and distribution of Tantalus monkey across each habitat type.

Table 7: Abundance of *Chlorocebus tantalus tantalus* recorded in Ngel Nyaki Forest Reserve and plant parts utilized

Habitat	Abundance	Freq. (%)	Abundance of Tantalus Monkeys found utilizing diff. Plant parts		
			Fruits	Leaves	Flowers
Forest Fragment	472	49.9	257	199	16
Forest Edge	363	38.3	222	122	19
Grassland	112	11.8	61	51	-
	947		**540**	**372**	**35**

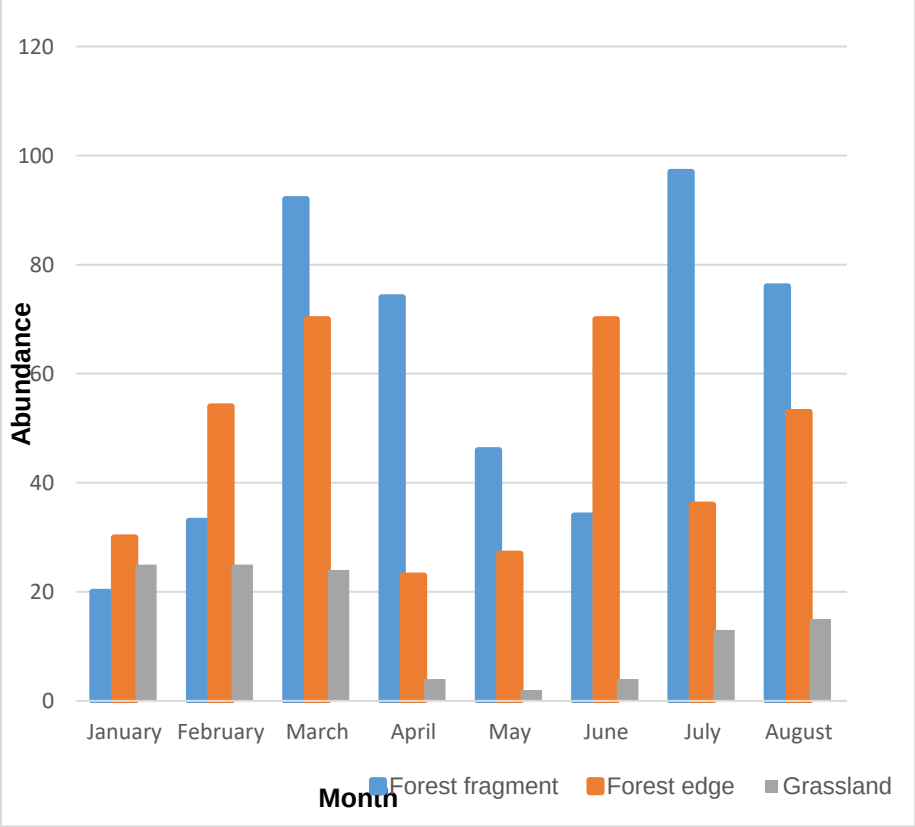

Figure 4: Observed monthly population density of *Chlorocebus tantalus tantalus* recorded across each habitat type.

Table 8: ANOVA for estimated *Chlorocebus tantalus tantalus* abundance in each habitat

		Sum of Squares	Df	Mean Square	F	Sig.
Forest Fragment	Between Groups	18114.000	7	2587.714	1478.694	.000
	Within Groups	28.000	16	1.750		
	Total	18142.000	23			
Grassland	Between Groups	2049.705	7	292.815	222.673	.000
	Within Groups	21.040	16	1.315		
	Total	2070.745	23			
Forest Edge	Between Groups	7523.625	7	1074.804	495.587	.000
	Within Groups	34.700	16	2.169		
	Total	7558.325	23			

Source: SPSS output version 25.0

The Preference of Fruit Tree Species Consumed by the Study Species in Ngel Nyaki Forest Reserve During the Study Period

According to Table 9, Tantalus monkeys fed on the following fruit trees species parts; fruits (544), leaves (365) and flowers (38); they fed more on fruits (544).

For the fruits, *Ficus spp* (178;32.7%) of the Moraceae family was consumed the most, followed by*Canthium sp.*(127;23.3%) of Rubiaceae, followed by *Bridelia speciosa* (84;15.4%) of the Phyllanthaceae family then *Maesa lanceolata* (72;13.2%) of the family Myrtaceae; the least were *Rauvolfia vomitoria* (3;0.6%) of the family Apocynaceae and *Harungana madagascariensis* (22;4.0%) of the family Guttiferae.

As for the leaves, *Entada abyssinica* (92;25.2%) of family Leguminosae-Mimsoideae was the most utilized, followed by *Anthonotha noldeae* (69;18.9%) of family Leguminosae-Caesalphinoideae, then *Albizia gummifera* (45;12.3%) of family Leguminosae-Mimsoideae; the least were *Bridelia Speciosa* (15;4.1%) of family Phyllanthaceae and *croton sp.* (22;6.0%) of family Euphorbiaceae.

The flowers sighted being eaten by the Tantalus monkey were that of the tree species *Syzygium guineensis* (31;81.6%) of family Myrtaceae, followed by *Polyscias fulva* (5;13.2%) of family Araliaceae and *Anthonotha noldeae* (2;5.3%) of family Leguminosae-Caesalphinoideae.

Table 9: Observed fruit tree species utilized by Tantalus monkeys indicating plant parts consumed during the study period

Fruit trees species	Family	Abundance (Freq. (%)) feeding on fruit	Abundance (Freq. (%)) feeding on leaves	Abundance (Freq. (%)) feeding on flowers
Ficus spp.	Moraceae	178 (32.7)	41 (11.2)	
Canthium sp	Rubiaceae	127 (23.3)		
Anthonotha noldeae	Leguminosae-Caesalphinoideae		69 (18.9)	2 (5.3)
Syzygium guineensis	Myrtaceae	58 (10.7)	37 (10.1)	31 (81.6)
Albizia gummifera	Leguminosae-Mimsoideae		45 (12.3)	
Bridelia speciosa	Phyllanthaceae	84 (15.4)	15 (4.1)	
Croton sp	Euphorbiaceae		22 (6.0)	
Landolphia sp	Apocynaceae		44 (12.1)	
Entada abyssinica	Leguminosae-Mimsoideae		92 (25.2)	
Maesa lanceolata	Myrtaceae	72 (13.2)		
Harungana madagascariensis	Guttiferae	22 (4.0)		
Rauvolfia vomitoria	Apocynaceae	3 (0.6)		
Polyscias fulva	Araliaceae			5 (13.2)
		544	**365**	**38**

DISCUSSION

Checklist of Fruiting Spp. in the Study Area

This study provides thechecklist of the floristic tree species recorded at the three (3) selected habitat types. The present work reveals that the study area endures agood number of tree species (H'=2.87589). A taxonomic inventory of fruiting trees of Ngel Nyaki Forest Reserve across each habitat was carried out during the study period and information on the presence and abundance of individuals in all the three (3) habitat types was incorporated and Forest edge was found to have harboured most of the plant species. The distribution pattern of the species showscomplete decrease in the species richness, with the highest occurrence recorded in the Forest edge, followed by Forest Fragment then Grassland which was recorded with few trees' species. The highest number of plant species present at the forest edge may be attributed to the level of protection it has gained long ago and the reduction of human interference in these studysite for purposes such as cattle grazing, logging and collection of fuel woodnon-timber forest produce which alters thevegetation structure and also influence thenatural regeneration of plant species.This finding agrees with Regassa (2005) who opined that high human and livestock populations have negatively affected the soil and vegetation structures particularly in the Ngel-Nyaki forest reserve and its community environs. Forest disturbance leads to patches and changes in the structure and tree composition of forests, as highlighted by Carlos and Erwin (2004).

The low tree species composition in the grassland habitat may be attributed to intense unsustainable human activities such as cattle grazing which was found to be the major issue in the grassland habitat and fire as well has been another major threat to fruit trees species as well as biodiversity. It was also found in this study that *Bridelia Speciosa* was the dominant tree species in the grassland and their abundance may be attributed to their ability to resist fire. It is evidential that in-situ conservation is no longer effective to conserve trees species growing in the grassland where it was recorded with least tree species abundance as a result of cattle grazing and fire within the region of the grassland habitat. This study is in tandemwith Bowman (1998), Van Langevelde *et al.* (2003) and Bond and Keeley (2005) who all observed that fire is a pervasive disturbance process globally, and it significantly shapes ecosystem structure and function, removal of shrubs and the rejuvenation of grasses. The grassland habitat has been severely affected by burning yearly, Afolayan (1979) showed that over eighty percent (80%) of the vegetation of Lake Kainji park is burnt

indiscriminately every year and as such it drastically reduces the growth of plant species. The most serious issues facing the local flora, according to Nodza *et al.* (2014), who conducted a study in Akoka, Lagos, were habitat conversion into residential areas (urbanization), indiscriminate degradation and reclamation of mangrove for the development of several infrastructure facilities in order to satisfy the insatiable human wants, and subsistence farming.

It has been noted that the natural range of numerous tree species is constrained by particular habitat types and environmental factors. Because of its altitude and particular climate, the research area's trees were all terrestrial. The Rubiaceae family had the highest number of tree species and the reason for more abundance may be attributed to its reproductive biology especially the dispersal mechanisms which allow widespread distribution across most of the diverse habitats found in Nigeria (Soladoye *et al.,* 2015). The reason for the poor establishment of some families such as Anacardiaceae, Verbenaceae, Annonaceae, Monimiaceae, Leguminosae-Caesalphinoideae, Rutaceae, Ebenaceae, Rosaceae, Buddlejaceae, Moraceae, Leeaceae, Meliaceae and Euphorbiaceae may be attributed to long done anthropogenic activities in the study area before the initiation of the protected area now called Ngel Nyaki Forest Reserve (Nigeria Montane Forest Project). Eenvironmental factors such as climate, soil and topography may have also determined the specific abundance of tree species in the study area. This study is similar to Stephen and Omondi (2017) who found anthropogenic activities to cause the distribution and decimation of tree species family in a habitat. The forest reserve is currently undergoing an active enrichment planting of trees due to the limited natural regeneration through agents of seeds dispersal.

Comparison of Diversity of Fruiting Trees Species Across Habitat Type

In comparison to the Forest Fragment and Grassland, the Fruit Tree species richness and variety were greater in the Forest Edge. The grassland, forest fragment, and forest edge differ significantly from one another in terms of the diversity of tree species. The reason for higher diversity in the Forest Edge maybe connected to its location within the protected or fenced area and may have been protected longer than Forest Fragment and Grassland where they are easily accessed by the villagers for grazing, logging for wood and fire that pose threat to tree species. Aerts *et al.* (2016) and Demie, (2015) also reported from a survey that Church Forest being highly diverse in tree species was as a result of being

highly protected for longer period of time than the Government and Private Forest. Demie (2015) and Shiferaw *et al.* (2019) also stated that the predominance of certain tree species or tree has a spiritual connection to the community surrounding and within the church forest and that this may be due to the deliberate preservation or planting of such species. Similar work was carried out by Koricho (2021) who reported the higher density of woody species within the church forest compared with the other two selected areas in the study could be due to the fact that the forest was set aside almost entirely for conservation purposes, except for the intensive sustainable use of *C. spinarum*, and otherwise may have had almost no human interference for a long time. In the light of the above reasons for diversity of tree species in Ngel Nyaki Forest Reserve specifically the protected area (forest edge) has more tree species abundance and diversity than Forest Fragment and Grassland may be connected to its high level of protection from human interference as shown in Barau *et al.* (2015) who reported in a study carried out in Kakulu forest of Zing reported that they were more tree species abundance in the undisturbed forest than the disturbed forest which was basically farming activities. The reason for more tree species in the undisturbed forest maybe attributed to less human interference in relation to utilization for either firewood, local house construction, timber, yam farming or their fruits, leaves and flowers.

Another reason for decimation in the pattern of tree species diversity in habitats as seen in Ngel Nyaki Forest Reserve could also be attributed to habitat fragmentation. This study is similar with Ihuma *et al.* (2011) who showed that the fruit tree diversity in Ngel Nyaki was showing a declining trend from the Main Forest through the Grassland and Fragments. The observed trends may be due to differences in protection level betweene Main Forest and the fragmented areas. Anthropogenic impacts of habitat fragmentation and/or degradation causes biodiversity decline worldwide. Harris and Silva-Lopez (1992) observed that habitat fragmentation is one of the most serious causes of diminishing biological diversity, while its main consequence – habitat loss- is responsible for biodiversity loss and ultimate extinction of species.

This result is consistent with the work of many researchers including Edet *et al.* (2012) who reported that Afi mountain Wildlife Sanctuary has more plant species than communal forests. The reason for low plant species in the communal forest may be accounted on anthropogenic impacts occasioned by bush burning and agriculture. Udofia *et al.* (2014) also reported that more tree composition was observed in Ayan Nsit sacred forest than in the adjourning community forest which may be connected to human interference.

The Abundance and Distribution of Tantalus Monkey Across Each Habitat.

This study revealed 947 individuals of *Cholorcebus tantalus tantalus* recorded in all the habitat types; the highest observation was recorded in Forest fragment and Forest edge habitat (49.9% and 38.3%, respectively). The highest abundance recorded in these habitat types may be connected with the fact that these habitats provide enough food, water, cover and breeding space for the study species throughout the year most especially *Ficus* tree which is unique among tropical plants because of their regular fruiting habit. Also, the presence of security guard patrol post in these habitats might have facilitated adequate protection of the study species fruiting tree from being logged by the community settlers thereby supporting increase in the population density of *Chlorocebus tantalus tantalus* and at the same time increasing food resources of existing fruiting tree population in each habitat. Good environments can increase animal population and distribution, according to Kideghesho *et al.* (2007) and Infield and Namara (2001). This observation validates their claims. However, the presence of running water in the Forest fragment may have contributed to high population density which may serve as or ensures constant provision of drinking water for the study species troop/population throughout the year. The tantalus monkeys that congregate in this habitat during the dry season may be attracted by the rushing water, which may also serve as a breeding site, cover, and an enhancement of leaf and fruit production. This implies that, as mentioned by Nakagawa (2000), the distribution and number of wild animals in a particular ecosystem are determined by the availability of food, water, cover, and nesting space. Grassland habitat harboured the least abundance of *Cholorocebus tantalus tantalus* (11.8%). The low abundance of tantalus monkey in the grassland may be connected to the sparsely distribution of fruit trees that may have survived forest clearing and burning long before the initiation of the protected area of the Montane Forest Reserve in 1969, thereby causing food scarcity (fruit), hence cessation of rain and prolong drought leading to sharp decrease/reduction in the available nutrients in vegetation. Perrins *et al.* (1991) equally asserted that the distribution of any species is limited by the distribution of habitats and availability of food andother resources within those habitats.

The findings revealed that the forest fragment (49.9%) had the highest abundance of *Chlorocebus tantalus tantalu*s compared to forest edge and grassland. It also showed a significant difference across habitat type in terms of abundance and distribution. The decimation of *Chlorocebus tantalus tantalus* abundance across habitat may be attributed to the

availability and abundance of their food resources, water, seasonality as well as suitability of foods. We found in this current study that the availability of fruits, water and other plant parts of top food species of Tantalus monkeys were the most likely drivers of the spatial distribution of Tantalus monkeys within Ngel Nyaki Forest Reserve. Balakrishinan (1986) stated that water and food or the combinations of both are the major factors determining the distribution of wildlife populations in their natural habitats. Their abundance or biomass correlated with the availability and species richness of their most preferred food (*Ficus*) in the forest fragment. According to Afolayan (1979), the availability of food, water, cover, and bush burning, especially during the dry season, usually affects the distribution and migrations of wild animals. The association of *Chlorocebus tantalus tantalus* (Tantalus monkey) with forest fragment might be due to the availability of abundant and diverse fruit tree species. In comparison across habitat type, there were more abundance of the study species' most preferred fruit tree (*Ficus*) in the forest fragment than forest edge and grassland. According to Benton (2003), guereza and blue monkey densities were positively impacted by food availability. Camaratta *et al.* (2017) showed that the spatial distribution of fruits and nuts was associated with habitat use and differences in Brown Howler areas. Half of their diet consisted of fruit with other important components including leaves and flowers. The higher number of *Chlorocebus tantalus tantalus* recorded in the forest fragment than forest edge and grassland may also be attributable to the higher number and diversity of fruit tree species which produces high abundance of fruit for primate to feed on. Most frugivorous animals depend substantially on fruits, most especially in the tropical region. A number of field studies have shown that the abundance of fruiting eating animals is strongly influence by fruit availability. Our result also showed a very high correlation between the diversity of fruit trees within habitat and that of Tantalus monkeys. This study also agrees with the view of Newton (1998) and Benton *et al.* (2003) that food abundance influences the distribution and abundance of wildlife species as well as habitat quality. Hence, no doubt this study has shown primate diet (plant parts) to have played a vital role in *Chlorocebus tantalus tantalus* pattern of habitat use.

In lesser cases, this monkey frequents human settlements and feeds extensively on cultivated plants such as maize during farming season resulting to a human-primate conflict. Another reason for visiting forest fragment more could be attributed to the availability of more abundance of *Ficus sp and Syzygium guineensis*; It seems the rural dwellers spared the fruit trees (most especially*Rauvolfia vomitoria*) in the course of exploitation of

resources in the unprotected fragment habitat since some of the fruits (e.g *Syzygium guineensis and Rauvolfia vomitoria* fruits) can also be consumed by human and are most likely to contribute to their livelihoods. Hanya and Chapman (2013) reported a positive relationship between the density of figs, the best food source for gibbons and orangutan abundance. This study followed Stevenson (2001) who estimated the relationship between fruits and abundance in the Neotropics and found a relationship between pithecine biomass and *Eschweilera* trees. According to Stevenson (2001), fruit production was revealed to be the most significant factor in explaining woolly monkey abundance across all scales. This is also consistent with research conducted by Bila-*Isia et al.* (2009) on the impact of food type and availability on bonobo distribution in the Democratic Republic of the Congo's Lake Tumba Swampy Forests. That study found that the distribution of terrestrial herbaceous vegetation, or THV, at various sites significantly influenced bonobo distribution.

For each habitat type, we compared number of Tantalus monkeys that used the habitat with respect to fruits and other plant parts available in different census periods (wet and dry seasons).The social groups of the study species were mostly driven by fruits availability except in the case of fruit scarcity where it is complimented by other plant parts such as the leaves and flowers as the case may be where some few individual species were seen feeding on flowers. Although the difference in the fruit abundance and availability between the habitat types maybe responsible for the monthly difference in the population density of Tantalus monkey between the sites, the seasonal changes in fruit abundance may explain the changes in the population density in each habitat. This study is similar to that of Hashimoto *et al.* (2003) who significant correlation between mean and minimum chimpanzees group size and mean monthly fruiting density on trees with low fruit availability, limiting group size in most years. It can also be deduced that fruit seasonality shows pattern of habitat used by the study species where high-fruiting season has more numbers of recorded individual visiting areas with much availability of food resource against the low-fruiting season with few recorded numbers where fruits was complimented with other food diet. Fruits were available throughout the study period, though their abundance correlated with seasonal variations. The highest densities of fruit were observed during the wet season and as such this result correlates with the abundance of Tantalus monkeys with respect to fruit availability. Despite the apparent seasonality, however, fruit was still present at any time of the study period and as such Tantalus monkeys had access

to fruits and other plants to utilize. The result of this study shows that seasonality as an ecological factor also has an effect on the distribution and abundance of primates in relation to fruit and other resource availability within Ngel Nyaki. This is similar to Basabose (2004) who found seasonality and distribution patterns of fruits as determinant ecological factors that controlled the size of chimpanzee at Kehuzi. Diriba *et al.* (2020) confirmed that primate resources change seasonally; hence, the abundance and distribution of primates differ from habitat because they prefer areas that meet all the requirements of life. Hanya *et al.* (2012) reported that food resource seasonality determines Japanese macaque abundance and distribution. The result of this study also conforms to Mourthé (2014) findings which showed fruit supply fluctuated with the seasons, being low in the dry season. Fruit availability was positively connected with *Ateles belzebuth* density during a fruit crisis. Mourthé (2014) also reported that during the general fruit crisis, the availability of Sapotaceae fruit played a significant role in defining the local distribution of *Ateles belzebuth*. *Ateles belzebuth,* a highly frugivorous ape, assembles in areas of forest with abundant fruit, especially those with numerous Sapotaceae plants, as a response to the seasonal reduction in fruit supply. This work also agrees with Behie and Pavelka (2014) who explained that frugivory is an important part of feeding ecology of Howler monkeys and that period of prolonged fruit shortage had a significant impact on their population dynamics and distribution.

Fruits, leaves and flowers were all relatively abundant in the forest fragment and forest edge explaining why more time spent in feeding occurs in these habitats than the grassland with Forest fragment having the highest accumulative value irrespective of seasonality and plant part consumed. The fact that most of the time is spent feeding in forest fragment and forest edge may reflect the food abundance of of the study species, for example, *Ficus sp., Syzygium guineensis, Bridelia speciosa, Canthium* fruit as well as other plant parts consumed around the forest fragment and forest edge. The One-way ANOVA for the abundance and distribution of Tantalus monkey across each habitat showed a significant difference for all variables since their p-value is less than (0.05); hence there is a significant difference among the abundance and distribution of Tantalus monkey across each habitat.

Fruit Tree Species preference of *Chlorocebus tantalus tantalus* in Ngel Nyaki Forest Reserve During the Study Period

This study showed that Tantalus monkeys predominantly had a substantive proportion of its time spent consuming fruits and leaves while a small proportion of flowers as food within the study period. The trends for fruit tree preference shown by the Tantalus monkeys may possibly be attributed to the following factors: the nature of fruit, fleshier/succulent and big or large the fruits are. These factors could explain the high preference shown for *Ficus spp., Canthium sp., Maesa lanceolata, Bridelia speciosa* fruits. According to Fashing *et al.* (2012), there are food preferences among different animals, but not all foods are suitable for them.The preferred food is the one that is consumed more than the nutritious food that is abundant in the area. The reason for high utility of fruits in this study may be connected to high protein content, taste, ecological zones, species nature for preference of fruit unlike other primate species which shows preference for leaves than fruits. The preference shown for particular plant species may be attributed to the presence of essential nutrients. Petrides (1975) observed that nimals generally prefer foods that contain essential nutrients. The preference of *Ficus sp.* by *Chlorocebus tantalus tantalus* may be linked to its high-quality nutrient which is ingested more than the relative abundance of other fruit trees in the habitat. This study is similar to that of White-bearded gibbons were reported by Clink *et al.* (2017) to be mostly frugivorous, accounting for 70% of their independent feeding observations in fruits and figs (*Ficus sp.).* However, in times of fruit scarcity, the gibbons' diets tended to include more of leaves.

Harrison (1985) found 50% of green monkeys' diet was fruits with 13% invertebrate, 13% flowers and 7% leaves; variables obtained and analysed in this study were limited to fruit tree species only. The results of this study are not consistent with the results of Kato *et al.* (2020) study who found guerezas in the Kalinzu Forest, Uganda to have shown a more preference for leaves than fruits and other diets; the study group was predominantly folivorous; the majority of their feeding time was involved in feeding on young leaves (87%) as this can be accounted for its nature for leave preference. The reason for more preference of guerezas for leaves than fruits may be attributed to ecological zones or location where the study was carried out as against what was observed as most preferred plant part for Tantalus monkey in Ngel Nyaki Forest Reserve.This is in line with the findings of Hopkins (2016) and Saliu *et al.* (2010) who found that 80% of Tantalus monkey feed on fruiting plants specifically high proportion of fruits.

The predominant food items of Tantalus monkey consumed more or plant parts in the study area were fruits. In thefruit consumed, *Ficus* constitute the highest fruit utilized which may be connected to its high potential of nutrients, natural fibre and vitamin. Also, the food preference may have been influenced by the nutritive value as well as micro climate and topography as reported by Petrides (1975). Figs are unique among tropical plants because of their irregular fruiting habits, they are a major primate food source as it produces fruit regularly and help to maintain the populations size through periods of food scarcity. This study suggests that group size is affected by fruit availability; this finding suggests that the decline of ficus tree species population may be due to illegal logging and this may force primates to move to other parts of the forest, including the forest reserve including compartments that are bordered by human settlements.

Thirteen distinct plant species were recorded to be consumed by Chlorocebus tantalus tantalus during the research period. All other plant parts were ingested in relatively small amounts, with the most commonly consumed plant parts being the fruits of Ficus spp. (38.1%) and the leaves of *Entada abyssinica* (21.8%). Nevertheless, these findings indicate unequivocally that *Chlorocebus tantalus tantalus* is an important frugivore in the area. There was no much difference in the fruiting tree (plant parts) utility or dietary composition of *Chlorocebus tantalus tantalus* when feeding in the Forest fragment compared with feeding in the Forest edge while a fairly small quantity was observed in the grassland due to anthropogenic activities which may have pose threat to fruiting tree species. The result of this study conforms to According to Kavanagh (1978), at least 41 distinct plant species are consumed by tantalus monkeys, and the amount of fruit in their diet varies depending on the season (8.8% to 97.1%). A great dietary range is typical in the dry season, with invertebrates a large clement, while fruit makes up the majority of the diet in the wet months (Kavanagh, 1978). Kaplin and Moermoud (1998) looked at two monkeys from *Cercopethecus* in Rwanda (Blue monkey and Mountain monkey) and found fruits to make up 48% and 24.28% respectively.

Feeding on plant parts in the Grassland was not as much as in the cases of Forest Edge and Forest fragment where individuals species activities were recorded but they still showed preference for *Ficus* fruit more than other plants; the monkeys were found feeding on some fruits and leaves of isolated trees in the grassland that have survived forest clearing and burning before the invent of the protection of the Montane Forest Reserve in 1969. This finding agrees with the earlier reports of Richard (1998), According to early

reports, Aubrey and Marian (1999) showed that fruits are preferred food of primates. It is evidential that *Ficus* was observed to be the most preferred fruit of Tantalus monkey in Ngel Nyaki Forest Reserve. According to Feilen and Marshall (2020), fruits and flowers were the favorite foods of proboscis monkeys.

CONCLUSION

Ngel Nyaki Forest Reserve is relatively abundant in wildlife and a home not just only to *Chlorocebus tantalus tantalus* but also to other different primates such as *Pan troglodytes ellioti, Papio anubis, Cercopithecus nictitans, Cercopethecus mona* and *Colobus guereza occidentalis.* The study area is diverse in tree species and has a small proportion of the most preferred (*Ficus*) fruit tree species utilized by Tantalus monkeys. There's a serious need to conserve tree species within the reserve as the availability and richness of plant foods are considered key drivers of population density as these variables influences the abundance and distribution of primates within habitat types.

Tantalus monkeys in the Ngel Nyaki Forest Reserve used the forest edge and fragment more frequently than grassland during the study period due to the availability of their abundant food resources and as such their abundance and distribution was significantly influenced by various plant parts utility.

The fruit tree species that Tantalus monkeys of Ngel Nyaki Forest Reserve use more frequentlymust be given due prioritize protection to maintain the population density of *Chlorocebus tantalus tantalus*and other primates' species within the forest reserve.

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