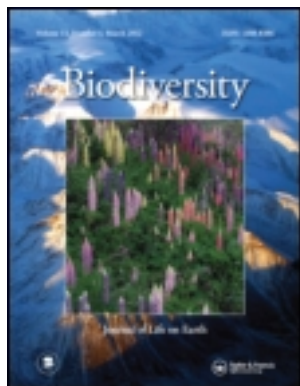


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Spatial distribution of turaco-preferred food plants in Ngel Nyaki Forest Reserve, Mambilla Plateau, Taraba State, Nigeria

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The relative distribution was investigated of turaco-preferred food plants in the main forest and the forest fragments of Ngel Nyaki Forest Reserve in Taraba State, Nigeria. Data collection was carried out in three sections within the forest reserve and these include (i) forest fragment, (ii) within the main forest and (iii) the boundary area of the main forest. Ten plots with size of 25 m × 25 m were laid at an interval of 50 m in each of the three selected sites making a total of 30 plots for the sampling of turaco-preferred fruiting plant species. The numbers of fruiting tree species identified were 22, 25 and 24, and out of these only seven (31.8%), eight (32%) and six (25%) were preferred by turacos in the forest fragment, within the main forest and the boundary area of the main forest, respectively. The preferred fruiting plant species in the forest fragment was *Syzygium guineense* (48.6%), in the boundary area of the main forest was *Ficus* sp. (13.3%) and within the main forest was *Polyscias fulva* (3.9%). Many of the fruiting tree species in the boundary area and within the main forest were not preferred by turacos. There is a need for effective pro-conservative measures aimed at preserving the remaining forest patches (especially the forest fragment) of the reserve.

Keywords: Ngel Nyaki Forest Reserve; *Ficus* sp; forest fragment; fruiting plant species; turacos

Introduction

The montane forests of Ngel Nyaki Forest Reserve (NNFR) are important because they harbour many threatened animal and plant species and have been identified as an Important Bird Area (IBA) (Chapman and Chapman 2001). Two globally threatened birds – the Bannerman's Weaver (*Ploceus bannermani*) and the Crossley's Ground-thrush (*Zoothera crossleyi*) – are found in the forest (Ihuma et al. 2007). The forest is also unique as it holds four turaco species (Figure 1): Guinea Turaco (*Tauraco persa*), Yellow-billed Turaco (*T. macrorhynchus*), White-crested Turaco (*T. leucolophus*), and the Great Blue Turaco (*Corythaëola cristata*) (Ihuma 2006). Turacos, exotic soft-billed birds, are endemic to Africa and are very vocal, all with similar raucous calls.

As discovered by Ihuma (2006), most (76%) afro-montane forest tree species have fleshy fruit with edible pulp, evolved to effect seed dispersal by animals. Meanwhile, fragmentation and land degradation has led to a massive decline in the number of many of the

wide-gaped frugivores from forest fragments of Mambilla Plateau. All primates except the Tantalus monkey (*Chlorocebus tantalus*) are confined to the only large forest on Ngel Nyaki (Ihuma and Chapman 2007). Also, there has been a massive decline in large avian frugivores such as pigeons and hornbills visiting the fragments. Gape width limits the size of fruit that avian frugivores can swallow, especially for single seeded fruits (drupes). The only common large-gaped frugivore living in the fragments is the White-crested Turaco (*Tauraco leucolophus*) which is confined to the forest fragment and the very edge of Ngel Nyaki forest.

Turacos, largely frugivorous birds, provide the ecological service of dispersing seeds within the forests. However, there has been scant study of the preferred fruiting food plants of turacos in Ngel Nyaki, though such study is pertinent to the conservation strategy and protection of the bird species. This study therefore investigated the relative distribution of turaco-preferred food plants in the main forest and the forest fragments of Ngel Nyaki Forest Reserve.

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Figure 1. (a) Great Blue Turaco (*Corythaeola cristata*). (b) Guinea Turaco (*Tauraco persa*). (c) White-crested Turaco (*Tauraco leucolophus*). (d) Yellow-billed Turaco (*Tauraco macrorhynchus verreauxii*).

Methodology

Study area

Ngel Nyaki (Figure 2) is located towards the western escarpment of Mambilla Plateau in the south-east corner of Taraba State, Nigeria, between longitude 11°00' and 11°30' East, and latitude 6°30' and 7°15' North. The plateau has an area of approximately 31,000 km² of grassland with islands of forests lying at 1400–1500 m, and can be reached on foot from Yelwa village within 40 minutes. Ngel Nyaki is currently gazetted as a Local Authority Forest Reserve under Gashaka-Mambilla Native Authority Forest Reserve, Order of 24 April 1969 (Chapman and Chapman 2001). The reserve covers 46 km², of which 8 km² is montane or sub-montane forest while the rest is degraded montane savanna woodland and grassland. Outside the reserve, but within what was the unofficial 'buffer zone', are streamside forest fragments in varying stages of degradation.

The forests of Ngel Nyaki Forest Reserve are important due to the presence of rare, undiscovered species. Over 146 vascular plant species were collected from Ngel Nyaki, many of which were endemic or near-endemic trees in the Afromontane Region. The high floristic diversity is reflected in the high number of primates and other animal species found in the forest. The rainy season in the reserve lasts for an average of 250 days, from March to October. Mean annual rainfall exceeds 1780 mm with peaks in June/July and September. The dry season lasts for about three months starting from the second week of November to February. The daily mean temperature does not exceed 30°C.

Forests within the reserve

The reserve contains the main forest and three forest fragments, A, B and C. The forest fragments are

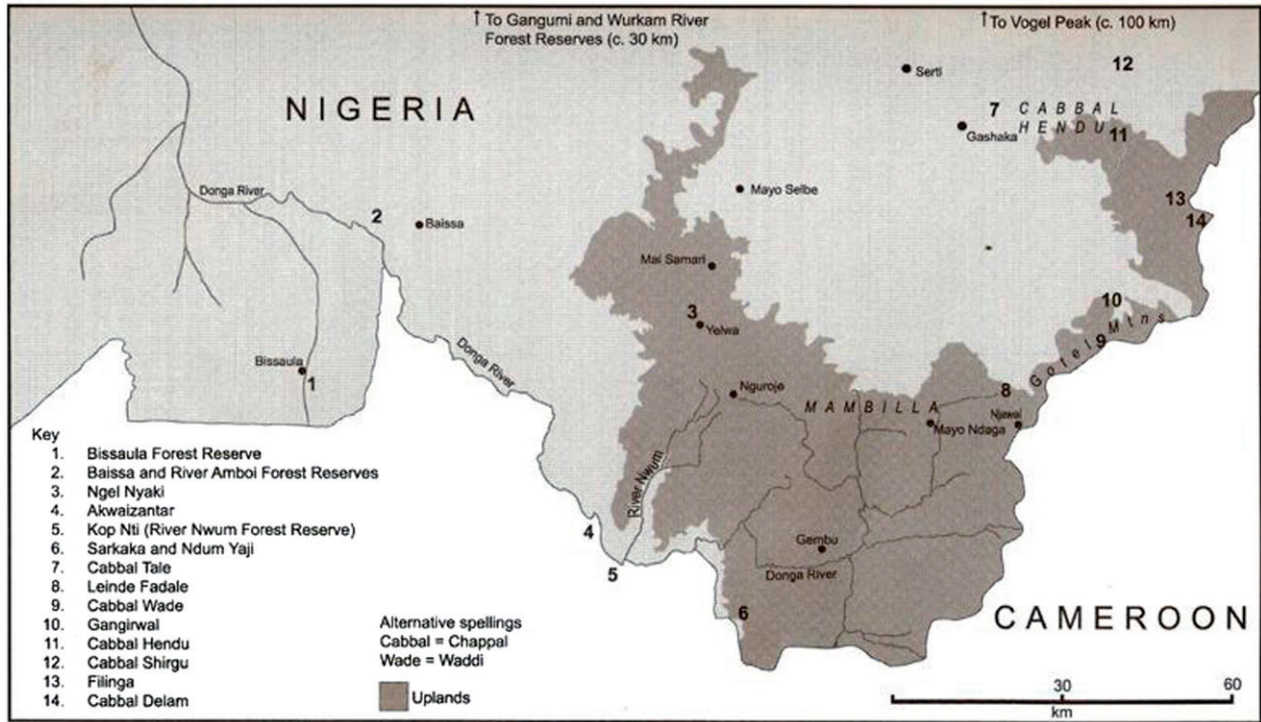


Figure 2. Map showing Ngel Nyaki at Western Escarpment of Mambilla Plateau (Source: Ihuma et al. 2007).

Table 1. Sampled plots within the three sites and their areas to total forest area in Ngel Nyaki Forest Reserve.

	Main forest			Forest fragment
	Boundary of forest	Within the forest	Total for the forest area	
Number of sample plots	10	10	20	10
Size of each plot	625 m ²	625 m ²	1250	625 m ²
Total area sampled (ha)	0.62	0.62	1.25	0.62
Percentage of sampled area to total forest area	0.78	0.78	1.56	17.36

located at increasing distances from the main forest with corresponding increase in degradation and decrease in fragment size (Ihuma 2006). However, despite the differences in area and state of degradation, the fragments are not significantly different from each other in terms of tree species composition or diurnal frugivore community. The three forest fragments were therefore grouped together as a single ‘forest fragment’ in this study.

It was envisaged that the distribution of turaco-preferred fruiting food species would be different in the forest fragment, main forest and boundary area of the main forest (forest outliers) (Ihuma, Chima, and Chapman, forthcoming). Due to this assumption, the reserve was further subdivided into three sites for data collection and these included (i) forest fragment,

(ii) within the main forest and (iii) the boundary area of the main forest. Equal numbers of sample plots were therefore laid in each of the three sites to determine the distribution of the turaco-preferred fruiting food species in Ngel Nyaki Forest Reserve.

Sampling of turaco-preferred fruiting plant species

A systematic sampling technique was adopted for survey of turaco-preferred fruiting plant species. Ten plots of 25 m × 25 m were laid at intervals of 50 m in each of the three selected sites (main forest, boundary of main forest, and forest fragments) making a total of 30 plots. Table 1 presents a summary of the plots laid within the three sampled site and

Table 2. Identified tree species in forest fragment of Ngel Nyaki Forest Reserve.

S/N	Plant species	Family	Count			Fruiting status of tree species			
						Fruiting		Not fruiting	
			Freq	%	Turaco feed	Freq	%	Freq	%
1	<i>Albizia gummifera</i> (J. F. Gmel.) C.A Sm	Leguminosae	8	3.8	–	0	0	3	1.6
2	<i>Allophylus africanus</i> P. Beauv.	Sapindaceae	8	3.8	+	0	0	8	4.3
3	<i>Anthocleista vogelii</i> A. Chev.	Longaniaceae	7	3.3	+	4	19.0	3	1.6
4	<i>Anthoantha noldeae</i> P. Beauv	Leguminosae	9	4.2	–	0	0	9	4.8
5	<i>Bridelia micrantha</i> (Hochst.) Baill.	Euphorbiaceae	10	4.7	–	0	0	10	5.4
6	<i>Canthium vulgare</i> K. Schum	Rubiaceae	1	0.5	+	0	0	1	0.5
7	<i>Celtis gomphophylla</i> Baker	Ulmaceae	1	0.5	–	1	4.8	0	0
8	<i>Clausena anisata</i> (Willd.) Benth	Rutaceae	2	0.9	–	0	0	2	1.1
9	<i>Croton macrostachyus</i> Hochst. ex Del	Euphorbiaceae	6	2.8	+	0	0	6	3.2
10	<i>Dombeya ledermannii</i> K. Schum	Sterculiaceae	1	0.5	+	0	0	1	0.5
11	<i>Ficus</i> sp.	Moraceae	6	2.8	+	4	19.0	2	1.1
12	<i>Garcinia smeathmannii</i> (Plank. & Triana) Oliv.	Guttiferae	6	2.8	–	4	19.0	2	1.1
13	<i>Macaranga occidentalis</i> Müll. Arg	Euphorbiaceae	1	0.5	–	0	0	1	0.5
14	<i>Maesa lanceolata</i> Forssk	Myrsinaceae	5	2.4	+	1	4.8	4	2.1
15	<i>Nuxia congesta</i> R.Br. ex Fresen	Buddlejaceae	1	0.5	–	0	0	1	0.5
16	<i>Prunus africana</i> Hook. f.	Rosaceae	1	0.5	–	0	0	1	0.5
17	<i>Psidium guajava</i> Linn.	Myrtaceae	1	0.5	+	1	4.8	0	0
18	<i>Psorospermum corymbiferum</i> Engl.	Guttiferae	23	10.8	+	0	0	23	12.4
19	<i>Rubiaceae</i> sp (unknown)	Rubiaceae	6	2.8	+	6	28.6	0	0
20	<i>Syzygium guineense</i> (Willd.) DC.	Myrtaceae	103	48.6	+	0	0	103	55.4
21	<i>Trema orientalis</i> (L.) Blume	Ulmaceae	4	1.9	+	0	0	4	2.2
22	<i>Trichilia</i> sp.	Meliaceae	2	0.9	–	0	0	2	1.1
	Total		212	100		21	100	186	100

Note: += fruit of tree species eaten by turacos; – = fruit of tree species not eaten by turacos. Field survey, 2010.

their areas in relation to the total forest area in the reserve.

Results

Identified fruiting tree species in the reserve

Of the identified 22 fruiting tree species in the forest fragment (Table 2), 12 (54.5%) were preferred by turacos. *Syzygium guineense* (family Myrtaceae) had the highest percentage (48.6%) among all the sampled fruiting tree species and was also preferred by turacos. Other identified fruiting tree species in the forest fragment with significant percentage and preferred by turacos include *Psorospermum corymbiferum* (10.8%), *Bridelia micrantha* (4.7%), *Allophylus africanus* (3.8%), *Anthocleista vogelii* (3.3%), *Ficus* sp. (2.8%), *Croton macrostachyus* (2.8%), *Rubiaceae* sp (2.8%) and *Maesa lanceolata* (2.4%). In addition, only seven (31.8%) out of all the 22 identified fruiting tree species were fruiting at the time the field data collection was carried out. Among the fruiting species, those preferred by turacos

include *Anthocleista vogelii*, *Ficus* sp., *Maesa lanceolata*, *Rubiaceae* sp and *Psidium guajava*.

Out of the identified 25 and 24 fruiting tree species at the boundary area (Table 3) and within the main forest (Table 4), eight (32%) and six (25%) were preferred by turacos, respectively. This means that many of the fruiting tree species in the boundary area and within the main forest were not preferred by turacos. *Anthocleista vogelii* (family Longaniaceae) (35.7%) and *Garcinia smeathmannii* (family Guttiferae) (12.6%) were the fruiting tree species with highest percentages in the boundary area and within the main forest respectively but were not preferred by turacos. The fruiting tree species preferred by turacos that occurred mostly in the boundary area of the main forest was *Ficus* sp. (13.3%) and within the main forest was *Polyscias fulva* (3.9%).

As shown in Figure 3a, many of the turaco-preferred fruiting tree species that were fruiting when the data collection was conducted were observed in the fragment forest. For other non-preferred fruiting species that were fruiting during the period of the

Table 3. Identified tree species at the boundary area of the main forest of Ngel Nyaki Forest Reserve.

S/N	Plant species	Family	Count		Turaco feed	Fruiting status of tree species			
			Freq	%		Fruiting		Not fruiting	
						Freq	%	Freq	%
1	<i>Albizia gummifera</i> (J. F. Gmel.) C.A Sm	Leguminosae	3	2.1	–	0	0	3	2.2
2	<i>Anthocleista vogelii</i> A. Chev.	Longaniaceae	51	35.7	–	0	0	51	38.1
3	<i>Beilschmiedia mannii</i> (Meissn.) Benth. & Hook.f.	Lauraceae	3	2.1	–	0	0	3	2.2
4	<i>Bridelia micrantha</i> (Hochst.) Baill.	Euphorbiaceae	6	4.2	–	0	0	6	4.5
5	<i>Carapa grandiflora</i> Sprague	Meliaceae	6	4.2	–	1	11.1	5	3.7
6	<i>Clausena anisata</i> (willd.) Benth	Rutaceae	4	2.8	–	0	0	4	3.0
7	<i>Croton macrostachyus</i> Hochst. ex Del	Euphorbiaceae	2	1.4	+	0	0	2	1.5
8	<i>Deinbollia</i> sp.	Sapindaceae	12	8.4	–	0	0	12	9.0
9	<i>Dombeya ledermannii</i> K. Schum	Sterculiaceae	1	0.7	+	0	0	1	0.7
10	<i>Eugenia gilgii</i> Engl. & Brehmer	Myrtaceae	6	4.2	–	0	0	6	4.5
11	<i>Ficus</i> sp.	Moraceae	19	13.3	+	5	55.6	14	10.5
12	<i>Garcinia smeathmannii</i> (Plank. & Triana) Oliv.	Guttiferae	7	4.9	–	1	11.1	6	4.5
13	<i>Isolona deightonii</i> Keay. ^ψ	Annonaceae	2	1.4	–	0	0	2	1.5
14	<i>Leptaulus daphnoides</i> Benth.	Icacinaceae	1	0.7	–	0	0	1	0.7
15	<i>Macaranga occidentalis</i> Müll. Arg	Euphorbiaceae	2	1.4	–	0	0	2	1.5
16	<i>Maesa lanceolata</i> Forssk	Myrsinaceae	1	0.7	+	0	0	1	0.7
17	<i>Millettia conraui</i> Harms	Leguminosae	4	2.8	–	0	0	4	3.0
18	<i>Polyscias fulva</i> (Hiern) Harms	Euphorbiaceae	4	2.8	+	1	11.1	3	2.2
19	<i>Psorospermum corymbiferum</i> Engl.	Guttiferae	1	0.7	+	0	0	1	0.7
20	<i>Pouteria altissima</i> (A. Chev.) Baehni	Sapotaceae	1	0.7	–	0	0	1	0.7
21	<i>Rauwolfia vomitoria</i> Afzel	Apocynaceae	1	0.7	+	0	0	1	0.7
22	<i>Strombosia scheffleri</i> Oliv.	Olacaceae	2	1.4	–	0	0	2	1.5
23	<i>Tarena pavettoides</i>	Rubiaceae	1	0.7	–	1	11.1	0	0
24	<i>Voacanga bracteata</i> Stapf	Apocynaceae	2	1.4	+	0	0	2	1.5
25	<i>Zanthoxylum leprieurii</i> (Guill. & Perr.) Engl	Rutaceae	1	0.7	–	0	0	1	0.7
Total			143	100		9	100	134	100

Note: + = fruit of tree species eaten by turacos; – = fruit of tree species not eaten by turacos
Field survey, 2010.

data collection, many were observed within the main forest followed by the boundary of the main forest (Figure 3b).

Correlations of the sampled fruiting tree species

There are strong correlations for the sampled fruiting tree species between the forest fragment and the boundary of the main forest (84.1%), and between the forest fragment and within the main forest (82.5%). Likewise, there is a strong correlation (88.0%) between the boundary and within main forests (Table 5). For the turaco-preferred fruiting tree species, the level of correlation was significant and very strong between forest fragment and boundary of main forest with 86.6% (Table 6). Meanwhile, there are inverse

(negative) correlations for the tree species between forest fragment and boundary of main forest (–0.862) as well as within the main forest (–0.0162).

Discussion

Turacos were observed converging on a large number of *Ficus* trees during the fruiting season. About 14 species of *Ficus* spp have been identified in NNFR (Misa, pers. comm.). Figures 4 and 5 show two of the different species of *Ficus* observed during the field survey. Other identified turaco-preferred fruiting tree species in the reserve include *Syzygium guineense*, *Canthium vulgare*, *Allophylus africanus*, *Anthocleista vogelii*, *Croton macrostachyus*, *Dombeya ledermannii*, *Maesa lanceolata*, *Psorospermum corymbiferum*,

Table 4. Identified tree species within the main forest of Ngel Nyaki Forest Reserve.

S/N	Plant species	Family	Count		Turaco feed	Fruiting status of tree species			
			Freq	%		Fruiting		Not fruiting	
						Freq	%	Freq	%
1	<i>Albizia gummifera</i> (J. F. Gmel.) C.A Sm	Leguminosae	5	2.4	–	0	0	5	2.5
2	<i>Anthonotha noldeae</i> P. Beauv	Leguminosae	29	14.1	–	2	66.7	27	13.3
3	<i>Bridelia micrantha</i> (Hochst.) Baill.	Euphorbiaceae	1	0.5	–	0	0	1	0.5
4	<i>Carapa grandiflora</i> Sprague	Meliaceae	24	11.7	–	0	0	24	11.8
5	<i>Celtis gomphophylla</i> Baker	Ulmaceae	1	0.5	–	0	0	1	0.5
6	<i>Croton macrostachyus</i> Hochst. ex Del	Euphorbiaceae	3	1.6	+	0	0	3	1.5
7	<i>Deinbollia</i> sp.	Sapindaceae	11	5.3	–	0	0	11	5.4
8	<i>Entandrophragma angolense</i> (Welw.) C. DC.	Meliaceae	3	1.4	–	0	0	3	1.5
9	<i>Ficus</i> sp.	Moraceae	6	2.9	+	0	0	6	3.0
10	<i>Garcinia smeathmannii</i> (Plank. & Triana) Oliv.	Guttiferae	26	12.6	–	0	0	26	12.8
11	<i>Isolona deightonii</i> Keay. ^ψ	Annonaceae	10	4.9	–	0	0	10	4.9
12	<i>Leptaulus daphnoides</i> Benth.	Icacinaceae	1	0.5	–	0	0	1	0.5
13	<i>Macaranga occidentalis</i> Müll. Arg	Euphorbiaceae	11	5.3	–	0	0	11	5.4
14	<i>Millettia conraui</i> Harms	Leguminosae	5	2.4	–	0	0	5	2.5
15	<i>Newtonia buchananii</i> (Baker f.) G.C.C. Gilbert & Boutique.	Leguminosae	14	6.8	–	0	0	14	6.9
16	<i>Polyscias fulva</i> (Hiern) Harms	Euphorbiaceae	8	3.9	+	0	0	8	3.9
17	<i>Rubiacea</i> sp	Rubiaceae	1	0.5	+	1	33.	0	0
18	<i>Strombosia scheffleri</i> Oliv.	Olacaceae	8	3.9	–	0	0	8	3.9
19	<i>Symphonia globulifera</i> L.f.	Guttiferae	20	9.7	–	0	0	20	9.9
20	<i>Tabernaemontana pachysiphon</i> Stapf.	Apocynaceae	13	6.3	–	0	0	13	6.4
21	<i>Trichilia</i> sp.	Meliaceae	2	1.0	–	0	0	2	1.0
22	<i>Vitex doniana</i> Sweet	Verbenaceae	1	0.5	+	0	0	1	0.5
23	<i>Voacanga bracteata</i> Stapf	Apocynaceae	2	1.0	+	0	0	2	1.0
24	<i>Zanthoxylum leprieurii</i> (Guill. & Perr.) Engl	Rutaceae	1	0.5	–	0	0	1	0.5
Total			206	100		3	100	203	100

Note: + = fruit of tree species eaten by turacos; – = fruit of tree species not eaten by turacos. Field survey, 2010.

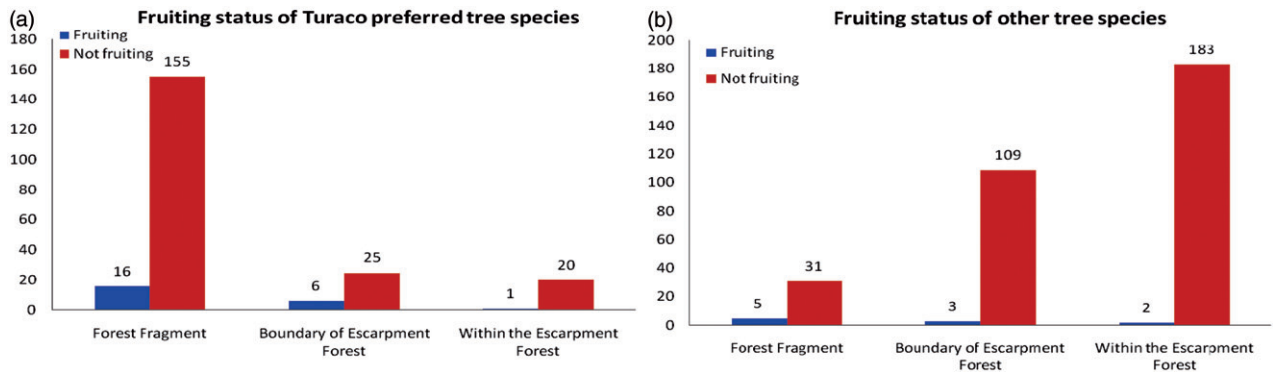


Figure 3. Fruiting status of (a) turaco-preferred and (b) non-preferred tree species at Ngel Nyaki Forest Reserve.

Table 5. Correlations of all the sampled turacos-preferred and non-preferred fruiting tree species within the three sites at Ngel Nyaki Forest Reserve.

	Forest fragment		Boundary of main forest	
	Pearson correlation	Sig. (2-tailed)	Pearson correlation	Sig. (2-tailed)
Boundary of main forest	0.841*	0.000	—	—
Within main forest	0.825*	0.000	0.880*	0.000

*Correlation is significant at the 0.01 level (2-tailed).

Table 6. Correlations of the turacos-preferred fruiting tree species within the three sites at Ngel Nyaki Forest Reserve.

	Forest fragment		Boundary of main forest	
	Pearson correlation	Sig. (2-tailed)	Pearson correlation	Sig. (2-tailed)
Boundary of main forest	-0.862*	0.000	—	—
Within main forest	-0.162	0.484 ns	0.196	0.047 ns

*Correlation is significant at the 0.01 level (2-tailed). ns = not significant.



Figure 4. A *Ficus* sp.: (a) tree; (b) fruit.



Figure 5. Another *Ficus* sp.: (a) tree; (b) fruit.

Trema orientalis, *Polyscias fulva*, *Voacanga bracteates*, *Rauvolfia vomitoria*, *Vitex doniana* and *Psidium guajava*. Turacos feed on both the flesh and seed of these fruits, but it was discovered that they peck only the flesh of *Anthocleista vogelii*. This result is a significant contribution to conservation strategy in the reserve. As discovered by Ihuma (2006) and from observations during the field data collection, the forest fragment has various levels of human and animal impacts resulting in deforestation and degradation.

Most of the trees were not in fruiting season during the survey. Their fruiting season is around March to June each year, while the peak fruiting period is May. The preferred fruiting tree species found fruiting during the survey included *Ficus sur*, *Ficus* sp., *Psidium guajava* and *Maesa lanceolata*. These preferred fruiting tree species were more in the forest fragment than in both the boundary area or the main forest; this is supported by the findings of Ihuma, Chima, and Chapman (forthcoming). For the main forest, there are more of the turaco-preferred fruiting tree species at the boundary with reduced frequency as one moves into the main forest. From the results of this survey, and corroborated by the findings of Ihuma (2006), more turacos were found in the forest fragments (A, B and C) of the NNFR followed by the boundary area of the main forest, and reduced further as one moves into the main forest of the reserve.

Conclusion

Turaco species depend on the remaining fruiting species in the forest fragments and boundary area of the main forest of the Ngel Nyaki Forest Reserve. This calls for effective conservation measures aimed at preserving the remaining forest patches of the reserve.

Such planning may avert a possible local extinction of the turaco species as well as associated flora and fauna found in the montane rainforest ecosystem.

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