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Rufford Small Grant Report

Seed Dispersal and the Long Term Survival of Nigeria's Montane Forests

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Cover image: Tantalus monkey in Ngel Nyaki forest.

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Seed Dispersal and the Long Term Survival of Nigeria's Montane Forests

Final Report to
Rufford Small Grant (for Nature Conservation)
In association with the Whitley Laing Foundation

Dr Hazel Chapman

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Background

On a global scale a lack of seed dispersers, rather than more overt physical destruction, may constitute a major threat to the long-term survival of tropical forests. This is because many forests have sufficient protection to prevent them being logged or farmed, but insufficient protection to prevent hunting. Yet almost nothing is known about plant-frugivore (fruit eating bird and animal) interactions, and the consequences of loosing dispersers in African montane forests.

The aims of our research were to:

1. describe and compare the diurnal frugivore species composition of Ngel Nyaki Forest and three associated riparian forest fragments;
2. assess the likelihood of dispersal limitation within Ngel Nyaki forest and the three fragments; and
3. discuss the significance of frugivore decline and reduced seed dispersal for the future of forests in degraded montane landscapes in Nigeria.
4. Investigate the role of putty nose monkeys in seed dispersal.

Understanding the role of montane forest frugivores in tree seed dispersal is crucial information for sustainable management of montane forests.

Entering seed dispersal data in the Nigerian Montane Forest field station at Ngel Nyaki. From left to right: Jerome Ihuma, Stephen Gawaisa and Musa Bawuro (field assistant).

Diurnal Frugivores Project

The identification of key diurnal frugivores in Ngel Nyaki forest and the three forest fragments A, B and C

Undertaken as MSc research by Ihuma Jerome from the Federal University of Technology, Yola and supervised by Dr Hazel Chapman and Dr Tella Iyiola.

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*Presented as a poster at the XVIII AETFAT Congress in Yaounde, Cameroon, February 2007 (see NMFP website).

*To be presented orally by Jerome Ihuma at the Nigerian Ecological Society Conference, Jos. October 2007.

Plate 1. Partial view of the main forest at Ngel Nyaki.

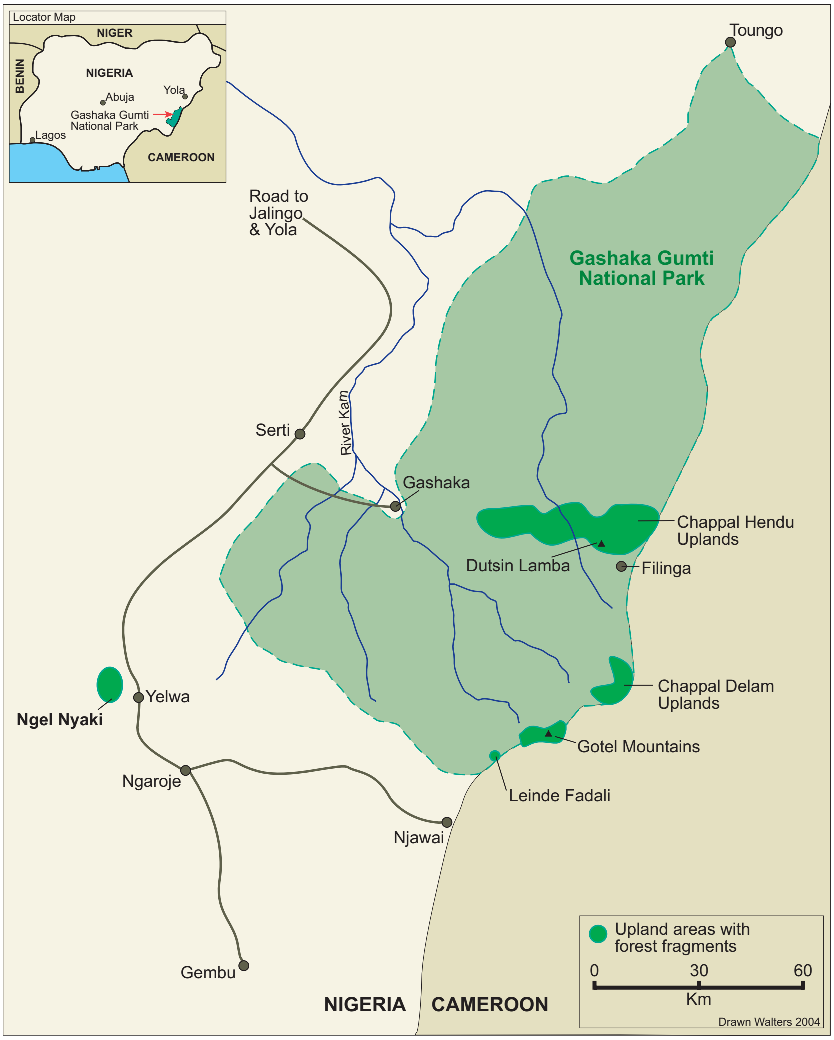

Figure 1. Map of the study area, showing Ngel Nyaki in relation to other Nigerian upland areas and to Gashaka Gumti National Park.

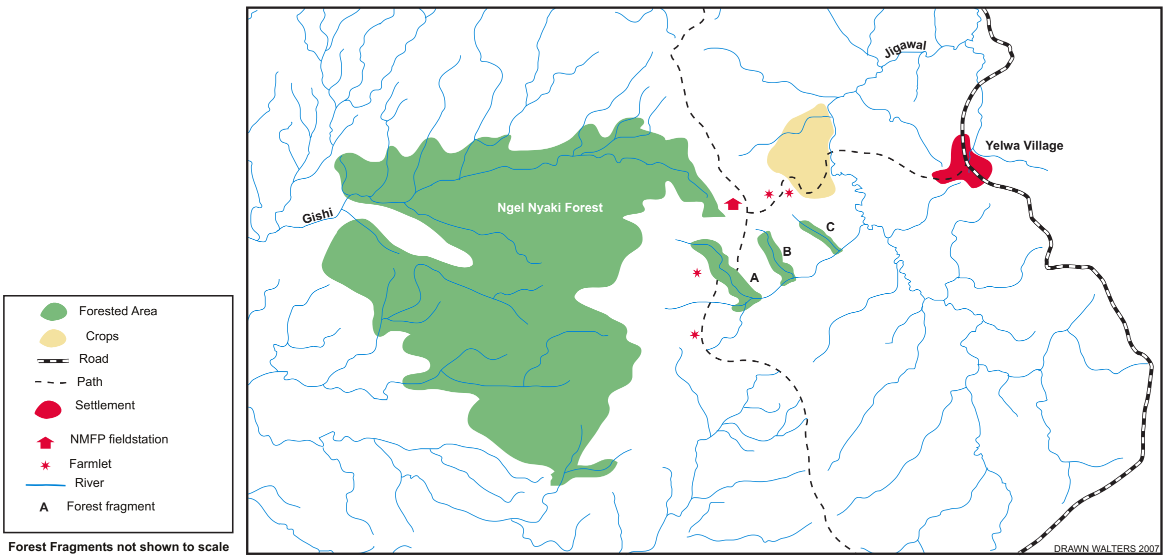

Figure 2. Ngel Nyaki forest and the three riparian forest fragments, A, B and C.

Methods

Study Area

Ngel Nyaki forest (N 07° 14', E 011° 04') is located between 14500-1500 m elevation on the western escarpment of Mambilla Plateau, an area of 3100 km^2 in the south east corner of Taraba State (Fig. 1). The Plateau is now dominated by rolling, overgrazed grassland, at an altitude of 1500-1600 m. Only one stand of forest remains on the Plateau, Ngel Nyaki Forest Reserve. The forest lies on the west facing slopes of an old volcano, between 1650 m to 1450 m elevation, and is *ca* 6.6 km^2 in area while Ngel Nyaki Forest Reserve is *ca* 46 km^2. The area was gazetted a Local Government Reserve in 1969, but the nearby riparian fragments along streams feeding into the Mayo Jigerwal (Fig 2) were not included within the reserve boundaries. Since the early 1980's the political situation in Nigeria has meant that patrolling and reserve management of Ngel Nyaki Forest Reserve has been neglected (although this is beginning to change). Local human and cattle populations have increased, exacerbated by a new road, which is only 40 mins walk from the forest edge. Hunting has been rife (it is only because of a weakening taboo against eating primates that so many of them remain), and the riparian fragments outside the Reserve have suffered various degrees of degradation, more severe the closer to the main road and Yelwa village (Fig. 2).

The study was designed to compare woody species composition and frugivore populations at four sites: one within Ngel Nyaki forest, and three small riparian forest fragments A, B, and C (Fig.2), suffering from increasing degradation in terms of species loss and disturbance with increasing distance from Ngel Nyaki forest and closer proximity to Yelwa village (Fig. 2).

Identification of Key Diurnal Frugivores in Ngel Nyaki Forest and Fragments

Two methods were used to determine the diurnal frugivore species composition of the four sites. In the first method each site was walked at random from 6 am -6 pm, for a total of five days per site. Every frugivore observed during this time was recorded. The sites were walked within four days of each other, to reduce any differences among sites which might be due to the weather or fruiting phenology. The second method involved observing frugivores feeding; at each of the four sites 20 focal fruiting trees (a total of 24 tree species) were identified and watched from 0600-1200 h and 1500-1800 h. Every frugivore visiting the tree was recorded in both the morning and afternoon, giving a total of 180 h of observations of focal fruiting trees at each of the four sites (720 h in total). Wherever possible the same tree species were observed in each of the four sites, in order to reduce any differences in frugivore composition among sites which might be better explained by tree species than overall frugivore composition. For both methods the observer used binoculars and a scope. Observations were carried out at intervals between July 2004 and January 2006.

Data Analysis

The frugivore data from the five 12 hours day observations was reduced to a summary table of the number of days out of five a frugivore species was observed at a site. The feeding data from the 20 morning and 20 afternoon observations per site was reduced to summary table of the number of times a frugivore species was observed feeding on a focal tree over those 40 visits. We again used DCA (Hill & Gauch 1980) to analyse species occurrences, and the results are presented as biplots where both frugivore species and sites are plotted in ordination space (Hill & Gauch 1980). Simpson's unbiased diversity index (see above) was calculated for each site. The statistical package MVSP was used for each analyses.

Results

There was almost no difference in results in terms of diurnal frugivore species composition between the five days observational data (method 1) and the focal tree observations (method 2), which suggests that differences among sites are real, and not merely a consequence of which focal tree species were observed. Here we describe the results from the focal tree data, as it was collected over a longer period of time and comprised more hours of observation. A total of 38 diurnal frugivore species were recorded from all four sites (Table 2), with more species in Ngel Nyaki forest (27) than in any of the fragments A B or C (20, 18 and 22 respectively).

Simpson's unbiased diversity index, which takes into account both number of species and their abundance, indicates a small decrease in frugivore diversity with increasing degradation (Table 3). Differences in frugivore visitors among sites are illustrated on the DCA biplot (Fig. 3), on which they are coded according to general gape-width categories: narrow up to 7 mm; medium 8-14 mm and wide >15mm. The first axis of the biplot (which ordinates both frugivores and sites) explained 87% of the variation, and axis 1and 2 together, 90.7%. Ordination of the data separated out species such that the frugivores more frequently associated with Ngel Nyaki forest lie to the right of axis 1, and those more frequently associated with fragments, towards the left of the axis. Diurnal frugiviores only recorded from Ngel Nyaki (Group 1 on the DCA plot) include all of the primate frugivores except for the *Cercopithecus aethiops* (Tantalus) and several of the wide gaped avian frugivores including the green turaco *(Tauraco persa)* and the piping hornbill (*Bycanistes fistulator*). Group 2 is the largest group with 20 species, and comprises frugivores recorded from both Ngel Nyaki and at least one of the fragments through to species only in the fragments - the farther along to the right of axis 1, the more often was the species recorded in fragments rather than Ngel Nyaki. This group includes *C. aethiops*, but mostly avian frugivores with gape widths ranging from *ca* 13 mm in *Tauraco leucolophus* to small passerines (Fig. 3). Species recorded from at least two fragments but not Ngel Nyaki forest were included in the same group because observational data show that all of these frugivores do feed on the edge of Nagel Nyaki, so that it would be contrived to include them in a separate group. Frugivores recorded only from the most degraded fragment C are located on the top left of the diagram. Despite only being recorded from fragment C, it is thought likely that they would not feed in the other fragments as well.

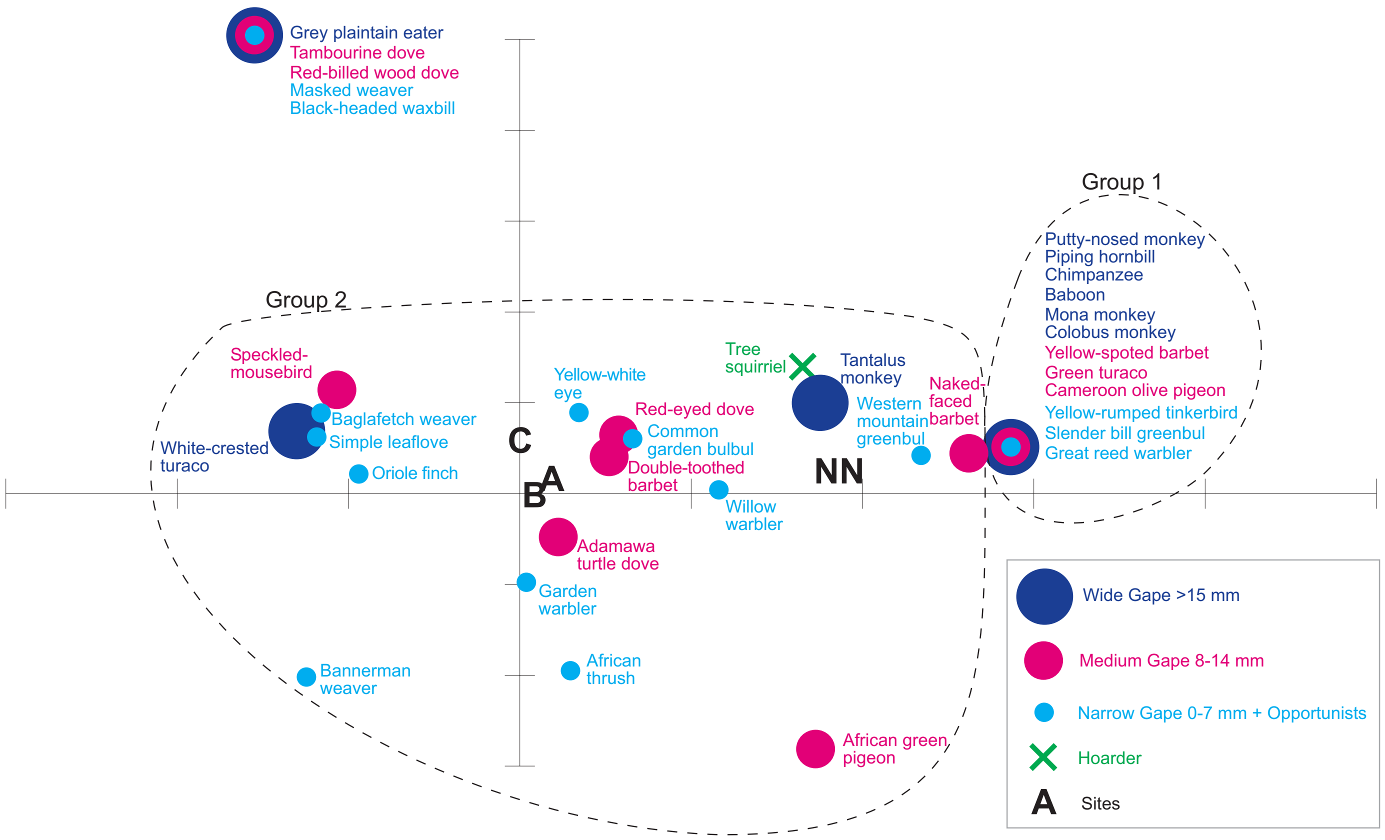

Figure 3. DCA plot of the four sites and each frugivore species.

					Site			
Family	**Tree species**	**Fruit size (mm)***	**Type**	**Colour**	**NN**	**A**	**B**	**C**
	HMC 900	9.8	Drupe	Black	X	-	-	-
Anacardiaceae	HMC 899	28.2	Drupe	Red	X	-	-	-
Araliaceae	*Polyscias fulva*	5	Drupe	Black/Purple	X	-	-	-
Burseraceae	*Santiria trimera*	28.3	Drupe	Red	X	-	-	-
Euphorbiaceae	*Croton macrostachyus*	10	Capsule	Red/Brown	-	X	X	X
	Bridelia micrantha	11	Drupe	Purple/Black	X	X	X	X
Guttiferae	*Symphonia globulifera*	24	Drupe	Green/Red/Brown	X	-	-	-
	Garcinia smeathmannii	42	Berry	Green	-	X	-	-
	Psorospermum corymbiferum	12.3	Drupe	Red	X	X	X	X
Moraceae	*Ficus sur*	30	Berry	Green/Yellow	X	X	-	X
	Ficus vallis-choudae	31	Berry	Green/Yellow	X	-	-	-
	Ficus sp. HMC 799	7	Berry	Green	X	-	-	-
	Ficus sp. HMC 808	4	Berry	Green	X	-	-	-
	Ficus sp. HMC 266	6	Berry	Green/Yellow	X	-	-	-
	Ficus sp. HMC 803	4	Berry	Green/Yellow	X	-	-	-
Myrsinaceae	*Maesa lanceolata*	4	Berry	Green/Brown	X	X	X	X
Myrtaceae	*Syzyguim guineense*	30	Drupe	Purple	X	X	X	X
Ochnaceae	*Campylospermum flavum*	9.1	Capsule	Black	X	-	-	-
Rubiaceae	*Canthium* sp	10	Drupe	Purple	-	-	X	X
Sapindaceae	*Deinbollia cf*	21	Drupe	Green	X	-	-	-
	Allophylus africanus	8.5	Drupe	Red	-	X	X	X
Sapotaceae	*Pouteria altissima*	30	Drupe	Green	X	-	-	-
Sterculiaceae	*Dombeya ledermannii*	8	Capsule	Brown	-	-	X	-
Ulmaceae	*Trema orientalis*	4	Drupe	Purple/Black	X	X	X	X

*Fruit size transverse diameter

Table 1. Focal trees observed in each of the four sites

Site	Index	Evenness	Num.Spec.
Ngel Nyaki	0.947	0.980	27.000
Fragment A	0.934	0.980	20.000
Fragment B	0.919	0.970	18.000
Fragment C	0.914	0.953	22.000

Table 3. Simpson’s unbiased diversity index in terms of frugivore species.

Family	Common name	Species
PYCNONOTIDAE		
	Western mountain greenbul	*Andropadus tephrolaemus*
	Slender billed greenbul	*Andropadus gracilirostris*
	Common bulbul	*Pycnonotus barbatus*
	Simple leaflove	*Chlorocichla simplex*
PHASIANIDAE		
	Double-spurred francolin	*Francolinus bicalcaratus*
COLUMBIDAE		
	African green pigeon	*Treron calvus*
	Tambourine dove	*Turtur tympanistria*
	Blue-spotted wood dove	*Turtur afer*
	Cameroon olive pigeon	*Columba sjostedti*
	Red-eyed dove	*Streptopelia semitorquata*
	Adamawa turtle Dove	*Streptopelia hypopyrrha*
CAPITONIDAE		
	Naked-faced barbet	*Gymnobucco calvus*
	Double-toothed barbet	*Lybius bidentatus*
	Yellow-rumped tinkerbird	*Pogoniulus bilineatus*
	Yellow-spotted barbet	*Buccanodon duchaillui*
TURDIDAE		
	African thrush	*Turdus pelios*
SYLVIIDAE		
	Garden warbler	*Sylvia borin*
	Willow warbler	*Phylloscopus trochilus*
MUSOPHAGIDAE		
	Green turaco	*Tauraco persa*
	White-crested turaco	*Tauraco leucolophus*
	Western grey plantain eater	*Crinifer piscator*
BUCEROTIDAE		
	Piping hornbill	*Bycanistes fistulator*
PLATYSTEIRIDAE		
	Common wattle-eye	*Platysteira cyanea*
PLOCEIDAE		
	Bannerman's weaver	*Ploceus bannermani*
	Baglafecht weaver	*P. baglafecht*
	Black-necked weaver	*P. nigricollis*
FRINGILLIDAE		
	Oriole finch	*Linurgus olivaceus*
ZOSTEROPIDAE		
	Yellow white-eye	*Zosterops senegalensis*
COLIIDAE		
	Speckled moosebird	*Colius striatus*
Mammals		
UNGULATES		
	Blue duiker	*Cephalophus monticola*
	Red flanked duiker	*C. rufilatus*
SCIURIDAE		
	Tree squirrel	*Funisciurus* sp
PTEROPODIDAE		
PRIMATES **CERCOPITHECINAE**		
	Olive baboon	*Papio anubis*
	Putty- nosed monkey	Cercopithecus *nicitans*
	Tantalus monkey	*C. aethiops*
	Mona monkey	*C. mona*
	Black and White colobus monkey	*Colobus guereza*
HOMINIDAE		
	Nigerian Chimpanzee	*Pan troglodytes vellerosus*

Bird nomenclature after (Borrow and Demey 1998);

Table 2. List of frugivores identified in the study.

Fragment A

Fragment B

Fragment C

Plate 2. The three riparian fragments.

Discussion

Frugivores And Seed Dispersal

There is generally a positive correlation between body size (weight) and the maximum size of fruit (seed) eaten by primates (Corlett 1998) and between avian frugivores body weight and gape size (Dunning 1993) , which means that large frugivores are most important in dispersing large seed (Wheelwright 1985;Wright *et al.* 2007), but large frugivores also disperse small seed. In Africa primates have been shown to be especially important in the dispersal of large seed (Wrangham *et al.* 1994; Lambert 1998; Stoner *et al.* 2007). For example Chimpanzees in Kibale are known to disperse seed up to 2.7 cm in diameter (Wrangham *et al.* 1994), and *Cercopthecus* species also disperse seed of a range of sizes in Afromontane forests (Dowsett Lemaire 1989; Beeson *et al.* 1996; Kaplin & Moermond 1998). In Ngel Nyaki forest *P. troglodytes vellerosus* and *Cercopthecus nicitans* spit, swallow, and disperse intact, viable seed of *Pouteria altissima* (28 mm in diameter), *Isolona cf. deightonii* (15 mm), and *Santiria trimera* up to 17mm in diameter, as well as small *Celtis gomphophylla*(<6 mm) and tiny *Ficus* seed (<1 mm) (unbublished data). In terms of avian frugivores hornbills are one of the most important seed dispersers in Afrotropical forests (Whitney *et al.*1998) as they disperse seed of a wide range of sizes and move a high proportion of seed away from the parent plant (Whitney *et al.* 1998); (Holbrook & Smith 2000)). Wide –gaped avian frugivores in this study include *Bycanistes brevis* (40-49mm), *Tauraco leucolophus* (> 24mm), *Tauraco persa,* (*ca.* 12-13mm), and both *Lybius bidentatus* and *Colius striatus* (slightly less than 12 mm), depending on the species (Dowsett-Lemaire 1988),

Frugivore Species Composition Of The Four Sites In This Study

Our results demonstrate that Ngel Nyaki forest differs in its diurnal frugivore community from the three riparian fragments (Fig. 3). While there is considerable overlap in terms of the small passerines, Ngel Nyaki harbors more wide - gaped frugivores than the fragments. For example, all the primates except *Cercopithecus aethiops* (which tends to be restricted to the forest edge), the ungulates, and the large avian frugivores except for *Tauraco leucolophus* and *Crinifer piscator* were only recorded from Ngel Nyaki (Group 1 in Fig. 3). The only wide-gaped frugivores seen in the fragments were C. *aethiops, T. leucolophus* (both of which are common) and *C. piscator* (which was only observed once in fragment C). Overall the three riparian fragments share the same diurnal frugivores, although there is trend for more forest loving species such as *Treron calvus* to decrease in frequency with increasing degradation.

Is There Dispersal Limitation In Ngel Nyaki Forest Or In The Fragments?

Despite the fact that some very large fruited species occur in Ngel Nyaki forest (eg *Tabernaemontana contorta* and *Carapa grandiflora)* (Table 1) there is no evidence of any tree species suffering from lack of dispersers (H. Chapman *pers. obs*). Empty fruit of *C. grandiflora* are commonly found on the ground, and almost always away from conspecific adults. Seed of the very similar species *Carapa procera* is dispersed by rodents (Forget & Jansen 2007), and in Ngel Nyaki porcupines eat the seed as well. Unlike some forests (Forget *pers. com*) there is no evidence of *C. grandiflora* fruit piling up beneath parent trees. Similarly the large fruits of *Tabernaemontana contorta,* and *Voacanga bracteata* appear to be dispersed, probably also by mammals such as rodents and porcupines. The large fruit of *Isolona cf. deightonii* sp. is broken open by primates and seed swallowed; we have found viable seed in both *P. troglodytes vellerosus* and *C. nicitans* dung (unpublished results), and seedlings of *Isolona cf. deightonii*. are abundant throughout the forest (*pers. obs.*). So despite the fact that large mammalian frugivore diversity is less than it has been historically; fruit is still being eaten and seed dispersed. It may be that the wide range of promiscuous frugivores capable of dispersing seed from fruit up to 40 mm in diameter is still ensuring dispersal. In Ngel Nyaki eight frugivore species were observed feeding on *Pouteria altissima* (seed 28 mm in diam), four primates (*Pan troglodytes vellerosus*, *Cercopithecus nicitans*, *C. aethiops* and *Papio anubis*), three birds (*Columba sjostedti, Bycanistes fistulator* and *Treron calvus*) and a tree squirrel *Funisciurus anerythrus*.

In the riparian fragments six tree species were identified with fruit >20 mm in diam.: *Anthocleista vogelii*, *Ficus sur, Garcinia smeathmannii, Dienbollia cf. pinnata. , Syzygium guineense,* and *Symphonia globulifera* (Table 1). While ripe fruit of *F. sur* and *A. vogelii* can be pecked at and chunks with seed swallowed by small passerine birds, the other four species depend upon wide-gaped frugivores for diurnal dispersal. *Dienbollia cf. pinnata* sp., S. *guineense* and *S. globulifera* are dispersed mainly by *Tauraco leucolophus,* but also by *Cercopithecus aethiops,* and *Funisciurus* sp, the latter a scatter horderer. Fruit of *G. smeathmannii* are too large to be swallowed by *T. leucolophus* , and consequently this species appears to depend mostly on *C. aethiops* and *Funisciurus* sp for diurnal dispersal. Overall these results indicate little, if any, dispersal limitation within the fragments because there are few large fruited / seeded tree species in them, and the largest of those *G. smeathmannii* (42 mm) appears to be dispersed by *C. aethiops.* Moreover we have not included nocturnal frugivores in our study. Rodents, small ungulates, bats and civet cats may all contribute in different ways to dispersal (Corlett 1998). Indeed civit cat dung is common throughout the grassland and almost always full of seed (H. Chapman pers. obs.).

So it doesn't look as if fruit removal is an issue within either Ngel Nyaki forest or in any of the three fragments; Ngel Nyaki has more large fruited tree species than any of the fragments, but also more large frugivores. Within Ngel Nyaki forest (Mattheus 2006) and the fragmnents (unpublished data) seedling distribution provides evidence that dispersal away from the parent tree is frequent, so that fitness is not limited through conspecific competition or predators / paradsites (Janzen 1970;Connell 1971). Moreover rare, unrecorded long distance dispersal event likely occur by birds, especially hornbills. Therefore as long as the current frugivore populations remain within forest stands such as Ngel Nyaki, and within riverine fragments such as A, B and C of this study, lack of frugivores do not appear to be a major threat to forest survival in terms of tree species composition in the short term.

However the loss of frugivore diversity and increased forest fragmentation that has taken place at this site, elsewhere on Mambilla Plateau, and within Nigerian montane systems in general over the past 50 years, must adversely affect patterns of seed dispersal (Clark *et al*. 2005). Seed shadows of seed dispersed by frugivores vary according to factors such as body size, digestive strategy, ranging behavior and defecation patterns (Stoner *et al*. 2007).Using a combination of seed traps and DNA-based genotyping of *Prunus mahaleb* (Jordano *et al*. 2007) were able to demonstrate that different frugivores were responsible for dispersing seed to different distances away from the parent tree and into different habitats, so that different frugivores made a different contribution towards dispersal, and affected the genetic structure of populations in unique ways. In African forests hornbills are able to disperse seed the greatest distances of any frugivore, and rarely deposit seed closer than 500m to the parent tree (Holbrook & Smith 2000). Historically on Mambilla Plateau and elsewhere in the Nigerian highlands it is likely that *B. fistulator* would have been much more common, and would have and played a major role in effecting gene flow for a wide range of species among montane forest fragments. Chimpanzees would also have moved seed large distances; they have large home ranges, and their propensity for seed swallowing, coupled with extended gut retention times (estimated mean >31 hrs (Lambert 2002) is ideal for long-distance dispersal (Gross-Camp & Kaplin 2005; Wrangham *et al.* 1994). However today the small Ngel Nayki population of chimpanzee is unlikely to disperse seed outside Ngel Nyaki forest, or even the small distance across open grassland to fragment A. Likewise *Cercopithecus nicitans* is very rarely found outside Ngel Nyaki forest, so despite the fact that Cercopithecus monkeys have long gut retention times and move across a range of habitats (Kaplin & Lambert 2002), they are unlikely to effect seed dispersal among populations any more.. The same likely applies to other small populations of primates in the Gotel Mountain forests of Gashaka Gumti National Park (Fig.1).

Forest restoration of degraded habitats is often dependent on naturally dispersed seeds (Wunderle 1997; Duncan & Chapman 1999). If land degradation and hunting is controlled around Ngel Nyaki Forest Reserve, what is the likelihood of natural forest restoration? The riparian fragments in our study are already 'pre-adapted' to fragmentation, in that they comprise trees adapted to disturbance, light and generalist seed dispersers, an advantage for restoration (Aizen & Feinsinger 1994). Several species, especially legumes such as *Albizia gummifera,* are wind dispersed, and many of the pioneers have small, light seeds well adapted for dispersal by a wide range of frugivores, *e.g.. Trema orientalis* (Richards 1998). (Aerts *et al.* 2007) has shown that pioneers shrubs in montane fragments in Northern Ethiopia act as nurse crops for *Olea europea* ssp.*cuspidata*. However Aerts *et al.* 2007 stress the need to exclude livestock if there is any hope of forest restoration. On Mambilla Plateau successful restoration will depend on protection of the forests from grazing and burning, as well as the whittling away of fragments for firewood and poles (at our study site this would mean officially including fragments A, B and C in a buffer zone associated with Ngel Nyaki Forest Reserve). If this is achieved, then it would seem that sufficient frugivore species are present to effect the natural restoration of most tree species on Mambilla Plateau, and more generally in the upland areas of Nigeria.

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Putty Nose Monkey Project

The role of *Cercopithecus nicitans* (putty nose monkey) in seed dispersal at Ngel Nyaki Forest Reserve.

Undertaken as PhD research by Stephen Gawaisa from the Federal University of Technology, Yola and supervised by Dr Hazel Chapman and Dr Callustris Akosim.

*To be presented orally by Stephen Gawaisa at the Nigerian Ecological Society Conference, Jos. October 2007.

Plate 3. Putty nose monkey in a Fig tree.

The field work for this part of the project was completed in January 2007, and is in the process of being analysed and written up for a PhD thesis (see above).

In summary a group of about 15 *Cercopithecus nicitans* at Ngel Nyaki forest were followed for five days a week, eight hours a day (6am-12pm; 4pm-6pm) for 18 months, from January 2005-January 2007. A focal group of Putty-Nosed Monkeys was followed for 8hrs. a day : 6hrs. in the morning from 6:00am – 12 noon, and 2hrs. in the evening from 4pm – 6pm local time. The method used was scan sampling with a fixed time interval; each scan sample was for 15 minutes, beginning on the hour, with an observation period of 5 minutes. Binoculars and a spotting scope were used for observation. During each observation period, the focal group was scanned from left to right on the first scan, then right to left next scan and so on. All feeding behaviour was observed and recorded. Only one activity was recorded for each member of the focal group during each scan period. Individuals were recorded as feeding if they were handling, pulling, biting, ingesting or chewing food. If they were feeding, the plant species and part (eg. leaf, flower or fruit) was recorded. The abundance of plant parts available was recorded using a score of 0 to 5 for each item. Scan sampling was chosen because it gives a representative cross-section of the activity budget (Nakawa, 2000).
This investigation has provided data on which tree species *C. nicitans* feed, and how this varies over the year.

In addition, information on seed species dispersed in *C nicitans* dung was obtained by collecting seed information from 65 dumps, collected over a year. Within each dump the number of seeds, seed species, and seed size was recorded.

An experiment was then carried out to determine if the germination success of seed from each species was enhanced by passing through a *C. nicitans*; the experiment was designed to compare germination rates of seed that had undergone one of three treatments: 1) not dispersed (fallen below the tree), 2) collected and then spat out by *C. nicitans* and 3) swallowed and passed out by *C. nicitans*.

Information on whether or not *C. nicitans* disperse seed into specific microsites was collected by recording microsite data (a 50 m radius round a dump), from 20 microsites sites where *C. nicitans* dumps were observed, and 20 sites where they were not. Habitat variables of these microsites included ground layer species composition; litter depth; light availability; tree species, height of tallest tree and distance to the nearest conspecific tree (conspecific to the seed species found in the dung).

All this data, as well as additional studies to estimate *C. nicitans* group size and

School of Biological Sciences
Tel: 364 2500, Fax: 364 2590
Email: biology@canterbury.ac.nz
www.biol.canterbury.ac.nz

University of Canterbury
Te Whare Wānanga o Waitaha
Private Bag 4800, Christchurch 8020, New Zealand
Tel: 3667001, Fax: 364 2999
www.canterbury.ac.nz