Global Scientific JOURNALS

GSJ: Volume 7, Issue 2, February 2019, Online: ISSN 2320-9186
www.globalscientificjournal.com

ASSESSEMENT OF THE NEST AND FEEDING ECOLOGY OF THE SYMPATRIC CROSS RIVER GORILLA AND NIGERIA CAMEROON CHIMPANZEE IN TOFALA HILL WILDLIFE SANCTUARY, SOUTH WEST REGION CAMEROON

Author 1: Enokenwa Allen Tabi

Environment and Rural Development Foundation (ERuDeF)

P.O Box 189, Buea, Cameroon

Author 2: Louis Nkembi

Environment and Rural Development Foundation (ERuDeF)

P.O Box 189, Buea, Cameroon

Author 3: Sebastian Linnarz

University of Bonn

Institute of Zoology

53111 Poppelsdorfer Schloß

Meckenheimer Allee 169

Preliminary studies of Cross River gorilla (*Gorilla gorilla diehli*) and Nigeria-Cameroon Chimpanzee (*Pan troglodytes ellioti*) have been going on in Tofala area since 2004. These studies were mostly focused on determining the distribution of these two great apes species in the area. Reliable information on the ecology of wild Cross River gorilla and Nigeria Cameroon chimpanzee is still scarce. Such information can provide insights into great ape cognition and evolution, and can provide valuable data to guide conservation efforts for remaining populations.

The aim of this study was to make assessment of the nesting and feeding ecology of Cross River gorilla and Nigeria Cameroon chimpanzee in Tofala Hill Wildlife Sanctuary. This study was conducted from November 2015 to August 2016. 55 kilometres reconnaissance (recce) walks and twelve camera traps functioning for1242 trap days (November 2015 to April 2016) were used to determine the nesting and feeding ecology of these great apes species. The study area was randomly stratified into 1km by 1km grids with laid down recce of different lengths in the centre of the grids, and camera traps planted along animal trails in the grids. The following data were collected; GPS coordinate of great apes nest, vegetation type, species, slope, canopy type, food type, nest sites, nest type, undergrowth of vegetation and elevation and photos of great apes from camera traps. Data was analysed using the Microsoft excel.

Results revealed that slope, vegetation and canopy cover have great influence on the ecology of great apes. 55.06% of nests and 60% of feeding signs for chimpanzee and, 61.5% of nests and 65.6% of feeding signs for gorilla were distributed across steep slopes. 56.2% of chimpanzee and 38.5% of gorilla nest were constructed in undergrowth made of small trees and lianas respectively. 40% of chimpanzee and 79.9% of gorilla feeding signs were distributed in bushes of secondary forest. 56.2 % of chimpanzee nest sites were constructed in very close canopy cover and 40% of feeding signs were distributed in open canopy. Similarly majority of gorilla nest (76.9%) were constructed under very close canopy and feeding signs (51.1%) were found in open canopy.

Aframomum sp was the most frequently encountered food remains for both chimpanzee and gorilla and can be considered as staple diet for great apes in the area. Chimpanzee fed on giant snails, mongoose and porcupine.

Though this study presents foundational research on the nesting and feeding ecology of Cross River gorilla and Nigeria Cameroon Chimpanzee it is limited in some important way, (i) the entire area of the Sanctuary was not survey, and (iii) faecal analyses were not conducted to determine the diversity of great apes diet.

However, this information obtained can be used in the long-term conservation of Cross River gorillas and Nigeria-Cameroon Chimpanzee in the Tofala Hill Wildlife Sanctuary.

1. Introduction

The Tofala Hill Wildlife Sanctuary is located in the Lebialem Highlands within the Cameroon-Nigeria cross border. The area harbours two sympatric great apes species, the Critically Endangered Cross River gorilla (*Gorilla gorilla diehli*) and the Endangered Nigeria-Cameroon chimpanzee (*Pan troglodytes ellioti)*. The entire Cross River gorilla population is thought to comprise of less than 300 individual fragmented across 15 hilly enclaves along the Nigeria-Cameroon border (Nicolas *et al.,* 2010) and the Nigeria-Cameroon chimpanzee numbering possibly as few as 3500 animals (Morgan *et al.,* 2011). Forest in these great apes habitat continues to be lost, degrade and fragmented through unsustainable agricultural practices and logging.

Although chimpanzee and gorilla are genetically related and show similarity in morphological features (Chivers & Hladix, 1984; Milton, 1984; Shea, 1983), they exhibit remarkably differences in ecological features and social organization. Though studies have been carried out on the ecology of sympatric low land gorilla and central chimpanzee, reliable information on the ecology of wild Cross River gorilla and Nigeria Cameroon chimpanzee is still scarce. Such information can provide insights into great ape cognition and evolution, and can provide valuable data to guide conservation efforts for remaining populations (Hockings *et al.,* 2015).

The aim of this study is to make an assessment of the nesting and feeding ecology of Cross River gorilla and Nigeria Cameroon chimpanzee in Tofala Hill Wildlife Sanctuary using reconnaissance survey and camera traps.
Camera traps are increasingly being used to study wildlife behaviour and to conduct population estimation (Cutler *et al.,* 1999; O'Connell *et al.,* 2011; Rovero *et al.,* 2013).

2. Materials and Methods

2.1 Study site

Tofala Hill Wildlife Sanctuary is located between longitude 598006m and 609830m and latitude 615778m and 634006m. This area is situated within the Wabane sub-division in the North and Alou sub-division in the south, in Lebialem Division, adjacent to the Forest Management Unit 11-002 and the Mone Forest Reserve, South West region covering a total surface area of about 8087ha (80.87 Km²).

The area is characterized by undulated landscape from Bechati (365m) in the lower altitudes to Fossimondi (2000m) in the higher altitudes. The topographic orientation of the area directs the flow of the water network from north to south.

This region is located in a zone with a humid tropical climate. The average rainfall is about 3,500mm, (Gartlan, 1989) with the peak in August. It has a distinct dry from November to February and rainy from March to October season. The daily temperatures vary between 20°c and 35°c, with the peak in March.

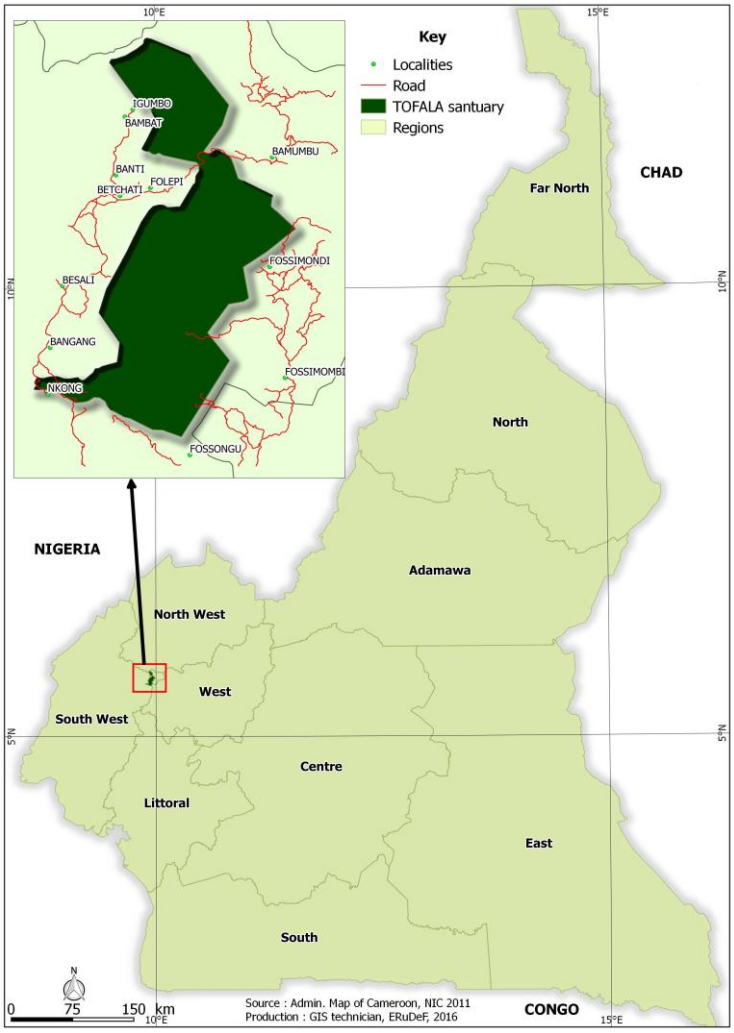

Figure 1: Location of Tofala Hill Wildlife Sanctuary in Cameroon

2.2 Census Method

The survey was conducted from November 2015 to August 2016 and included both dry and the rainy season periods. The entire Tofala Hill Wildlife Sanctuary was randomly stratified into 1km by 1km grids with laid down transects (recce) of different lengths in the centre of grids, and planting of camera traps along animal trails in the grids. The Eastern part (35 square kilometres) of the Sanctuary was effectively surveyed.

Instead of using standard transects method in animal density censuring (Burnham *et al.,* 1980, Buckland *et al.,* 1993), we used the guided reconnaissance (recce) walk (Walsh and White 1999; Kuhl et al., 2008; McNeilage et al., 2006). All starting points of recces were determined by using a hand held GPS unit (GPSmap 62 GARMIN). These recces were walked by a team made up of a

leader, one assistant and a guide. The leader was responsible for reading the bearing, searching for great apes signs and recording them in a designed data sheet, the assistant was responsible for recording the GPS coordinates of great apes signs and the guide was the pathfinder and cutter of vegetation to facilitate passage and identification of starting point. Cutting of recce was restricted to the minimum necessary to facilitate passage of the team and 55 km recces walk were covered. The following data were collected; GPS coordinate of great apes nest, vegetation type, species, slope, canopy type, food type, nest sites, nest type, undergrowth of vegetation and elevation. Slope values were classified into four categories; flat (0°), slight (1-5°), moderate (5-10°) and steep (>10°).

We used the definition of Tutin and Fernandez (1984) for the identification of nest. We defined a nest site as all nest ≤ 50m from each other that were created by the same ape species and the same age class. We attributed all arboreal nest sites and nest sites made up of arboreal nests higher than 10m above ground level and grown nests of same age to chimpanzee and a nest site with only ground nest to gorillas.

We also set up twelve camera traps (10 Bushnell HD and 2 MOULTRIE model number MCG-12632) in the area. Cameras were setup along animal trails (Farris *et al.,* 2014; Head *et al.,* 2012) by taken into consideration the knowledge of the local field guides who have once been hunters in the area.

Each camera trap was given an identification number (Cam 1 to Cam 12), and were fixed approximately 30-40 cm above ground level on sturdy trees. Any vegetation that would obstruct the camera's field of view or could falsely trigger the motion sensor was removed. The date of installation and location of each camera was recorded with a hand held GPS unit. All cameras at the survey locations were active 24 hours per day and were set to take three videos or pictures in rapid succession, each with a date and time stamp. After taking a set of videos or pictures, cameras will remain inactive for 30 seconds before re-arming to take pictures to avoid unnecessary videos or photo.

Camera traps were regularly checked (for at least every 2 weeks) to download data, change battery and make sure that the camera is functioning. Cameras were occasional move to another location in the study site to maximize animal detection and to make sure the study area is effectively surveyed. Cameras traps were allowed to run for 1242 trap days (November 2015 to April 2016). Camera trap days are the number of 24-hour periods that cameras are employed, multiplied by the number of cameras in operation (Blake *et al.* 2010; Rovero *et al.* 2013).

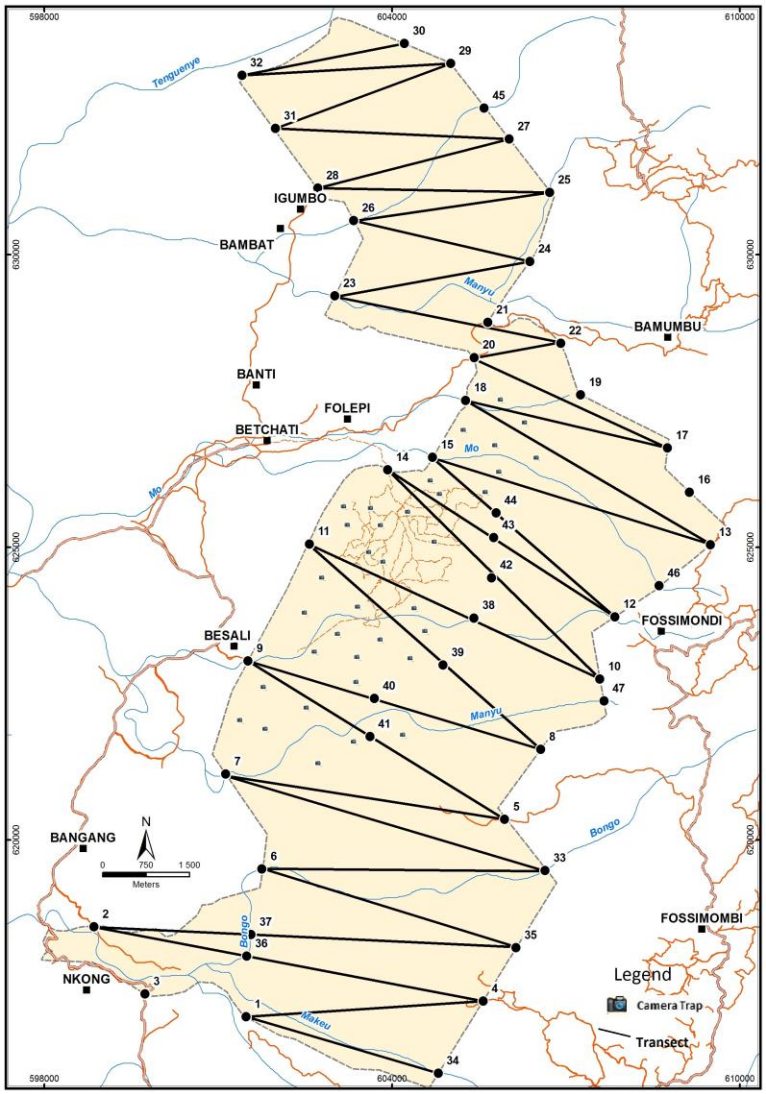

Figure 2: Placement of Camera traps in study area

2.3 Data analysis

The guided recce map was generated using the QGIS. The exact positions of the camera trap stations were geo-referenced with the GPS and then imported into the QGIS software. All data from camera traps were retrieved and saved in a laptop for identification of great apes pictures and videos.

We calculated the overall capture rate and capture rate of each great ape from the photo data. Total capture events for each species are divided by the number of trap-nights, and then multiplied by 100, to reach the capture rate per 100 trap-nights. This standardization allows for comparisons of relative trap success between species and locations. Data was filtered to exclude photos of the same species at the same camera trap station within a period of 30 minutes to make sure that the events are independent (O'Brien *et al.,* 2003).

The relative densities of great apes species were calculated from the following formula below;

Encounter Rate = Number of great apes signs/ Distance covered (Km).

The nest encounter rates were calculated from all fresh nests recorded during the survey period.

3. Results and Discussion

3.1 Results

In the transect survey 55km were covered between the month of November 2015 to August 2016. Meanwhile camera traps were placed in the survey area for 1242 trap days (November **2015 to April 2016).**

3.1.1 Relative Abundance of great apes

Table 1. Encounter Rate of Great Apes

Great ape species	Nest Encounter Rate	Capture Rate
Cross River Gorilla	0.22	0.01
Nigeria Cameroon Chimpanzee	1.54	0.81

3.1.2 Influence of slopes, vegetation undergrowth and canopy cover on great apes nesting and feeding.

The results show that slope, vegetation and canopy cover have a great influence on the ecology of great apes in Tofala Hill Wildlife Sanctuary. Figures 4, 5, 6,7,8,9 illustrate the distribution of great apes nests and feeding signs across slopes, vegetation and canopy cover.

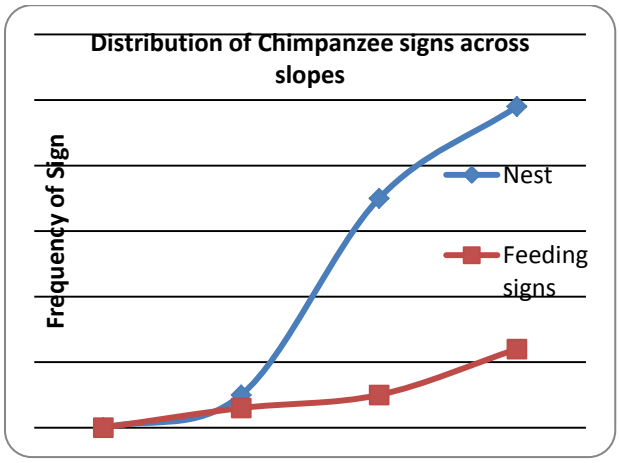

Figure 4: Distribution of chimpanzee signs across slopes

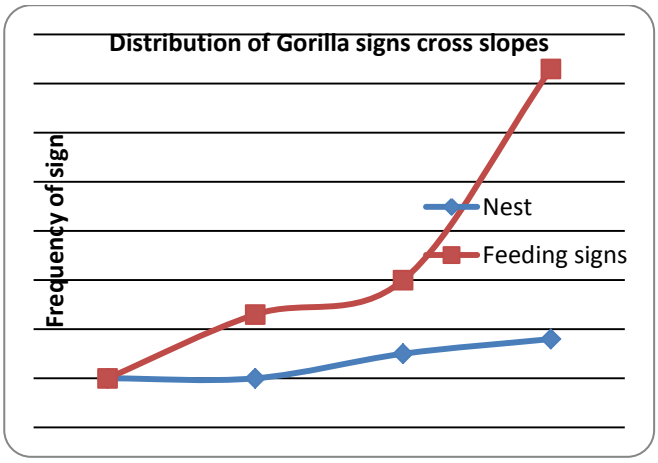

Figure 5: Distribution of gorilla signs across slopes

55.06% of nests and 60% of feeding signs for chimpanzee and 61.5% of nests and 65.6% of feeding signs for gorilla were distributed across steep slopes as shown in figure 4&5.

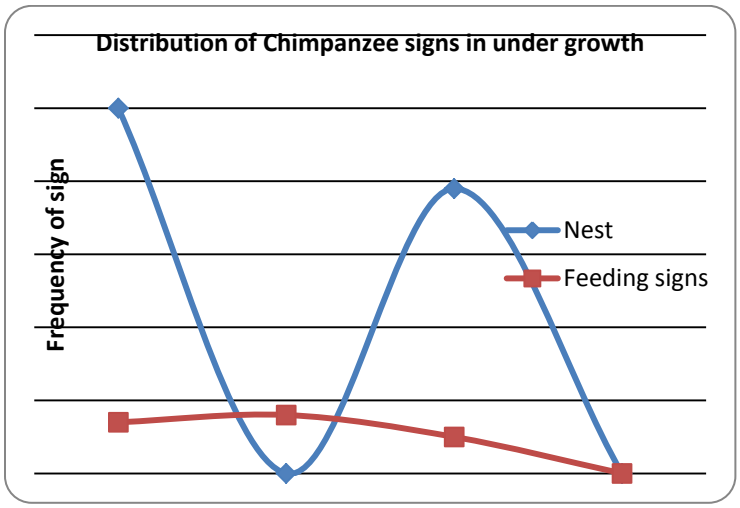

Figure 6: Distribution of chimpanzee signs in under growth

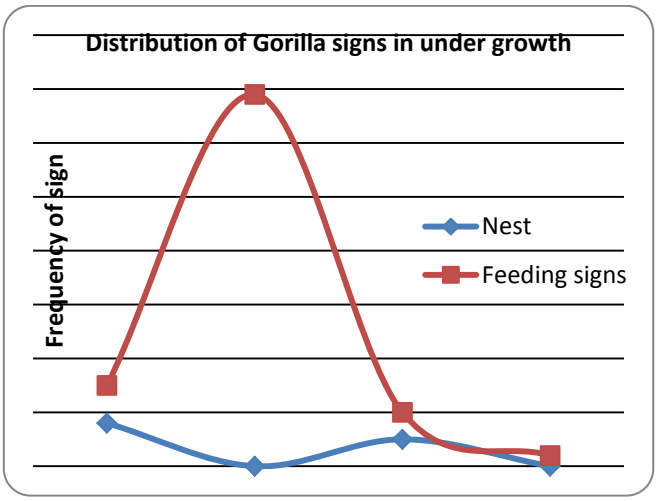

Figure 7: Distribution of gorilla signs in under growth

56.2% of chimpanzee and 38.5% of gorilla nest were constructed in undergrowth made of small trees and lianas respectively. 40% of chimpanzee and 79.9% of gorilla feeding signs were distributed in bushes of secondary forest (figure 6&7).

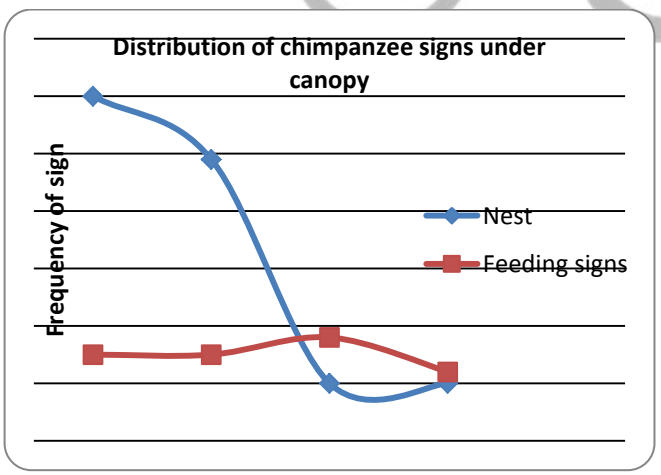

Figure 8: Distribution of chimpanzee signs under canopy

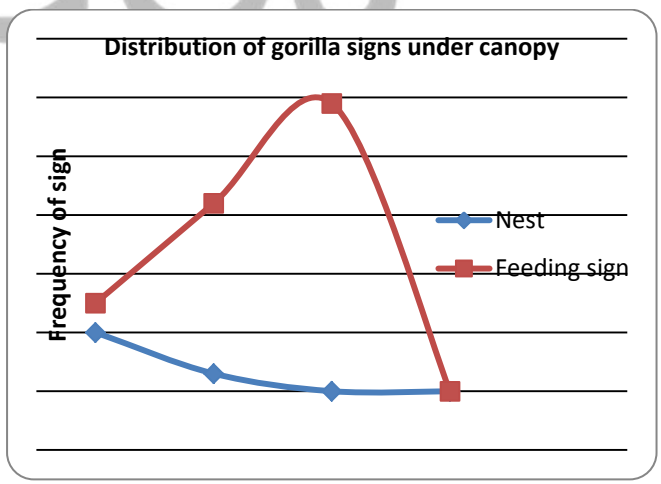

Figure 9: Distribution of chimpanzee signs under canopy

56.2 % of chimpanzee nest sites were constructed in very close canopy cover and 40% of feeding signs were distributed in open canopy cover. Similarly majority of gorilla nest (76.9%) were constructed under very close canopy and feeding signs (51.1%) in open canopy.

Figure 10: Gorilla ground nest

Figure 11: Chimpanzee tree nest

3.1.3 Available great apes diet in Tofala Hill Wildlife Sanctuary

In Tofala Hill Wildlife Sanctuary great apes diet is made up of mostly fruits, leaves, small mammals and insects. The table 2 below shows the different food types of gorilla and chimpanzee based on camera trap analysis and signs found on trails.

Table 2. Frequency of food types in Cross River gorilla and Nigeria-Cameroon Chimpanzee diet based on camera trap analysis and signs on trails in Tofala Hill Wildlife Sanctuary

Great apes	Food Type	Frequency (N) of food type recorded	
		On camera trap	On trail
Chimpanzee	*Cola laurifolia*		20
Chimpanzee* & gorilla	*Raphia* sp		30* & 15
Chimpanzee* & gorilla	*Pseudospondia microcarpa*		25*& 10
Chimpanzee	*Monanthotaxis sp*		15
Chimpanzee	*Heckeldora staudtii*	1	23
Chimpanzee	*Salacia lebrunii*		3
Chimpanzee	Canarium shweinfurthii		18
Chimpanzee* & gorilla	*Landolphia* sp		50* & 13

Chimpanzee	*Angelocalyx pyneatii*		17
Chimpanzee	*Penianthus longifolus*		12
Chimpanzee	*Achatina fulica*		35
Chimpanzee* & gorilla	*Aframomum* sp	1	52* & 30
Chimpanzee	*Cola suboppostifolia*		28
Chimpanzee	*Elaeis guineensis (nuts)*		22
Chimpanzee* & gorilla	*Agaricus* sp		10* & 4
Chimpanzee	Termites		40
Chimpanzee	Mongoose	1	
Chimpanzee* & gorilla	*Musa* sp		48* & 24
Chimpanzee	*Atherurus africanus*	1	

3.1 Discussion

Our results have shown that nest survey and camera trap can be used to study the nesting and feeding ecology of Cross River gorilla and Nigeria Cameroon Chimpanzee in the wild. Though the study was designed to cover the entire area of the Tofala Hill Wildlife Sanctuary, only 35 km² was surveyed because of topographical challenges and malfunctioning of the camera traps. The encounter rates (see table 2 above) of great apes were calculated only from fresh nest. Given that, the population estimate from nest count are often unreliable (Tutin *et.,al* 1995; Bradley *et.,al* 2008) more accurate and precise density estimates are needed.

3.2.1 Nesting Ecology

In Tofala Hill Wildlife Sanctuary 3 types of apes nest were recorded, this includes arboreal nest, ground nest and bare ground nest. However only two types (tree and ground nest) were effectively attributed to chimpanzee and gorilla (see figure 10 & 11). 55.06% and 61.5% chimpanzee and gorilla nest respectively were distributed across steep slopes (figure 4&5). This result is consistent with other studies in Kagwene (De Vere *et al.,* 2011; Funwi-Gabga and Mateu 2011) and Mt. Oku Forest (Sawyer and Brashares 2013) also found a higher percentage of Cross River gorilla nests on the steep slopes. A preference for steep slopes for nesting has also been reported for chimpanzee (Nishida 1989; Kano 1972; Koops *et al.,* 2007; Hernandez-

Aguilar 2009). This nesting behaviour might be due to the high human pressure in the area, in which great apes will prefer vantage points of the slopes that will increase their visibility of the surrounding environment. Other factors for the construction of nest in steep slopes might be increase shelter for evening winds, exposure to early morning sunlight.

56.2% of chimpanzee and 38.5% of gorilla nest were constructed in undergrowth made of small trees and lianas respectively (figure 6&7). This behaviour might be due to availability of preferred nesting materials (Nishida 1989) and a strategy of dietary opportunism (Hashimoto 1995 and Ancrenaz *et al.,* 2004). 56.2 % of chimpanzee nest sites were constructed in very close canopy cover (figure 8). Similarly, majority of gorilla nest (76.9%) were constructed under very close canopy (figure 9) which is observed as a strategy for avoidance of human predators. Human disturbance has been shown to affect nesting behaviour in other species of great apes (Remis 2000; Arnhem *et al.,* 2007; Stokes *et al.,* 2010; Tagg and Willie 2013).

3.2.2 Feeding ecology

Majority of great apes feeding signs were encountered in steep slopes, bushes of secondary forest and in open canopy cover (see figure 4, 5, 7, 8&9). Cross River gorilla and Nigeria-Cameroon Chimpanzee relies on a variety of food sources. However in this study the methodology deployed did not permit us to identify all the food sources available. Table 2 above shows the frequency of some food types of Cross River gorilla and Nigeria Cameroon Chimpanzee recorded during the study period in Tofala Hill Wildlife Sanctuary. *Aframomum* sp was the most frequently encountered (N= 52* & 30) food remains for both chimpanzee and gorilla and can be considered as the most stable diet for great apes in the area.

On trails we found remains of giant snails which have been fed upon by chimpanzee. Results from camera traps showed that chimpanzees also fed on other small mammal such as mongoose and porcupines.

Chimpanzee eating the carcasses of mongoose

Aframomum sp (stem)

Landolphia sp

Figure 12: Gallery of some food type of great apes in Tofala Hill Wildlife Sanctuary

4. Conclusion

Though this study presents foundational research on the nesting and feeding ecology of Cross River gorilla and Nigeria Cameroon Chimpanzee it is limited in some important way, (i) The entire area of the Sanctuary was not survey and (ii) data was collected only on fruits. Leaves and other plant parts were not considered and (iii) faecal analyses were not conducted to determine the diversity of great apes diet.

However, the information gather can be used in the long-term conservation of Cross River gorillas and Nigeria-Cameroon Chimpanzee in the Tofala Hill Wildlife Sanctuary.

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