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FOREST STRUCTURE AND COMPOSITION OF TREES IN HABITAT OF PRIMATES IN GHANA

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Abstract

Tree composition, density and diversity were assessed within a monkey sanctuary that has been tempered with by human beings. The study took place in Buabeng-Fiema monkey Sanctuary in Ghana to document the vegetation structure of the non-human primate habitat. The habitat types were stratified into three classes; as natural forest, mixed forest and cultivated area and 20 plots of dimensions 20m x 25m were established in each of the habitat types. All trees ≥ 10 cm diameter at breast height were identified and measured. In the mean number of trees per hectare was 17.5 (S.D=5.5, N=20), 12.7 (S.D=3.6, N=20) and 7.4 (S.D=7.4, N=20) in the natural forest , mixed forest and cultivated area respectively. The diversity, relative density and relative dominance differed in all the three habitat types. Moreover, the number of trees reduced with increasing height and basal area in all the three habitat types. The variations in the three habitat type provide good resources that may be required by the primates for survival but can promote and deepen human-wildlife conflict.

Keywords: Anthropoid monkey, Buabeng-Fiema, habitat types, wildlife sanctuary

Özet

Bu çalışmada insanlar tarafından açığa çıkarılmış bir maymun korunağı alanında ağaç türü bileşimi, yoğunluğu ve çeşitliliği incelenmiştir. Çalışma Buabeng-Fiema'da (Gana) yer alan ve insansız bir bölge olan primat yaşam alanındaki bitki yapısını ortaya çıkarmak için maymun korunağı alanında yürütülmüştür. Yaşam alanındaki bitki toplumu doğal orman, karışık orman ve suni bitkilendirilmiş alan olarak üç sınıfta incelenmiş olup her bir alandan 20'şer tane 20m x 25m'lik alanlar örneklenmiştir. Göğüs yüksekliği çapı 10cm'den büyük olan bütün bireyler teşhis edilmiş ve ölçülmüştür. Hektardaki ortalama ağaç sayısı doğal orman, karışık orman ve suni bitkilendirilmiş alanda sırasıyla 17.5 (S.D=5.5, N=20), 12.7 (S.D=3.6, N=20) ve 7.4 (S.D=7.4, N=20) olarak tespit edilmiştir. Tür çeşitliliği, bağıl yoğunluk ve bağıl başatlık değerleri bakımından her üç habitat için de farklı sonuçlar elde edilmiştir. Ayrıca her üç habitatta da ağaç sayısı azaldıkça ağaç boyu ve göğüs yüzeyi alanı artmıştır. Habitatlardaki orman kuruluşlarındaki çeşitlilik primatların yaşamı için gerekli kaynakları tatmin edici düzeyde sunmakla birlikte insan-vahşi yaşam çatışmasını tetikleme potansiyeli taşımaktadır.

Anahtar kelimeler: İnsansı maymun, Buabeng-Fiema, Habitat türleri, Vahşi yaşam habitatları.

INTRODUCTION

Non-human primates and trees have been evolved to be involved in a very complex set of interaction (Tutin *et al.* 1996; Chapman and Chapman 1996). It is apparent that trees offer a lot of services to primates such as food and cover (Kinnaird 1992; Cowlishaw and Dunbar 2000). In the efforts of extracting these services from the plant community, primates also contribute to the evolution and existence of plants in services like pollination of flowers (Carthew and Goldingay 1997), dispersal of seeds (Chapman

1989; Chapman and Chapman 1996; Howe 1988) and germination of seeds (Liberman *et al*. 1979) which tends to play a crucial role in regeneration of tropical forests (Wrangham *et al*. 1996; Chapman and Onderdonk 1998). Kessler *et al*. (2005) defines forest community as an association of interacting plant species inhabiting some definite area. Thus, we may have entire plants (as well as shrubs, herbs, etc.) communities interacting in an area in terms of competition, exploitation, and mutualism. According to Kessler *et al*. (2005), the community structure includes attributes such as number, relative abundance and diversity of tree species. Huang *et al.* (2003) stated that for an individual forest community, there are many factors which can affect the numbers of species present. Some of the influences on the community are from within the community itself while others including human-induced forest disturbances such as farming and logging are external. Huang *et al*. (2003) further added that severe or frequent forest disturbances affect the structure and number of plant species in the forest community. When forest community is disturbed, more room is created for natural regeneration to take place. However, if the disturbance becomes too much then the forest becomes too harsh and species diversity may decline. From this, it can be deduced that human induced forest disturbances such as logging and intensive farming alters the dynamics of tree species abundance and diversity.

Tropical forests are complex ecosystems (Gibbs *et al*., 2007) which have not been well understood. The forest that appears to be unchanging climax vegetation passes through elusive changes in floristic composition and structural characteristics as result continuous flux of different species with varying recruitment and mortality rates (Whitmore, 1992) . Therefore, investigations into floristic composition and structure of forests are very useful exercise for providing information on species richness of the plants and the changes that they undergo that can potentially be useful for management purpose and assist in understanding forest ecology and ecosystem functions (Pappoe *et al*. 2010). However, the documentation on the composition of trees and structure of most of the forests in Ghana for scientific community in general is scant except for those of Vordzogbe *et al*. (2005), Anning *et al*. (2008) and Addo-Fordjour *et al*. (2009); Hall and Swaine (1981) and Pappoe *et al*. 2010). Though little attention is focused on vegetation monitoring at where the object of management is animal conservation such as national parks, resource reserves and wildlife sanctuary; there is an urgent need for information on vegetation due to increasing rate of deforestation in tropical areas. There is the need, therefore, for regular survey of the forest to generate information on its compositional and structural attributes to update existing ones and thereby contribute knowledge to the understanding of the forest ecosystem for effective management.

The aim of this study was to investigate the characteristics of the trees that play a vital role to the existence of two primate species. The objectives of the study were to determine the species composition of the trees, investigate the trend of size class distribution of the trees and examine the density and diversity of the tree species occurring in different habitat types of the monkey range. This will be used as base-line information for future monitoring of the primates' vegetation.

Study Area

The area of study, Buabeng-Fiema Monkey Sanctuary (Figure 1) is located in the Brong-Ahafo Region within the Nkoranza North District, by the latitude 7º 40' 0" N to 7º 44' 10" N and longitude 1º 37' 45" W to 1º 42' 0" W approximately. The altitude of the sanctuary is 350m above the sea level and the topography is flat with gentle slope (25m fall/km) into a ground spring that originates in the sanctuary with a mixture of savanna woodland and forest (Fargey 1991). Fargey (1991) further described the vegetation as savanna sub-climax vegetation type and would succeed to dry semi-deciduous forest in the absence of human disturbance and bushfire.

The village around the sanctuary have traditionally had a taboo against killing the black and white Colobus (*Colobus polykomos*) and Lowe's monkey (*Cercopithecus cambelli loweii*) which the sanctuary harbors (Fargey 1991). The sanctuary covers an area of 499.2 hectares which is surrounded by maize, yam, groundnut, cassava and oil palm farms with villages.

Since the past 150 years the monkeys have been considered as scared by locals. The myth is that several years ago, a chief of the area was mysteriously protected by some of the monkeys during a tribal war. During the tribal war, the enemies were unable to shoot the chief because he was surrounded by the monkeys; hence the local chief priest decreed that no one should kill or catch the monkeys. Since then, the villages have always regarded the monkeys as a totem or sacred (Appiah-Opoku 2007).The traditional norm and belief was strictly adhered to until early 1970s when Christians thought otherwise. According to one

Christian sect, the Savior Church, maintains that humans are not bound by traditional beliefs and taboos and God has given man dominion over all creatures, including the monkeys. Subsequently, church members started killing the monkeys for food (Appiah-Opoku 2007; Fargey 1991).

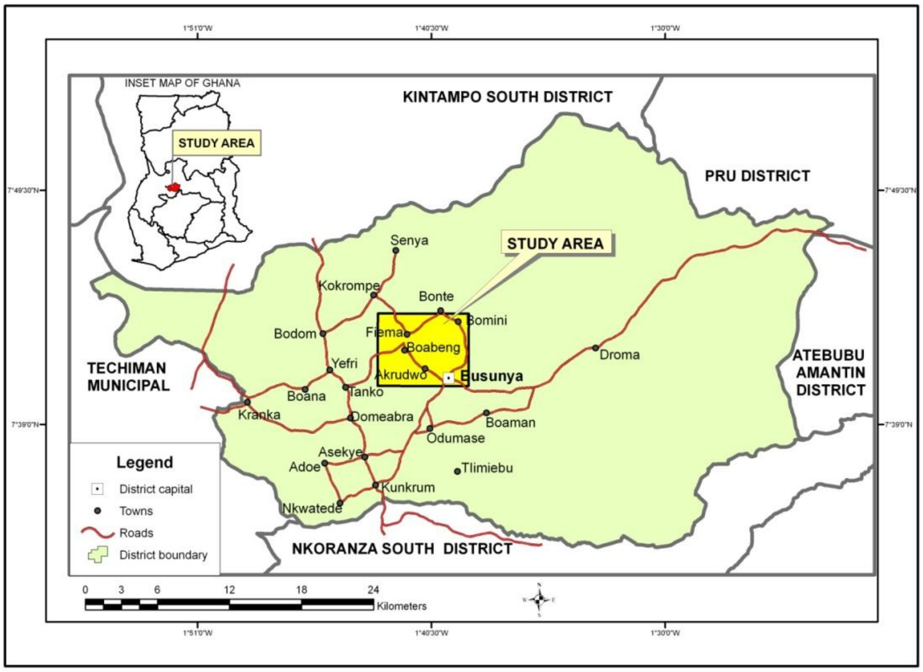

Fig. 1: Map of Ghana showing the location of the study area

As the traditional authorities were concerned about the killing of the animals for food, they appealed to the department of Game and Wildlife, now the Wildlife Division of the Forestry Commission which incorporated the area into the National Protected Area System to add the conventional method of wildlife protection to the traditional method (Appiah-Opoku 2007).

METHODS

Data collection

Plots Demarcation and Enumeration Procedure

The area designated as sanctuary was broadly stratified into natural forest or core zone, mixed forest or forest edge and cultivated areas or farmlands in accordance with the composition and land-use of the monkeys' habitats as shown in Table 1. In each habitat type, four sets 500m transect was constructed systematically in the north-south direction that were 250m apart. On each transect within a particular transect, five rectangular plots of dimensions 20m by 25m were also systematically established at 100m interval. Red ribbons were tied at the corners of the plot and if the greater part of a border tree fell within the plot the tree was enumerated, and if the greater part fell outside the plot then the tree was excluded.

Table 1: Stratified areas and characteristics of Buabeng-Fiema monkey sanctuary

Stratified area	Description of the area
1) Natural forest (core zone)	Core areas of the sanctuary with naturally established trees; where no land use type as aside conservation is allowed.
2) Mixed forest (forest edge)	Buffer area of the sanctuary, mixture of naturally established trees and artificially planted trees, tree planting can be allowed.
3) Cultivated area (farming area)	Farmlands composed of crops cultivated for human consumption and commercial purposes.

The enumeration team was made up of a recorder, a tree spotter and an assistant. The main duty of the tree spotter was to record all the information about the trees, including identification and measurements and the assistant helped in measurements and specimen collection.

Moving in a clock-wise direction within a plot, all trees with girth at breast height (1.30m from the ground) equal to or greater than 31cm ($\geq$31cm, gbh), were identified, measured and recorded. The girth at breast height of each sampled tree was measured over bark with the linear tape. However, there were some reasons to deviate sometimes from this standard "breast height" and execute the girth/diameter measurements at another position on the sample tree. These were as follows:

1. Sample trees with buttresses: the stem diameter was measured approximately 30 cm above the buttress.
2. Sample trees with aerial or stilt roots: the stem diameter was measured at 1.3m above the beginning of the stem.
3. Forked trees were regarded as two sample trees if the fork was below 1.3m. Consequently, forked trees were regarded as one tree if the fork is above 1.3m.

The girth values (gbh) were converted to diameter at breast height (dbh) values by using the formula:

D=C/3.142

Where D represents diameter and C represents girth.

Tree height was defined as the total length from the ground up to the tip of the tallest vertical branch of the sample tree. As the measurement of the tree height is very time consuming, mostly not very accurate and additionally not very important to increase the precision of floral information, it was replaced with estimation of stem height in meters. Therefore, an assistant stood at the foot of the sample tree and held a 2m-long ranging pole in his hand (when he lifted up the ranging pole while holding it on one end the upper part of the ranging pole shows the length of 4m). Relative to this given length, the total height of the sample was estimated quite precisely. Species local name or common name, girth at breast height, and estimated height were mentioned by the men who identified and measured trees to the recorder. To ensure that the right information has been recorded, the recorder in turn calls back the same information to the source. All trees were identified to the species level and specimens of unidentified trees were collected and sent to the Resource Management Support Center's herbarium, Kumasi, Ghana, for identification. Nomenclature was after Hawthone and Jongkind (2006).

Calculation of Community Parameters and Data Analysis

$$Density = \frac{\text{Total number of species}}{\text{unit area (ha)}} \qquad (1)$$

$$\text{Diversity } (H') = -\sum \text{pi ln pi} \qquad (2)$$

Where:

H' = the Shannon-Weaver Diversity Index

p_i = the relative abundance of each group of organisms

$$\text{Basal area} = \frac{\pi D^2}{4} \qquad (3)$$

Where:

D= diameter at breast height and π =3.142

$$\text{Relative density} = \frac{\text{number of a particular species}}{\text{number of all enumerated species}} \quad (4)$$

$$\text{Relative dominance} = \frac{\sum \text{basal area for all trees of a particular species}}{\sum \text{basal area of all species pooled}} \quad (5)$$

Data analysis was depended on non-parametric statistics. For comparisons across more than two habitat types or between three or more variables, Kruskal-Wallis tests were conducted; for evaluation of differences between two habitat types, Mann-Whitney U tests were utilized.

RESULTS AND DISCUSSIONS

Density and Diversity of trees found in the Natural, Mixed and Closed forest habitat

The tree densities were found to vary from one habitat type from another. In the natural forest the mean number of trees per hectare was 17.5(S.D=5.5, N=20), from mixed forest 12.7 (S.D=3.6, N=20), and Cultivated area 7.4 (S.D=7.4, N=20), and the density differ significantly in all the three areas (H=41.35, P<0.001) (Figure 2). The abundance of all trees in the natural forest area differed significantly from that of mixed forest (U=1910, p<0.05) and cultivated area (U=1323, p<0.0001) and that of mixed and cultivated forest area also differed (U=1854, p<0.001).

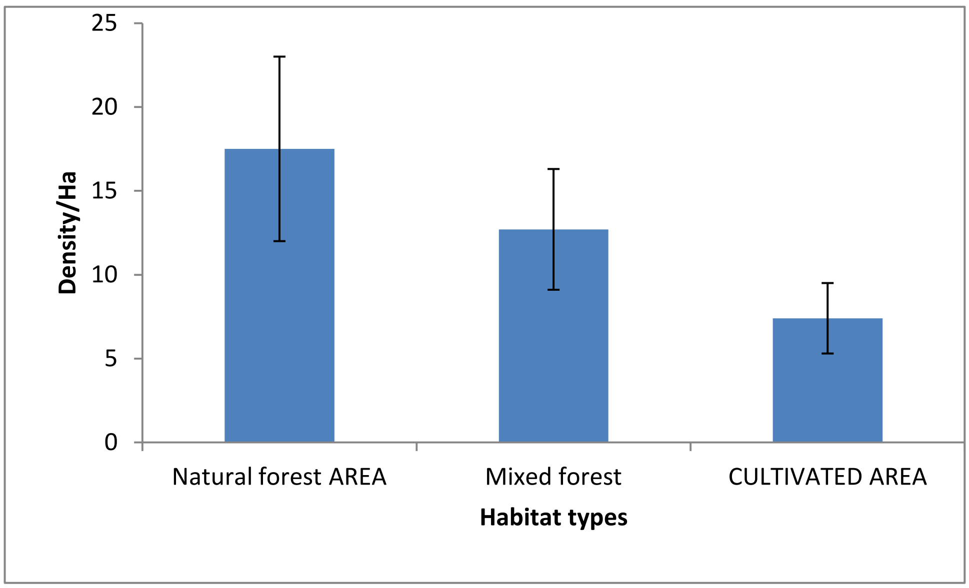

Fig. 2: Densities of trees enumerated in the natural forest, mixed forest and cultivated area of BFMS

The diversity of trees found in the natural forest area were 3.34 (evenness=0.78), mixed forest area 3.10 (evenness=0.79) and cultivated forest area 2.97 (evenness=0.89). The diversity in the natural forest area differs from the mixed forest area (t=-2.11, p<0.03) and cultivated area (t= - 3.47, p<0.0001). But no difference was found between the diversity of trees in the mixed and cultivated areas (t=1.21, p=0.226).

Species Composition and Space Occupancy of Enumerated Tree Species in Three Habitat types

In total 49 species of trees were enumerated in the natural forest, 35 in mixed forest and 25 in cultivated type of habitat that included 335, 220 and 144 individual trees respectively with varying sizes. The species richness differed significantly among the three habitat types with high richness in the natural forest area than mixed forest and cultivated area (H=16.35, p<0.0001). However, no difference was found between mixed forest and cultivated area (U=2687, p=0.081) but differences were found between natural forest and mixed forest (U=2558,

$p<0.05$) as well as cultivated area ($U=2042$, $p<0.0001$).

Similarly relative densities of trees varied across the three habitat types (Figure 2) ($H=8.22$, $p=0.016$). However relative densities did not differ between natural forest and mixed forest ($U=2920$, $p=0.228$) but with the natural forest and cultivated area ($U=2381$, $p=0.0026$) and mixed forest and cultivated area ($U=2874$, $p=0.174$) the differences were significant. The relative dominance differed significantly across the three habitat types ($H=11.25$, $p=0.0036$), between natural forest and mixed forest ($U=2653$, $p=0.036$) and natural forest and cultivated area ($U=2234$, $p=0.0009$). In contrast, no significant difference was found between mixed forest and cultivated area ($U=2865$, $p=0.2543$). Furthermore, a significant difference was found when compared the basal area of trees across the three habitat types ($H=27.09$, $p<0.001$). A similar result emerged when compared natural forest with mixed forest ($U=2312$, $p<0.001$) and with cultivated area ($U=1719$, $p<0.0001$) and mixed forest and cultivated area ($U=2575$, $p<0.05$) (Table 2).

Table 2: Species Richness, Relative Density and Relative Dominance Of Trees Enumerated In Natural Forest, Mixed Forest and Cultivated Area

	Species richness			Relative Density%			Relative Dominance %			Basal Area (cm²)		
Name of species	**Natural forest**	**Mixed forest**	**Cultivated area**	**Natural forest**	**Mixed forest**	**Cultivated area**	**Natural forest**	**Mixed forest**	**Cultivated area**	**Natural forest**	**Mixed forest**	**Cultivated area**
Acassia sp.	3	0	0	0.86	0.00	0.00	0.01	0.00	0.00	29.40	0.00	0.00
Adansonia digitata	2	0	0	0.57	0.00	0.00	1.47	0.00	0.00	3580.56	0.00	0.00
Albizia adianthifolia	0	1	4	0.00	0.38	2.72	0.00	0.01	3.30	0.00	11.50	1504.50
Albizia ferruginea	0	1	0	0.00	0.38	0.00	0.00	1.51	0.00	0.00	1790.26	0.00
Albizia zygia	1	12	3	0.29	4.62	2.04	0.01	0.85	3.99	15.60	1009.40	1822.10
Alchormea condifolia	0	7	3	0.00	2.69	2.04	0.00	0.04	0.06	0.00	43.10	27.40
Alstonia boonei	2	0	2	0.57	0.00	1.36	0.07	0.00	1.90	168.10	0.00	868.00
Amphimas pterocarpoides	1	0	0	0.29	0.00	0.00	0.73	0.00	0.00	1790.30	0.00	0.00
Anacardium occidentale	0	7	12	0.00	2.69	8.16	0.00	0.60	6.97	0.00	716.30	3177.40
Anogeissus leiocarpus	69	46	13	19.83	17.69	8.84	39.22	53.12	1.33	95748.50	63072.58	606.10
Antiaris toxicaria	5	2	0	1.44	0.77	0.00	1.38	1.51	0.00	3373.10	1798.20	0.00
Aubrevillea kerstingii	1	0	0	0.29	0.00	0.00	0.73	0.00	0.00	1790.26	0.00	0.00
Baphia nitida	13	6	3	3.74	2.31	2.04	0.76	0.27	2.90	1848.60	318.34	1320.80
Blighia welwichii	1	0	0	0.29	0.00	0.00	0.21	0.00	0.00	509.20	0.00	0.00
Cedrella odorata	1	0	0	0.29	0.00	0.00	0.11	0.00	0.00	277.00	0.00	0.00
Table 2 cont'd												
Ceiba pentandra	4	2	1	1.15	0.76	0.68	0.72	1.52	0.02	1750.00	1801.80	8.00
Celtis milbredii	2	0	0	0.57	0.00	0.00	0.00	0.00	0.00	10.80	0.00	0.00
Celtis zenkerii	0	1	0	0.00	0.38	0.00	0.00	0.43	0.00	0.00	509.20	0.00

Cola caricifolia	3	0	0	0.86	0.00	0.00	0.31	0.00	0.00	751.80	0.00	0.00
Cola gigantia	67	7	8	19.25	2.69	5.44	12.99	4.11	15.81	31703.70	4875.00	7212.30
Cola millenii	0	1	0	0.00	0.38	0.00	0.00	0.00	0.00	0.00	1.27	0.00
Cola nitida	0	1	0	0.00	0.38	0.00	0.00	0.33	0.00	0.00	389.90	0.00
Daniella ogea	0	1	0	0.00	0.38	0.00	0.00	0.54	0.00	0.00	644.50	0.00
Daniella oliveri	4	3	15	1.15	1.15	10.20	1.46	0.14	30.37	3562.30	171.00	13855.20
Dialium guineense	0	0	1	0.00	0.00	0.68	0.00	0.00	1.74	0.00	0.00	795.70
Distemonanthus bentamianus	2	0	0	0.57	0.00	0.00	0.85	0.00	0.00	2076.70	0.00	0.00
Entandrophragma cilindricum	2	0	0	0.57	0.00		0.25	0.00		612.10	0.00	
Entandrophrama angolense	1	1	0	0.29	0.38	0.00	0.00	0.06	0.00	2.90	66.92	0.00
Ficus capensis	4	4	5	1.15	1.54	3.40	0.81	0.56	1.97	1984.40	664.00	898.20
Ficus exasperata	1	0	0	0.29	0.00	0.00	0.20	0.00	0.00	484.10	0.00	0.00
Ficus sp.	1	0	0	0.29	0.00	0.00	0.26	0.00	0.00	644.50	0.00	0.00

Table 2 cont'd

Ficus sur	2	0	0	0.57	0.00	0.00	0.32	0.00	0.00	779.80	0.00	0.00
Gmelina arboreus	35	20	22	10.06	7.69	14.97	3.71	7.15	8.32	9059.30	8486.50	3794.20
Hannoa klaineana	0	0	1	0.00	0.00	0.68	0.00	0.00	0.02	0.00	0.00	8.00
Hymenostegia afzelii	1	0	0	0.29	0.00	0.00	0.21	0.00	0.00	509.20	0.00	0.00
Khaya anthotheca	1	0	0	0.29	0.00	0.00	0.73	0.00	0.00	1790.26	0.00	0.00
Khaya senegalensis	6	5	0	1.74	1.92	0.00	1.10	2.84	0.00	2660.50	3370.40	0.00
Lannea welwitschii	6	0	0	1.72	0.00	0.00	0.07	0.00	0.00	176.10	0.00	0.00

Leucaena leucocephala	11	2	1	3.16	0.77	0.68	0.12	0.03	0.06	299.00	41.40	25.80
Magaritaria discoidea	9	21	7	2.59	8.08	4.76	1.27	1.12	1.97	3103.30	1330.20	899.70
Mangifera indica	2	3	6	0.57	1.15	4.08	0.33	2.47	8.79	803.60	2936.00	4008.90
Milicia excelsa	0	1	0	0.00	0.38	0.00	0.00	0.06	0.00	0.00	71.60	0.00
Millitia thonninghii	0	2	0	0.00	0.77	0.00	0.00	0.01	0.00	0.00	15.90	0.00
Monodora myristica	1	0	0	0.29	0.00	0.00	0.03	0.00	0.00	81.50	0.00	0.00
Morinda lucida	5	4	2	1.44	1.54	1.36	0.01	1.11	0.39	28.10	1316.70	177.00
Murus mesozygia	2	0	0	0.57	0.00	0.00	6.60	0.00	0.00	16120.40	0.00	0.00
Nauclea diderrichii	1	0	0	0.29	0.00	0.00	0.39	0.00	0.00	962.80	0.00	0.00
Piptadeniastrum africanum	1	0	0	0.29	0.00	0.00	0.64	0.00	0.00	1559.52	0.00	0.00
Pterygota macrocarpa	1	0	0	0.29	0.00	0.00	0.64	0.00	0.00	1559.50	0.00	0.00
Table 2 cont'd												
Pycnanthus anglensis	6	5	4	1.72	1.92	2.72	4.91	2.00	3.19	11993.70	2374.30	1453.20
Rauvolfia vomitoria	3	3	0	0.86	1.15	0.00	0.01	1.75	0.00	12.90	2078.80	0.00
Ricinodendron heudelotii	0	1	3	0.00	0.38	2.04	0.00	0.00	0.91	0.00	2.90	413.70
Senna siamia	11	14	2	3.16	5.38	1.36	1.32	3.45	0.29	3229.40	4097.10	133.80
Solanum erianthum	2	0	3	0.57	0.00	2.04	0.12	0.00	0.05	297.90	0.00	23.90
Spathodea campanulata	1	2	0	0.29	0.77	0.00	0.01	1.51	0.00	15.60	1793.10	0.00
Sterculia rhinopetala	2	1	5	0.57	0.38	3.40	0.46	0.97	4.31	1113.00	1145.80	1963.80
Tectona grandis	2	1	0	0.57	0.38	0.00	0.29	0.54	0.00	716.10	644.50	0.00
Terminalia superba	6	11	5	1.72	4.23	3.40	1.12	1.00	0.22	2744.30	1189.10	100.40

Tetrapleura tetraptera	1	0	0	0.29	0.00		0.11	0.00		277.00	0.00	
Trema orientallis	20	20	13	5.75	7.69	8.84	1.43	1.95	0.19	3485.90	2311.70	87.60
Triplochton scleroxylon	5	0	0	1.44	0.00	0.00	9.53	0.00	0.00	23273.40	0.00	0.00
Voacanga africana	2	1	0	0.57	0.38	0.00	0.12	0.01	0.00	288.40	11.60	0.00

The highest tree enumerated in the monkey sanctuary was not taller than 30m and the lowest was not less than 1m. The greater number of trees enumerated were found in the shorter height and the number reduced with trees with taller heights. This pattern of height structure did not differ across the three habitat types (H=2.728, p=0.2567) as shown in Figure 3.

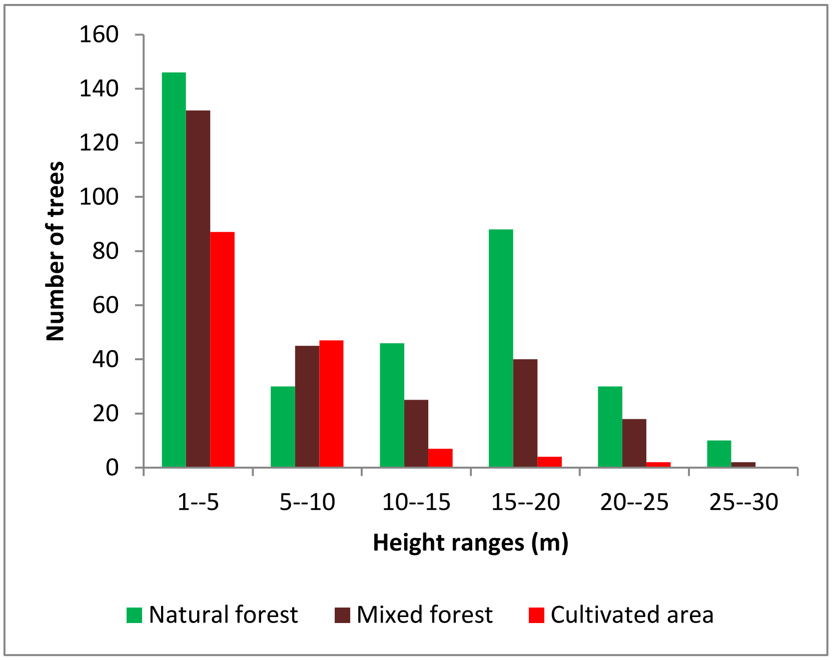

Fig. 3: Number of Trees distributed over the various height ranges

Similarly, trees with smaller basal area far outnumber trees larger basal area (Figure 4). In other words, few trees were enumerated with larger diameter and the numbers of trees with smaller diameter were many. Comparing the three habitat types this trend of distribution did not differ significantly (H=0.3563, p=0.836).

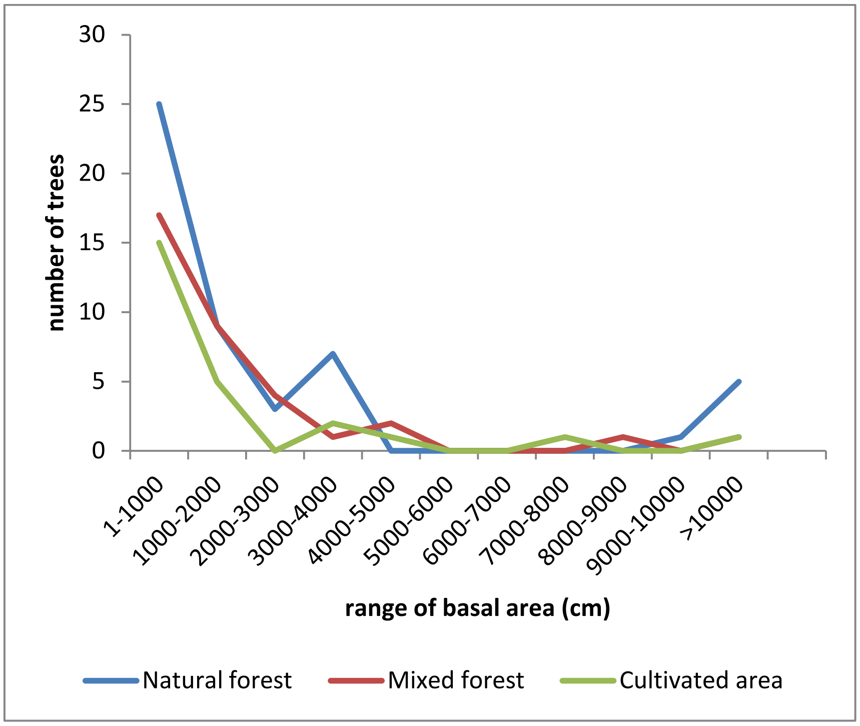

Fig. 4: Trends of enumerated trees of basal area ranges in the three habitat type

In recent past, tropical rainforests were thought to be more or less homogenous in terms of composition and structure but due to anthropogenic based influence forest landscapes are changing and even at an accelerated rate (Garzoul and Shiel 2010). The vegetation of BFMS varied greatly in many respect and render it somehow bias to classify it into only three distinct vegetations but for conveniences this three broad indistinct classifications were settled on. It is a known fact that the anthropoid monkeys lack prehensile tails, have fully opposable digits and utilize broader varieties of habitat types coupled with their capacity to learn cultural behavior. This render the vegetation as described in BFMS a very useful resource for the primates that inhabit in this area. It therefore makes it apparent that in Africa, that heterogeneous habitat mosaics support primates and other primary consumer populations that homogeneous type of habitat (Oates *et al.* 1990; Fimbel 1994; Thomas 1991). Moreover, it is even hard to find monkeys (and almost absent) in some mono dominant forests (Thomas 1991).

The variations in species composition, richness and diversity among the three habitat types have the potential to offer a great deal of services other living species that depend on the vegetation in the sanctuary. For example, it can be viewed that the daily movements of the two types of primates (Lowe's monkey and black and white colobus) may likely be influenced by this heterogeneity of the vegetation structure and movement. This is because, as the area occupied by larger trees (natural forest) may offer places for sleeping and refuge for the monkeys, the mixed forest and cultivated area may be considered as places foraging. This may explain the reasons for high complains of crop raiding incidence reported by Wiafe and Arku (2012), associated with Lowe's monkeys in BFMS. Furthermore, in comparison with more opened habitats (mixed forest and cultivated area) the natural forest area i.e. the core zone of the sanctuary may provide cooler, more humid and darker environment.

Importance of the Result to Primates Conservation

The analyses discussed above indicate that the variations in the community characteristics of the habitat types can be used to offer an understanding of the behavior of the two species sharing resources in space and time. The fewer trees encountered in the more opened habitat types means more human preferred crops in these areas and if the non-human primates utilize them it suggest that a deepening conflict between human and wildlife. A similar study should be repeated at regular intervals like every five years in order to monitor the growth pattern and changes that might have occurred in the vegetation in future.

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