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Habitat structure of chimpanzee communities in Nigeria: a comparison of sites

B.G.OGUNJEMITE[1*]，B.A.JAYI[2]，E.A.AGBELUSI[1]

1. Department of Fisheries and Wildlife，Federal University of Technology，Akure，Nigeria

2. Department of Forestry and Wood Technology，Federal University of Technology，Akure，Nigeria

Abstract Habitat structure of chimpanzee communities was studied in three sites across Nigeria. The Point-Center Quarter (PCQ) method was used to assess vegetation in all the sites. A total of 150 species of plants in 38 families were recorded in all the sites. Seventy species in 28 families were recorded at site A，Kwano chimpanzee community in Gashaka Gumti National Park Northeast Nigeria. One hundred and twenty species in 36 families were recorded at site B，Butatong chimpanzee community in Okwango Division of Cross Rivers National Park Southeast Nigeria while 92 species in 30 families were recorded at site C，Ise Forest Reserve Southwest Nigeria. Thirty-four species (22.67%) were common to all sites; these include *Afzelia africana*，*Drypetes gilgiana*，*Blighia sapida*，*Brachystegia eurycoma* and *Tetrapleura tetraptera*. Twenty-three families (60.53%) are common to all study sites. The families Apocynaceae (*Alstonia boonei* and *Picralima nitida*)，Mimosoideae (*Piptadeniastrum africanum* and *Tetrapleura tetraptera*)，Caesalpinioideae (*Brachystegia* spp. and *Daniellia ogea*)，Moraceae (*Antiaris africana*，*Bosqueia angolensis* and *Ficus* spp.) and Sterculiaceae (*Cola* spp. and *Sterculia* spp.) are important to chimpanzees in all the sites. Trees in the height class 1 m – 10 m were the most abundant in all study sites. Girth size distribution was highest in site B followed by site C，and least at site A. These results suggest that there are key families of plants that are very important in chimpanzee habitats in Nigeria. There are also indications that vertical stratification of plants might be an area of concern in the management of chimpanzee habitats in Nigeria [*Acta Zoologica Sinica* 53 (4): 579 – 588，2007].

Key words Floristic composition，Site potential，Conservation，Chimpanzee

尼日利亚不同区域黑猩猩社群的栖息地比较

B.G.OGUNJEMITE[1*]　B.A.JAYI[2]　E.A.AGBELUSI[1]

1. Department of Fisheries and Wildlife，Federal University of Technology，Akure，Nigeria

2. Department of Forestry and Wood Technology，Federal University of Technology，Akure，Nigeria

摘　要　研究了尼日利亚三处黑猩猩群落的生境结构，并利用点中心四分样方法评估了植被。共记录了 38 科 150 种植物，其中位于尼日利亚东北部的 Gashaka Gumti 国立公园 Kwano 栖息地（A 区）有 28 科 70 种、位于尼日利亚东南部的 Cross Rivers 国立公园 Butatong 区域（B 区）有 36 科 120 种、位于尼日利亚西南部的 Ise 森林保护区（C 区）有 30 科 92 种。23 科（60.53%）34 种植物（22.67%）为三个区域的共有种，包括 *Afzelia africana*、*Drypetes gilgiana*、*Blighia sapida*、*Brachystegia eurycoma*、*Tetrapleura tetraptera* 等。在所有区域，对黑猩猩重要的科包括夹竹桃科（羊角棉 *Alstonia boonei*、*Picralima nitida*）、含羞草亚科（腺瘤豆 *Piptadeniastrum africanum*、*Tetrapleura tetraptera*）、云实亚科（*Brachystegia* spp.、*Daniellia ogea*）、桑科（非洲毒箭木 *Antiaris africana*、*Bosqueia angolensis*、*Ficus* spp.）和梧桐科（*Cola* spp.、*Sterculia* spp.）。在所有区域中，1 m – 10 m 高的树木是最常见的，胸径分布为 B 区最高，次之为 C 区，A 区最低。结果表明，在尼日利亚的黑猩猩生境中具有重要的关键性植物，植物的垂直分层结构是尼日利亚黑猩猩生境管理的重要方面 [动物学报 53 (4): 579 – 588，2007]。

关键词　植被组成　区域潜力　保护　黑猩猩

The potential of forest habitation to the management of wild animals is grossly unexplored in many areas across Nigeria. Many forest communities support unique flora and fauna，making them important sites in terms of conservation and scientific interest. However，a major problem facing wildlife conservation is increasing rate of

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* Corresponding author.　E-mail: ogunjemite@yahoo.com

habitat loss or modification due to human activities (John and Skorupa, 1987). There is no doubt that there has been large scale destruction and mismanagement of the rainforest ecosystem of Nigeria. Ecological disasters and climatic changes have resulted in loss of soil fertility and have greatly reduced biological productivity (Agbelusi et al., 1999). Afolayan et al. (2004) observed that about 75% of the original wildlife habitat in Nigeria had been lost. This has affected wildlife resources within these ecological systems. Available information on chimpanzee populations in Nigeria, though very scanty, reveals that this animal still exists within some of the rainforests, although their conservation status may be bordering on critically endangered or locally extinct (Agbelusi, 1994; Gonder et al., 1997; Persson and Warner, 2003; Kormos et al., 2003).

Two subspecies of chimpanzee are now recognized in Nigeria: the Nigerian chimpanzee *Pan troglodytes vellerosus* and the west African chimpanzee *Pan troglodytes verus* (Gagneux et al., 2001; Gonder et al., 2006). The Nigerian chimpanzee is found in Gashaka/Gumti and in Cross River National Park while the West African chimpanzee is found in Southwestern Nigeria. Gonder et al. (1997) opined that chimpanzees in Nigeria and Cameroon may provide a key to understanding the recent evolutionary history of the species. The two west African subspecies differ as much as the eastern forms. Their proper placement in evolutionary context holds the key to a clear reclassification of chimpanzees. Gashaka/Gumti National Park remains one of the strongholds for the Nigerian chimpanzee and the population in the park has significant conservation potential not only in Nigeria but in the West African sub-region as a whole (Sommer et al., 2004). The Nigerian chimpanzees are also found in the primary forest of South Eastern Nigeria (Obot, 1996)*. The West African chimpanzee was reported in Southwestern Nigeria at Ise Forest Reserve, by Agbelusi (1994) and Gonder et al. (1997) and at Omo Forest Reserve by Persson and Warner (2003). The chimpanzee population in Gashaka/Gumti seems the most secure of all populations in Nigeria while the Southwest populations are the most threatened and under constant threat of extinction.

Vegetation structures have been used to describe the habitat of many wildlife species. Floristic composition in particular could be indicative of potential in terms of site selection for conservation purposes. The structure of vegetation is often defined as a function of three components: the vertical stratification of the vegetation, the spatial distribution of the individual plants, and the abundance of each species (Kershaw, 1973). These factors have been shown to strongly influence the associated community of fauna, especially arboreal mammals (Bright and Morris, 1990).

The quantification of habitat structure is often not a straight forward issue, especially when tropical forests are involved. Forest trees exhibit a variety of growth forms, and canopies are graded into one another. Other forest components such as shrubs and lianas present some complex arrangements. McCoy and Bell (1991) suggest a conceptual model indicating that habitat structure comprises three components: heterogeneity (variation in the relative abundance of different structure types), complexity (the absolute abundance of types) and scale (the order of magnitude in which the components are set). Moffatt et al. (2005) conclude that given the practical and theoretical difficulties in quantifying structure, it is clear that all methods used to measure habitat structure can only be approximations.

Most studies of vegetation often involve mature systems or those that have not been disturbed for a long time. Such studies are important in that the knowledge of such natural systems serve as ideals for conservation managers. The effective management of natural systems requires the understanding of their functioning not only for their improvement but also to arrest their further degradation. One aspect of the understanding of the functioning of these systems is the knowledge of their species composition and arrangement. An understanding of habitat requirements is an integral part of any wildlife management. For all species of wildlife, defining habitat requirement always involves at least two kinds of evidence, available habitats and animals present and associated with these habitats (Riney, 1982). It is difficult to imagine any management programme or management oriented study that would not profit from increased understanding of habitat requirements. It is against the above background of the importance of woody elements (trees) to animals' well being that the studies on habitat structure of chimpanzee communities in Nigeria were embarked upon. It is necessary to study this animal in its different ranges in Nigeria to make informed decision about its conservation in the country. The specific objectives of the study are to identify the plant species composition and to determine their spatial arrangement in the chimpanzee ranges in Nigeria.

1 Materials and method

1.1 Study sites

Three sites (Fig.1) were selected from the Nigerian chimpanzee communities. Site A is Kwano chimpanzee community in Gashaka/Gumti National Park (6° – 8°N and 11° – 12°E). It is a mixture of lowland forest, gallery forest and open woodland which exhibits a marked

* Obot EA, 1996. Primates of Cross River National Park. In: Okwango Division ed. Biological Research and Scientific Monitoring Activities. Forest Progress Report, Nigeria.

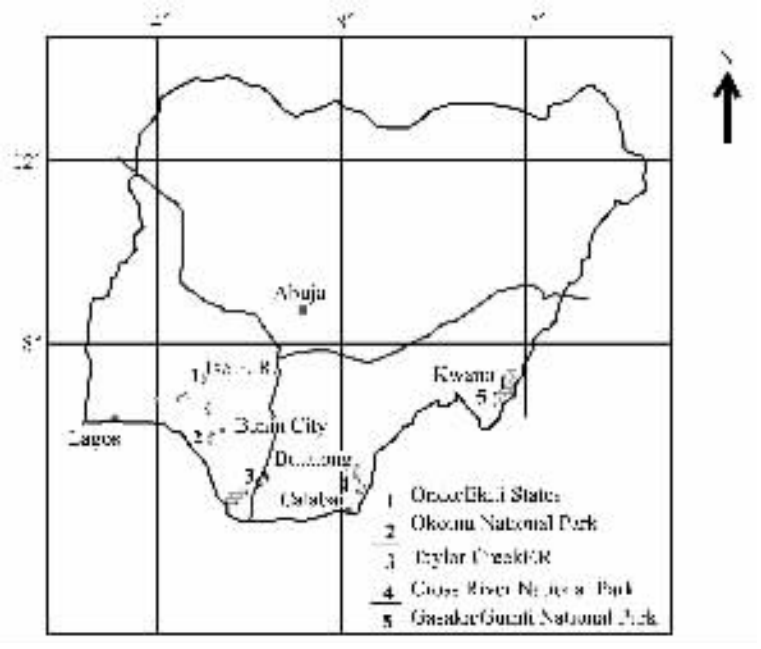

Fig.1 Chimpanzee range in Nigeria

seasonality; heavy rains alternating with dry months. Rainfall in the area is generally above 1 200 mm annually (Dunn, 1999). Sommer et al. (2004) reported that the Kwano community comprises of at least 35 chimpanzees within a home range of 26 km^2. Site B is Butatong chimpanzee community (6°25′N and 9°10′E). It is a part of Okwango Division of Cross River National Park. The vegetation is described as evergreen lowland guinea rainforest (Obot, 1996). Rainfall is usually higher than 2 000 mm annually with very short dry period. No estimate of the chimpanzee density in this region has been produced. However, chimpanzees' nests are often observed in this range of the Park. Site C is Ise Forest Reserve chimpanzee community (7°0′ – 7°20′N and 5°0′ – 5°20′E). It is a commercially exploited forest reserve in South Western Nigeria. Rainfall average is about 1 500 mm, distributed over 8 – 9 month period (March – October/November). The vegetation is described as lowland rainforest, moist type (White, 1983). Ogunjemite (2004) reported an estimated 12 – 17 individual chimpanzee in the reserve.

1.2 Data collections

The Point-Center Quarter (PCQ) method (Cottam and Curtis, 1956) as described by Mueller-Dombis and Ellenberg (1974) was used for the enumeration of tree species in chimpanzee habitat in all the sites. PCQ has been widely used with satisfactory results in Europe and North America (Caplenor, 1968; Habek, 1968), the method is less laborious, time conserving and eliminates personal error in estimating parameters being studied (Akinsoji, 2003). Samplings were carried out in February 2003 (dry season). At each location, a base line, often human-made linear landscape feature (e.g., tracks, paths, and hunters' trail) that runs across the extent of the area to be enumerated was selected. Transects perpendicular to the base line were laid. A total of 125 sampling points (translating to 500 trees) was assessed at 10 m intervals along the line transect at each site. Once a sampling point was located, the Quarter (a right-angled wooden cross bar) was laid on the transect such that one axis is aligned in the direction of the transect: thus, four quarters were marked. The distance from the origin (center of the quarter) to the nearest woody plant in each of the quarters was recorded. The tree was identified to species level as described by Keay (1989). The diameter at breast height was measured to the nearest centimeter while the height of the tree was measured to the nearest meter using Haga altimeter. Only woody trees that were one meter and above were enumerated. Species composition of all trees, girth size and the height were computed for each site. Percentage distribution of trees within the strata of each forest was compiled and classified into three layers based on the recommendations of Longman and Jenik (1987). Variations within sample means were tested using the analysis of variance (ANOVA) procedure as described by Steel and Torrie (1980). Least Significant Difference (LSD) test was used to separate significant means at $P = 0.05$.

2 Results

2.1 Species compositions

The total numbers of plant species identified in this study are presented in Appendix 1. Seventy (70) species in 28 families were recorded at site A. The species most frequently encountered include *Lecaniodiscus cupanioides*, *Cola gigantea*, *Rothmannia* spp., *Cola hispida*, *Albizia* spp., *Celtis* spp. and *Bridelia* spp. The highest

numbers of 120 species in 36 families were recorded in site B, Butatong chimpanzee community. *Picralima nitida*, *Strombosia pustulata*, *Buchholzia coriacea*, and *Bridelia atroviridis* were commonly encountered. Site C (Ise Forest Reserve chimpanzee community) recorded 92 species in 30 families. The commonly encountered species include *Ricinodendron heudelotii*, *Albizia* spp., *Cola gigantea*, *Celtis* spp. and *Drypetes gilgiana*. A total of 34 tree species, representing 22.67% of the enumerated plants were common to all the sites. Analysis of variance indicated that the sites were significantly different ($P < 0.05$) from one another in species composition (Table 1).

Table 1 Result of the variation in sample means of habitat indexes of three chimpanzee communities in Nigeria*

Sites	Stratification				
	Species composition	Family diversity	Under storey	Middle storey	Upper storey
A. Kwano	42.33 ± 8.08^a	18.67 ± 3.05^a	273.33 ± 11.50^a	156.67 ± 10.41	70.00 ± 13.75^a
B. Butatong	69.00 ± 7.81^b	26.67 ± 1.15^b	251.67 ± 20.2^b	153.33 ± 11.50	95.00 ± 14.80^a
C. Ise F.R	54.33 ± 4.16^a	22.33 ± 1.15^a	293.33 ± 27.54^a	170.00 ± 28.06	36.67 ± 7.02^b
ANOVA	0.008**	0.009**	0.003**	0.554	0.128

* Each sample is a mean of three replicates ± standard error. ** Significant at $P = 0.05$.

Site A: Kwano chimpanzee community, Gashaka/Gumti National Park. Site B: Butatong chimpanzee community, Okwango Division, Cross river National Park. Site C: Ise Forest reserve chimpanzee community, Ekiti State, Southwest Nigeria.

Table 2 Diversity of tree families in chimpanzee habitats in Nigeria

Families	Site A Kwano	Site B Butatong	Site C Ise F.R.
Agavaceae	+	+	−
Anacardiaceae	+	+	+
Anisophylleaceae	−	+	+
Annonaceae	+	+	+
Apocynaceae	+	+	+
Bignoniaceae	+	+	+
Avicenniaceae	−	+	−
Balanitaceae	+	−	−
Bombaceaceae	+	+	+
Boraginaceae	−	+	−
Burseraceae	−	+	+
Capparaceae	+	+	+
Caesalpinioideae	+	+	+
Combretaceae	+	+	+
Compositae	+	+	+
Chrysobalanceae	+	+	−
Ebenaceae	−	+	+
Euphorbiaceae	+	+	+
Guttiferae	−	+	−
Irvingiaceae	−	+	+
Meliaceae	+	+	+
Mimosaceae	+	+	+
Moraceae	+	+	+
Myristicaceae	−	+	−
Ochnaceae	+	+	+
Olacaceae	+	+	+
Palmae	+	+	+
Papilionaceae	+	+	+
Rubiaceae	+	+	+
Rutaceae	+	−	+
Sapindaceae	+	+	+
Sapindaceae	+	+	+
Sapotaceae	+	+	+
Sterculiaceae	+	+	+
Tiliaceae	−	+	+
Ulmaceae	+	+	+
Simaroubaceae	−	+	+
Verbenaceae	+	+	−

+: Family present at the site.: − Family absent at the site.

2.2 Species diversity

Table 2 shows the diversity of some of the families in the sites. The families Apocynaceae (*Alstonia boonei* and *Picralima nitida*), Mimosoideae (*Piptadeniastrum africanum* and *Tetrapleura tetraptera*), Caesalpinioideae (*Brachystegia* spp. and *Daniellia ogea*), Moraceae (*Antiaris africana*, *Bosqueia angolensis* and *Ficus* spp.) and Sterculiaceae (*Cola* spp. and *Sterculia* spp.) are important to chimpanzees in all the sites. They are the most diversified in all study sites. A total of 23 families (60.53%) are common to all the study sites.

2.3 Stratification

The general height distribution of the trees is presented in Table 3. Results indicate that the three sites were not significantly different in their architectural arrangement, especially in the middle and uppermost layers.

Table 3 Percentage distribution of trees with strata of three chimpanzee communities in Nigeria

Site	Kwano	Butatong	Ise F.R.
Under storey	54.67	50.33	58.67
Middle storey	31.33	30.67	43.0
Upper storey	14.0	19.0	7.33

2.4 Girth size distribution

The distribution of girth size shows that the habitats were similar in many respects especially in the girth size 0 – 60 (small trees) and 61 – 100 (medium trees). In the girth size 100 and above (large trees), Ise forest reserve was seriously depleted. The number of large trees was highest in site B followed by site C, and least at site A as shown in Fig.2.

3 Discussion

The results of this work give an indication that the general architectural arrangement of plants appears to be

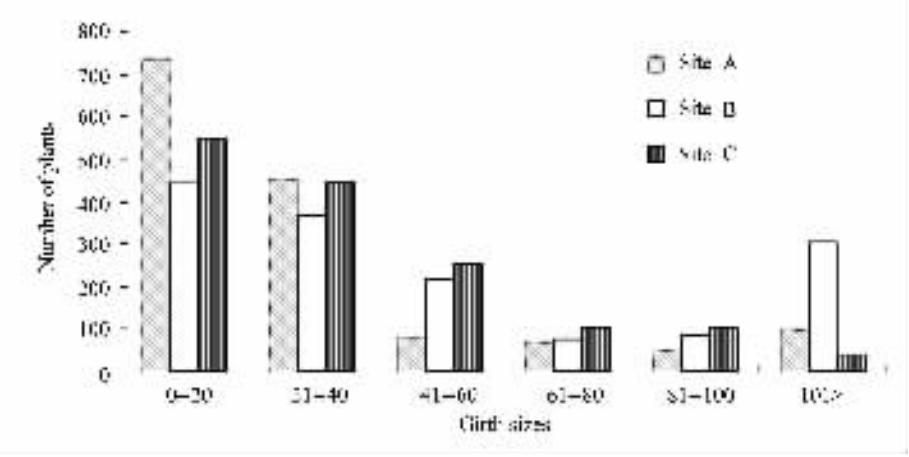

Fig.2 Girth size distribution in chimpanzee habitats in Nigeria

similar across the studied sites. This suggests that arrangement of vegetational structures and species diversity of some key families could be an influencing factor in the management of chimpanzees' habitats across Nigeria. The important plants families in the three study sites include: Apocynaceae, Caesalpinioideae, Euphorbiaceae, Meliaceae, Mimosoideae, Moraceae and Sterculiaceae. The members of family Apocynaceae (*Alstonia boonei*, *Funtumia africana*, *F. elastica*, *Hunteria umbellata*, *Rawolfia vomitoria* and *Picralima nitida*) are an essential component of the lower stratum in chimpanzee habitats and they provide escape cover for the animal when in flight. These plants are well represented at all three study sites. The Leguminosae (Caesalpinioideae and Mimosoideae) are an essential component of the diet of chimpanzees. These are represented by *Afzelia africana*, *Brachystegia* spp., *Piptadeniastrum africanum*, *Tetrapleura tetraptera* and *Daniellia ogea*. All were recorded as food stuff of chimpanzee in Ise Forest Reserve by Ogunjemite et al. (2005). The families Sterculiaceae and Moraceae also contribute substantially to chimpanzee diet in the Nigerian ranges. Sterculiaceae are represented by the *Cola* spp. while Moraceae through the *Ficus* spp. These two families are of further importance to the chimpanzees for nesting.

A total of 23 families (60.53%) are common to all sites. Although the family distribution showed significant differences among sites, it is apparent that some families dominate the habitats. The dominant groups appear to be important to the existence of chimpanzees at the sites. The enormous varieties of organic substances needed by animals are often group specific (families and genera). These include starch grain, protein components, fats and oil, glycosides and terpenes. The presence of these components might influence the distribution of the animals in their habitats. The observed plant distribution in this study has shed some light on plant species list that are associated with chimpanzee habitats in Nigeria, although species occurrence and family diversity varied statistically from site to site. The results have shown that some plant groups are commonly encountered in chimpanzee habitats and may play a vital role in chimpanzee distribution. It has been suggested that information on compositional similarity between different areas could be used as a basis for conservation planning across regions (Ferrier, 2002; Steinitz et al., 2005). Another important finding of this study is that architectural arrangements (vertical stratification) of plants appear to be similar throughout the studied sites supporting the view of Bright and Morris (1990) that the architectural arrangement of floral influences the distribution of associated faunal species. The different arrangement of plants (layering) is very crucial to the arboreal life of the chimpanzee. The layerings are essentially similar in all three study sites, suggesting that the arrangement is important for the existence of the chimpanzees in the habitats.

Teleki (1989) observed that the selection of appropriate area to be protected is crucial to subspecies survival. He further pointed out that chimpanzee adaptability makes it difficult to identify optimum habitat for subspecies. Nevertheless, it has been established that deforestation is a serious threat to wild chimpanzee population (Chapman et al., 2006). This is a serious problem in the chimpanzee communities of Southwestern Nigeria. Teleki (1989) further observed that such problems are international in origin and scope and that they must be addressed through international cooperation and innovative approaches. It is therefore pertinent to call attention to the population of chimpanzees in the region of Southwestern Nigeria bearing in mind the importance of the population in evolutionary history of chimpanzees (Gagneux et al., 2001; Gonder and Disotell, 2006). This study presents the floral composition of chimpanzee habitats in three sites across Nigeria. A study comparing sites like this is necessary to formulate conservation policies on chimpanzee populations. The study sites could therefore play complementary roles in the efforts to conserve chimpanzee populations across Nigeria.

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Appendix 1 Species composition of chimpanzee's habitat in Nigeria

S/N	Scientific name	Families	Site A	Site B	Site C
1	*Afzelia africana*	Caesalpinioideae	+	+	+
2	*Afzelia bipindensis*	Caesalpinioideae	−	+	−
3	*Albizia adianthifolia*	Mimosoideae	−	+	−
4	*Albizia ferruginea*	Mimosoideae	−	+	−
5	*Albizia zygia*	Mimosoideae	+	+	+
6	*Allanblackia floribunda*	Guttiferae	−	+	−
7	*Alstonia boonei*	Apocynaceae	+	+	+
8	*Alstonia congensis*	Apocynaceae	−	+	+
9	*Aningeria robusta*	Sapotaceae	−	+	+
10	*Anisophyllea* sp.	Anisophylleaceae	−	+	+
11	*Anogeissus leiocarpa*	Combretaceae	+	−	−
12	*Anthocleista djalonensis*	Oleaceae	−	+	+
13	*Anthocleista vogelii*	Oleaceae	−	+	−
14	*Anthonotha macrophylla*	Caesalpinioideae	−	+	+
15	*Antiaris africana*	Moraceae	+	+	+
16	*Antiaris toxicaria*	Moraceae	−	+	+
17	*Avicennia germinans*	Avicenniaceae	−	+	−
18	*Azadirachta indica*	Meliaceae	+	−	−
19	*Balanites aegyptiaca*	Balanitaceae	+	−	−
20	*Balphia nitida*	Papilionoideae	−	+	−
21	*Blighia sapida*	Sapindaceae	+	+	+
22	*Blighia unijugata*	Sapindaceae	−	+	+
23	*Bombax buonopozense*	Bombaceaceae	+	+	+
24	*Bosqueia angolensis*	Moraceae	+	+	+
25	*Brachystegia eurycoma*	Caesalpinioideae	+	+	+
26	*Brachystegia kennedyi*	Caesalpinioideae	−	+	+
27	*Brachystegia nigerica*	Caesalpinioideae	−	+	+
28	*Bridelia atroviridis*	Euphorbiaceae	+	+	+
29	*Bridelia ferruginea*	Euphorbiaceae	+	−	−
30	*Buchholzia coriacea*	Capparaceae	+	+	+
31	*Burkea africana*	Caesalpinioideae	+	−	−
32	*Canarium schwienfurthii*	Burseraceae	−	+	+
33	*Canthium palma*	Compositae	+	+	−
34	*Canthium vulgare*	Compositae	−	+	+
35	*Cassia* sp.	Caesalpinioideae	+	−	−
36	*Cieba pentandra*	Bombaceaceae	+	+	+
37	*Celtis mildbraedii*	Ulmaleae	−	+	+
38	*Celtis wightii*	Ulmaleae	+	+	−
39	*Celtis zenkeri*	Ulmaleae	+	+	+
40	*Chrysophyllum albidum*	Sapotaceae	+	+	+
41	*Cleistopholis patens*	Annonaceae	+	+	+

续表(**Continued**)

S/N	Scientific name	Families	Site A	Site B	Site C
42	*Cola acuminata*	Sterculiaceae	−	−	+
43	*Cola gigantea*	Sterculiaceae	+	+	+
44	*Cola hispida*	Sterculiaceae	+	−	+
45	*Cola laurifolia*	Sterculiaceae	−	+	+
46	*Cola millenii*	Sterculiaceae	+	−	+
47	*Cola* sp.	Sterculiaceae	−	+	−
48	*Campylospermum flavum*	Ochnaceae	+	−	−
49	*Cordia millenii*	Boraginaceae	−	+	+
50	*Cordia platythyrsa*	Boraginaceae	−	+	+
51	*Cylicodiscus gabonensis*	Mimosoideae	−	+	+
52	*Dacryodes edulis*	Burseraceae	−	+	−
53	*Daniellia ogea*	Caesalpinioideae	−	+	+
54	*Daniellia oblonga*	Caesalpinioideae	−	+	−
55	*Desplastsia* sp.	Tiliaceae	−	+	+
56	*Detarium macrocarpum*	Caesalpinioideae	+	−	−
57	*Detarium* sp.	Caesalpinioideae	+	+	−
58	*Dialium guineense*	Caesalpinioideae	−	+	−
59	*Diospyros* sp.	Ebenaceae	−	+	+
60	*Dracaena arborea*	Agavaceae	+	+	−
61	*Dracaena* sp.	Agavaceae	+	+	−
62	*Drypetes gilgiana*	Euphorbiaceae	+	+	+
63	*Drypetes floribunda*	Euphorbiaceae	+	−	−
64	*Elaeis guinensis*	Palmae	+	+	+
65	*Enantia chlorantha*	Annonaceae	−	+	+
66	*Entanda* sp.	Mimosoideae	+	−	−
67	*Entrandrophragma angolensis*	Meliaceae	−	+	−
68	*Entrandrophragma cylindricum*	Meliaceae	−	+	+
69	*Euphorbia kamerunica*	Euphorbiaceae	−	+	−
70	*Erythrophleum ivorense*	Caesalpinioideae	−	+	−
71	*Erythrophleum suaveolens*	Caesalpinioideae	+	+	−
72	*Fagara rubescens*	Rutaceae	−	−	+
73	*Fagara zanthoxyloides*	Rutaceae	+	−	+
74	*Ficus capensis*	Moraceae	+	−	−
75	*Ficus exasperate*	Moraceae	+	+	+
76	*Ficus goliath*	Moraceae	−	+	+
77	*Ficus mucoso*	Moraceae	−	+	+
78	*Ficus pseudomangifera*	Moraceae	−	+	+
79	*Funtumia africana*	Apocynaceae	+	+	+
80	*Funtumia elastica*	Apocynaceae	+	+	+
81	*Garcinia kola*	Guttiferae	−	+	−
82	*Hannoa* sp.	Simaroubaceae	−	+	+

续表(**Continued**)

S/N	Scientific name	Families	Site A	Site B	Site C
83	*Hildegardia barteri*	Sterculiaceae	−	+	+
84	*Holarrhena floribunda*	Apocynaceae	−	+	+
85	*Holoptelea grandis*	Ulmaceae	−	−	+
86	*Hunteria umbellate*	Apocynaceae	+	+	+
87	*Irvingia gabonensis*	Irvingiaceae	−	+	+
88	*Irvingia grandifolia*	Irvingiaceae	−	+	+
89	*Khaya grandifoliola*	Meliaceae	−	+	+
90	*Khaya ivorensis*	Meliaceae	+	+	+
91	*Khaya senegalensis*	Meliaceae	+	+	−
92	*Kigelia africana*	Bignoniaceae	−	−	+
93	*Klainedoxa gabonensis*	Irvingiaceae	−	+	−
94	*Lannea acida*	Anacardiaceae	−	+	+
95	*Lecaniodiscus cupanioides*	Sapindaceae	+	+	+
96	*Lecaniodiscus* sp.	Sapindaceae	+	−	−
97	*Lovoa trichiliodes*	Meliaceae	−	−	+
98	*Lophira alata*	Ochnaceae	+	+	+
99	*Olax subscorpioidea*	Olacaceae	+	−	−
100	*Macaranga barteri*	Euphorbiaceae	−	+	+
101	*Mansonia altissima*	Sterculiaceae	−	−	+
102	*Maranthes glabra*	Chrysobalanaceae	−	+	+
103	*Maranthes robusta*	Chrysobalanaceae	−	+	−
104	*Milicia excelsa*	Moraceae	+	+	+
105	*Millettia thonningii*	Papilionoideae	−	−	+
106	*Mitragyna stipulosa*	Rubiaceae	+	+	+
107	*Mitragyna ledermannii*	Rubiaceae	−	+	−
108	*Monodora tenuifolia*	Annonaceae	+	−	−
109	*Musanga cecropioides*	Moraceae	−	+	+
110	*Myrianthus arboreus*	Moraceae	−	+	+
111	*Nauclea diderrichii*	Rubiaceae	−	+	−
112	*Nesogordonia papaverifera*	Sterculiaceae	+	+	−
113	*Newbouldia laevis*	Bignoniaceae	+	+	−
114	*Parkia bicolor*	Mimosoideae	+	+	−
115	*Parinari excelsa*	Chrysobalanaceae	−	+	−
116	*Pentaclethra macrophylla*	Mimosoideae	+	+	−
117	*Poga aleosa*	Anisophylleaceae	−	+	−
118	*Picralima nitida*	Apocynaceae	+	+	+
119	*Piptadeniastrum africanum*	Mimosoideae	+	+	+
120	*Psuedocedrela kotschyi*	Meliaceae	+	−	−
121	*Pseudospondias microcarpa*	Anacardiaceae	−	+	+
122	*Pterocarpus soyauxii*	Papilionoideae	+	+	−
123	*Pterocarpus osun*	Papilionoideae	−	+	−

续表(**Continued**)

S/N	Scientific name	Families	Site A	Site B	Site C
124	*Pterocarpus* sp.	Papilionoideae	+	+	+
125	*Pterygota macrocarpa*	Sterculiaceae	−	−	+
126	*Pycnanthus angolensiss*	Myristicaceae	+	+	−
127	*Rauvolfia vomitoria*	Apocynaceae	+	+	+
128	*Raphia hookeri*	Palmae	−	+	+
129	*Ricinodendron heudelotii*	Euphorbiaceae	−	−	+
130	*Rothmannia* sp.	Rubiaceae	−	+	−
131	*Spathodea campanulata*	Bignoniaceae	+	+	−
132	*Spondianthus preussii*	Euphorbiaceae	−	+	−
133	*Spondias mombins*	Anacardiaceae	+	+	+
134	*Staudtia stipilata*	Capparaceae	−	+	+
135	*Sterculia rhinopetala*	Sterculiaceae	−	+	+
136	*Sterculia tragacantha*	Sterculiaceae	−	+	+
137	*Strombosia grandifolia*	Olacaceae	+	+	+
138	*Strombosia pustulata*	Olacaceae	+	+	+
139	*Tabernaemontana pachysiphon*	Apocynaceae	−	−	+
140	*Terminalia* sp.	Combretaceae	+	−	−
141	*Terminalia superba*	Combretaceae	−	+	+
142	*Terminalia ivorensis*	Combretaceae	−	+	+
143	*Tetrapleura tetraptera*	Mimosoideae	+	+	+
144	*Treculia Africana*	Moraceae	−	+	−
145	*Triplochiton scleroxylon*	Sterculiaceae	−	+	+
146	*Uapaca guineesis*	Euphorbiaceae	+	+	+
147	*Vitex ferruginea*	Verbenaceae	−	+	−
148	*Vitex doniana*	Verbenaceae	+	−	−
149	*Xylopia aethiopica*	Annonaceae	+	+	−
150	*Xylopia rubescens*	Annonaceae	−	+	+