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THE FATE OF A TROPICAL RAINFOREST IN NIGERIA: ABEKU SECTOR OF OMO FOREST RESERVE

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ABSTRACT

Sixteen permanent sample plots of one hectare each, established in 1985 at Abeku sector of Omo Forest Reserve, South west Nigeria by the European Economic Community/ Nigeria Federal Government (High Forest Monitoring Plots Project) (EEC/HFMPP) were used for this study. The plots were re-enumerated in 1987. Further assessment took place in 1997 and 2000 respectively for the purpose of assessing the floristic characteristics of the plots. The present study aims at assessing the floristic composition during the sampling years. Out of the original 16 plots only eleven and nine plots were available for assessment in 1997 and 2000 respectively. The remaining plots had been converted to plantations of arable and cash crops. The numbers of tree species encountered were 98, 109, 95 and 71 for 1985, 1987, 1997 and 2000 enumerations respectively. Also 28,31, 29 and 23 families were encountered in 1985, 1987, 1997 and 2000 respectively. In terms of density, basal area and spread, the ten most abundant species are *Diospyros iturensis* (Plant nomenclature follows Hutchinson and Dalziel (1954-72); Keay (1989) and Lowe and Soladoye (1990)), (DIAL),*Tabernaemontana pachysiphon* (TAPA), *Octolobus angustatus* (OLAN), *Strombosia pustulata* (SBPU), *Diospyros dendo* (DIDE), *Diospyros suaveolens* (DISU), *Drypetes gossweileri* (DRGO), *Rothmania hispida* (ROHI), Hunteria unbellata (HUUM) and *Anthonotha aubryanum* (ASAU) and the six most prominent families are *Ebenaceae, Apocynaceae, Euphorbiaceae, Sterculiaceae, Olacacea*e and *Rubiaceae* .Mean number of stems per hectare ranges from 400.44 to 1134.0 for the small trees (5-20cm dbh); 89.78 to 174.25 for the medium trees (20-40cm dbh) and 8.33 to 17.06 for the large trees (> 40cm dbh) Mean basal area per hectare ranges from 4.94m^2 to 8.81m^2 for the small trees, 5.4m^2 to 9.63m^2 for the medium trees and 4.64m^2 to 9.04m^2 for the large trees.

Inverse of Simpson diversity indices range between 15.1 to 16.27 for the small tree, 13.43 to 16.37 for the medium trees and 23.44 to 26.34 for the large trees. The highest mean values per hectare of these parameters were found in 1987 enumeration, while the least values were found in the year 2000 enumeration. This variability may not be due only to the number of plots available for enumeration alone, but also as a result of poaching in the remaining plots before the 2000 enumeration. The study recommends that conscious efforts should be made to protect and maintained the permanent sample plots not only to reduce the possibility of encroachment but also to achieve the objective for which they were established which was to elucidate the dynamics and growth pattern of the natural rainforest. There is also a need for international assistance to achieve this.

INTRODUCTION

Tropical forests are among the richest and most complex terrestrial ecosystems supporting a variety of life forms of not less than half of all species on earth (Phillips, 1996) and a tremendous intrinsic ability for self-regeneration if properly maintained. However, many of these forests are losing these properties due mainly to interference by anthropogenic actions. The rate of deforestation has been estimated variously for different parts of the world. In Nigeria, the annual rate of deforestation has been estimated as ranging between 3% to 5% (Ojo, 1993). However, these may just be guess estimate and far from reality. It has been espoused that forests have been recently affected by large scale anthropogenic and natural changes (Philips, 1996) and better understanding of the ecological changes in natural forest depends on progress in monitoring network of tropical forest plots. One of the major purposes of permanent sample plots (PSPs) is to monitor forest diversity and processes over time period in order to enhance better understanding of both local and large scale pattern in forest ecology.

Early long term assessment of the Nigerian rainforest had been made possible by Forestry Research Institute of Nigeria (FRIN) through permanent sample plots (PSP) established at different parts of the county in the early 1920s (Okali and Ola-Adams, 1987). Unfortunately, some of these plots had not been maintained in recent years. A network of 80 permanent sample plots of one hectare each were established within the rainforest of southern Nigeria between 1985 and 1987 (Table 1) by the European Economic Community/Nigerian Federal Department of Forestry High Forest Monitoring Project (HFMP). The objectives of the HFMP include the periodic monitoring for information on tree population dynamics. All the plots had been re-examined after two years of establishment. Reports based on the two samplings in all the plots had been made by Ojo (1990, 1996). However, plots at Abeku sector of Omo forest reserve had additional re-sampled in 1997 and 2000. The present study is based on the four samplings at Abeku sector of Omo Forest Reserve in 1985, 1987, 1997 and 2000 with the aim of assessing the developments in the forest. This is expected to be achieved by analysing plot parameters including tree density and basal area, species and family composition, tree species diversity etc. at different sampling periods.

MATERIALS AND METHODS

Study Area

Omo forest reserve is located between 6° 35" to 7° 05"N and 4° 19" to 4° 40"E in the South-West of Nigeria, about 135 km North-East of Lagos and 80 km East of Ijebu-Ode. It covers an area of about 130,500 hectares. Abeku sector is located in the north-eastern end of Omo forest reserve. (Figure 1) The vegetation and other general description of the study site had been carried out by various authors (Okali and Ola-Adams, 1987; Ojo, 1990; Ojo, 1996; Ola-Adams *et al.*, 1998; Ola-Adams, 1999).

Vegetation

The vegetation of Omo Forest Reserve is a mixed moist semi-deciduous rainforest. This can be distinguished into a dry evergreen mixed deciduous forest in the northern part and a wet evergreen forest in the southern part. With the exception of the 640 hectare Strict Nature Reserve, now a Biosphere Reserve at the centre of the forest reserve, most of the forest are disturbed with a substantial parts converted to tree plantations. The plant families with the most abundant individuals include *Araceae, Compositae, Ebenaceae, Lilliaceae, Papilionoideae, Poaceae, Rubiaceae and Violaceae*. The most common tree species *include Diospyros* spp., *Drypetes* spp., *Strombosia pustulata*, *Rinorea dentata* and *Voacanga africana*.

Topography, Geology and Soil

The topography of the sites varies widely from nearly flat to rolling. About 80% of the sites are well-drained into the watershed of River Omo the major river that traverses the sites. The uneven topography is characterised by numerous small hills which are dissected by tributaries of the Omo, Shasha and Oluwa Rivers. This unevenness has been attributed to past geological events. The area was once composed of sedimentary rocks, probably sandstone, of varying coarseness. A period of volcanic activity in the past heated these rocks to such an extent that they became viscous and flowed.

In many places schist (mainly low grade muscovite-biotite) and gueinsses can be found. Good flow banding and folding are also visible usually on outcrops on top of hills. In other places homogeneous outcrops of granodiorite can be found as well as quartzites outcrops in one or two localities. As a result the metamorphic rock has produced terrain that is quite resistant to the actions of physical and chemical weathering. About 80% of the sites are well-drained into the watershed of river Omo. The sites are made up of several soil types but they all belong to the tertiary sediments. Most of the soils are heavily leached, being Oxic.

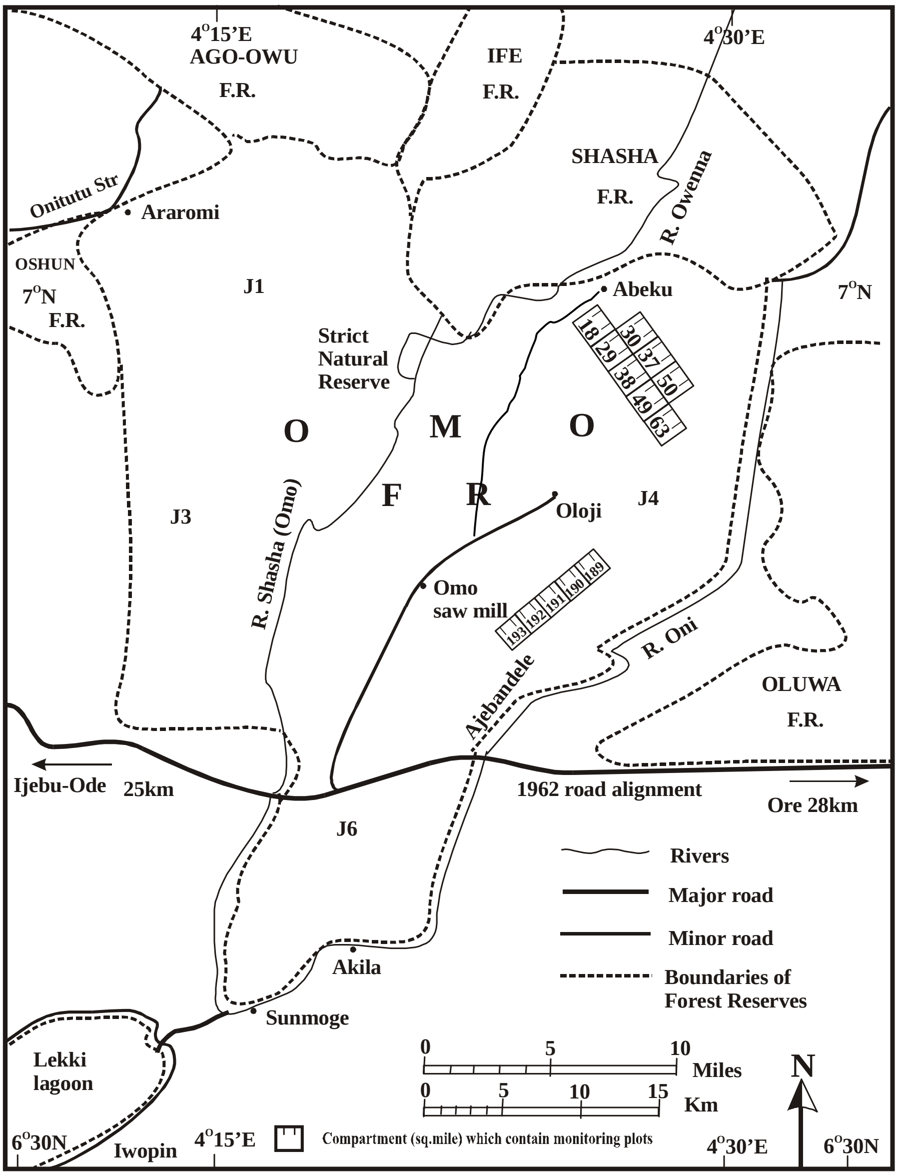

Figure 1. Map of Omo Forest Reserve showing the position of Abeku

Tropudalfs and Rhodic Paleudults. The most commonly occurring series are Alagba, Owode and Oteyyi The Alagba series are well drained and usually located near slope top and nearly level summit areas of the project site. They are deep soils without stones and concretions. The soil texture is usually sandy loam topsoil and sandy clay subsoil. The soils are derived from ferruginous sandstones.

The Owode series are also well drained. They occur in gently sloping upper slope sites, occasionally with steep-sided ironstone capped hills. The Oteyyi series are concretionary soils. They contain a large amount of medium sized rounded concretionary materials, though occasional larger lumps may be found. They occur on moderate or gentle slopes in middle and upper slopes sites. The top soil is usually dark brown clayey-sand and the subsoil is usually reddish brown sandy clay.

Data Collection and Analyses:

Sixteen plots of one hectare each comprising plots 11-26 of the High Forest Monitoring Plots (HFMP) (Ojo, 1990) located in compartments 18, 29,30, 37, 38, 49, 50, and 63 at Abeku sector of Omo forest reserve were enumerated in 1985 and re-enumerated in 1987 (Table 1). However as a result of human activities especially farming, not all the sixteen plots were available for further enumeration in 1997 and 2000 (Table 1). Each plot is one hectare in extent (40m by 250m) and offset perpendicularly 50m from the reference baseline.

Table 1. Location of High Forest Monitoring Plots within the rainforest of southern Nigeria

	Location	**Number of plots**	**Year of establishment**	**Year(s) of remeasurement**
1	Omo (Sawmill sector)	10	1985	1987
2	Omo (Abeku sector	16	1985	1987,1997,2000
3	Oban East	10	1987	1989
4	Oban West	10	1987	1989
5	Owan	13	1986	1988
6	Sapoba	21	1986	1988

The centreline of each plot is demarcated and marked at intervals of 50m. Floristic data comprising mainly diameter at breast height (dbh) were collected from each plot at three levels:
Small trees 5-20 cm dbh measured within 2.5m either side of the centreline.
Medium trees 20-40cm measured within 5m either side of the centreline.
Large trees >40cm dbh in the entire plot.
Thus, the three tree size classes: small trees, 5-20 cm dbh; medium trees, 20-40 cm dbh and large trees, >40 cm dbh were measured in different percentages of the plot (12.5%, 25% and 100% respectively). The enumeration data per plot and at each year were summarised into frequency and basal area tables using FORTRAN program STANDTAB and STANDBA (Lowe R.G., Personal communications). Each table comprised the scientific names, codes, family names and frequency or basal area at the three tree size classes. These plot tables were then collated for further statistical analyses including the following:
(a) Correlation analysis was carried out to compare the frequencies and basal areas of the size classes at the measuring periods.
(b) Simpson diversity index (I): In order to explore the diversity in terms of species heterogeneity taking into consideration the number of species and the density of individual species, Simpson diversity indices were computed for each size classes at the different measuring periods. The inverse of the original Simpson index was used so as to remove the ambiguity in the original Simpson index, hence the higher the value of I, the greater the heterogeneity, thus:

$$I = \frac{N(N-1)}{\sum_{i=1}^{q} n_i(n_i - 1)}$$

Where: N= total number of individual enumerated
q= number of different species enumerated
n= number of individuals of ith species enumerated

(c) Sorensen, similarity index (SI): In order to compare the species composition during the measuring periods, Sorensen's similarity indices were computed between pair periods. Only the nine plots available for all the four sampling periods were used, thus:

$$SI = \frac{a}{a+b+c} \times 100$$

Where: SI = percentage similarity index
a = number of species present in both sampling years
b = number of species present in the first sampling year and not in the second
c = number of species present in the second sampling year and not in the first.

RESULTS AND DISCUSSION

The full list of tree species enumerated with their families and total frequencies for the four measuring periods (1985, 1987, 1997 and 2000) are presented in Appendix 1. The summaries of floristic variables assessed are presented in Table 3.

Floristic composition

Tree species

There were 98, 109, 95 and 71 plant species enumerated in 1985, 1987, 1997 and 2000 respectively. The increase from 1985 to 1987 was due to more species being identified in the 1987 enumeration but the subsequent decrease in 1997 and 2000 are due to long interval between

Table 2. Plots available for enumeration in subsequent years of measurement at Abeku sector of Omo Forest Reserve, Nigeria

Plot code number	Measurement years			
	1985	1987	1997	2000
11	√	√	√	√
12	√	√	n.av	n.av
13	√	√	√	√
14	√	√	√	√
15	√	√	√	√
16	√	√	n.av	n.av
17	√	√	n.av	n.av
18	√	√	n.av	n.av
19	√	√	√	√
20	√	√	n.av	n.av
21	√	√	√	n.av
22	√	√	√	n.av
23	√	√	√	√
24	√	√	√	√
25	√	√	√	√
26	√	√	√	√

√ : Plots measured
n.av: Plots already converted to plantations of arable and cash crops and hence not available for enumeration

measurement during which the plots had been encroached and some plots completely lost to cash and arable crop farmers (Table 2). This no doubt affected the diversity of the tree species. The ten most abundant plant species in 1985 are *Diospyros iturensis* (DIAL),*Tabernaemontana pachysiphon* (TAPA), *Octolobus angustatus* (OLAN), *Strombosia pustulata* (SBPU), *Diospyros dendo* (DIDE), *Diospyros suaveolens* (DISU), *Drypetes gossweileri* (DRGO), *Rothmania hispida* (ROHI), *Hunteria umbellata* (HUUM) and *Anthonotha aubryanum* (ASAU). The ten species account for over 54% of the total tree frequency (Table 4). The composition of the ten most abundant species did not change drastically in subsequent measurements. Thus in 1987, 1997 and 2000, the ten most abundant tree species represent 63.2%, 66.6% and 64.5% of the frequency of all trees respectively. With regards to basal area, two clear distinction are noticeable. First, some upper storey large trees such as *Erythrophleuem ivorensis* (ERIV) and *Terminalia superba* (TESU) had been added to the list of the first ten species. This is not surprising since basal area defines area occupied by individual species. The second distinction is that *Strombosia pustulata* (SBPU) consistently occupied the first position in all the four measuring periods. This may be attributed to the large number of individuals present and the ability of the tree species to grow to a fairly large sized tree. Nevertheless, the ten largest trees at each enumeration accounted for 47.8%, 47.2%, 56.6% and 50.8% of the total basal area during 1985, 1987, 1997 and 2000 enumerations respectively (Table 4).

Tree species and family distribution

The spread of species among plots, their percentage and cumulative percentages at each measuring time are presented in Table 5. The percentages were based on the number of plots available for measurement. Thus 16 plots in 1985 and 11 and 8 plots in 1997 and 2000 respectively. The results show that only 32.65% and 35.77% of the species were present in 8 out of the i6 plots in 1985 and 1987 while over 35% of the species occur in less than three plots. The situation is somewhat the same in 1997 where less than 40% of the species were present in five out of 11 plots. In 2000, no single tree species occur in all the nine plots, while 33% of the species were present in four out of the nine plots enumerated. For the sparsely distributed species,

Table 3. Summary of sample plots parameters at Abeku sector of Omo Forest Reserve, Nigeria

Parameters measured	Years of Measurement			
	1985	1987	1997	2000
Number of plots	16	16	11	9
Numbers of Species	98	109	95	71
Numbers of Families	28	31	29	23
Mean stems per hectare:				
5-20cm dbh	1134.0	1167.0	864.73	400.44
20-40cm dbh	171.75	174.25	128.0	89.78
>40cm dbh	17.06	17.94	14.73	8.33
Total	1322.81	1359.19	1007.46	498.56
Mean basal area per hectare:				
5-20cm dbh	8.28	8.81	7.88	4.94
20-40cm dbh	9.31	9.63	7.24	5.4
>40cm dbh	9.04	9.0	8.03	4.64
Total	26.63	27.43	23.15	14.97
Simpson diversity indices				
5-20cm dbh				
20-40cm dbh	16.05	16.27	15.72	15.10
>40cm dbh	16.37	16.30	14.06	13.43
Total	24.27	26.34	24.23	23.44
	18.07	18.41	17.43	17.75

not less than 19% had occurrence in only one plot. These sparsely or "restricted" species are sources of concern in relation to conservation of genetic resources in the face of reducing areas of forested land.

A total of 32 tree families were encountered during the study. Of these 22 families were common in each of the four enumerations (Table 6). 31 families were enumerated in 1987 while 28, 29 and 23 families enumerated in 1985, 1997 and 2000. This meant that additional four families were discovered in 1987 while one family, Anacardiaceae disappeared after 1985 sampling. In 1985, the six families which account for over 86% of stand density with total density are Ebenaceae, Apocynaceae, Euphorbiaceae, Sterculiaceae, Olacaceae and Rubiaceae. The six have 7,6,16,4,1 and 9 species respectively. It is of interest to note that Olacaceae has only one specy i.e. Strombosia pustulata, it is still among the largest six families that dominate the landscape. The six families still dominate the landscape in subsequent enumerations accounting for 84.2, 85.4 and 77% of total density in 1987, 1997 and 2000. The four families enumerated in 1987 but not found in earlier enumeration in 1985 are Capparaceae, Guttiferae, Passiloraceae and Rhamnaceae. They have one species member each. They are the families of Bucholzia coriacea, Garcinia kola, Barteria fistulosa and Maesopsis emini. Unfortunately, except for Bucholzia coriacea, other three species were not encountered in 1997 and 2000. The decreasing number of species and families from 1987 through 1997 to 2000 indicates the extent of danger to the diversity of the natural forest due to dereservation and deforestation.

Stand Density and Basal area

Stand density per plot and size classes at each measuring periods are presented in Table 7. Generally, as will be expected, mean density decreases from small trees to the larger trees. In 1985, mean density per plot ranges from 17.06, 117.75 to 1134.0 for large trees, medium trees to small trees respectively. In 1987, the trend is not different from that of 1985 but there is increase in the mean density per plot at all tree size classes.

Thus 1167.0, 174.25 and 17.94 for small, medium and large sized tress. Increase in the mean density per plot for the small trees in 1997 may be due to new recruitment to the minimum size class. For 1997 and 2000, there is general decrease in the mean density per plot.

Table 4. Relative proportion (pi) of tree density and basal area of the ten most abundant species at different years of measurements

(a) Tree density								
	1985		1987		1997		2000	
	Species	**pi**	**Species**	**pi**	**Species**	**pi**	**Species**	**pi**
1	DIAL*	0.120	DIAL	0.114	TAPA	0.111	TAPA	0.123
2	TAPA	0.103	TAPA	0.107	SBPU	0.104	DIAL	0.094
3	OLAN	0.090	OLAN	0.091	DIAL	0.103	SBPU	0.093
4	SBPU	0.087	SBPU	0.083	OLAN	0.091	ASAU	0.082
5	DIDE	0.073	DIDE	0.066	DIDE	0.061	OLAN	0.056
6	DISU	0.040	DISU	0.045	ASAU	0.046	DIDE	0.054
7	DRGO	0.035	DIPI	0.038	DISU	0.046	STRH	0.039
8	ROHI	0.032	ASAU	0.029	DIPI	0.038	ROHI	0.036
9	HUUM	0.030	ROHI	0.029	HUUM	0.037	DIPI	0.034
10	ASAU	0.028	MCBA	0.028	ROHI	0.029	DISU	0.034
$\sum$		0.5486		0.632		0.666		0.645
(b) Relative Basal area								
	1985		1987		1997		2000	
	Species	**pi**	**Species**	**pi**	**Species**	**pi**	**Species**	**pi**
1	SBPU	0.089	SBPU	0.082	SBPU	0.107	SBPU	0.113
2	DIAL	0.067	DICR	0.063	ASAU	0.054	ASAU	0.081
3	ERIV	0.058	DIAL	0.062	ERIV	0.049	ERIV	0.060
4	TESU	0.051	ERIV	0.048	RIHE	0.047	DIAL	0.043
5	DIDE	0.042	TESU	0.047	TESU	0.046	RIHE	0.043
6	DISU	0.038	DISU	0.045	DISU	0.039	STRH	0.039
7	MCBA	0.036	MCBA	0.039	DIDE	0.035	MICI	0.032
8	HUUM	0.031	DIDE	0.033	HUUM	0.032	DISU	0.031
9	SCCO	0.029	ASAU	0.027	STRH	0.030	HUUM	0.031
10	RIHE	0.027	HUUM	0.027	TAPA	0.028	DIDE	0.031
$\sum$		0.4782		0.472		0.566		0.508

*: Full names of plants are provided in Appendix 1

Thus 864.73, 128.0 and 14.73 for small, medium and large trees in 1997 and 400.44, 89.79 and 8.33 for the three size classes in 2000. The decrease in these values in 1997 and 2000 were not only due to few plots enumerated but possibility of encroachment into the plots and outright conversion to plantations of monocultural tree crops and food crops as in plots 12, 16, 17 and 18 between 1987 and 1997 and plots 21 and 22 between 1997 and 2000. The stem basal area per plot and in the three tree size classes at the four measuring periods are presented in Table 8. The pattern of distribution of basal area among the tree size classes is different from that of stem density. While stem density follows an inverted J, basal area increase with increasing tree size depending of course on the number of trees represented in the size classes. In 1985, the mean basal area per one hectare plot was 27.24 m^2. This was made up of 8.28 m^2, 9.31 m^2 and 9.04 m^2 in the small, medium and large trees respectively. As in the tree density, the mean basal area per hectare in 1987 had increased to 27.43 m^2 made up of 8.81 m^2, 9.93 m^2 and 9.0 m^2 in the three size classes respectively. Mean basal area per hectare in the 1997 and 2000 enumerations had decreased to 23.15 m^2 and 14.97 m^2 respectively (Table 8). From the stand density and basal area values for each plot, size class and years of enumeration, it is clear that the plots are heterogeneous. Student's t statistic computed showed that there is significant difference between the plots at 99% probability (Tables 7 and 8).

Correlation between Measurement Periods

The correlation matrices of both stand density

Table5. Percentage distribution of tree species in the sample plots at different measuring periods at Abeku Sector of Omo Forest Reserve, Nigeria.

	Year s of measurement											
	1985			1987			1997			2000		
No of plots present	**Spp**	**%**	**c%**	**Spp**	**%**	**c%**	**Spp**	**%**	**c%**	**Spp**		
16	10	10.204	10.204	9	8.2568	8.256						
15	1	1.0204	11.224	3	2.7522	11.00						
14	3	3.0612	14.285	2	1.8348	12.84						
13	6	6.1224	20.408	2	1.8348	14.67						
12	1	1.0204	21.428	5	4.5871	19.26						
11	4	4.0816	25.510	4	3.6697	22.93	8	8.4210	8.4210			
10	3	3.0612	28.571	2	1.8348	24.77	3	3.1578	11.578			
9	1	1.0204	29.591	4	3.6697	28.44	2	2.1052	13.684	0	0	0
8	3	3.0612	32.653	8	7.3394	35.77	3	3.1578	16.842	4	5.633	5.633
7	7	7.1428	39.795	4	3.6697	39.44	2	2.1052	18.947	4	5.633	11.267
6	2	2.0408	41.836	6	5.5045	44.95	4	4.2105	23.157	4	5.633	16.901
5	11	11.224	53.061	6	5.5045	50.45	10	10.526	33.684	5	7.042	23.943
4	4	4.0816	57.142	9	8.2568	58.71	9	9.4736	43.157	7	9.859	33.802
3	7	7.1428	64.285	9	8.2568	66.97	9	9.4736	52.631	5	7.042	40.845
2	16	16.326	80.612	11	10.091	77.06	21	22.105	74.736	19	26.76	67.605
1	19	19.387	100	25	22.935	100	24	25.263	100	23	32.39	100
TOTAL	98	100		109	100		95	100		71	100	

and basal area at different periods of measurement are presented in Tables 7& 8. In order to ensure proper comparisons, only the nine plots that were available throughout the study were used. For the stand density, the relationship between subsequent measurement was only significant at 99% for 1985 and 1987 and 1985 and 1997 while relationship between 1987 and 1997 and also between 1997 and 2000 were significant at 95%. The other two size classes only have significant correlation at 99% between 1985 and 1997. The pattern is not different for basal area. The implications of this trend is that there had been a tremendous change in both the stand density and basal area and consequently on the stand structure.

Diversity indices

The results of the inverse of Simpson diversity indices are presented in Table 3. The inversion of Simpson formula is to avoid the ambiguity associated with the normal rendition of the formula. In the present form, the higher the value, the more heterogeneous the site.

Two patterns can be distinguished in the diversity indices, one across the years of measurement and the other along the tree sizes. For 1985 and 1987, the values increase with increasing tree size while the figures dropped for the medium trees in 1997 and 2000.

The indices for the total stem for each year of measurement are between the lowest and highest value. Across the measuring period, the diversity indices follows the same pattern as the stand density and basal area, increasing in 1987 but decreasing through 1997 to 2000. In 1985, diversity indices varies from 16.05, 16.37 to 24.27 for the small, medium and large trees respectively. The values in each class increase in 1987 varying from 16.27, 16.30 to 26.34 for the small, medium and large trees respectively. In 1997, the figures dropped to 15.72, 14.06 t 24.43 for the three size classes. There is further drop in the figures for 2000 thus 15.10, 14.43, 23.44 for the tree.

Similarity indices

Sorensen/s similarity indices between pair sampling periods for the nine plots available during the four sampling periods are presented in Table 9. High values were found between 1985 and 1987 (86.46); 1987 and 1997 (88.120 and 1997 and 2000 (71.47), while least value was found between 1985 and 2000 (69.79). This trend of decreasing values with subsequent with subsequent sampling, thus, 1985 and 1987> 1985 and 1997 >1985 and 2000 further confirms that change in floristic composition is not only due to outright loss of some plots but also due to encroachment of the remaining plots.

CONCLUSION

The 1985 and 1987 values for the various parameters assessed showed that Abeku Sector of Omo Forest Reserve was a well stocked

Table 6. Families of tree species and the number of species enumerated in 1985, 1987, 1997 and 2000 at Abeku sector of Omo Forest Reserve, Nigeria

		1985						1987						1997						2000					
S/	FAMILY	5-20cm	20-40cm	>40 cm	TOT	Spp	pi	5-20cm	20-40cm	>40cm	TOT	Spp	pi	5-20cm	20-40cm	>40 cm	TOT	Spp	pi	5-20cm	20-40cm	>40 cm	TOT	Spp	pi
1	Ebenaceae	4616	544	4	5164	7	0.25230	5144	560	5	5709	7	0.27201	2486	236	2	2742	5	0.25209	920	80	0	1000	5	0.201734
2	Apocynaceae	3032	240	7	3279	6	0.16020	3192	232	10	3434	6	0.16361	1728	156	7	1891	5	0.17385	784	84	2	870	5	0.175509
3	Euphorbiaceae	2664	476	44	3184	16	0.15556	2520	512	50	3082	16	0.14684	1408	240	40	1688	6	0.15518	616	180	21	817	14	0.164817
4	Sterculiaceae	2216	68	8	2292	4	0.11198	2304	56	8	2368	5	0.11282	1176	32	10	1218	4	0.11197	400	32	4	436	3	0.087956
5	Olacaceae	1304	468	3	1775	1	0.08672	1296	468	4	1768	1	0.08423	832	296	9	1137	1	0.10453	256	164	1	421	1	0.084930
6	Rubiaceae	1264	180	35	1479	9	0.07226	1104	172	39	1315	12	0.06265	512	88	17	617	2	0.05672	224	40	10	274	11	0.055275
7	Annonaceae	336	136	17	489	5	0.02389	248	152	18	418	6	0.01991	120	52	8	180	6	0.01654	8	32	6	46	4	0.009279
8	Flacourtaceae	288	112	6	406	1	0.01983	328	80	8	416	1	0.01982	128	36	4	168	1	0.01544	72	24	2	98	1	0.019770
9	Meliaceae	248	100	24	372	9	0.01817	248	56	18	322	8	0.01534	144	16	4	164	8	0.01507	40	4	1	45	4	0.009078
10	Violaceae	328	8	0	336	1	0.01641	232	8	0	240	1	0.01143	80	0	0	80	1	0.00735	40	0	0	40	1	0.008069
11	Caesalpinioideae	168	28	33	229	6	0.01118	264	32	34	330	9	0.01572	64	16	15	95	7	0.00873	72	12	7	91	5	0.018357
12	Ulmaceae	176	36	6	218	2	0.01065	176	36	6	218	2	0.01038	104	32	3	139	2	0.01277	456	60	5	521	2	0.105103
13	Tiliaceae	160	40	1	201	1	0.00982	176	48	3	227	1	0.01081	104	24	2	130	1	0.01195	56	28	1	85	1	0.017147
14	Rutaceae	168	32	0	200	1	0.00977	144	40	0	184	1	0.00876	64	48	0	112	1	0.01029	16	12	0	28	1	0.005648
15	Boraginaceae	64	68	7	139	1	0.00679	96	64	8	168	1	0.00800	80	36	6	122	2	0.01121	16	24	3	43	1	0.008674
16	Moraceae	56	56	20	132	5	0.00644	64	52	21	137	4	0.00652	80	12	8	100	3	0.00919	8	4	5	17	2	0.003429
17	Loganiaceae	120	0	1	121	1	0.00591	40	0	0	40	1	0.00190	32	0	0	32	1	0.00294	16	0	0	16	1	0.003227
18	Combretaceae	72	8	24	104	1	0.00508	88	12	23	123	1	0.00586	8	0	10	18	1	0.00165	8	0	1	9	1	0.001815
19	Mimosoideae	32	36	1	69	3	0.00337	16	32	2	50	4	0.00238	0	24	1	25	2	0.00229	0	8	2	10	2	0.002017
20	Myristicaceae	64	4	0	68	2	0.00332	64	4	0	68	1	0.00323	40	4	0	44	1	0.00404	16	4	0	20	1	0.004034
21	Irvinginaceae	56	4	0	60	2	0.00293	32	12	3	47	2	0.00223	16	4	1	21	2	0.00193	0	0		0		0
22	Papilionoideae	48	4	0	52	2	0.00254	48	4	0	52	2	0.00247	32	0	0	32	2	0.00294	0	0		0		0
23	Agavaceae	24	4	0	28	1	0.00136	24	4	0	28	1	0.00133	0	4	0	4	1	3.67748	0	0		0		0
24	Samydaceae	24	0	1	25	3	0.00122	48	4	3	55	3	0.00262	16	4	1	21	2	0.00193	24	4	1	29	1	0.005850
25	Bombacaceae	8	4	7	19	2	9.28324	16	8	7	31	2	0.00147	16	4	4	24	2	0.00220	0	0	1	1	1	2.01735E
26	Bignoniaceae	16	0	1	17	1	8.30605	16	0	0	16	2	7.62340	8	0	0	8	1	7.35497	0	0		0		0
27	Anacardiaceae	8	0	0	8	1	3.90873	0	0		0		0	0	0		0		0	0	0		0		0
28	Sapotaceae	0	0	1	1	1	4.88591	8	0	1	9	2	4.28816	8	0	0	8	1	7.35497	0	0		0		0
29	Capparaceae	0	0		0		0	72	20	1	93	1	0.00443	40	12	1	53	1	0.00487	32	8	0	40	1	0.008069
30	Guttiferae	0	0		0		0	8	0	0	8	1	3.81170	0	0		0		0	0	0		0		0
31	Passifloraceae	0	0		0		0	8	0	0	8	1	3.81170	0	0		0		0	0	0		0		0
32	Rhamnaceae	0	0		0		0	8	16	0	24	1	0.00114	0	4	0	4	1	3.67748	0	0		0		0
	TOTAL	17560	2656	251	20467		1	18032	2684	272	20988		1	9326	1380	153	10877		1	4080	804	73	4957		1

Table 7. Number of stems per hectare in the three size classes at each measuring periods at Abeku Sector of Omo Forest Reserve, Nigeria

	1985				1987				1997				2000			
PLTS	5-20	20-40	>40	Tot/Ha	5-20	20-40	>40	Tot/Ha	5-20	20-40	>40	Tot/Ha	5-20	20-40	>40	Tot/Ha
11	1112	176	25	1313	1192	184	25	1401	552	124	14	690	48	12	3	63
12	1176	124	18	1318	1272	116	20	1408					0	0		0
13	1472	164	14	1650	1512	164	14	1690	1504	164	14	1682	480	96	6	582
14	1024	204	20	1248	1104	212	20	1336	784	148	13	945	328	116	11	455
15	1280	204	18	1502	1288	204	20	1512	1288	200	20	1508	648	144	8	800
16	1072	200	10	1282	1088	196	11	1295								
17	1016	224	15	1255	1000	224	17	1241								
18	1024	184	15	1223	1040	180	16	1236								
19	1040	172	22	1234	1088	188	23	1299	392	56	8	456	32	12	0	44
20	984	92	17	1093	1016	84	15	1115								
21	1000	132	27	1159	1040	132	29	1201	616	84	17	717				
22	1448	192	10	1650	1488	208	11	1707	1024	112	6	1142				
23	1200	132	12	1344	1216	144	13	1373	856	140	25	1021	672	92	10	774
24	1144	164	16	1324	1160	168	16	1344	920	116	13	1049	632	108	8	748
25	1096	188	24	1308	1088	188	26	1302	768	168	19	955	456	148	21	625
26	1056	196	10	1262	1080	196	11	1287	808	96	13	917	408	80	8	496
TOTAL	18144	2748	273	21165	18672	2788	287	21747	9512	1408	162	11082	3704	808	75	4587
MEAN	1134.0	171.75	17.06	1322.81	1167.0	174.25	17.94	1359.19	864.73	128.0	14.73	1007.46	400.44	89.78	8.33	498.56
SEM	37.62	8.89	1.35	38.73	38.95	9.52	1.41	40.25	96.23	12.50	1.62	105.72	77.01	16.49	1.95	92.06
T	30.14	19.32	12.62	34.15	29.97	18.30	12.72	33.77	8.99	10.24	9.10	9.53	5.20	5.44	4.27	5.42

$t_{0.01}$ (15) = 2.497; $t_{0.01}$ (10) = 3.169; $t_{0.01}$ (8) = 3.355

CORRELATION OF CORRESPONDING STEM CLASS

	85/5	87/5	97/5
87/5-20	0.980		
97/5-20	0.817	0.773	
2k/5-20	0.491	0.348	0.706

	85/40	87/40	97/40
87/>40	0.981		
97/>40	0.119	0.164	
2k/>40	0.054	0.122	0.542

	85/20	87/20	97/20
87/20-40	0.981		
97/20-40	0.337	0.221	
2k/20-40	0.291	0.133	0.770

	85tot	87tot	97tot
87tot	0.979		
97tot	0.803	0.733	
2ktot	0.444	0.271	0.727

$r_{0.01}(9) = 0.798$; $r_{0.05}(9) = 0.666$

Table 8. Stems basal area (m^2) per hectare in the three size classes at each measuring periods at Abeku Sector of Omo Forest Reserve, Nigeria

	1985				1987				1997				2000			
PLTs	5-20	20-40	>40	Tot/Ha	5-20	S20-40	>40	Tot/Ha	S5-20	S20-40	>40	Tot/Ha	S5-20	S20-40	>40	Tot/Ha
11	7.945	8.6398	10.9401	27.5249	8.8755	9.5284	12.0255	30.4294	6.0973	7.0277	9.2147	22.3397	0.6572	0.4662	2.7166	3.84
12	8.2744	6.9621	6.7095	21.946	9.5499	6.7423	7.9353	24.2275								
13	10.4118	8.2422	9.7921	28.4461	11.4424	8.4666	11.3315	31.2405	11.4198	8.4666	11.3315	31.2179	5.8517	5.5322	5.1527	16.5366
14	8.2025	12.0908	8.3157	28.609	8.6647	12.4729	8.8066	29.9442	7.8246	9.1012	7.4899	24.4157	4.7147	6.9549	5.3454	17.015
15	9.5959	10.969	10.7269	31.2918	9.9144	11.3674	11.5077	32.7895	9.9144	11.1864	11.5077	32.6085	8.3578	8.4125	3.2582	20.0285
16	7.7339	10.0392	5.9286	23.7017	7.9332	10.457	6.3119	24.7021								
17	9.6819	12.3031	5.727	27.712	9.8026	11.9462	5.7615	27.5103								
18	8.3785	9.975	13.5831	31.9366	8.3834	10.3006	9.9514	28.6354								
19	8.4541	9.7611	12.8883	31.1035	9.0643	10.875	13.857	33.7963	5.6198	3.2763	4.8429	13.739	0.5293	0.6471	0	1.1764
20	7.1156	4.9421	7.8856	19.9433	7.6978	4.2696	6.662	18.6294								
21	5.632	7.2295	15.3342	28.1957	6.3336	7.3607	13.5722	27.2665	5.0802	5.0769	8.8093	18.9664				
22	9.3749	10.9175	4.1284	24.4208	9.7162	11.6424	4.5457	25.9043	8.2955	6.2665	1.762	16.324				
23	8.1176	7.1689	4.8883	20.1748	8.0764	7.9822	5.585	21.6436	7.4209	8.4543	10.236	26.1112	6.6909	5.4449	4.8367	16.9725
24	7.3175	9.2904	9.0196	25.6275	7.828	9.6181	7.3821	24.8282	8.347	6.4834	8.3676	23.198	6.994	6.6584	4.3941	18.0465
25	9.316	10.3935	8.2238	27.9333	10.0116	10.9764	9.1256	30.1136	9.1108	9.0005	6.9914	25.1027	6.4334	8.5116	10.3384	25.2834
26	7.0354	9.9872	10.5029	27.5255	7.6368	9.9955	9.6362	27.2685	7.5841	5.2921	7.7982	20.6744	4.1899	5.9507	5.7251	15.8657
Total	132.587	148.9114	144.5941	426.0925	140.9308	154.0013	143.9972	438.9293	86.7144	79.6319	88.3512	254.6975	44.4189	48.5785	41.7672	134.7646
Mean	8.28	9.31	9.04	26.63	8.81	9.63	9.0	27.43	7.88	7.24	8.03	23.15	4.94	5.4	4.64	14.97
SEM	0.30	0.50	0.80	0.93	0.31	0.55	0.72	1.01	0.56	0.68	0.86	1.73	0.92	0.99	0.93	2.55
t	28.58	18.62	11.27	28.69	28.31	17.64	12.46	27.12	13.97	10.65	9.37	13.41	5.39	5.47	5.02	5.88

$t_{0.01}(15) = 2.497$; $t_{0.01}(10) = 3.169$; $t_{0.01}(8) = 3.355$

CORRELATION OF CORRESPONDING STEM CLASS

	85/5	87/5	97/5
87/5-20	0.957		
97/5-20	0.775	0.762	
2k/5-20	0.305	0.155	0.752

	85/40	87/40	97/40
87/>40	0.899		
97/>40	0.281	0.319	
2k/>40	-0.556	-0.525	0.066

	85/20	87/20	97/20
87/20-40	0.978		
97/20-40	0.273	0.231	
2k/20-40	0.397	0.248	0.690

	85tot	87tot	97tot
87tot	0.900		
97tot	0.045	0.104	
2ktot	-0.213	-0.316	0.660

$r_{0.01}(9) = 0.798$; $r_{0.05}(9) = 0.666$

Table 9. Sorensen's similarity indices between sampling periods of nine plots available during the four measuring periods

	1985	1987	1997	2000
No. of tree species	92	97	93	71
1985		86.46	72.90	69.79
1987			88.12	73.20
1997				74.47
2000				

natural rainforest. The values compared favourably with other parts of the Nigerian rainforest (Ojo, 1990; Okali and Ola-Adams, 1987 and Ojo and Ola-Adams, 1996). The five plots lost between 1987 and 1997 and additional two plots between 1997 and 2000 should be a serious concern and indicates the level of dereservation/deforestation in the study site and by extension most parts of the Nigerian rainforest. These have serious implications on global climate. It is a matter for verification to confirm if the remaining nine plots have not been converted to plantations of arable and cash crops. It should be noted that the ten plots at the Sawmill sector of the forest reserve (Table 1) had earlier been converted to monocultural plantations of Gmelina, Teak and Pines. It will be necessary to investigate what is going on in other EEC/HFMP plots in other parts of the rainforest of southern Nigeria viz. Owan, Sapoba, Oban East and Oban West (Table 1).The low values of all the parameters assessed in 1997 and 2000 may not entirely be due to the loss of these plots but also to the encroachment of the remaining plot which depleted them of small, medium and large trees. One of the reasons why deforestation of reserved forest especially the research sample plots, is made easy is the interval between measurement and re-measurements which results in near neglect of the plots. For example, ten years (1987-1997) as in this study, is a long time to abandon research plots at the centre of a rainforest surrounded by enclaves. However, possibility of encroachment will be reduced if the plots are frequently visited and assessed. The fact that additional tree species and families were found in 1987 enumeration showed that if continuous and consistent enumerations were carried out at constant intervals, tree diversity would have improved with subsequent enumeration.

The high values of parameters measured in 1985 and 1987 confirmed that if the forest is properly managed and protected, there will be increased turnover as reported for other forest in the tropics (Phillips, 1996). It is therefore necessary that the remaining forests especially those in research plots should be properly maintained and periodically assessed to be able to achieve the purposes for which they were established, which is to monitor their diversity and development through time. This is very essential as tropical forest support more than half of all species on earth and also because of the important role of tropical forests in amelioration of climate. The original plan for the EEC/HFMP was to assess them at 2-years interval. The attainment of this objective cannot be achieved without international assistance to enhance their continuous assessment. Tropical forest anywhere in the world is a great asset to humankind. Their wanton destruction at this time, when researches are still going on to determine the uses of their numerous resources (especially plants) and potentials will deny both present and future generations of these benefits.

REFERENCES

Hutchinson J. and Dalziel J.M. (1954-72), Flora of West Tropica Africa, ed.2, Revision editors Keay R.J.W. (Vol. 1) and Happer F.N (Vols II & III), Crown Agents.

Keay R.W.J.(1989), Trees of Nigeria, Clarendon Press, Oxford.

Lowe J. and Soladoye, M.O. (1990), Some changes and corrections to names of Nigerian plants since publication of Flora of West Tropical Africa, ed. 2., Nigerian Trees, *Nig. J. Botany* 3, 1-24.

Ojo L.O. (1990), High forest veariation in southern Nigeria: implications for conservation and Management, Ph.D. thesis, University of Wales, Bangor, U.K.

Ojo, L.O. (1993), Estimation of carbon dioxide uptake and emission from deforestation of the Nigerian forests, *Nigerian Journal of Forestry*, 23, 33-41.
Okali D.U.U. and Ola-Adams B.A. (1987), Tree population changes in treated rainforest at Omo forest reserve, south-western Nigeria, *Journal of Tropical Ecology*, 3, 291-313.
Ola-Adams B.A. (1999), Biodiversity inventory of Omo Biosphere reserve, Nigeria. Country report on Biosphere reserve for biodiversity conservation and sustainable development in Africa (BRAAF) project, eds. Ola-Adams B.A.
Ola-Adams B.A., Ojo L.O. and Adetunji M.T. (1998), Accumulation of nutrient under different forest land uses, *Nigerian Journal of Forestry*, 28, 5-14.
Pelou E.C. (1984), The interpretation of ecological data: a primer on classification and ordination, eds. Wiley - Interscience, New York, pp 263.
Phillips O.L. (1996), Long term environmental changes in tropical forests: increasing tree turnover, *Environmental Conservation*, 23, 235-248.

Appendix 1. Total number of stems per species at each of the measuring years

S/n	PL				TOTAL STEMS			
	CODE	SPECIES NAME	FAMILY	HABIT	1985	1987	1997	2000
1	ACDJ	Anthocleista djalonensis	Loganiaceae	Tree	16	5	4	2
2	ADGE	Aidia genipiflora	Rubiaceae	Tree	1	30	5	4
3	ADLA	Antidesma laciniatum	Euphorbiaceae	Tree	6	13	12	6
4	AFAF	Afzelia africana	Caesalpinioidae	Tree	5	3	1	1
5	AIRO	Aningeria robusta	Sapotaceae	Tree	1	1		
6	ALFE	Albizia feruginea	Mimosoideae	Tree	8	6	4	1
7	ALZY	Albizia zygia	Mimosoideae	Tree		1		
8	ANAF	Antiaris toxicaria	Moraceae	Tree	15	15	12	6
9	AOMA	Annimidium mannii	Annonaceae	Tree	3	4	2	
10	ASAU	Anthonatha aubryanum	Euphorbiaceae	Tree	90	99	83	63
11	ASBO	Alstonia boonei	Apocynaceae	Tree	1	1		
12	ASCO	Alstonia congensis	Apocynaceae	Tree	13	14	4	2
13	ATFR	Anthonatha fragrans	Euphorbiaceae	Tree	25	25	8	4
14	ATMA	Anthonotha macrophylla	Caesalpiniodeae	Tree	9	12	1	1
15	AYMI	Antrocaryon micraster	Anacardiaceae	Tree		1	1	
16	BDMI	Bridelia micrantha	Euphorbiaceae	Tree	9	1		
17	BECO	Berlinia confusa	Caesalpinioidae	Tree		6	3	5
18	BOBU	Bombax buonopozense	Bombacaceae	Tree	2	5	3	
19	BPNI	Baphia nitida	Papilionoideae	Tree	5	4	3	
20	BPPU	Baphia pubescens	Papilionoideae	Tree	2	3	1	
21	BREU	Brachystegia eurycoma	Caesalpinioidae	Tree	2	1		
22	BRNI	Brachystegia nigerica	Caesalpinioidea	Tree	23	28	12	7
23	BTFI	Bateria fistulosa	Passifloraceae	Tree		1		
24	BUCO	Buchholzia coriacea	Capparaceae	Tree		15	9	6
25	CASU	Canthium subcordatum	Rubiaceae	Tree	16	14	7	2
26	CAVU	Canthium vulgare	Rubiaceae	Tree	4	2	1	1
27	CBPE	Ceiba pentandra	Bombacaceae	Tree	6	6	4	1
28	CEMI	Celtis milbraedii	Ulmaceae	Tree	17	16	12	6
29	CEZE	Celtis zenkeri	Ulmaceae	Tree	20	21	12	7
30	CF	Coffea sp	Rubiaceae	Tree		5	2	1
31	CJPA	Corynanthe pachyceras	Rubiaceae	Tree		8	4	2
32	CKPL	Chrysophyllum albidum	Sapotaceae	Tree		1	1	
33	CLPA	Cleistopholis patens	Annonaceae	Tree	38	42	17	10
34	COAC	Cola accuminata	Sterculiaceae	Tree	12	6	2	
35	COGI	Cola gigantea	Sterculiaceae	Tree		1		
36	CPPR	Carapa procera	Meliaceae	Tree	1	4	1	
37	CQCE	Craterispermum cerinanthum	Rubiaceae	Tree	2	2	2	1
38	CRMI	Cordia milenii	Boraginaceae				2	

S/n	PL				TOTAL STEMS			
	CODE	SPECIES NAME	FAMILY	HABIT	1985	1987	1997	2000
39	CRPL	Cordia platthyrsa	Boraginaceae	Tree	32	36	23	11
40	CXHE	Claoxylon hexandrum	Euphobiaceae	Tree	1	12	7	4
41	DAOL	Daniellia olliveri	Caesalpinioidea	Tree		1	1	
42	DGCA	Discoglypremna calonuera	Euphorbiaceae	Tree	60	60	30	15
43	DIAL	Diospyros iturensis	Ebenaceae	Tree	332	327	151	55
44	DICR	Diospyros crassiflora	Ebenaceae	Tree	5	5		
45	DIDE	Diospyros dendo	Ebenaceae	Tree	205	185	89	33
46	DIPI	Diospyros insculpta	Ebenaceae	Tree	2	1		19
47	DIPI	Diospyros piscatoria	Ebenaceae	Tree	44	105	53	
48	DISU	Diospyros suaveolens	Ebenaceae	Tree	128	153	76	25
49	DIUN	Diospyros undabunda	Ebenaceae	Tree	1	12	5	3
50	DLGU	Dialium guineense	Caesalpinioidae	Tree		2	1	
51	DR	Drypetes sp	Euphorbiaceae	Tree	9			
52	DRAF	Drypetes aframensis	Euphorbiaceae	Tree	13	8	3	2
53	DRGI	Drypetes gilgiana	Euphorbiaceae	Shrub	40	28	14	6
54	DRGO	Drypetes gossweileri	Euphorbiaceae	Shrub	96	80	45	9
55	DRLE	Drypetes leonensis	Euphorbiaceae	Tree	9	2	2	1
56	DRMO	Drypetes molunduana	Euphorbiaceae	Tree	4	6	2	2
57	DRPA	Drypetes paxii	Euphorbiaceae	Tree		1		
58	DRST	Drypetes staudtii	Euphorbiaceae	Tree			1	
59	DSBE	Disthemonanthus benthamianum	Caelsalpinioideae	Tree	4	4		
60	DTAR	Dictyandra arborscens	Rubiaceae	Shrub	15	15	6	
61	DX	Dracaena sp	Agavaceae	Shrub	4	4	1	
62	ENAN	Entandrophragma angolense	Meliaceae	Tree	7	4	2	
63	ENCA	Entandrophragma candolii	Meliaceae	Tree	3	1	1	2
64	ERIV	Erythrophleum ivorense	Caesalpinioideae	Tree	18	18	8	5
65	ETCH	Enantia chlorantha	Annonaceae	Tree	13	13	8	1
66	FAMA	Zanthoxylum macrophylla	Rutaceae	Tree	29	28	20	5
67	FIEX	Ficus exasperata	Moraceae	Tree	1	1	2	
68	FIMU	Ficus mucoso	Moraceae	Tree	1	1		
69	FUEL	Funtumia elastica	Apocynaceae	Tree	59	59	37	22
70	GCKO	Garcinia kola	Guttiferae	Tree		1		
71	GRCO	Grewia coriacea	Tiliaceae	Shrub	31	37	21	15
72	GUCE	Guarea cedrata	Meliaceae	Tree	8	4	2	1
73	GUTH	Guarea thomsonii	Meliaceae	Tree	1	2	2	
74	HOAF	Homallium africanum	Samydaceae	Tree	1	5	2	
75	HOAY	Homallium aylmeri	Samydaceae	Tree	1	2	2	
76	HOLE	Homalium letestui	Samydaceae	Tree	1	3		5
77	HSZE	Hypodaphinis zenkeri	Irvinginacea	e Tre		6	2	
78	HUUM	Hunteria umbellata	Apocynaceae	Tree	95	93	63	24
79	IRGA	Irvingia gabonensis	Irvinginaceae	Tree	4			
80	KHIV	Khaya ivorensis	Meliaceae	Tree	17	17	6	2
81	KLGA	Klainedoxa gabonensis	Irvinginaceae	Tree	4	4	2	
82	LAWE	Lannea welwitchii	Anacardiaceae	Tree	1			
83	LOTR	Lovoa trichilioides	Meliaceae	Tree	12	13	9	2
84	MCBA	Macaranga barteri	Euphorbiaceae	Tree	93	103	37	14
85	MDPU	Microdesmis puberula	Euphorbiaceae	Shrub	2	3	2	1
86	MEEM	Maesopsis eminii	Rhamnaceae	Tree		5	1	
87	MICI	Mitragyna ciliata	Rubiaceae	Tree	21	25	14	9
88	MNMY	Monodora myristica	Annonaceae	Tree	10	9	2	
89	MUCE	Musanga cecrepioides	Moraceae	Tree	24	25	7	1
90	NADI	Nauclea diderichii	Rubiaceae	Tree	12	12	4	1
91	NBLA	Newbouldia laevis	Bignoniaceae	Tree		1	1	
92	OLAN	Octolobus spectabilis	Sterculiaceae	Tree	231	248	124	32
93	PCMA	Penthacletha macrophyla	Mimosoideae	Tree	4	4	3	3

S/n	PL				TOTAL STEMS			
	CODE	**SPECIES NAME**	**FAMILY**	**HABIT**	**1985**	**1987**	**1997**	**2000**
94	PHDI	Phyllanthus discoides	Euphorbiaceae	Tree	5	17	6	3
95	PIAF	Piptadeniastrum africanum	Mimosoideae	Tree	1	1		
96	PMSU	Greenwayodendron suaveolens	Annonaceae	Tree		1	1	1
97	PRCL	Porterandia clandatha	Rubiaceae	Tree	49	25	12	3
98	PUJO	Pausinystalia johimbe	Rubiaceae	Tree	5	7	2	2
99	PUMA	Pausinystalia macroceras	Rubiaceae	Tree		4	3	1
100	PUTA	Pausinystalia talbotii	Rubiacea	Tree	33	25	8	4
101	PXAR	Polysphaera arbuscula		Shrub	1			
102	PYAN	Pycnanthus angolense	Myristicaceae	Tree	8	9	6	3
103	RIHE	Ricinodendron heudelotii	Euphorbiaceae	Tree	34	35	21	10
104	RNOB	Rinorea oblongifolia	Violaceae	Tree	43	31	10	5
105	ROHI	Rothmania hispida	Rubiaceae	Tree	83	78	40	21
106	RVVO	Rauvolvia vomitoria	Apocynaceae	Shrub	15	17	4	1
107	SBPU	Stombosia pustulata	Olacaceae	Tree	283	283	187	74
108	SCCO	Scottellia coriacea	Flacourtaceae	Tree	70	69	29	17
109	SPCA	Spathodea campanulata	Bignoniaceae	Tree	3	1		
110	STOB	Sterculia oblonga	Sterculiaceae	Tree	7	1	1	1
111	STRH	Sterculia rhinopetala	Sterculiaceae	Tree	52	54	38	29
112	SUST	Staudtia stipitata	Myristicaceae	Tree	1			
113	TAPA	Tabernaemontana pachysiphon	Apocynaceae	Tree	263	283	154	72
114	TESU	Terminalia superba	Combretaceae	Tree	35	37	11	2
115	THEM	Trichilia emetica	Meliaceae	Tree	29	18	3	
116	THMO	Trichilia monadelpha	Meliaceae	Tree	2			
117	UA	Uapaca sp	Euphorbiaceae	Tree	1			
118	XY	Xylopia spp	Annonaceae	Tree	29	18	6	3