Available online: www.notulaebiologicae.ro
Print ISSN 2067-3205; Electronic 2067-3264
Not Sci Biol, 2014, 6(4):433-440. DOI:10.1583/nsb649373

Floristic Composition and Structural Diversity of Shasha Forest Reserve in Ile-Ife, Southwestern Nigeria

Damilare Stephen AKINYEMI*, Samson Olajide OKE

*Obafemi Awolowo University Ife-Ife, Department of Botany, Nigeria; sakinyemi@oauife.edu.ng (*corresponding author); soke@oauife.edu.ng*

Abstract

The floristic composition and structural diversity were studied in two plots, 25 m x 25 m each, in three different sites of varying vegetation physiognomy: Taungya system, Regrowth forest and *Gmelina arborea* plantation (TS, RF and GA respectively) of Shasha forest reserve in Ile- Ife southwestern Nigeria. A total of 119 plant species belonging to 51 families and 100 genera were identified in the forest reserve. Woody species represented the most diverse life form. Plant species diversity was higher in the GA (H'=3.5) compared to the RF (H'=3.4) and TS (H'=2.9). Woody plant species density also differed significantly ($p < 0.05$) among the different physiognomy. Mean basal area and mean girth size were higher in RF compared to TS and GA. Species evenness was also quantitatively higher in the TS (E=0.12) compared to RF (E=0.09) and GA (E=0.08). Sorensen index of similarity were 12.12% (TS and RF), 19.71% (TS and GA) and 20.20% (RF and GA), which is an indication of the heterogeneity of the three different sites, as a result of different management systems of the sites. The knowledge about species composition in the forest reserve will go a long way in identifying important elements of plant diversity, protecting and preserving threatened plant species, monitoring and providing effective management of the forest reserve.

Keywords: density, flora, heterogeneity, physiognomy, structure, woody species

Introduction

Worldwide the degradation, fragmentation and conversion of forest ecosystems is progressing rapidly (Abramovitz, 1998). Globally, concerns are raised over the rapid loss of biodiversity in all its forms and at all levels. Habitat destruction is the main cause of the biodiversity loss. Habitats can either disappear completely or they may be degraded and/or fragmented, both causing serious impacts on species development, as well as lack of balance between ecosystems' processes (Raghubanshi and Tripathi, 2009). Presently, many forests persist as forest fragments and there is a growing interest in quantifying habitat characteristics such as forest structure, floristic composition and plant species richness in intact and degraded forest fragments and forest landscapes (Bierregaard *et al.,* 1992; Myers *et al.,* 2000). Knowledge of the floristic composition and structure of forest reserves is critical to understanding the greater dynamics of forest ecosystems and for identifying important elements of plant diversity, protecting threatened or economic species and monitoring the state of reserves, and it is with this data that management practices can be applied. The effective management of such ecosystems requires the understanding of their functioning, not only for their improvement, but also to arrest their further degradation (Oke and Isichei, 1997). Thus, the study of floristic composition and structure of tropical forest becomes more imperative in the face of ever increasing threat to the forest ecosystem.

Studies have shown that composition and structure of forests are influenced by a number of factors (Klinge *et al.*, 1995; Haugaasen *et al.,* 2003; Wittmann and Junk, 2003). One of these factors are disturbances which cause local species variation within forests based on their intensity, scale and frequency (Hill and Curran, 2003; Laidlaw *et al.*, 2007). Disturbance regimes dominated by natural and anthropogenic factors may alter composition, diversity and structure of the forest. There have been massive deforestation and forest degradation of forest reserves in Nigeria as a result of human activities and inadequate or lack of effective management of the reserves. This endangers the forest reserves and the services (socio-economic and ecological) they render.

The Shasha forest reserve was one of the forest reserves established in Nigeria, generally believed to be ecologically rich and biologically abundant with forest tree species. Shasha forest reserve was originally created in 1925 and has witnessed a rapid rate of destruction from excessive logging, conversion to plantations and farming (Field Trip Earth, 2008). Deforestation is widespread, leaving no section untouched (Salami *et al.*, 2007). For the conservation status of the Shasha forest reserve to be known and to allow effective management of the forest reserve there is a need for proper documentation of its plant species. Knowledge of the current floristic composition and structure of the Shasha forest reserve is thus invaluable. Floristic data obtained in this regard would be useful for the application of sound management practices in the forest. This study was therefore carried out to determine the composition, structure and assess the soil status of the forest reserve.

Materials and methods

Study area

The study was carried out in the Shasha forest reserve in Ife south Local government Area of Osun state, southwestern Nigeria (Fig. 1). The forest reserve lies between latitude 7°8' and 7°10' N and longitude 4°20' and 4°40' E. The study site has a land area of 310798 km^2/31079.85 ha (Salami *et al.,* 2007). The vegetation is part of the tropical rainforest ecosystem in Southwest Nigeria. The altitude of the forest is 122 m, with a mean annual rainfall of 1421 mm (Adekunle, 2006). It is an area with high relative humidity. There are two prominent seasons: dry and rainy season. The dry season lasts from November to March, while the rainy season is from April to October. The soil of the site is ferruginous tropical soil on crystalline acid rock, the topography gently undulating plain. The study was specifically carried out in three distinct study sites, namely a *Taungya* system (TS), cultivated site consisting of arable crops and woody species- a natural Regrowth forest (RF) and a mono-culture plantation of *Gmelina arborea* (GA), which were all selected from the forest reserve based on their physiognomy. The reserve has witnessed some form of disturbance such as logging and farming activities.

Data collection and analysis

The data was collected in March (dry season month). Two sample plots of 25 m x 25 m in each being identified vegetation physiognomy (sites TS, RF and GA). The sites were laid out using a measuring tape and demarcated with wooden pegs for the study. In all three sites, all woody plants that were greater than (or about) one meter in height were enumerated and identified to species level. The diameter at breast height (dbh) of all the identified woody species was measured. The identification followed the Flora of West Africa (Hutchinson and Dalziel, 1954-1972). The species whose identities were in doubt were collected and taken to IFE herbarium where proper identification was carried out. Floristic composition, densities, diversity and distribution of the plant species were determined using the following parameters: species richness, diversity indices, Shannon – Wiener index, Sorenson's index and species evenness (E).

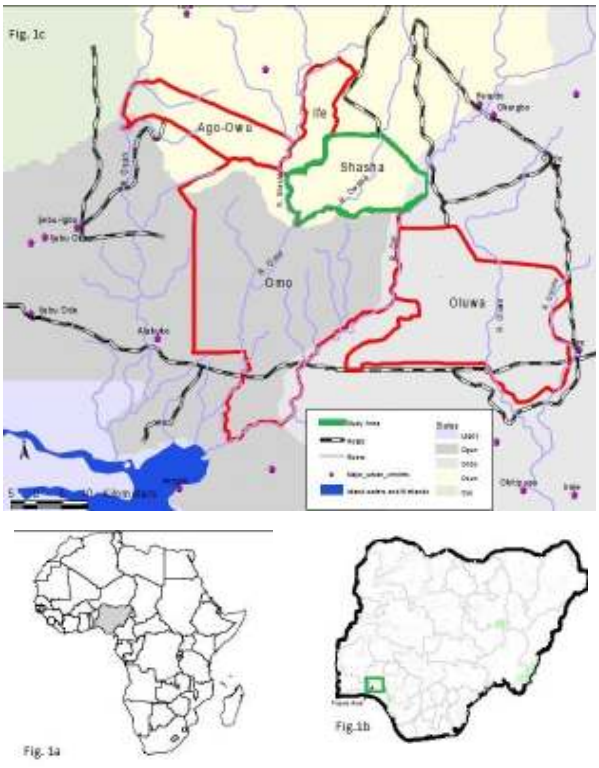

Fig. 1. Map of Africa (Fig. 1a), Nigeria (Fig. 1b) and Shasha forest reserve (Fig.1c). Adapted from Omo-Shasha-Oluwa Initiative in Protected areas

The diversity index H' was calculated using the method prescribed by Shannon and Wiener index (1963) as:

$$H = -\sum \frac{n_1}{N} \ln \frac{n}{N}$$

N – Importance value for each species
N – Total importance values

Species evenness was calculated using Shannon's equitability

$E_H = H'/H_{max}$,

where H' is Shannon – Wiener index of diversity, $H_{max} = \ln S$

S is the total number of species in the community.

The degree of similarity in species composition among sites was compared using Sorenson's index of similarity:

$$IS_s = \frac{2C}{A+B} \times 100$$

Where C is the species occurring in both communities under consideration.

A – Number of species occurring in plot A.

B – Number of species occurring in plot B.

The Sorenson index of similarity (IS_s) was calculated for each pair wise plot comparison (Blanc *et al*., 2000) and this was used to generate a dendrogram showing floristic similarities.

Results and discussion

Floristic composition

A total of 119 plant species were identified in the three selected sites in the Shasha forest reserve. These belonged to 51 families and 100 genera (Tab. 1). Euphorbiaceae, Moraceae, Papilonaceae and Rubiaceae were the overall diverse families (in terms of species richness) of the adult species, contributing 28.5% of all the species in the study (Fig. 2). Trees (39.5%) were the most dominant life forms, followed by herbs (22.7%), shrubs (21.8%) climbers (12.6%) and grasses (3.4%) (Fig. 3). Euphorbiaceae and Moraceae were the most diverse families in the TS, whereas Euphorbiaceae and Rubiaceae constituted the most diverse families in RF. The most important family in GA was Rubiaceae (Fig. 4). Generally, 26 woody species were encountered in TS, 41 woody species in RF and 42 woody species in GA. Woody species common to the three sites include *Deinbollia pinnata, Ficus exasperata, Milicia excelsa, Rauvolfia vomitora, Rinorea dentata* and *Terminalia superba.*

Tab. 1. List of plant species encountered in the three study sites in Shasha forest reserve

S/N	Woody species	Family	S/N	Woody species	Family
1	*Albizia zygia*	Mimosaceae	62	*Spondias mombin*	Anacardiaceae
2	*Alchornea cordifolia*	Euphorbiaceae	63	*Sterculia rhinopetala*	Sterculiaceae
3	*Alstonia boonei*	Apocynaceae	64	*Sterculia trigancantha*	Sterculiaceae
4	*Allanblackia floribunda*	Guttifereae	65	*Tectona grandis*	Verbanaceae
5	*Allophylus africanus*	Sapindaceae	66	*Terminalia ivorensis*	Combretaceae
6	*Amphimas pterocarpoides*	Ceasalpinaceae	67	*Terminalia superba*	Combretaceae
7	*Anglocalyx zenkeri*	Papilionaceae	68	*Trema guinensis*	Ulmaceae
8	*Anthocleista djalonensis*	Loganiaceae	69	*Trichilia prieureana*	Meliaceae
9	*Anthonotha macrophylla*	Caesalpinaceae	70	*Triplochiton scleroxylon*	Sterculiaceae
10	*Antiaris africana*	Moraceae	71	*Vernonia amygdalina*	Asteraceae
11	*Baphia nitida*	Papilionaceae	72	*Voacanga africana*	Apocynaceae
12	*Blighia unijugata*	Sapindaceae	73	*Xylopia* spp	Annonaceae
13	*Bridelia ferruginea*	Euphorbiaceae		FORBS	
14	*Bridelia micrantha*	Euphorbiaceae	1	*Asytasia gangetica*	Acanthaceae
15	*Bulchozia coriacea*	Capparidaceae	2	*Carica papaya*	Cariaceae
16	*Ceiba pentandra*	Bombacaceae	3	*Chromolaena odorata*	Asteraceae
17	*Celtis mildbraedi*	Ulmaceae	4	*Corchorus aestuans*	Tiliaceae
18	*Celtis zenkeri*	Ulmaceae	5	*Costus afer*	Custaceae
19	*Chassalia kolly*	Rubiaceae	6	*Culcasia scandens*	Araceae
20	*Clausena anisata*	Rutaceae	7	*Culcasia saxatilis*	Araceae
21	*Cleistopholis patens*	Annonaceae	8	*Cyanastrum cordifolium*	Tecophiliaceae
22	*Cnestis ferruginea*	Connaraceae	9	*Cyathula postrata*	Amaranthaceae
23	*Cola gigantea*	Sterculiaceae	10	*Cyathula* spp	Amaranthaceae
24	*Deinbollia pinnata*	Sapindaceae	11	*Euphorbia heterophylla*	Euphorbiaceae
25	*Dictyandra* spp	Rubiaceae	12	*Euphorbia hirta*	Euphorbiaceae
26	*Diospyros mobuttensis*	Ebenaceae	13	*Geophylla obvellata*	Rubiaceae
27	*Entandrophragma angolense*	Melanaceae	14	*Ipomea hederifolia*	Convolvulaceae
28	*Fagara macrophylla*	Rutaceae	15	*Ipomea* spp	Convolvulaceae
29	*Ficus exasperata*	Moraceae	16	*Musa nana*	Musaceae
30	*Ficus mucuso*	Moraceae	17	*Musa sapientum*	Musaceae
31	*Funtumia elastica*	Apocynaceae	18	*Palisota ambigua*	Commelinaceae
32	*Glyphea brevis*	Tiliaceae	19	*Palisota manii*	Commelinaceae
33	*Gmelina arborea*	Verbanaceae	20	*Pauridantha hirtella*	Rubiaceae
34	*Homalium alymeri*	Simaroubaceae	21	*Phyllanthus amarus*	Euphorbiaceae
35	*Icacina tricantha*	Icacinaceae	22	*Piper umbellatum*	Piperaceae
36	*Jatropha gossypifolia*	Euphorbiaceae	23	*Psychotria dorothy*	Rubiaceae
37	*Keetia vulgare*	Rubiaceae	24	*Sida corymbosa*	Malvaceae
38	*Lecaniodiscus cupanoides*	Sapindaceae	25	*Sida acuta*	Malvaceae
39	*Lonchocarpus cyanescens*	Papilionaceae	26	*Synedrela nodiflora*	Asteraceae
40	*Macaranga barterii*	Euphorbiaceae	27	*Xanthosoma mafaffa*	Araceae
41	*Macaranga* spp	Euphorbiaceae		GRASSES	
42	*Magaritaria discodeus*	Euphorbiaceae	1	*Andropogon gayanus*	Poaceae
43	*Massularia macrophylla*	Rubiaceae	2	*Eragrostis* spp	Poaceae
44	*Microdesmis puberula*	Pandaceae	3	*Oplismenus burmanii*	Poaceae
45	*Milicia excelsa*	Moraceae	4	*Setaria barbata*	Poaceae
46	*Monodora tennuifolia*	Annonaceae		CLIMBERS	
47	*Morinda lucida*	Rubiaceae	1	*Acacia ataxacantha*	Mimosaceae
48	*Musanga cercropoides*	Moraceae	2	*Calopogonium mucunoides*	Papilionaceae
49	*Myrianthus arboreus*	Moraceae	3	*Cissus* spp	Vitaceae
50	*Oxyanthus* spp	Rubiaceae	4	*Combretum* spp	Combretaceae
51	*Pycnanthus angolensis*	Myristicaceae	5	*Culcasia scandens*(creeper)	Araceae
52	*Rauvolfia vomitoria*	Apocynaceae	6	*Dioscorea bulbifera*	Dioscoraceae
53	*Rinorea dentata*	Violaceae	7	*Dioscreophyllum cumminsi*	Menispermaceae
54	*Rinorea welwiltchii*	Violaceae	8	*Dioscorea dumentorum*	Dioscoraceae
55	*Rothmania whitfiedii*	Rubiaceae	9	*Dioscorea* spp	Dioscoraceae
56	*Sabicea africana*	Rubiaceae	10	*Momordica charantia*	Cucurbitaceae
57	*Salacia pallescens*	Celastraceae	11	*Mondia whitei*	Periplocaceae
58	*Senna hirsuta*	Ceasalpinaceae	12	*Passiflora foetida* (creeper)	Passifloraceae
59	*Senna occidentalis*	Caesalpinaceae	13	*Piper guineense*	Piperaceae
60	*Solanum verbascifolium*	Solanaceae	14	*Sabicea calycina*	Rubiaceae
61	*Sphenonocentrum jollyanum*	Menispermaceae	15	*Vigna gracillis*	Papilionaceae

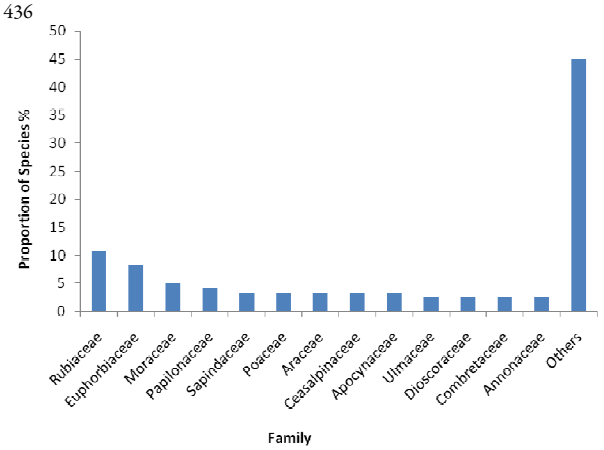

Fig. 2. Family dominance of plant species in the three study sites in Shasha Forest reserve

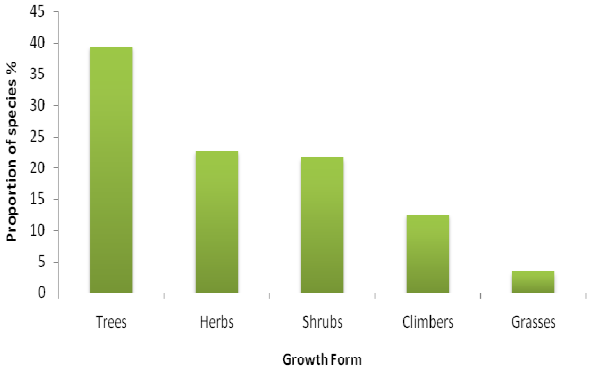

Fig. 3. Composition of plant species in the various life forms identified in the study sites in Shasha forest reserve

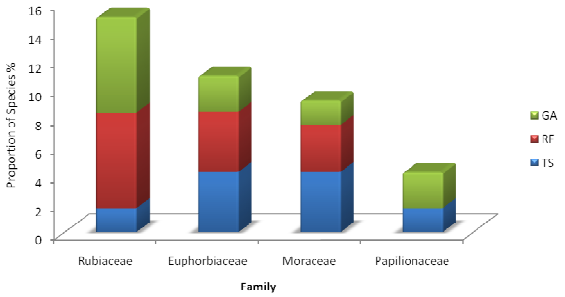

Fig. 4. Dominance of the top five families based on species richness in the respective forest sites

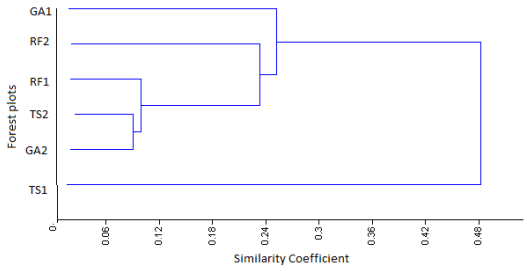

Fig. 5. Dendrogram constructed from similarity Sorenson Index matrix based on species composition in the various plots within the site

More herbaceous species were recorded in TS (14) than in the GA (12) and RF (7) sites, whereas climber species richness was greater in the GA (8) in relation to the other vegetation physiognomy TS (7) and RF (4). The herbaceous species common to the three sites is *Chromolaena odorata*. Some of the climber species observed in the three sites includes *Acacia atazacantha, Cissus spp* and *Combretum spp*. Grass species were absent in RF, but present in both TS and GS and these include *Andropogon gayanus, Eragrostis spp, Oplismenus burmanii* and *Setaria barbata*. Similarity levels were depicted in a dendrogram (Fig. 5). Some plots from different forest types were floristically different. TS1 was floristically different from other plots. TS2 and GA2 were more similar to each other, more than GA1 and RF2, while RF1 was more similar to TS2 and GA2, more than RF2 and GA.

Structure

There were a total of 2628/ha individuals of woody species (excluding other life forms) identified in the three different physiognomies. Woody species density was highest in GA (1192/ha) followed by RF (1092/ha) and least in TS (344/ha) (Tab. 2). Shannon-Wiener index was higher in the GA (H′=3.5) compared to the RF (H′=3.4) and TS (H′=2.9) (Tab. 3). Density of woody species differed significantly between the forest types ($p < 0.05$). In all, *Gmelina arborea* and *Terminalia. superba* were the most abundant species accounting for an average 26% and 10% respectively of stems in all the three sites. In terms of basal area, *Alchornea cordifolia* had the highest basal area in TS, contributing with 33% of the total, in RF *Alstonia boonei* had the highest values contributing 65% of the total, while in GA *Gmelina arborea* had the highest basal area contributing 35% of the total.

On physiognomy basis, *Celtis zenkeri*, *Ficus exasperata*, *Gmelina arborea* and *Spondias mombin* were the dominant species in the TS (Tab. 2). In the case of RF, *Ficus exasperata*, *Rauvolfia vomitora, Senna hirsuta, Terminalia superba* and *Trichilia prieureana* were the dominant species. In GA, *Blighia unijugata, Chassalia kolly, Funtumia elastica, Gmelina arborea* and *Rauvolfia vomitora* were the species that dominated the woody flora.

In terms of size, majority of the trees were of the smaller diameter class (0-20 cm) (Fig. 4). The number of individual trees in the categories decreased with increasing size of the trees. Larger diameter trees (< 100 cm) were very low in TS and GA, but not found in RF. Mean basal area recorded in the RF (5.8±2.1 m^2/ha) was higher compared with that of GA (2.5±0.2 m^2/ha) and TS (0.1±0.05 m^2/ha). The result of species evenness showed that evenness was quantitatively higher in TS (E =0.1) compared with RF (E =0.07) and GA (E = 0.08) (Tab. 3).

Tab. 2. Mean density of woody species (per hectare) in the three sites of the Shasha forest reserve

S/N	Species	Family	TS	RF	GA
1	*Albizia zygia*	Mimosaceae		24	24
2	*Alchornea cordifolia*	Euphorbiaceae	8		
3	*Alstonia boonei*	Apocynaceae		16	16
4	*Allanblackia floribunda*	Guttifereae	16		
5	*Allophylus africanus*	Sapindaceae		32	
6	*Amphimas pterocarpoides*	Ceasalpinaceae	8		16
7	*Anglocalyx zenkeri*	Papilonaceae			16
8	*Anthocleista djalonensis*	Loganiaceae			8
9	*Anthonotha macrophylla*	Caesalpinaceae		32	
10	*Antiaris africana*	Moraceae	8		16
11	*Baphia nitida*	Papilonaceae	16		
12	*Blighia unijugata*	Sapindaceae			40±8
13	*Bridelia ferruginea*	Euphorbiaceae		8	8
14	*Bridelia micrantha*	Euphorbiaceae		24	
15	*Bulchozia coriacea*	Capparidaceae		32	24
16	*Ceiba pentandra*	Bombacaceae			32
17	*Celtis mildbraedi*	Ulmaceae		8	16
18	*Celtis zenkeri*	Ulmaceae	24±8	24	
19	*Chassalia kolly*	Rubiaceae	8	8	48
20	*Clausena anisata*	Rutaceae			16
21	*Cleistopholis patens*	Annonaceae			32
22	*Cnestis ferruginea*	Connaraceae	8		8
23	*Cola gigantea*	Sterculiaceae		16	24
24	*Deinbollia pinnata*	Sapindaceae	16	24	16
25	*Dictyandra spp*	Rubiaceae		24	
26	*Diospyros mobuttensis*	Ebenaceae	8		
27	*Entandrophragma angolense*	Melanaceae	8		
28	*Fagara macrophylla*	Rutaceae		16	
29	*Ficus exasperata*	Moraceae	32±16	40±8	24±8
30	*Ficus mucuso*	Moraceae	8		
31	*Funtumia elastica*	Apocynaceae		80	32±16
32	*Glyphea brevis*	Tiliaceae	8		24
33	*Gmelina arborea*	Verbanaceae	32		320±8
34	*Homalium alymeri*	Simaroubaceae		8	
35	*Icacina tricantha*	Icacinaceae			8
36	*Jatropha gossypifolia*	Euphorbiaceae	8		
37	*Keetia vulgare*	Rubiaceae		8	24
38	*Lecaniodiscus cupanoides*	Sapindaceae		8	
39	*Lonchocarpus cyanescens*	Papillonaceae			32±16
40	*Macaranga barterii*	Euphorbiaceae		40±8	16
41	*Macaranga spp*	Euphorbiaceae		8	
42	*Magaritaria discodeus*	Euphorbiaceae		16	16
43	*Massularia macrophylla*	Rubiaceae			24
44	*Microdesmis pubeurla*	Pandaceae			24
45	*Milicia excelsa*	Moraceae	16	40±8	8
46	*Monodora tennuifolia*	Annonaceae			16
47	*Morinda lucida*	Rubiaceae		8	
48	*Musanga cercropoides*	Moraceae		8	
49	*Myrianthus arboreus*	Moraceae	8	8	
50	*Oxyanthus spp*	Rubiaceae		24±8	
51	*Pycnanthus angolensis*	Myristicaceae		32	
52	*Rauvolfia vomitora*	Apocynaceae	16	56±8	48
53	*Rinorea dentata*	Violaceae	8	32±16	24
54	*Rinorea welwiltchii*	Violaceae		32	
55	*Rothmania whitfiedii*	Rubiaceae		24	
56	*Sabicea africana*	Rubiaceae			24
57	*Salacia pallescens*	Celastraceae		52	24±8
58	*Senna hirsuta*	Ceasalpinaceae		64	
59	*Senna occidentalis*	Caesalpinaceae	16		
60	*Solanum verbascifolium*	Solanaceae	16		
61	*Sphenonocentrum jollyanum*	Menispermaceae		16	16
62	*Spondias mombin*	Anacardiaceae	24		
63	*Sterculia rhinopetala*	Sterculiaceae		16	24
64	*Sterculia trigancantha*	Sterculiaceae			24±8
65	*Tectona grandis*	Verbanaceae			16
66	*Terminalia ivorensis*	Combretaceae			16
67	*Terminalia superba*	Combretaceae	8	104±40	24
68	*Trema guinensis*	Ulmaceae			8
69	*Trichilia prieureana*	Meliaceae		56	
70	*Triplochiton scleroxylon*	Sterculiaceae	8		24
71	*Vernonia amygdalina*	Asteraceae	8		
72	*Voacanga africana*	Apocynaceae		16	16
73	*Xylopia spp*	Annonaceae		8	
	TOTAL		344	1092	

TS – *Taungya* system
RF – Regrowth forest
GA – *Gmelina arborea* plantation

Tab. 3. Summary characteristics of floristic composition and structure of the Shasha forest reserve

S/N	Characteristics	TS	RF	GA
1	Number of Families	32	33	41
2	Number of woody species	26	41	42
3	Number of trees	19	30	29
4	Number of shrubs	7	11	13
5	Number of herbs	14	7	12
6	Number of climbers	7	4	8
7	Density of trees ha^{-1}	272±24	752±40	896±48
8	Density of woody species ha^{-1}	344±24	1092±96	1192±72
9	Basal area m^2 ha^{-1}	0.06791±0.0491	5.7931±2.1081	2.4872±0.1848
10	Mean girth size (cm)	25±4.0	35 ±5.0	32±6.0
11	Shannon wiener H′	2.9	3.4	3.5
12	Species evenness	0.12	0.09	0.08

TS – *Taungya* system
RF – Regrowth forest
GA – *Gmelina arborea* plantation

Discussion

Studies on floristic composition and structure in forests are instrumental in the sustainability of forest since they play a major role in the conservation of plant species and the management of forest ecosystems as a whole (Mohandass *et al*., 2009; Tilman, 1988; Ssegawa and Nkuutu, 2006). The results of this study show that the floristic composition of Shasha forest reserve (119 species/ha) were higher than many other tropical forests. For instance, Addo- Fordjour *et al*. (2009) recorded a much lower species richness (48 species/ha) in a moist semi-deciduous forest in Ghana, Mohandas and Priya (2009) recorded 86 species in a tropical montane evergreen forest in India. On the other hand, Gustav *et al*. (2001) recorded a much higher species richness of 208 species in the tropical wet lowland of Amazon forest, Parthasarathy (2001) recorded 125 species in a tropical wet evergreen forest in Sengaltheri of the Western Ghats in India. The species composition of the forest reserve might have been affected of the various human disturbances, such as slash and burn agriculture, felling of mature trees for timber, collection of fuel wood and other non-timber forest products, which has led to species attrition, thus leaving behind a less balanced structure.

The density of the woody and herbaceous species varied considerably in the different sites under consideration. There were more herbaceous species in TS than all other sites; this might be an indicator of the type of anthropogenic disturbances (slash and burn agriculture) in TS, facts which might favour the growth of herbaceous species. Mishra *et al*. (2008) observed greater diversity of herbs in disturbed forest than in undisturbed ones. There were more woody species in GA than RF; this observation could be as a result of the presence of woody species and tree saplings in the under storey of the plantation. Studies from around the world have shown that single- species plantations are at the stand scale, often less diverse than natural or semi-natural forests with respect to plants (Aubin *et al*., 2008). Nevertheless, it has been shown that forest plantations can contribute to restoring some of the floristic diversity on abandoned agriculture land (Newmaster *et al*., 2006; Aubin *et al*., 2008) and some plantations may have a surprisingly diverse understory (Allen *et al*., 1995; Keenan *et al*., 1997; Oberhauser, 1997) as observed in this study. This is in agreement with Tripathi and Bajrang (2009) who observed that species richness at ground layer was higher in forest plantation than in natural re-growth forest. It has been observed that pure stands (i.e. deciduous or coniferous) could support, in some cases, a richer understory vegetation than mixed- species stands and that species richness was generally greater in deciduous stands than in coniferous stands (Barbier *et al*., 2008). Furthermore, some conifer plantations may have greater plant species richness than broad- leaved secondary forests (Nagaike, 2002).

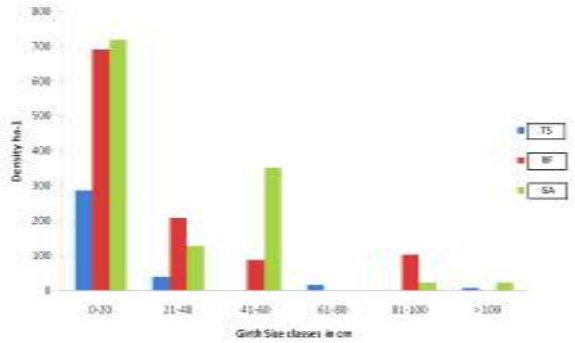

Fig. 5. Girth size distribution of trees

Grass species were present in both TS and GA, but not in RF. This observation could be as a result of open canopy in the plantations versus closed canopy in Regrowth forest. The observations in this study regarding the re-growth forest is in agreement with the results of White (1985) who noted that in a forest the ground layer is often sparse or absent, as grasses are absent or if present are localized or inconspicuous. The low similarity index observed among the three study sites is an indication of the heterogeneity in species composition in the standing vegetation of the three sites. Species similarity indices were 12.12 % (TS and RF), 19.71% (TS and GA) and 20.20% (RF and GA). Similarity index showed that similarity is highest between Regrowth forest and *Gmelina arborea* plantation and lowest between *Taungya* system and Regrowth forest. This may be due to the different system of management in the three sites. TS is a vegetation of tree species and arable crop species, while RF is a natural re-growth forest and GA is a mono - culture plantation of *Gmelina arborea*. Shannon-Wiener diversity index (H′) followed the order *Gmelina arborea* > Regrowth forest >

Taungya system. The H′ of 3.34 – 3.66 for some rainforest sites in Nigeria (Adekunle, 2006) is similar to that of RF and GA, but higher than that of TS. The high species diversity of RF (3.47) and GA (3.49) is a reflection of the presence of high number of species found in these sites. Our results revealed that species evenness was low in all the three study sites. This might be due to the different disturbance in form of human activities such as slash and burn agriculture and gathering of wood for fuel in TS, logging in RF and GA where certain species are preferred than others. In rainforests from India, tree species richness decreased with the increase in intensity of forest disturbance (Nath *et al*., 2005).

Tree size class distribution can be used as indicators of changes in population structure and species composition (Newbery and Gartlan, 1996). The distribution of the girth size class has shown that TS, RF and GA were characterized by small and young tree species whose girths were mostly 0-20 cm, 21-40 cm and 41-60 cm. Most species in the study plots followed reverse J-shaped distribution with greater number of individuals in small size classes. Such a trend has also been reported in the forests of Great Andaman groups (Padalia *et al.,* 2004). This might be as a result of selective felling and logging of higher girth size classes' trees, hence most of the tree species are secondary forest re-growth species. It also indicates that the forest sites are disturbed and they are in their early successional stages. Moreover, the basal area of the woody species (8×10^{-6}-4.5524 m^2) further shows that the sites were characterized by recovery from disturbance. The general small basal area of most species, respectively small girth size, is an evidence of disturbance and degradation in the three study sites of Shasha forest reserve.

Conclusion

The study revealed that Shasha forest reserve has a reasonably good tree and shrub species composition and richness in the face of logging and slash and burn agriculture in the forest. Anthropogenic disturbances have affected the floristic composition of the forest reserve to an extent. Logging affected the structural composition of the forest reserve through the removal of large and tall trees. Thus, there is need to control human activities in the forest reserve so as to protect the plant species for effective management and utilization.

References

Abramovitz J (1998). Putting a value on Natures free services, Nature's Hidden Economy Worldwatch Institute, 11(1).

Addo-Fordjour P, Obeng S, Anning AK Addo, MG (2009). Floristic composition, structure and natural regeneration in a moist deciduous forest following anthropogenic disturbances and plant invasion. International journal of biodiversity and conservation 1(2):21-27.

Adekunle VAJ (2006). Conservation of tree species diversity in tropical rainforest ecosystem of South-west Nigeria. Journal of Tropical Forest Science 18(2):91-101.

Allen RB, Platt KH, Coker REJ (1995). Understorey species composition patterns in a *Pinus radiata* plantation on the central North Island Volcanic Plateau, New Zealand. New Zealand. Journal of Forestry Science 25(3):301-315.

Aubin I, Messier C, Bouchard A (2008). Can plantations develop understory biological and physical attributes of naturally regenerated forests. Journal of Biodiversity Conservation 141:2461-2476.

Barbier S, Gosselin, FS, Balandier P (2008). Influence of tree species on understory vegetation, diversity and mechanism involved a critical review for temperate and boreal forest. Forest ecology and management 254:1-15.

Bierregaard Jr RO, Lovejoy TE, Kapos V, dos Santos AA, Hutchings RW (1992). The biological dynamics of tropical rain-forest fragments. Bioscience 42:859-866.

Field Trip Earth (2008). Surveying Wildlife in Nigerian Forest.

Gustav N, Jens D, Vanclay JK (2001). Structure and floristic composition of flood plain forests in the Peruvian Amazon II. The understory of Restinga forests. Journal of Forest Ecology and Management doi: 10.1016/s0378-1127(00)00681-2.

Haugaasen T, Barlow J, Peres CA (2003). Surface wildfires in central Amazonia: Short-term impact on forest structure and carbon loss. For Ecol Manage 179:321-333

Hill JL, Curran PJ (2003). Area, shape and isolation of tropical forest fragments: effects on tree species diversity and implications for conservation forest area. J Biogeogr 30:1391-1403.

Hutchinson J, Dalziel JM (1954). Flora of West Tropical Africa 1(1):34-54. Keenan R, Lamb D, Woldring O, Irvine TJR (1997). Restoration of plant biodiversitybeneath tropical tree plantations in Northern Australia. Journal of Forest Ecology and Management 99:117-131.

Klinge H, Adis J, Worbes M (1995). The vegetation of a seasonal várzea in the lower Solimões river, Brazilian Amazon. Acta Amazonica 25:201-220.

Laidlaw M, Kitching R, Goodall K, Small A, Stork N (2007). Temporal and spatial variation in an Australian tropical rainforest. Austral Ecol 32:10–20.

Mishra RK, Upadhyay VP, Mohanty RC (2008). Vegetation ecology of the Similipal Biosphere Reserve, Orissa, India. Appl Ecol Env Res 6:89-99.

Mohandass D, Priya Davidar (2009). Floristic structure and diversity of a tropical and montane and evergreen forest (shola) Nilgiri mountains southern India. Tropical Ecology 50(2):219-229.

Myers N, Mittermeier RA, Mittermeier CG, da Fonseca GA, Kent J (2000). Biodiversity hotspots for conservation priorities. Nature 403:853-858.

Nagaike T (2002). Differences in plant species diversity between conifer (*Larix Kaempferi*) plantations and broad leaved (*Quercus crispula*) secondary forests in Central Japan. Forest Ecology and Management 168:111-123.

Nath PC, Arunachalam A, Khan ML, Arunachalam K, Barbhuiya AR (2005). Vegetation analysis and tree population structure of tropical wet evergreen forests in and around Namdapha National Park, Northeast India.

Biodiversity and Conservation 14:2109-2136.

Newbery D, Gartlan JS (1996). A structural analysis of rain forests at Korup and Douala-Edea, Cameroon. Proceedings of Royal Society Edinburgh 104B:107-224.

Newmaster SG, Bell FW, Roosenboom CR, Cole HA, Towill WD (2006). Restoration of floral diversity through plantations on abandoned agricultural land. Can For Res 36:1218-1235.

Oberhauser U (1997). Secondary forest regeneration beneath pine (*Pinus kesiya*) plantations in the Northern Thai highlands: a chronosequence study. Journal Forest Ecology and Management 256:114-120.

Oke SO, Isichei AO (1997). Floristic and structure of the fallow vegetation in the Ile–Ife Area of South Western. Nigeria Journal of Botany Vol 10:30-50.

Padalia H, Chauhan N, Porwal MC, Roy PS (2004). Phytosociological observations on tree species diversity of Andaman Islands, India. Current Science 87:799-806.

Parthasarathy N (2001). Changes in forest composition and structure in three sites of tropical evergreen forest around Sengaltheri, Western Ghats Curr Sci 80:389-393.

Raghubanshi AS, Tripathi Anshuman (2009). Effect of disturbance, habitat fragmentation and alien invasive plants on floral diversity in dry tropical forests of Vindhyan highland: a review. Tropical Ecology 50(1):57-69.

Salami AT, Balogun BO, Oloyede- Kosoko SOA (2007). Geospatial data application in the assessment of population impact on a tropical lowland rainforest of Southwest Nigeria. Geo Observateur 16:31-37.

Ssegawa P, Nkuutu DN (2006). Diversity of Vascular plants on Ssese Islands in Lake Victoria Central Uganda. Afri J Ecol 44:22-29.

Tilman D (1988). Plant strategies and the dynamics and structure of plant communities. Princeton University Press. Princeton, New Jersey.

Tripathi KP, Bajrang Singh (2009). Species diversity and vegetation structure across various strata in natural and plantation forests in Katerniaghat Wildlife Sanctuary, North India. Tropical Ecology 50(1):191-200.

White PS, Pickett STA (1985). Natural disturbance and patch dynamics: an introduction, 3-13p. In Picket STA and White PS, (Eds.). The ecology of natural disturbance and patch dynamics. Academic Press, Orlando, Florida.

Wittmann F, Junk WJ (2003). Sapling communities in Amazonian whitewater forests. J Biogeogr 30:1533-1544.