Pak. J. Bot., 49(4): 1359-1371, 2017.

FLORISTIC COMPOSITION AND STRUCTURAL DIVERSITY OF IBODI MONKEY FOREST, IBODI, SOUTHWESTERN NIGERIA

KOMOLAFE EMMANUEL TIMILEHIN[1*], OKE SAMSON OLAJIDE[1], ODELEYE ADEMAYOWA[1] AND OLATUNJI OLUSANYA[2]

[1]*Obafemi Awolowo University Ife-Ife, Department of Botany, Nigeria*
[2]*University of Chinese Academy of Sciences, Center for Ecological Studies, Chengdu, China;*
[*]*Corresponding author e-mail: komolafeet@yahoo.com; Tel. +2347062319435*

Abstract

This study investigated the floristic composition and vegetation structure among different physiognomies in Ibodi Monkey forest, Ibodi, Osun State, Southwestern Nigeria. It also assessed the effects of anthropogenic activities on the forest with a view to providing detailed information on the floristic composition structure and diversity of species of the standing vegetation of the forest.

Seven plots of 25 m x 25 m dimension were established within three physiognomies in the forest; Regrowth forest (RF), Tree fallow (TF) and Cocoa plantation. (CP) A total of 209 individual woody species were encountered in the seven plots. The highest density of woody species was found in the RF (1483), followed by CP (1072) and TF (792). The basal area in CP was the highest (21.44) while RF had the lowest (2.5567) with TF having an intermediate value (6.283). Crown area also indicated that RF had the highest cover while TF had the lowest crown area. Shannon-Wiener, Evenness, Richness indices followed the order RF > TF > CP. Similarity index was highest between CP and TF and lowest between RF and CP. The study concluded that Ibodi monkey forest has been influenced by human disturbance in form of selective logging of economic species, agriculture (shifting cultivation) and seasonal bush burning.

Key words: Tree fallow, Physiognomy, Regrowth, Anthropogenic activities, Selective logging, Bush burning, Shifting cultivation.

Introduction

The study of floristics and structure of tropical forest has become more vitally important in the face of the ever increasing risk to the forest ecosystem. Studies have proven that floristic composition and structure of forests are influenced by a number of factors (Klinge *et al.*, 1995; Haugaasen *et al.,* 2003; Wittmann & Junk, 2003). Striking among these factors are disturbances which are thought to be key aspects, and the cause of local species variation within forests based on their intensity, scale and frequency (Hill & Curran, 2003; Laidlaw *et al.,* 2007). This may include logging, mining, slash and burn agriculture or grazing depending on the peculiarity of each location. Woody species, i.e., trees and shrubs, are unprotected and threatened in many different parts of the world (Augusseau *et al.,* 2006). Williams (1998) estimated that 10% of all tree species are under threat of extinction. Biodiversity Conservation has emerged a major issue of both scientific and political concern majorly because of an increase in extinction rates caused by anthropogenic activities (Ehrlich & Wilson, 1991). Loss of biodiversity has been recognized as one of the main dangers to the world's forests, and there is a general machinery being adopted and put in place for developing new global, regional and national programs for the conservation and management of forest biodiversity (Köhl *et al.,* 1998). Köhl and his co-workers consider biodiversity as an irreplaceable value in itself since the diversity of the biosphere creates a genetic bank, pivotal for running of ecosystems and to the restoration of ecosystems after perturbation. Hence, aside the huge economic, ethical and aesthetic benefits, biodiversity is essential for ecosystem operation and stability (Tilman, 2000). In Nigeria, forest biodiversity is lost as a result of rapid wave of deforestation, fragmentation, and degradation of all forest types and this trend is continued at an alarming rate. According to Nigerian Environmental Study/Action Team NEST, (1991) more than 30,000 ha of forest and natural vegetation are being lost annually in Nigeria. As a result, several individuals, national and international organizations have shown great concern in biological diversity conservation (Adekunle, 2005). Biodiversity assessment has been acknowledged by international policy processes such as the Convention on Biological Diversity, as an inexorable tool guiding biodiversity conservation (Margules & Pressey, 2000; Phillips *et al.,* 2003; Royal Society, 2003). According to Slik *et al.* (2003), floristic analyses and inventory are very useful for identifying spatial orientation and patterns in plant species diversity and composition. Quantitative floristic inventories have been used in over the years to characterize forest vegetation throughout the tropics, though many of the investigators were interested in documenting the structure and floristic composition of forest communities (Smith & Killeen, 1995). Tropical forest contains a great deal of resources upon which most African countries depend. It ecologically functions as hydrological cycler, nutrient cycler, soil stabilizer and plays a great role in carbon sequestration which aid ecosystem balance that makes life bearable on earth. Furthermore, forests products are harvested for food, raw materials for wood industries, medicines for the local communities, fodder, house construction and handicrafts (Emerton, 2003). In addition to its ecological importance, a diversity of forest wildlife provides citizens with a wealth of economic and social benefits. Although it is difficult to put a price or figure on its educational, aesthetic, cultural and spiritual benefits, these intangibles and seemly irrelevants are becoming increasingly important factors in decisions regarding forest management. Conserving the natural diversity of forest species preserves and protect the potential to discover and develop new products for medicine, biotechnology, forestry and agriculture (Natural Resources, Canada, 1994).

Despite the great significance of forest and its resources, the forests are being continuously cut down in order to build facilities for industrial complex or/ and to provide products for industrial development (Sanderson *et al*., 2004) and this has continued at a startle rate (Pimm *et al.*, 1995; Prance *et al.*, 2000). Nigeria, at the rate of 14.3%, has one of the towering deforestation rates in the world (Butler, 2005; FAO, 2005). It has been estimated that about 10 million hectares of rainforests are being degraded each year, with selective exploitation, felling damage done to residual forests and left behind over exploitation of non-timber forest products being the chief causes (FAO, 2005). Forest degradation is most of the time accompanied by species extinction, reduction in biodiversity and decrease in primary productivity of the forest (Wilcox, 1995).

As conscious efforts are being put in place towards preventing total destruction of the tropical rainforest and ensuring the conservation of its rich biodiversity, adequate and appropriate quantitative and qualitative ecological data on floristic composition and its structure that produce multiple products are imperative. Such information is required in fashioning out realistic, appropriate and effective conservation strategies. This study, therefore described the floristic composition and vegetative structure of Ibodi Monkey forest south western Nigeria.

Materials and Methods

Study area: The study was carried out in Ibodi Monkey Forest in Osun State Southwestern Nigeria (Fig. 1). Ibodi Monkey forest is located on latitude 7^o 35' N and longitude 40 40' E. Ibodi has a tropical climate with prominent rainy and dry seasons. The rainy season generally occurs between March and October while the dry season occurs between November and February yearly. Ibodi has an average annual rainfall of 1157 $mmyr^{-1}$ and average annual temperature of 26.1°C (Climate-Data.org (http://climate-data.org/).

Selection of plots: Three major physiognomies were identified during the reconnaissance survey; regrowth forest (RF), Tree fallow (TF) and Cocoa plantation (CP). The tree fallow and cocoa plantation represent the fringes of the forest reserve. A total of seven 25m x 25m plots were randomly chosen within the physiognomies; three plots (A1, A2 and A3) in the natural regrowth forest and two plots each in the Cocoa plantation (B1 and B2) and Tree fallow (C1 and C2). Each plot was established using a measuring tape and demarcated with wooden pegs.

The geographical location of each plots.

Physiognomies		Plot location
	A1	07^0 35. 249'N, 004^0 40.370'E
RF	A2	07^0 35.243'N, 004^0 40.375'E
	A3	07^0 35.28'N, 004^0 40.35'E
CP	B1	07˚35.375'N, 004˚40.687'E
	B2	07˚3.35.380'N, 004˚40.675'E
TR	C1	07˚35.293'N,004˚40.564'E
	C2	07˚35.281'N, 004˚40.584'E

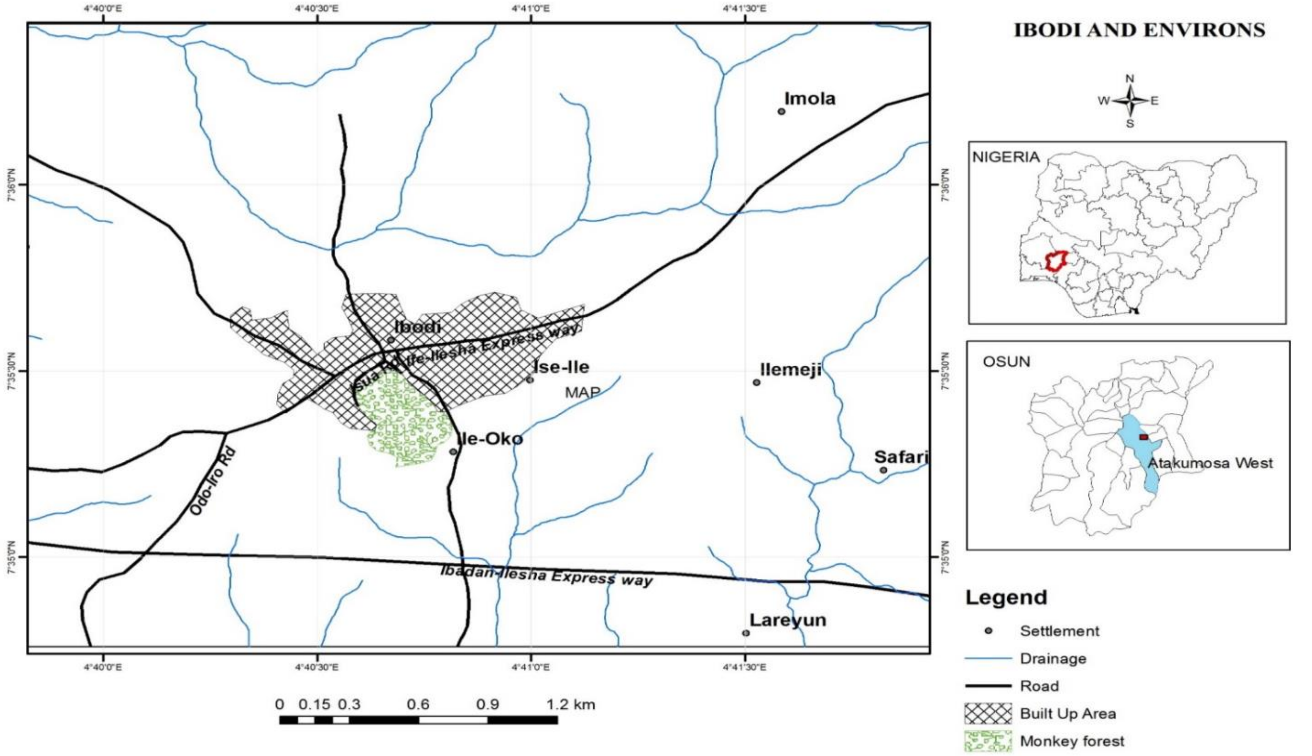

Fig. 1. Map of Ibodi Monkey Forest Ibodi, Atakumosa West Local Government Area of Osun State, Nigeria.

In each plot, all woody plants ≥ 2 meters in height were identified, enumerated and their girths at breast height (GBH; 1.3m) were measured. Trees were assigned numbers to avoid double enumeration. This number, once given to a particular species in any plot did not change, such that a particular plant species retained the same number in all the plots where it occurred within the same physiognomy. 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 (R), Shannon –Wiener index (H′), Sorenson's index of Similarity (SI) and species evenness (*J*).

The diversity index H′ was calculated using the Shannon & Wiener index (1963).

$$H' = -\sum_{i=1}^{s}(pi.\ln pi)$$

where
$P_i = n_i/N$ (proportion)
n_i = Number of individuals of i^{th} species.
N = Total number of individuals

The evenness of distribution was calculated using Pielou's evenness index:

$$J = \frac{H^1}{\ln(S)}$$

where
J = Equitability (range 0-1)
H^1 = (Shannon- Weiner function)

where S is the total number of species in the plot

Sorenson's index of similarity (SI)

$$SI = \frac{2J}{A + B}$$

where
J = Species occurring in both communities
A = number of species occurring in community X
B = number of species occurring in community Y

while X and Y are two different communities under consideration.

Plant species richness (R)

$$R = (S-1)/\log N$$

where N is the number of individual plants in the population and S is the number of all species.

Basal area

$$\text{Basal area } (m^2) = C^2/4\pi$$

where C is the girth size (circumference) in meters. The basal area for each species was determined by adding the basal area of individuals of the species; the plot basal area was calculated by adding basal areas ($m^2.ha^{-1}$) of all the species in each plot while the forest basal area was calculated as mean woody species basal area of all the sample plots.

Results

Floristic composition: A total of 163 plant species were identified in the three selected physiognomies in Ibodi Monkey forest. These belonged to 57 families and 129 genera (Table 1). Rubiaceae (15 Species), Apocynaceae and Fabaceae (11 Species each), Moraceae and Sterculiaceae (9 Species each), Asteraceae and Sapindaceae (6 Species each), Acanthaceae, Combretaceae, Euphorbiaceae and Verbenaceae (5 Species each) were the overall diverse families (in terms of species richness) contributing 53.4% of all the species in the study (Fig. 2). Woody Species (Trees and Shrub) (57.4%) were the dominant life form in the study area followed by climbers (22.2%), herbs (20.4%) and grasses (0.62%).

Woody species: Sixty woody species were encountered in the RF, Twenty Six woody species in the CP and forty one woody species in the TF physiognomy. Four woody species were common to the three physiognomies in the study area and these are *Albizia zygia*, *Baphia nitida*, *Elaeis guineensis* and *Ficus exasperata*. Fourteen woody species were common to the RF and CP and they include *Albiza zygia, Antiaris toxicaria, Baphia nitida, Carpolobia lutea, Celtis zenkeri, Chassalia kolly, Elaeis guineensis, Ficus exasperata, Funtumia elastica, Lecaniodiscus cupanioides, Spondias mombin, Tabernaemontana pachysiphon, Trilepisium madagascariense and Voacanga africana*. Seven species were common to the RF and the TF; *Albizia zygia, Antiaris africana, Baphia nitida, Elaeis guineensis, Ficus exasperata*, *Icacina trichantha* and *Vitex doniana*. Species common to the TF and CP include *Albizia adianthifolia, Albizia zygia, Alchornea laxiflora, Allophylus africana, Baphia nitida, Cnestis ferruginea, Elaeis guineensis, Ficus exasperata, Gliricidia sepium, Holarrhena floribunda, Manihot esculenta, Markhamia tomentosa, Myrianthus arboreus, Newbouldia laevis, Rauvolfia vomitoria* and *Theobroma cacao.*

Herbaceous species: Six herbaceous species in the RF, seventeen species in the CP and nineteen species in the TF were encountered. Herbaceous species common to the three physiognomies include *Anchomanes difformis* and *Chromolaena odorata.* Herbaceous species common to RF and CP include *Anchomanes difformis, Chromolaena odorata* and *Culcasia scandens.* Species common to RF and TF include *Anchomanes difformis, Chromolaena odorata* and *Parquetina nigrescens.* Species common to CP and TF include *Acanthus montanus, Anchomanes difformis*; *Asystasia gangetica, Chromolaena odorata* and *Sida acuta.*

Climber species: Ten climber species were found in the RF, twelve species in the CP and twenty species in the CP. None of the climber species was common to all the three physiognomies. While *Acacia athaxacantha* was common to the RF and CP, *Simicratia welwitia* was common to the RF and TF. Common species in the CP and TF include *Aristolochia ringens, Cissampelos owariensis, Combretum racemosa, Mondia whitei, Paullina pinnata* and *Thumbergia grandiflora.*

Table 1. List of species encountered in the three physiognomies in Ibodi Monkey Forest.

S. No.	Woody species	Family	S. No.	Woody species	Family
1.	*Albizia ferruginea*	Fabaceae	48.	*Mallotus oppositifolius*	Euphorbiaceae
2.	*Amphimas pterocarpoides*	Papilionaceae	49.	*Mangifera indica*	Anacardiaceae
3.	*Albizia adianthifolia*	Fabaceae	50.	*Manihot esculenta*	Euphorbiaceae
4.	*Albizia zygia*	Fabaceae	51.	*Markhamia tomentosa*	Bignoniaceae
5.	*Alchornea cordifolia*	Euphorbiaceae	52.	*Microdesmis puberula*	Pandaceae
6.	*Alchornea laxiflora*	Euphorbiaceae	53.	*Monodora myristica*	Anonaceae
7.	*Allophylus africanus*	Sapindaceae	54.	*Myrianthus arboreus*	Moraceae
8.	*Alstonia boonei*	Apocynaceae	55.	*Napoleona imperialis*	Lecythidaceae
9.	*Anonidium mannii*	Anonaceae	56.	*Newbouldia laevis*	Bignoniaceae
10.	*Antiaris africana*	Moraceae	57.	*Pauridiantha hirtella*	Rubiaceae
11.	*Antiaris toxicaria*	Moraceae	58.	*Persia americana*	Lauraceae
12.	*Baphia nitida*	Fabaceae	59.	*Piper umbellatum*	Piperaceae
13.	*Blighia unijugata*	Sapindaceae	60.	*Psilanthus bengalensis*	Rubiaceae
14.	*Bombax buonopozense*	Bombacaceae	61.	*Psilanthus ebracteolatus*	Rubiaceae
15.	*Bridelia micrantha*	Euphorbiaceae	62.	*Psychotria viridis*	Rubiaceae
16.	*Carpolobia lutea*	Polygalaceae	63.	*Pterygota macrocarpa*	Steculiaceae
17.	*Ceiba pentandra*	Bombacaceae	64.	*Rauvolfia vomitoria*	Apocynaceae
18.	*Celtis lindheimeri*	Ulmaceae	65.	*Rhus dentate*	Violaceae
19.	*Celtis zenkeri*	Ulmaceae	66.	*Rothmannia hispida*	Rubiaceae
20.	*Chassalia kolly*	Rubiaceae	67.	*Rothmannia longiflora*	Rubiaceae
21.	*Chrysophyllum albidum*	Sapotaceae	68.	*Rothmannia urcelliformis*	Rubiaceae
22.	*Citrus sinensis*	Rutaceae	69.	*Rothmannia whitfieldii*	Rubiaceae
23.	*Cnestis ferruginea*	Connaraceae	70.	*Rytigynia umbellulata*	Rubiaceae
24.	*Cola acuminata*	Sterculiaceae	71.	*Salacia pallescens*	Celastraceae
25.	*Cola hispida*	Sterculiaceae	72.	*Simicratea welwitschii*	Celastraceae
26.	*Cola millenii*	Sterculiaceae	73.	*Smilax anceps*	Smilacaceae
27.	*Combretum platypterum*	Combretaceae	74.	*Sphenocentrum jollyanum*	Menispermaceae
28.	*Combretum* spp.	Combretaceae	75.	*Spondias mombin*	Anacardiaceae
29.	*Dalbergia latifolia*	Fabaceae	76.	*Stachytarpheta cayennensis*	Verbenaceae
30.	*Deinbollia pinnata*	Sapindaceae	77.	*Sterculia apetala*	Steculiaceae
31.	*Desmodium velutinum*	Fabaceae	78.	*Sterculia rhinopetala*	Olaceae
32.	*Diospyros monbuttensis*	Steculiaceae	79.	*Sterculia tragacantha*	Sterculiaceae
33.	*Dracaena arborea*	Dracaenaceae	80.	*Strombosia pustulata*	Olacaceae
34.	*Elaeis guineensis*	Arecaceae	81.	*Tabernaemontana pachysiphon*	Apocynaceae
35.	*Ficus exasperata*	Moraceae	82.	*Terminalia ivorensis*	Combretaceae
36.	*Ficus mucuso*	Moraceae	83.	*Terminalia superba*	Combretaceae
37.	*Ficus sur*	Moraceae	84.	*Theobroma cacao*	Sterculiaceae
38.	*Flacourtia dentata*	Flacourtiaceae	85.	*Trema orientalis*	Ulmaceae
39.	*Funtumia elastica*	Apocynaceae	86.	*Trichilia heudelotii*	Miliaceae
40.	*Gliricidia sepium*	Fabaceae	87.	*Trichilia prieureana*	Miliaceae
41.	*Hippocratea* spp.	Celastraceae	88.	*Trilepisium madagascariense*	Moraceae
42.	*Holarrhena floribunda*	Apocynaceae	89.	*Triplochiton scleroxylon*	Sterculiaceae
43.	*Holoptelea grandis*	Ulmaceae	90.	*Vitex doniana*	Verbenaceae

Table 1. Cont'd.

S.No.	Woody species	Family	S.No.	Woody species	Family
44.	*Icacina trichantha*	Icacinaceae	91.	*Vitex grandifolia*	Verbenaceae
45.	*Lannea welwitschii*	Anacardiaceae	92.	*Voacanga africana*	Apocynaceae
46.	*Lecaniodiscus cupanioides*	Sapindaceae	93.	*Zanthoxylum zanthoxyloides*	Rutaceae
47.	*Malacantha alnifolia*	Sapotaceae			
S.No.	**Herbaceous species**	**Family**	**S.No.**	**Herbaceous species**	**Family**
1.	*Acanthus montanus*	Acanthaceae	18.	*Marantochloa congensis*	Marantaceae
2.	*Ageratum conyzoides*	Asteraceae	19.	*Melanthera scandens*	Asteraceae
3.	*Ananas comosus*	Bromeliaceae	20.	*Merremia* spp.	Convolvulaceae
4.	*Anchomanes difformis*	Araceae	21.	*Musa* spp.	Musaceae
5.	*Aneilema beninense*	Commelinaceae	22.	*Nephrolepis biserrata*	Nephrolepidaceae
6.	*Asystasia gangetica*	Acanthaceae	23.	*Parquetina nigrescens*	Asclepiadaceae
7.	*Chromolaena odorata*	Asteraceae	24.	*Phaulopsis falcisepala*	Acanthaceae
8.	*Chrysocephalum* spp.	Asteraceae	25.	*Pouzolzia guineensis*	Ulticaceae
9.	*Colocasia esculenta*	Araceae	26.	*Psilantex ebracteolata*	Rubiaceae
10.	*Costus* spp.	Costaceae	27.	*Sansevieria liberica*	Dracaenaceae
11.	*Culcasia scandens*	Araceae	28.	*Sida acuta*	Malvaceae
12.	*Cyathula prostrata*	Amaranthaceae	29.	*Sida urens*	Malvaceae
13.	*Denonia sineria*	Asteraceae	30.	*Urera repens*	Urticaceae
14.	*Geophila afzelii*	Rubiaceae	31.	*Vernonia cinerea*	Asteraceae
15.	*Geophila obvallata*	Rubiaceae	32.	*Vigna* spp.	Fabaceae
16.	*Ipomoea involucrata*	Convolvulaceae	33.	*Xanthosoma esculentum*	Arecaceae
17.	*Justicia schimperi*	Acanthaceae			
S.No.	**Climber species**	**Family**	**S.No.**	**Climber species**	**Family**
1.	*Acacia ataxacantha*	Fabaceae	19.	*Dioscoreophyllum cumminsii*	Menispermaceae
2.	*Agelaea obliqua*	Connaraceae	20.	*Ficus aurea*	Moraceae
3.	*Aristolochia ringens*	Aristolochiaceae	21.	*Gloriosa superba*	Colchicaceae
4.	*Alafia barteri*	Apocynaceae	22.	*Iodes africana*	Icacinaceae
5.	*Baisse subsessilis*	Apocynaceae	23.	*Iodes* spp.	Icaceraceae
6.	*Cardiospermum grandiflorum*	Sapindaceae	24.	*Ipomoea batata*	Convolvulaceae
7.	*Cissampelos owariensis*	Menispermaceae	25.	*Ipomoea involucrata*	Convolvulaceae
8.	*Cissus kanadensis*	Vitaceae	26.	*Momordica charantia*	Curucurbitaceae
9.	*Cissus petiolate*	Vitaceae	27.	*Mondia whitei*	Asclepiadaceae
10.	*Cissus populnea*	Vitaceae	28.	*Montandra guineensis*	Apocynaceae
11.	*Cissus* spp.	Vitaceae	29.	*Mucuna pruriens*	Fabaceae
12.	*Clerodendrum splendens*	Verbenaceae	30.	*Mucuna* spp.	Papilionoideae
13.	*Clerodendron voluvii*	Verbenaceae	31.	*Paullinia pinnata*	Sapindaceae
14.	*Combretum racemosum*	Combretaceae	32.	*Pergularia daemia*	Asclepiadaceae
15.	*Combretum* sp.	Combretaceae	33.	*Secamone afzelii*	Asclepiadaceae
16.	*Culcasia scandens*	Araceae	34.	*Simicratia welwitia*	Celastraceae
17.	*Dalbergia* spp.	Fabaceae	35.	*Thunbergia grandiflora*	Acanthaceae
18.	*Dioscorea preusii*	Dioscoreaceae	36.	*Vigna* spp.	Fabaceae
S.No.	**Grass species**	**Family**			
1.	Panicum brevifolium	Poaceae			

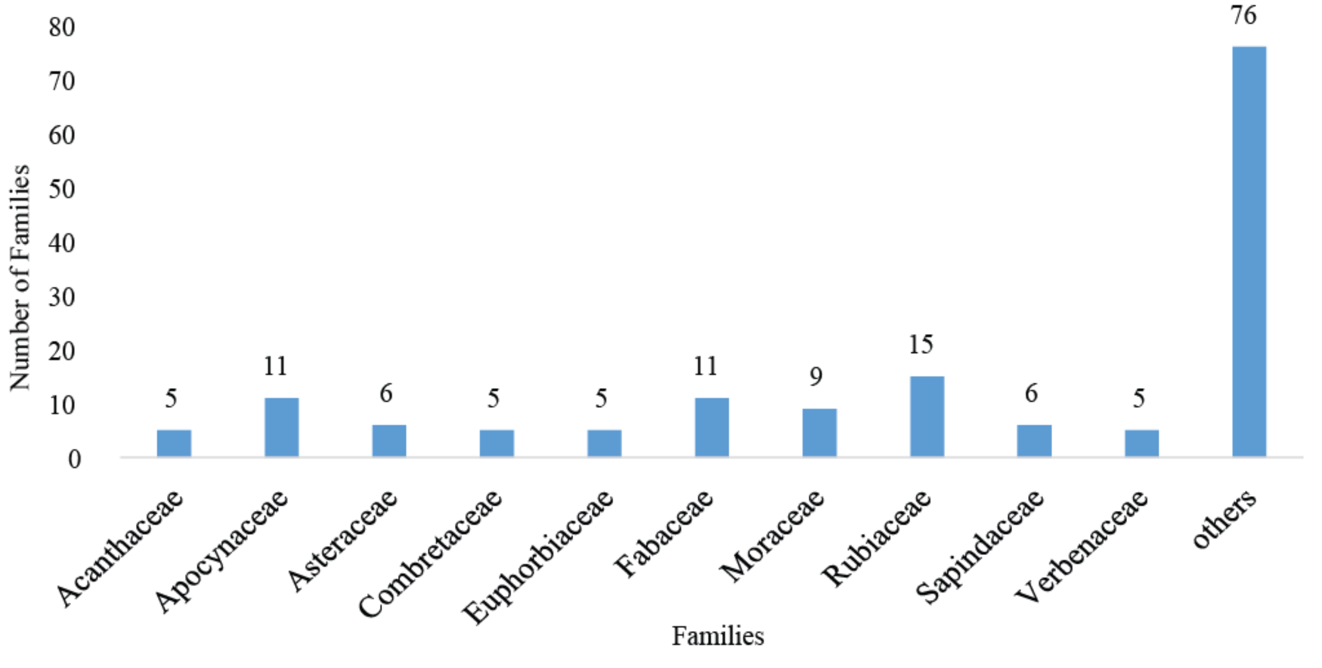

Fig. 2. Family dominance of plant species in Ibodi monkey forest.

Grass species: *Panicum brevifolium* was the only grass species encountered in all the physiognomies which accounted for 0.62% of the whole vegetation. Two species of *Panicum brevifolium* were encountered in two physiognomies, one in the RF and the other in the CP (Table 1).

Structural characteristics: A total of 3347 individual woody species per hectare (excluding other life forms) were identified in the three different physiognomies. The highest density of woody species/ha (1483) was in the RF while the TF had the lowest density of woody species per hectare (792). CP had an intermediate value of 1072 individual woody species per hectare. The dominant species in terms of density in the Regrowth forest were *Trichilia prieureana*, (160 individuals per hectare), *Rothmannia longiflora, Celtis zenkeri, and Pterygota macrocarpa* (96 species per hectare each). Two species, *Theobroma cacao* (640 species per hectare) *and Cola acuminata* (208 species per hectare) were dominant in the Cocoa plantation and they accounted for about 60% of the total density. In the *Tree fallow*, the dominant species was *Gliricidia sepium* (296 individuals per hectare) which accounted for 37% of the total density. *Amphimas pterocarpoides* and 19 other species in the Regrowth forest had the lowest density of 16 stems per hectare. In the Cocoa plantation, *Albizia zygia* and *Myrianthus arboreus* had the lowest density of 16 stems per hectare. In the Tree fallow, *Albizia ferruginea* and 13 other species had the lowest densities of 16 Individuals per hectare while the other species in the physiognomy had intermediate values (Table 2).

Plant species richness in the three physiognomies ranged from 10.82 to 15.81 with the richness highest in the Regrowth forest with a value of 15.81 and lowest in the Cocoa plantation with a value of 10.82. Shannon Wiener index (H**'**) shows that the regrowth forest had the highest community diversity (3.403) followed by Tree fallow (3.238) with Cocoa plantation having the lowest diversity index (2.501). The result of species evenness for all the three physiognomies in the study showed evenness values ranging from 0.799 (Cocoa plantation) to 0.931 (Regrowth system) with the Tree fallow having an intermediate value of 0.927 (Table 3).

The evaluation of similarity index between all the five plots using Sorensen index of similarity showed low similarity between all the physiognomies with Tree fallow and Cocoa plantation being the most similar with a similarity index of 40.28%. Similarity between Regrowth forest and Cocoa plantation was 21.11%. Regrowth forest and Cocoa plantation had the least similarity index value of 16.54% (Table 4).

Comparison of the woody species girth sizes distribution in the three physiognomies revealed that RF had the highest density of 352 woody species/ha in girth size 0-25 cm, CP had the lowest (32 ha^{-1}) while the TF had an intermediate value in the girth size class (Fig. 3). In the girth size class 76-100 cm, RF had the highest density of 587 woody species/ha while CP had the lowest (256 ha^{-1}), TF had an intermediate value (296 ha^{-1}).

Considering the basal area, the CP had the highest mean basal area (21.44 m^2ha^{-1}) while the RF had the lowest mean basal area (2.55 m^2ha^{-1}) with the TF having intermediate mean basal area (6.28 m^2ha^{-1}) (Table 5) The contribution of each species to the overall basal area of the physiognomy showed that in RF, *Celtis zenkeri* contributed the largest mean basal area of 0.63 m^2ha^{-1} (25% of the total), *Chassalia kolly* had the lowest mean basal area of 0.000411 m^2ha^{-1} while other species had intermediate values. In CP, *Theobroma cacao* contributed the largest mean basal area of 18.96 m^2ha^{-1} (88.4% of total), *Citrus sinensis* had the smallest mean basal area of 0.014 m^2ha^{-1} while other species had intermediate values. In the TF physiognomy, *Gliricidia sepium* contributed the largest mean basal area of 5.83 m^2ha^{-1} (92% of the total), *Alchornea cordifolia* had the smallest mean basal area of 0.0000318 m^2ha^{-1} while other species had intermediate values.

In general, CP had the species with the highest basal area (18.96 m^2ha^{-1}) while TF had the species with the lowest basal area (0.0000318 m^2ha^{-1}).

Table 2. Mean density of woody species (Per Hectare) in the three physiognomies in monkey forest, Ibodi, Osun State.

S. No.	Species	Family	Rf	Cp	Tf
1.	*Albizia ferruginea*	Fabaceae		-	16
2.	*Amphimas pterocarpoides*	Papilionaceae	16	-	-
3.	*Albizia adianthifolia*	Fabaceae	-	-	-
4.	*Albizia zygia*	Fabaceae	16	16	32
5.	*Alchornea cordifolia*	Euphorbiaceae	-	-	16
6.	*Alchornea laxiflora*	Euphorbiaceae	-	-	-
7.	*Allophylus africanus*	Sapindaceae	-	-	16
8.	*Alstonia boonei*	Apocynaceae	-	-	-
9.	*Anonidium mannii*	Anonaceae	32	-	-
10.	*Antiaris Africana*	Moraceae	32	-	-
11.	*Antiaris toxicaria*	Moraceae	32	-	16
12.	*Baphia nitida*	Fabaceae	27	-	-
13.	*Blighia unijugata*	Sapindaceae	16	-	-
14.	*Bombax buonopozense*	Bombacaceae	27	-	-
15.	*Bridelia micrantha*	Euphorbiaceae	-	-	16
16.	*Carpolobia lutea*	Polygalaceae	-	-	-
17.	*Ceiba pentandra*	Bombacaceae	-	-	16
18.	*Celtis lindheimeri*	Ulmaceae	16	-	-
19.	*Celtis zenkeri*	Ulmaceae	96	-	-
20.	*Chassalia kolly*	Rubiaceae	16	-	-
21.	*Chrysophyllum albidum*	Sapotaceae	16	-	-
22.	*Citrus sinensis*	Rutaceae	-	32	-
23.	*Cnestis ferruginea*	Connaraceae	-	-	
24.	*Cola acuminata*	Sterculiaceae	-	208	-
25.	*Cola hispida*	Sterculiaceae	16	-	-
26.	*Cola millenii*	Sterculiaceae	16	-	-
27.	*Combretum platypterum*	Combretaceae	-	-	-
28.	*Combretum spp*	Combretaceae	-	-	-
29.	*Dalbergia latifolia*	Fabaceae	-	-	-
30.	*Deinbollia pinnata*	Sapindaceae		-	-
31.	*Desmodium velutinum*	Fabaceae	-	-	-
32.	*Diospyros monbuttensis*	Steculiaceae	16	-	-
33.	*Dracaena arborea*	Dracaenaceae	-	-	-
34.	*Elaeis guineensis*	Arecaceae	37	48	32
35.	*Ficus exasperata*	Moraceae	32	-	32
36.	*Ficus mucuso*	Moraceae	-	-	-
37.	*Ficus sur*	Moraceae	-	-	16
38.	*Flacourtia dentata*	Flacourtiaceae	16	-	-
39.	*Funtumia elastica*	Apocynaceae	32	-	32
40.	*Gliricidia sepium*	Fabaceae	-	32	296
41.	*Hippocratea spp.*	Celastraceae	-	-	-
42.	*Holarrhena floribunda*	Apocynaceae	-	-	-
43.	*Holoptelea grandis*	Ulmaceae	16	-	-
44.	*Icacina trichantha*	Icacinaceae	-	-	-
45.	*Lannea welwitschii*	Anacardiaceae	48	-	-
46.	*Lecaniodiscus cupanioides*	Sapindaceae	32	-	16
47.	*Malacantha alnifolia*	Sapotaceae	16	-	-

Table 2. (Cont'd.)

S. No.	Species	Family	Rf	Cp	Tf
48.	*Mallotus oppositifolius*	Euphorbiaceae	16	-	-
49.	*Mangifera indica*	Anacardiaceae	-	-	16
50.	*Manihot esculenta*	Euphorbiaceae	-	-	-
51.	*Markhamia tomentosa*	Bignoniaceae	-	-	-
52.	*Microdesmis puberula*	Pandaceae	-	-	-
53.	*Monodora myristica*	Anonaceae	16	-	-
54.	*Myrianthus arboreus*	Moraceae	-	16	-
55.	*Napoleona imperialis*	Lecythidaceae	-	-	-
56.	*Newbouldia laevis*	Bignoniaceae	-		16
57.	*Pauridiantha hirtella*	Rubiaceae	32	-	-
58.	*Persia americana*	Lauraceae	-	80	-
59.	*Piper umbellatum*	Piperaceae	-	-	-
60.	*Psilanthus bengalensis*	Rubiaceae	48	-	-
61.	*Psilianthus ebracteolatus*	Rubiaceae	-	-	-
62.	*Psychotria viridis*	Rubiaceae	-	-	-
63.	*Pterygota macrocarpa*	Steculiaceae	96	-	-
64.	*Rauvolfia vomitoria*	Apocynaceae	-	-	32
65.	*Rhus dentata*	Violaceae	-	-	-
66.	*Rothmannia hispida*	Rubiaceae	64	-	-
67.	*Rothmannia longiflora*	Rubiaceae	96	-	-
68.	*Rothmannia urcelliformis*	Rubiaceae	16	-	-
69.	*Rothmannia whitfieldii*	Rubiaceae	64	-	-
70.	*Rytigynia umbellulata*	Rubiaceae	-	-	-
71.	*Salacia pallescens*	Celastraceae	-	-	-
72.	*Simicratea welwitschii*	Celastraceae	-	-	-
73.	*Smilax anceps*	Smilacaceae	-	-	-
74.	*Sphenocentrum jollyanum*	Menispermaceae	16	-	-
75.	*Spondias mombin*	Anacardiaceae	16	-	16
76.	*Stachytarpheta cayennensis*	Verbenaceae	-	-	32
77.	*Sterculia apetala*	Steculiaceae	-	-	-
78.	*Sterculia rhinopetala*	Olaceae	64	-	-
79.	*Sterculia tragacantha*	Sterculiaceae	-	-	16
80.	*Strombosia pustulata*	Olacaceae	-	-	-
81.	*Tabernaemontana pachysiphon*	Apocynaceae	16	-	-
82.	*Terminalia ivorensis*	Combretaceae	32	-	-
83.	*Terminalia superba*	Combretaceae	15	-	-
84.	*Theobroma cacao*	Sterculiaceae	-	640	16
85.	*Trema orientalis*	Ulmaceae	-	-	48
86.	*Trichilia heudelotii*	Miliaceae	-	-	-
87.	*Trichilia prieureana*	Miliaceae	160	-	-
88.	*Trilepisium madagascariense*	Moraceae	64	-	16
89.	*Triplochiton scleroxylon*	Sterculiaceae	-	-	-
90.	*Vitex doniana*	Verbenaceae	-	-	-
91.	*Vitex grandifolia*	Verbenaceae	-	-	-
92.	*Voacanga africana*	Apocynaceae	32	-	32
93.	*Zanthoxylum zanthoxyloides*	Rutaceae	-	-	-
	Total		**1483**	**1072**	**792**

Table 3. Margalef, Shannon-Wiener and Pielou indices in the three physiognomies of the study area.

Physiognomies	R	H′	J
Re-growth forest	15.81	3.403	0.931
Cocoa plantation	10.82	2.501	0.799
Tree fallow	13.57	3.238	0.927

R - Margalef's species richness
H′ - Shannon-Wiener species diversity index
J - Pielou's evenness index

Table 4. Sorensen's index (%) of similarity of the three Physiognomies of the study area.

Physiognomies	RF	CP	TF
RF	-		
CP	16.54	-	
TF	21.11	40.28	-

RF- Re-growth forest physiognomy
CP- Cocoa plantation physiognomy
TF- Tree fallow physiognomy

Table 5. Summary of floristic composition and structural characteristics of the three physiognomies in Ibodi monkey forest.

S. No.	Attributes	RF	CP	TF
1.	Number of families	35	34	36
2.	Number of woody species	60	26	41
3.	Number of trees	40	17	30
4.	Number of shrub	20	9	18
5.	Number of herbs	5	17	15
6.	Number of climbers	12	11	23
7.	Density of woody (ha^{-1})	1483	1072	792
8.	Mean Basal area (m^2ha^{-1})	2.5567	21.44	6.283
9.	Shannon-Wiener	3.403	2.501	3.238
10.	Species evenness index	0.931	0.799	0.927

RF- Re-growth forest physiognomy
CP- Cocoa plantation physiognomy
TF- Tree fallow Physiognomy

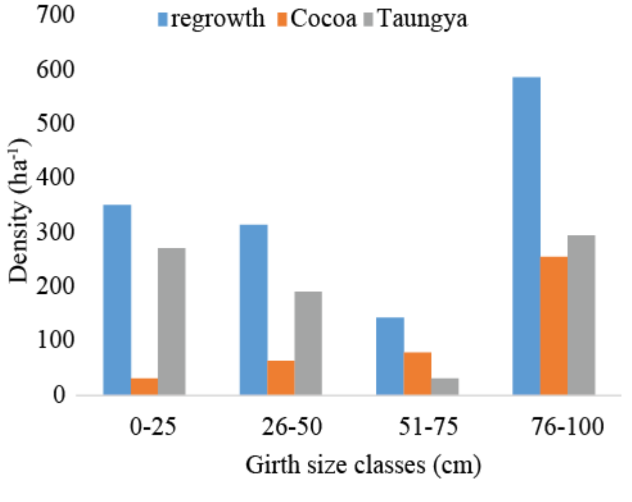

Fig. 3. Density of woody species in various girth size classes in all the three physiognomies in Ibodi monkey forest, Osun State, Nigeria.

Discussion

A number of environmental factors that operates over multiple temporal and spatial scale govern the pattern of plant diversity distribution (Shmida & Wilson, 1985; Brockway, 1998; Moreno & Halffter, 2001). Climate and topography seem to have an extensive effect on diversity across the landscape, while edaphic and biological factors seem to influence and affect diversity of species more at the site level (Richerson & Lum, 1980; Rey Benayas, 1995; Lovett *et al*., 2000; Pausas & Austin, 2001; Tuomisto *et al*., 2003).

The studies of forest flora and structure are required in understanding the value and importance of forest ecosystem. In the present study, density of woody, herbaceous, grass and climber species varied considerably in the different physiognomies under consideration. There were more herbaceous species in the Cocoa plantation than the other two physiognomies. This might be due to anthropogenic disturbances as a result of anthropogenic activities going on at the fringes of the forest of which Cocoa plantation physiognomy is part. These activities range from fuel wood gathering to continuous clearing of vegetation to make way for the plantation species (*Theobroma cacao*) growing and new seedlings being introduced. The herbaceous species was more than that of the tree fallow physiognomy because tree fallow has been left to fallow for about 6 years after long regime of smallholder farming. This supports the findings of Mishra *et al.* (2008), who stated that in disturbed areas, herbs are more prominent than woody species. Futhermore, herbaceous species found in this study such as *Anchomanes difformis* and *Chromolaena odorata* are common herbaceous species found in tropical forest as reported by Oke & Isichei (1997).

The density of woody species varied considerably across the physiognomies. Four species common to all the three physiognomies studied; *Albizia zygia, Baphia nitida, Elaeis guineensis and Ficus exasperata;* have been listed by one or more authors (Oke & Isichei, 1997) as constituents of the early stages of secondary forest regrowth. The remaining species of importance such as *Spondias mombin*, *Sterculia tragacantha* and *Funtumia* *elastica* are all very widely characteristic of regrowth in the lowland tropical rainforest region. Maximum density of woody species was recorded in the regrowth forest physiognomy, which could be as a result of less disturbance. Since the physiognomy represents the main forest, disturbance is relatively mild and restricted, to a large extent, to the fringes of the forest. However, there is selective exploration of matured economic tree species within the forest.

There were more herbs, climbers and grasses in both Tree fallow and Cocoa plantation than regrowth forest. This observation could be as a result of open canopy in both physiognomies in contrast with closed canopies in the regrowth forest physiognomy which has less of these species. This observation agrees with White (1985) who noted that in a forest, the ground layer is often sparse or absent; grasses are absent and, if present, they are localized or inconspicuous. Furthermore, host tree identity and availability (Ibarra-Manríquez & Martínez-Ramos, 2002; Phillips *et al*., 2005), forest disturbance (Hegarty & Caballe, 1991), and seasonality (Gentry, 1991 Schnitzer, 2005; Dewalt *et al*., 2010) are factors most strongly controlling the abundance, species richness, and distribution of climbers in forests. Results obtained in this study are in agreement with the work of Sosef *et al*. (2015), who in their study of structure and composition of the liana assemblage of a mixed rain forest in the Congo Basin, reported the abundance of climbers in Swamp forest plots than in Terra Firme forest plots. They attributed this to the generally higher light levels in the more open Swamp plots. Openness of the canopy creates higher irradiance at the forest floor, which is generally favorable for liana proliferation (Schnitzer & Carson, 2001; Schnitzer *et al*., 2004). However, Addoford *et al*. (2008) reported that climber density was higher in undisturbed site than disturbed site which is supported by the higher diversity index they recorded for the undisturbed site. This finding is inconsistent with some studies in which disturbance of the forest favoured climber density (Hegarty & Caballe, 1991; Bongers *et al*., 2005). They opined that the lesser climber density in the disturbed site reflect the level of human influence and the fact that some tree species in the undisturbed site are more susceptible to climber infestation than others which is in agreement with and Putz & Chai (1987) and Muoghalu & Okeesan (2005).

Family Rubiaceae was the most abundant family in the study area. It has been reported that Rubiaceae family has a cosmopolitan distribution with their largest species diversity in the tropical forest. Goevarts *et al.* (2006) reported that Rubiaceae represents one of the five most species-rich flowering plant families with 13,000 species classified in 620 genera, more than 40 tribes, and three subfamilies. They occur on all continents, even on the Antarctic Continent but most taxa are in tropical or subtropical areas. Furthermore, Ndah *et al.* (2013) in their study of species composition, diversity and distribution in a disturbed Takamanda Rainforest, South West, Cameroon reported that Rubiaceae was the most dominant family in the site. They opined that dominance of this family could be as a result of habitat adaptation and favourable environmental conditions which encourage pollination, dispersal and eventual establishment of species. Similar situations were reported by Pausas & Austin (2001) on species richness in relation to environment. Austin *et al*. (1996) found that edaphic parameters, especially soil nutrients played a major role in species richness and establishment in an ecosystem. The poor establishment of some families with low species may be attributed to competition for nutrients, limited light by canopy trees and destruction of undergrowth during tree snapped and logged on the forest floor. Egbe *et al*. (2012) gave similar reports in a disturbed and natural regeneration forest in Korup National Park; Coley & Barone (1996) also recorded anthropogenic activities affecting growth and distribution of species.

Shannon-Wiener index (H') followed the order Regrowth forest > Tree fallow > Cocoa plantation. This corroborates Krebs (1999) that opined that higher number of species and their random distribution in the Regrowth forest result in higher Shannon-weiner diversity index. Furthermore, studies from around the world have shown that monoculture plantation are at the stand scale often less diverse than natural or semi natural forest with respect to plant (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). Higher Shannon-Wiener diversity index in the regrowth forest is also a pointer to the fact that there is less disturbance compared to the fringes (Cocoa plantation and Tree fallow). This is contrary to the work of Decocq *et al.* (2004) who reported that species diversity is higher in disturbed ecosystem than in undisturbed forest.

Low level of similarity was observed between the three physiognomies and this is a reflection of the differences in species composition in the three physiognomies. The highest similarity (least dissimilar) was observed between Tree fallow and cocoa plantation (40.28%), which may be due to the fact that both physiognomies occur at the fringes where various degrees of disturbances are taking place. This corroborates the findings of Chandrashekara & Ramakrishnan (1993) that the level of disturbance and succession ages of forest have effect on species composition.

Species evenness is a measure of the abundance of species that makes up the richness of an area with the index of evenness being maximum at 1 (one) when all species in a site have similar population size. The more the value of evenness index tends towards 1(one), the more even the species in their distribution (Kent & Coker, 1992). Regrowth forest had the highest evenness index while cocoa plantation had the least value. The result in this study might be due to differences in disturbance regime occurring at various physiognomies under consideration which includes farming activities in Cocoa plantation, selective logging in Regrowth forest and slash and burn agriculture and fuel wood gathering in Tree fallow physiognomy.

Highest species richness found in the regrowth forest is in corroboration with the work of Nath *et al.* (2005) who, in an Indian Rainforest found that tree species richness decreased with increase in intensity of forest disturbance. Past and present disturbances are the main cause of low number of species per family. Such alteration of species composition affects the future ecosystem integrity, resilience and sustainability (Mutiso *et al*., 2015). Similar concerns are expressed by Swamy *et al*. (2010) who stated that many tropical forests have tremendous intrinsic ability of self-maintenance though many of them are losing this ability due to excessive biotic interferences such as anthropogenic disturbances. Having majority of the families and genera represented by one species raises a lot of concerns on threat of extinction. Saptoka *et al*. (2010) recorded similar families with one species in a study in Sal forests which were attributed to limitations in recruitment and pioneer species that only responds to major disturbances. High species richness cushions collapse/extinction of a given family/genera and ensures ecosystem's parallel and cyclic configuration processes are taken over by other species in the family/genera in case of disappearance of a member (Mutiso *et al*., 2015). Gaaf (1986) and Finegan and Camacho (1999) stressed the importance of maintaining species richness as a strategy against ecosystem collapse following disturbances. Similar views are expressed by Huang *et al.* (2003) who asserted that the species richness-abundance relationship suggests that large populations are less prone to extinction than small ones. The observed decline in species richness at the fringes of the forest (Cocoa and Tree fallow) is greatly attributed to the past and present disturbances occurring at the sites.

The woody species girth size class distribution in the three physiognomies showed that regrowth Forest had the highest number of woody species in the smallest girth size while Cocoa plantation had the lowest. This trend was also applicable to the largest girth size class which indicated that the regrowth forest was less disturbed probably due to the mythological believes passed down by priests of the town that the trees must not be cut this trend is also true for the mean basal area for the three physiognomies studied.

Conclusion

Investigation into floristic composition and structure of different physiognomies of Ibodi Monkey forest revealed that the forest vegetation has been influenced by human disturbance in form of selective logging of economic species, agriculture (shifting cultivation) and seasonal bush burning. Thus it is imperative that educational programs should be introduced and implemented to create awareness i.e. to give people better understanding of how forest works and why they are important and to change wrong opinions so that more people, especially the local people in Ibodi can appreciate the use and potentials of forest.

References

Addoford, P., K.A. Alexander, A. Emmanuel and S.A. Patricia. 2008. Diversity and distribution of climbing plants in a semi deciduous rainforest, KNUST Botanic Garden, Ghana. *Int. J. Bot.*, 4 (2): 186-195, 2008.

Adekunle, V.A.J. 2005. Trends in forest reservation and biodiversity conservation in Nigeria. *Environmental conservation and research team, Federal University of Technology, Akure, pp 82–90*

Aubin, I., C. Messier and A. Bouchard. 2008. Can plantations develop understory biological and physical attributes of naturally regenerated forests? *J. Bio. Conserv*., 141: 2461-2476.

Augusseau, X., P. Nikiéma and E. Torquebiau. 2006 Tree biodiversity, land dynamics and farmers' strategies on the agricultural frontier of southwestern Burkina Faso. *Bio. Conserv*., 15: 613-630.

Austin M. P., J. G. Pausas, A.O. Nicholls. 1996. Patterns of tree species richness in relation to environment in south-eastern New South Wales. *Aust. J. Ecol*. 21:154-164.

Bongers F., M.P.E. Parren and D. Traoré. 2005. Forest climbing plants of West Africa: diversity, ecology and management. *Wallingford, Oxfordshire, CAB International*, pp: 5-18

Brockway, D.G. 1998. Forest plant diversity at local and landscape scales in the Cascade Mountains of Southwestern Washinton. *For. Ecol. Manage*., 190: 323-341.

Butler, R.A. 2005. Mongabay.com. World deforestation rates and forest cover statistics, 2000 2005, [updated to correct FAO change in data]. *http://news.mongabay.com/ 2005/ 1115forests.html*

Chandrashekara, U.M. and P.S. Ramakrishnan. 1993 Germinable Soil Seed bank dynamics during gap phase of a humid tropical forest in the Western Ghats of Keralla, India. *Journal of Tropical Ecology*, 9: 455-467.

Coley, P.D. and J.A. Barone. 1996 Herbivory and plant defenses in tropical forests. *Annu. Rev. Entomol*., 27: 305-335.

Decocq, G.M., F. Aubert, D.R. Dupont and A. Wattez-Franger. 2004. Plant diversity in a managed temperate deciduous forest: under storey response to two silvicultural systems. *J. Appl. Ecol*., 41: 1065-1079.

DeWalt, S.J., S.A. Schnitzer, J. Chave, F. Bongers, R.J. Burnham, Z. Cai, G. Chuyong, D.B. Clark, C.E.N. Ewango, J.J. Gerwing, E. Gortaire, T. Hart, G. Ibarra-Manríquez, K. Ickes, D. Kenfack, M.J. Macía, J.R. Makana, M. Martínez-Ramos, J. Mascaro, S. Moses, H.C. Muller-Landau, M.P.E. Parren, N. Parthasarath, D.R. Pérez-Salicrup, F.E. Putz, H. Romero-Saltos and D. Thomas. 2010. Annual rainfall and seasonality predict Pan-tropical patterns of liana density and basal area. *Biotropica*, 42: 309-317.

Egbe, E.A., G.B. Chuyong, B.A. Fonge and K.S. Namuene. 2012. Forest disturbance and natural regeneration in African rainforest at Korup National Park, Cameroon. *Int. J. Biodiver. Conserv*., 4(11): 377-384.

Ehrlich, P.R. and E.O. Wilson. 1991. Biodiversity studies: science and policy. *Science*, 253: 758-762.

Emerton, I. 2003. Forest environment values and social-economic development: A case study of Lao PDR. A paper submitted to the XXI World Forestry Congress in Canada.

FAO. 2005. Export competition: selected issues and the empirical evidence. FAO Trade Policy Technical Notes on issues related to the WTO negotiations on agriculture, No.4.Rome *(available at ftp://ftp.fao.org/docrep/fao/007/ j5013e/j5013e00.pdf).*

Finegan, B. and M. Camacho. 1999. Stand dynamics in a logged and silviculturally treated Costa Rican rain forest, 1988-1996. *For. Ecol. Manage*., 121: 177-189.

Gaaf, R. 1986. A silvicultural system for natural regeneration of tropical rain forest in Suriname *(Ecology and management of tropical rain forests in Suriname 1)*, Wageningen Agricultural University Press, Wageningen, the Netherlands.

Gentry, A.H. 1991. The distribution and evolution of climbing plants. In: *The biology of Vines Cambridge University Press*, (Eds.): Putz, F.E. & A.H. Mooney. Cambridge, UK. pp. 3-51.

Goevarts, R., M. Ruhsam, L. Andersson, E. Robbrecht, D. Bridson, A. Davis, L. Schanzer and B. Sonke. 2006. World checklist of Rubiaceae. *Royal Botanic Gardens, Kew.* http://www.kew.org/wcsp/rubiaceae/

Haugaasen T., J. Barlow and C.A. Peres. 2003. Surface wildfires in central Amazonia: Short-term impact on forest structure and carbon loss. *For. Ecol. Manage*., 1(79): 321 -331.

Hegarty, E.E. and G. Caballe. 1991. Distribution and abundance of vines in forest communities. In: *The biology of vines*. (Eds.): Putz, F.E. & Mooney A.H. pp. 313-336. Cambridge, Cambridge University press.

Hill, J.L. and P.J. Curran. 2003. Area, shape and isolation of tropical forest fragments: Effects on tree species diversity and implications for conservation forest area. *J. Biogeogr*., 30(1): 391-1 403.

Huang, W., V. Pohjonen, S. Johansson, M. Nashanda, M. Katigula and O. Luukkanen. 2003. Species diversity and species composition in Tanzanian tropical forests. *For. Ecol. Manage*., 173: 11-24, Elsevier science B.V.

Ibarra-Manríquez G. and M. Martínez-Ramos. 2002. Landscape variation of liana communities in a Neotropical rainforest. *Plant Ecol*., 160: 91-112.

Kent, M. and P. Coker. 1992. Vegetation Description and Analysis. A Practical Approach. Belhaven Press, London, pp. 351.

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

Köhl, M., J. Uuttera, P. Bachmann and R. Päivinen. 1998. Assessment and planning for forest biodiversity: a European initiative. Pages 357-363. In:. *Forest biodiversity research, monitoring and modeling.* (Eds.): Dallmeier, F. & J.A. Comiskey, United Nations Educational, Scientific and Cultural Organization, Paris, and the Parthenon Publishing Group, New York.

Krebs, C.H.J. 1999. Ecological Methodology. 2nd Edn., Addison-Wesley Educatinal Publishers, Longman, Inc., California, CA., Pages: 581.

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

Lovett, G.M., K.C. Weathers and W.V. Sobczak. 2000. Nitrogen saturation and retention in forested watersheds of the Catskill Mountains, New York. *Ecol. Appl*., 10: 73-84.

Margules, C.R. and R.L. Pressey. 2000. Systematic conservation planning. *Nature,* 405: 243-252.

Mishra, R.K., V.P. Upadhyay and R.C. Mohanty. 2008. Vegetation ecology of the Similipal Biosphere Reserve, Orissa, India. *Appl. Ecol. Env. Res*., 6: 89-99.

Moreno, C.E. and G. Halffter. 2001. Spatial and temporal analysis of alpha, beta and gamma diversities of bats in a fragmented landscape. *Biodiver. Conserv*., 10: 367-382.

Muoghalu, J. I. and O.O Okeesan. 2005. Climber species composition, abundance and relationship with trees in a Nigerian secondary forest. *Afri. J. Ecol*., 43: 258-266.

Mutiso, F.M., J. Mware, J. Cheboiwo, F. Sang and G.K. Tarus. 2015. Floristic composition, affinities and plant formations in tropical forests: A case study of mau forests in Kenya. *Inter. J. Ag. For*., 5(2): 79-91.

Nath, P.C., A. Arunachalam, M.L. Khan, K. Arunachalam and A.R. Barbhuiya. 2005. Vegetation analysis and tree population structure of tropical wet evergreen forests in and around Namdapha National Park, northeast India. *Bio. Conserv*., 14: 2109-2136.

Natural Resource Canada. 1994. The state of Canada's forests, 1993 Ottawa, Ont. Canadian forest service- Natural Resouces Canada.

Ndah, R.N., E.A. Egbe, E. Bechem, S. Asaha, T. Yengo, L.E. Chia and M.N. Ngaiwi. 2013. Ethnobotanical study of commonly used medicinal plants of the Takamanda Rainforest South West, Cameroon. *Afr. J. Plant Sci*., 7(1): 21-34.

NEST. 1991. Nigerian threatened environment. Nigerian environmental action/study team (NEST), Ibadan, 288 pp.

Newmaster, S.G., F.W. Bell, C.R. Roosenboom, H.A. Cole and W.D. Towill. 2006. Restoration of floral diversity through plantations on abandoned agricultural land. *Can. For. Res*., 36: 1218-1235.

Oke, S.O. and A.O. Isichei. 1997. Floristics and structure of the Fallow Vegetation in Ile-Ife area of Southwestern Nigeria. *Nig. J. Bot.,* 10: 37-50.

Pausas, J.G. and M.P. Austin. 2001. Patterns of plant species richness in relation to different environments: an appraisal. *J. Veg. Sci*., 12: 153-166.

Phillips, O., R.V. Martinez, P.N. Vargas, A.L. Monteagudo, M.E.C. Zans, W.G. Sanchez, A.P. Cruz, M. Timana, M. Yli-Halla and S. Rose. 2003. Efficient plot-based floristic assessment of tropical forests. *J. Trop. Ecol*., 19: 629-645.

Phillips, O.L., R.V. Vásquez, M. Mendoza, A. Baker T.R., Nuñez and P. Vargas. 2005. Large lianas as hyper dynamic elements of the tropical forests canopy. *Ecol*., 86: 1250-1258.

Pimm, S.L., G.J. Russell, J.L. Gittleman and T.M. Brooks. 1995. The future of biodiversity. *Science*, 269: 347350.

Prance, G.T., H. Beentje, J. Dransfiedl and R. Johns. 2000. The tropical flora remains undercollected. *Ann. Mo. Bot. Gard*., 87: 67-71.

Putz, F.E. and P. Chai. 1987. Ecological studies of Lianas in Lambir National Park, Sarawak, *Malaysia. J. Ecol*., 75(2): 523-531.

Rey Benayas, J.M. 1995. Patterns of diversity in the strata of boreal montane forest in British Columbia. *J. Veg. Sci*., 6: 95-98.

Richerson, P.J. and K.L. Lum. 1980. Patterns of plant species diversity in California: Relation to weather and topography. *Am. Nat*., 116: 504-536.

Royal Society. 2003. Measuring biodiversity for conservation. Royal society policy document, 11/03. Royal Society, London.

Sanderson, M.A., N. Soder, L. Brzezinski, L. Muller and R.H. Skinnners. 2004. Plant species diversity influences forage production performance of dairy cattle on pasture. *Grassland Sci. Eur*., 9: 632-634.

Saptoka, I., M. Tigabu and P. Oden. 2010. Changes in tree species diversity and dominance across disturbance gradient in Napelese Sal (*Shorea robusta* Gaertn. f.) forests, *J. For. Res. (Engl. Ed.)*, 21(1): 25-32.

Schnitzer, S.A. 2005. Disentangling above- and below-ground completion between lianas and trees in a tropical forest. *J. Ecol*., 93: 1115-1125.

Schnitzer, S.A. and W.P. Carson. 2001. Tree fall gaps and the maintenance of species diversity in a tropical forest. *Ecol*., 82: 913-919.

Schnitzer, S.A., M.P.E. Parren and F. Bongers. 2004. Recruitment of lianas into logging gaps and the effects of pre harvest climber cutting in a lowland forest in Cameroon. *For. Ecol. Manage*., 190: 87-98.

Shannon, C.E. and W. Wiener. 1963. The Mathematical theory of communication. University of Juionis Press, Urbana. 117(1963).

Shmida, A. and M.W. Wilson. 1985. Biological determinants of species diversity. *J. Bio*., 12: 1-20.

Slik, J.W., F. Poulsen, P.S. Ashton, C.H. Cannon, K.A.O. Eichhorn, K. Kartawinata, I. Lanniari, H. Nagamasu, M. Nakagawa, M.G. L. Nieuwstadt, J. Payne, G. Purwaningsih, A. Saridan, K. Sidiyasa, R.W. Verburg1, C.O. Webb and P. Wilkie. 2003. A floristic analysis of the lowland dipterocarp forests of Borneo. *J Biogeogr*., 30: 1517-1531.

Smith, D.N. and T.J. Killeen. 1995. A comparison of the structure and composition of montane and lowland tropical forest in the Serrania Pilon Lajas, Beni, Bolivia, http://www.mobot.org.

Sosef, S.M., E.N. Ewango, F. Bongers, R. Makana and L. Poorter. 2015. Structure and composition of the liana assemblage of a mixed rain forest in the Congo Basin. *Plant Ecol. Evol*., 148(1): 29-42.

Swamy, S., C. Dutt, M. Murthy, A. Mishra and S. Bargali. 2010. Floristics and dry matter dynamics of tropical wet evergreen forests of Western Ghats, India. *Curr. Sci*., 99 (3): 353-364.

Tilman, D. 2000. Causes, consequences and ethics of biodiversity. *Nat*., 405: 208-211.

Tuomisto, H., K. Ruokolainen, M. Aguilar and A. Sarmiento. 2003. Floristic patterns along a 43-km long transect in an Amazonian rain forest. *J. Ecolo*., 91: 743-756.

White, P.S. 1985. Natural disturbance and patch dynamics: an introduction, 3-13 p. In: *The ecology of natural disturbance and patch dynamics*. (Eds.): Picket, S.T.A. and P.S. White. Academic Press, Orlando, Florida.

Wilcox, B.A. 1995. Tropical forest resources and biodiversity: *The risks of forest loss and degradation. Unasylva*, 46: 43-49.

Williams, N. 1998. Study finds 10% of tree species under threat. *Sci*., 281: 1426.

Wittmann, F. and W.J. Junk. 2003. Sapling communities in Amazonian whitewater forests. *J. Biogeogr*., 30: 1533-1544.

(Received for publication 18 May 2016)