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# Vegetation Development Dynamics of Fire Experimental Plots at Olokemeji Forest Reserve, Nigeria.

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**Abstract**
An enumeration of trees in the three fire investigation plots of Forestry Research Institute of Nigeria (FRIN) at Olokemeji Forest Reserve, Nigeria was carried out. Since the inception of the investigation Plot A was burned annually at the end of dry season, when the plants were very dry, Plot B was burned early in the dry season when plants were still wet and Plot C was not subjected to burning, hence the control Plot. All the trees in each plot were counted and their girths were measured. The data was used to calculate and compare the Shannon-Weiner diversity index for plots and the Importance Values (IV) as a measure of dominance of the species. The late burn plot (Plot A) had changed to savanna woodland formation with a diversity index of 2.76 and the dominant trees were *Dalbergia sisso, Gmelina arborea* and *Crossopteryx febrifuga.* Plot B had changed to transitional woodland with a diversity index of 2.83 while the dominant trees were *Gmelina arborea, Anogeissus lieocarpus and Malacantha alnifolia.* A few fire tender species such as *Manilkara obovata* and *Mimusops andongensis* were present. Plot C had developed into a full fledge forest formation with a diversity index of 3.8 while the dominant trees were *Manilkara obovata, Hildegardia barteri* and *Gmelina arborea*. Only plot C had soil litter with a biomass of 153.4g.$m_2$. Girth size/class curve for plot A showed a characteristic curve for populations under stress while those for Plots B and C showed curves characteristic of stable populations but curve C showed a better ecological status.
**Keywords**: .fire, Olokemeji Forest Reserve, vegetation development, Nigeria

## INTRODUCTION

Vegetation development on a plot is a function of several factors one of which is fire. Fire is the rapid oxidation of a material in the chemical process of combustion releasing heat, light, and various products including smoke. Prolonged drought and poor land use practices; conditions prevalent in the tropics, have caused frequent fires resulting in habitat loss and atmospheric pollution. Korontzi (2005) reported that burning in an African savanna increased the amounts of greenhouse gases ($CO_2$, CO, and $CH_4$) in the atmosphere and contributed to global warming. Forest fires can be anthropogenic either through deliberate human activities like slash and burn agriculture, setting of forests on fire for game hunting, burning by grazers for grass regeneration (Adegbola, 1983) or accidental acts arising from careless handling of cigarette butts or unquenched campfires and sparks from automobile exhausts. Natural causes of forest fires can be by lightning, earthquakes and volcanic activities. Whether anthropogenic or natural, fire tends to occur in the dry season when the water deficit is strong (Oguntala, 1993).

Improper handling of fire has destroyed many ecosystems (Soares, 1991). Fire alters forest structure and composition (Cochrane, 2007), suppresses species diversity (Corlett, 2004), and reduces live vegetative biomass (Gerwing, 2002). Surface fires reduced seed availability by 85% in litter layer (Slik *et al*, 2002) and in upper 1.5 cm of soil (van Nieuwstadt*et a*l, 2001). Swaine (1992) reported that smaller trees were more susceptible to fires than bigger trees in an Ivorian forest while Barlow et al, (2003) reported that thick- barked tress survived fire better than thin- barked trees and that buttress trees were more vulnerable because of accumulation of litter which fuels fire. It has been estimated that smoke and ash resulting from fires had effects equivalent to four packs of cigarettes per person per day on humans (Talbot and Brown, 1998) and cardiovascular and respiratory complications have been reported to increase mortality of older people (Sastry, 2002).

Natural fires cannot be controlled but anthropogenic fires can be subjected to control. Such controlled fires can be used as a forest management technique. This technique called prescribed burning has been used to control pathogenic fungi and budworms in a *Pseudotsugamenziensii* (Douglas fir) stand in USA (Bradley *et al,* 1992), while Wright and Bailey (1982) reported the use of prescribed burning to eliminate spread of mistletoe in *Pinus* stands. Prescribed burning has been reported to alter stand composition, nutrient cycling and other ecosystem components (Means *et al*, 1996). Prescribed burning has also been used to reduce potentially hazardous natural fuels and remove accumulated dead plant materials (Harrington, 1987).

The fire investigation plots at Olokemeji Forest Reserve, Nigeria were set up by Forestry Research Institute of Nigeria in 1929 to monitor the number of trees on each plot when fire is introduced at different times during the dry season and to be able to recommend appropriate time of burning of fields for shifting cultivators(Udugba, 1977) and to monitor the effects of prescribed periodic burning on long term vegetation development (Akinsoji and Sowemimo, 2005). Three contiguous plots each measuring 0.1735ha were demarcated with a 3.3m fire trace surrounding each plot. Plot A was burned in late dry season (ca march) while plot B was burned in early dry season (Nov./Dec.). Plot C was fire-protected so it served as the control (Fig. 1). The plots were clear-felled in 1929 and left to grow naturally and the prescribed burning was applied annually. Charter and Keay (1960) observed that late burn promoted the development of savanna vegetation on plot A while early dry season burn was changing the vegetation to forest type but at a rate slower than plot C (the fire- protected plot). This study was carried out to compare the vegetation dynamics of the three plots seventy years after the investigation commenced.

## STUDY AREA

Olokemeji Forest Reserve is located in Ogun State, 90-140 km NE of Abeokuta and 32 km west of Ibadan in Oyo State on an undulating topography with altitude ranging between 90m asl and 140m as. It lies on latitude $70^o$ 25' N and longitude $3^o$32' E. (Akinsoji and Sowemimo, 2005) in the transition zone between lowland rainforest to the south and guinea savanna to the north. The fire investigation plots are bordered by plantations of *Gmelina arborea, Dalbergia sisso* and *Senna siamea*. The physical features, climate and vegetation of the reserve have been described by Hopkins (1962).

## MATERIALS AND METHODS.

All the trees on each plot were identified, counted and sorted into species. Girths at breast height were measured with a measuring tape. The data collected was used to calculate Shannon-Weiner indices (Shannon and Weaver, 1963) for the plots and importance values (IV) were calculated for each species on the plots. IVs were calculated as the sum of relative density and relative dominance of each species (Mueller-Dombois and Ellenberg, 1974). Five $1m^2$quadrats were randomly demarcated on each plot and soil surface litter was collected from each quadrat. The litter samples were collected in cellophane bags and brought to the laboratory at the University of Lagos where they were oven dried to estimate their biomasses.

## RESULTS AND DISCUSSION

The late burn plot (A) has developed into a savanna woodland with grasses and scattered trees. A total of forty trees comprising nine species distributed in seven families were recorded. Shannon Weiner diversity index was calculated to be 2.76. The dominant trees included *Dalbergia sisso*, *Crossopteryx febrifuga* and *Gmelina arborea* (Table 1). The trees have crooked boles and thick barks which are characteristics of savanna vegetation resulting from previous annual fires. Grasses such as *Andropogon tectorum, Andropogon schirensis, Schizachryum* spp. and *Hyparrhenia* sp were present. Leaf litter was not found on the plot due to earlier fires which had burned the grasses and any other dead plant material that might have accumulated on the soil surface.

The early burn plot (B) has developed into a transitional woodland dominated by trees with scanty presence of grasses. The few grass species include *Andropogon* and *Hyparrhenia* spp. A total of 93 trees comprising 13 species distributed into eight families (Table 2).The dominant trees included *Gmelina arborea, Anogeissus lieocarpus* and *Malacantha alnifolia.* The presence of some fire tender species such as *Malacantha alnifolia* , *Manilkara obovata* and *Mimusops andongensis* indicates a more mesic condition and a tendency for colonization by forest species if fire treatments were stopped. Shannon Weiner index was calculated to be 2.83. Leaf litter was not found on the plot due to earlier periodic fires.

The control plot (C) has developed into a full-fledged forest formation with a closed canopy. No grass was present and the forest floor was littered with fallen leaves of deciduous trees in various stages of decomposition. The mean litter biomass was 153.4 +/-0.23g.$m^2$. Many insects and worm casts were seen indicating detritus decomposition of organic matter by detritus organisms such as bacteria, fungi, earthworm and many invertebrates. Akinsoji and Sowemimo (2005) have isolated several species of heterotrophic bacteria and fungi from the top soil of the control plot. Stratification has been established and lianas are well represented. Many trees have developed buttress roots which are characteristic of forests. However some savanna trees such as *Anogeissus, Pseudocedrella* and *Daniella* were seen close to the edge of the forest. Their seeds must have been recruited from surrounding plantations and they were able to establish because of the open nature of the forest edge. Cochrane (2007) stated that unburnt forest fragments can serve as source of seeds for post fire vegetation recovery.

A total of 171 trees comprising 22 species distributed into 12 families were recorded (Table3). Shannon Weiner index was 3.8.The dominant trees included *Manilkara obovata, Hildegardia barteri, Gmelina arborea* and *Afzelia africana* Some of the trees bear lichen patches and mosses indicating the relatively higher relative humidity within the forest.

Fig. 2 shows the girth size distribution of trees in the experimental plots. Plot C had the highest density of trees for all girth classes while plot A had the least. This implies that the more intense the fire intensity the fewer the density of trees in the plot. Plot A has a curve characteristic of populations under stress (Obot, 1991, 1994). The stress might have been induced by the intense late burning regime that the plot is subjected to. Plots B and C have reversed J curves characteristic of stable populations (Obot, 1991, 1994) but plot C curve shows a better ecological status.

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LEGENDS TO TABLES.
Table 1.Phytosociological Analyses of Late Burn Plot (A)
Table 2.Phytosociological Analyses of Early Burn Plot (B)
Table 3.Phytosociological Analyses of Control Plot (C)

LEGENDS TO FIGURES.
Fig. 1. Map of Olokemeji Forest Reserve showing the Experimental plots.
Fig. 2. Girth size distribution curves for the experimental plots.

Table 1.

| **Species** | **FAMILY(*)** | **RD** | **RDo** | **IV** |
|---|---|---|---|---|
| *Dalbergia sisso* | PAP | 30 | 6 | 36 |
| *Gmelina arborea* | VER | 12.5 | 16 | 28.5 |
| *Crossopteryx febrifuga* | RUB | 20 | 6 | 26 |
| *Terminalia glaucescens* | COM | 7.5 | 16 | 23.5 |
| *Vitellaria paradoxa* | SAP | 7.5 | 16 | 23.5 |
| *Anogeissus lieocarpus* | C0M | 7.5 | 11 | 18.5 |
| *Pterocarpus erinaceus* | PAP | 5 | 13 | 18 |
| *Pseudocedrella kotschyii* | MEL | 7.5 | 4 | 11.5 |
| *Maytenus senegalensis* | CEL | 2.5 | 2 | 4.5 |

(*)- Family abbreviations follow Weber (1982)
RD- Relative Density
RDo-Relative Dominance
IV- Importance Value

Table 2.

| **Species** | **FAMILY (*)** | **RD** | **RDo** | **IV** |
|---|---|---|---|---|
| *Gmelina arborea* | VER | 35.5 | 6 | 41.5 |
| *Anogeissus lieocarpus* | COM | 18.3 | 13 | 31.3 |
| *Malacantha alnifolia* | SAP | 1.1 | 23 | 24.1 |
| *Manilkara obovata* | SAP | 1.1 | 23 | 24.1 |
| *Mimusops andongensis* | SAP | 11 | 8 | 19 |
| *Dalbergia sisso* | PAP | 15 | 2 | 17 |
| *Vitellaria paradoxa* | SAP | 8.6 | 3 | 11.6 |
| *Pterocarpus erinaceus* | PAP | 4 | 6 | 10 |
| *Crossopteryx febrifuga* | RUB | 5.4 | 4 | 9.4 |
| *Pseudocedrella kotschyii* | MEL | 5.4 | 3 | 8.4 |
| *Terminalia glaucescens* | COM | 2 | 6 | 8 |
| *Cussonia arborea* | ARA | 1.1 | 3 | 4.1 |
| *Piliostigma thonningii* | CAE | 1.1 | 1 | 2.1 |

(*)- Family abbreviations follow Weber (1982)
RD- Relative Density

RDo- Relative Dominance
IV- ImportanceValue

Table 3.

| **Species** | **FAMILY(*)** | **RD** | **RDo** | **IV** |
|---|---|---|---|---|
| *Manilkara obovata* | SAP | 34 | 3 | 37 |
| *Hildegardia barteri* | STE | 11 | 9.4 | 20.4 |
| *Gmelina arborea* | VER | 8 | 5.2 | 13.2 |
| *Afzelia africana* | CAE | 5 | 7 | 12 |
| *Anogeissus lieocarpus* | COM | 4 | 6.2 | 10.2 |
| *Daniella oliveri* | CAE | 1 | 9 | 10 |
| *Mimusops andongensis* | SAP | 1 | 8.3 | 9.3 |
| *Parkia bicolor* | MIM | 1 | 8 | 9 |
| *Pterocarpu serinaceus* | PAP | 2 | 7 | 9 |
| *Diospyros mespiliformis* | EBE | 8 | 0.5 | 8.5 |
| *Malacantha alnifolia* | SAP | 4 | 4.2 | 8.2 |
| *Cassia siamea* | CAE | 4 | 4 | 8 |
| C53 | | 1 | 7 | 8 |
| C 411 | | 1 | 6.3 | 7.3 |
| *Vitellaria paradoxa* | SAP | 4 | 3 | 7 |
| *Pseudocedrella kotschyii* | MEL | 2 | 4 | 6 |
| C 331 | | 1 | 4 | 5 |
| *Polysphaera arbuscula* | RUB | 4 | 0.4 | 4.4 |
| *Albizzia zygia* | MIM | 3 | 1.3 | 4.3 |
| *Zanthoxylum zanthxyloides* | RUT | 2 | 2.2 | 4.2 |
| *Sterculia tragacantha* | STE | 1 | 0.6 | 1.6 |
| *Olax subscorpioidea* | OLA | 1 | 0.3 | 1.3 |

(*) Family abbreviations follow Weber (1982)
**RD**- Relative Density**, RDo**- Relative Dominance, **IV**- Importance Value

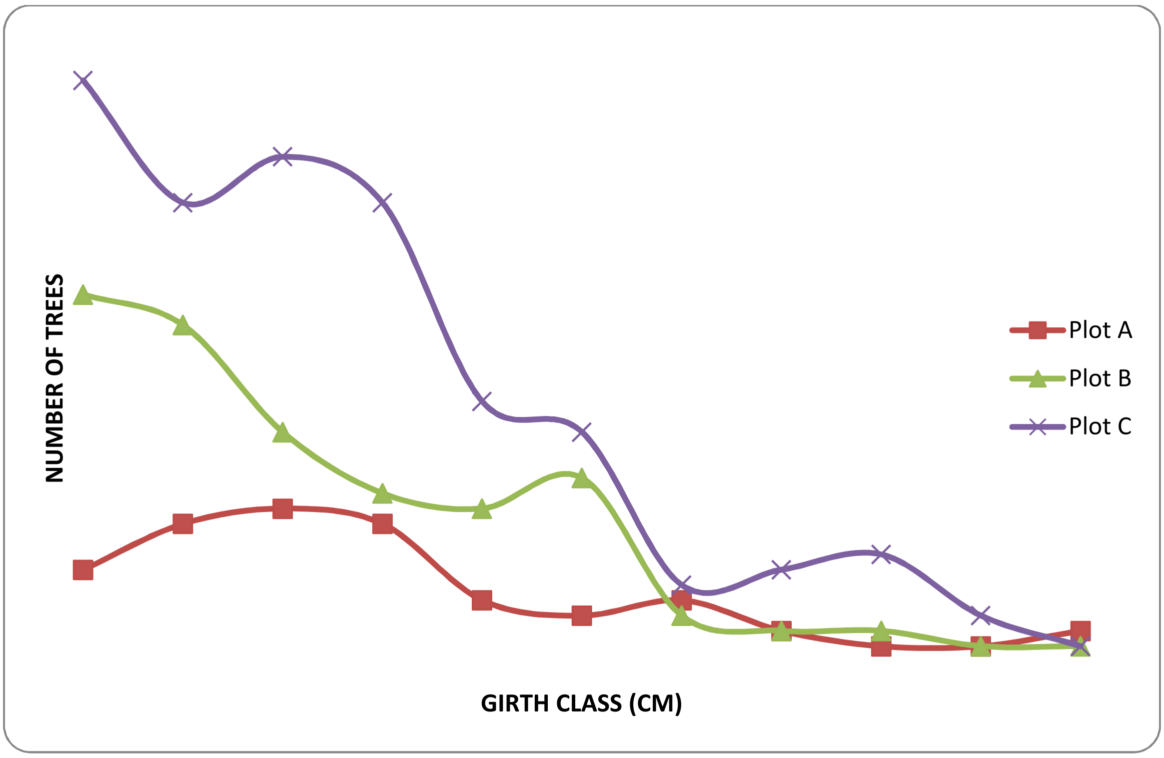


**FIG. 2.**

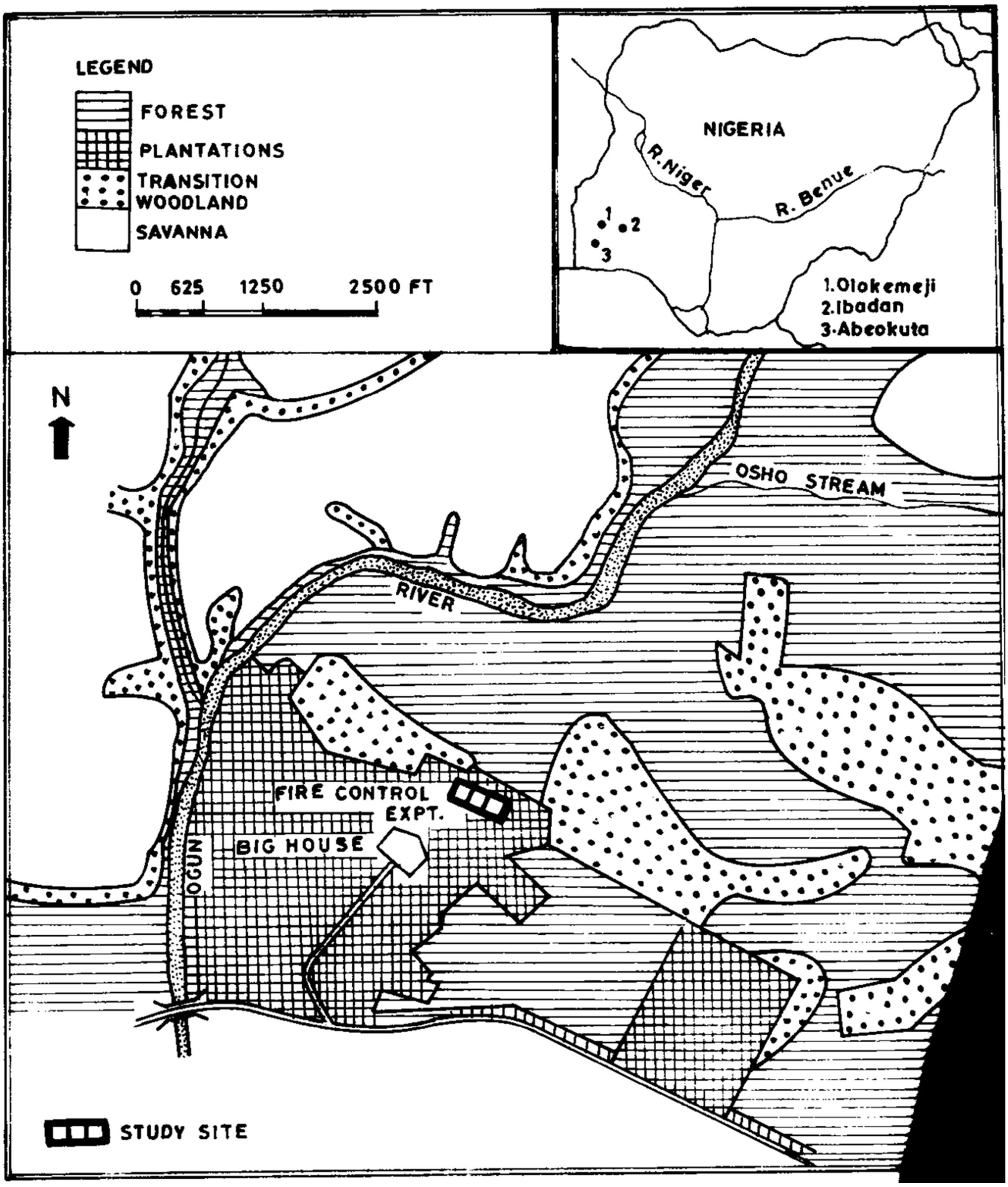
LEGEND
FOREST
PLANTATIONS
TRANSITION WOODLAND
SAVANNA
0 625 1250 2500 FT
NIGERIA
R.Niger
R. Benue
1.Olokemeji
2.Ibadan
3.Abeokuta
N
OSHO STREAM
RIVER
FIRE CONTROL EXPT.
BIG HOUSE
OGUN
STUDY SITE

**FIG. 1.**