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Diversity and Abundance of Tree Species in the University of Benin, Benin City, Nigeria

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ABSTRACT

Trees are of great importance to man and the environment. They may be used for food, construction, windbreak, shade and aesthetic potentials amongst others. In this study, the diversity and abundance of tree species at the University of Benin main campus, Benin City, Nigeria was assessed. The University was divided into two sites for proper sampling using transects. Results reveal a total of 214 individual trees of 20 tree species from 12 families were encountered. Most common tree species include Elaeis guineensis, Cocos nucifera, Terminalia catappa, Areca catechu and Roystonea regia. The dominant families are Arecaceae, Fabaceae, Myrtaceae, Moraceae, Combretaceae and Euphorbiaceae. Monocotyledonous and dicotyledonous trees account for 59.04 % and 40.96 % of trees available in the sampled sites respectively. About 76.13 % of the trees encountered were exotic while 23.87 % were native. Angiosperms had 188 representatives (84.68 %) while gymnosperms had 34 representatives (15.32 %). Elaeis guineensis (with relative density of 22.07) was the most abundant species. Trees such as Albizia zygia, Delonix regia, Terminalia ivorensis had relative density < 1 and as such may be considered threatened within the study area. Margalef species richness index was 2.568 for site A and 2.108 for site B while Shannon-Wiener diversity index was 0.836 and 0.675 for sites A and B respectively. Comparing the levels of diversity using Sørensen's similarity coefficient suggest both sites are only 25 % similar. Within the study area, trees species are threatened by anthropogenic activities especially tree felling for infrastructural developments regardless of their environmental roles and inherent benefits. Therefore sustainable conservation efforts should be geared towards ensuring their continuous existence in order to maintain environmental integrity.

Key words: Tree flora, Environmental services, Margalef index, Shannon-Weiner index, Plant Diversity and conservation

INTRODUCTION

Over the years trees have undergone different levels of disturbance due to unprecedented increase in human population, which have led to cutting of trees for firewood collection, charcoal production, and infrastructural developments (Omoro *et al.,* 2010). This has impacted tree diversity, abundance, species composition, indigenous knowledge of tree flora and conservation. Sustainable development advocates that humans and biodiversity coexist side by side. A university campus should be promoted as a model environment for sustainable development. To protect trees from declining, it is essential to examine the current status of species diversity, composition and abundance as it will provide guidance for their management and valuable reference for assessment as well as improve our knowledge in identification of ecologically useful species. (Suratman, 2012). A higher number of tree species increases the number of ecological niches and as well as the number of associated species (Wunderle, 1997; Kanowski *et al*., 2003). More so, trees provide many ecosystem services such as species conservation, prevention of soil erosion, and preservation of habitat for plants and animals (Armenteras *et al.,* 2009). Overexploitation has resulted in the rapid loss of tree diversity and is recognized as a major environmental and economic problem around the world (Mani and Parthasarathy, 2006). Therefore, information on composition, diversity of tree species and species-rich communities is of primary importance in the planning and implementation of biodiversity conservation efforts (Suratman, 2012).

The tree of a community such as a University campus can be used as its defining features. They define the landscape by their beauty and presence. In particular, long-lived species, which can endure periodic reproductive failures without direct negative demographic consequences (Ashman *et al.,* 2004). This flexibility explains why woody plants generally display stronger pollen limitation than herbs (Knight *et al.,* 2000). Secondly, spreading reproduction over many years boosts lifetime reproductive output and overall benefits. However, a long lifespan also means that individuals have to cope with variable environmental conditions including catastrophic events (Gutschick and Bassirirad, 2003). Therefore, trees within such areas require proper management and documentation of their characteristics. These will promote their retention and incorporate them into the history of such communities for future developmental goals.

There are several uses of trees to man. Early humans depended on natural woodlands for foods such as fruit and nuts (Carol *et al*., 2005). Systematic planting of street trees for timber production is widely practised in China and Malaysia (Webb, 1999). According to Ayo (2013), timber and latex from different species of trees are used to satisfy different human needs. In many developing countries large parts of the urban population are dependent upon fuelwood (Kuchelmeister, 1998). Energy saving through tree-planting around houses ranges from 10 – 50 % of cooling and from 4 - 22 for heating (NAA/ISA, 1991). Trees fulfil certain physiological, social and cultural needs of urban dwellers (Dwyer *et al.,* 1991). They play a social role in easing tensions and creating a serene environment that helps relax the minds of dwellers in the urban environment (Ulrich, 1990).

The knowledge of the tree flora of a community will enable inhabitants to positively relate with the trees as well as promote the diversity and sustainable management of the trees. Therefore, the objective of this study is to identify, document and evaluate the diversity and abundance of trees in the Ugbowo campus of the University of Benin, Benin City, Nigeria.

MATERIALS AND METHODS

Study area

This study was carried out at the University of Benin main campus (6.20 ^{o}N and 5.37 ^{o}E) situated in Ugbowo, Benin City with a land area of 361 hectares. The study area falls within Ovia – North East Local Government Area of Edo state with a land area of 2,301 Km^2. Edo state is geologically characterised by deposits, laid during the tertiary and cretaceous periods (Reyment, 1965). Radiation is fairly high and varies according to different period of the year. Radiation of above 1600 hours per year has been reported (Onwueme and Sinha, 1991). The natural vegetation of this study area is similar to that of tropical lowland rainforest but heavy anthropogenic alteration over a long period of time had replaced previous forest with secondary forest (Dania-Ogbe *et al*., 1992).

Methods of data collection

Field inventory of tree flora was adopted for data collection. The study area was divided into two (sites A and B) for accurate recording of different tree species. Site A begins from Department of Biochemistry and ends at the Junior Staff Quarters and Site B from School of Medicine and ends at the Capitol gate. Using the main road as transect, sampling was done on both sides to enable accurate enumeration of all tree species. Three field surveys were conducted with two weeks interval between each survey. Through these surveys, all the tree species encountered within the sample areas were recorded as well as their frequency of occurrence. Tree species identification was done with the aid of tree identification guide books, including Tropical Tree Crops (Okpeke, 1987), Trees of Nigeria (Keay, 1989), Flora of West Tropical Africa (Hutchinson and Dalziel, 1958-1968), Useful Plants of West Tropical African (Burkill, 1985; 1994; 1995; 1997 and 2000). Local names were also used to identify taxonomic species. Herbarium collections were made and referred with those of FHI, Ibadan. Vouchers of trees collected were deposited in the Herbarium unit, Department of Plant Biology and Biotechnology, University of Benin, Benin City.

Data analysis

From each site, diversity indices were determined using the following:

i. Margalef species richness index (d), which is used as a simple measure of species richness according to Margalef (1958).

$$d = (S - 1) / \text{In } N$$

Where S = total number of species; N = total number of individuals in the site and In = natural logarithm.

ii. Shannon-Weiner index (H), which is the measure of diversity within a site according to Shannon and Wiener (1949).

$$H = -\sum Pi \text{ In } Pi$$

Where Pi = S / N, S = number of individuals of one species; N = total number of all individuals in the site and In = logarithm to base e

iii. Sørensen similarity coefficient (C_S), which measures similarity in species composition for two sites, A and B, according to Sørensen (1948).

$$C_S = \frac{2a}{(2a+b+c)} x\ 100\%,$$

Where a = number of species found in both sites; b = number of species found only in site A and c = number of species found only in site B. Expressed as a percentage of similarity or dissimilarity.

iv. Relative density of species (RD) = $\frac{Number\ of\ individual\ species}{Total\ number\ of\ trees}\ x\ 100$

v. Relative abundance of species (Pi) = $\frac{Relative\ density\ of\ species}{100}$

The various species were scored according to their relative densities (RD); i.e. abundant (RD ≥ 5.00), frequent (4.00 ≤ RD ≤ 4.99), occasional (3.00 ≤ RD ≤ 3.99), rare (1.00 ≤ RD ≤ 2.99) and threatened/endangered (0.00 < RD ≤ 1.00).

RESULTS

The botanical names, common names, families, habitat and economic values of all the tree species encountered in the study sites are presented in Table 1.

Table 1: List of tree flora in study area and their economic values from respondents.

Botanical name	Common name	Family	Economic values
Albizia zygia (DC.) J. F. Macbr.	African walnut	Fabaceae	Timber, vegetables, ornamentals, forages, auxiliary and medicinal purposes.
Areca catechu (L.)	Betel nut palm	Arecaceae	Stimulants and medicinal purposes.
Carica papaya (L.)	Pawpaw	Caricaceae	Fruits, vegetables, medicinal plants, spices and fibres.
Cocos nucifera (L.)	Coconut	Euphorbiaceae	Vegetable oils, dyes and tannins, ornamentals, forages, fruits, timbers, spices and condiments.
Delonix regia (Bojer) Raf.	Flame of the forest	Fabaceae	Ornamentals, essential oils, dyes and tannins.
Elaeis guineensis (Jacq.)	Oil palm	Arecaceae	Vegetable oils, vegetables, ornamentals, forages, fruits, timbers and biofuel production.
Eucalyptus camaldulensis (Dehn.)	Red-river gum	Myrtaceae	Biofuel extraction, ornamental, timber and auxiliary purposes.
Ficus benjamina (L.)	Benjamin tree	Moraceae	Ornamentals, timbers, medicinal plants, essential oils and fibres.
Ficus umbellate (Vahl.)	Fig tree	Moraceae	Ornamentals, fruits, fuel, dyes and tannins.
Greenwayodendron suaveolens (Engl. and Diels.)	House-post masquerade tree	Annonaceae	Forage, timber, medicinal plants and fruits.
Hura crepitans (L.)	Sand-box tree	Euphorbiaceae	Ornamentals, timbers, auxiliary purposes and medicinal roles.
Jacaranda mimosifolia (D. Don.)	Blue jacaranda	Bignoniaceae	Timbers, ornamentals, auxiliary, fuel and medicinal plants.
Mangifera indica (L.)	Mango	Anacardiaceae	Fruits, vegetables, forages, timbers, medicinal roles, dyes and tannins.
Peltophorum pterocarpum (Dc.)	Yellow flamboyant	Fabaceae	Ornamentals, forages, timber, essential oils.
Pinus sylvestris (L.)	Scots pine	Pinaceae	Ornamentals, fuel plants.
Psidium guajava (L.)	Guava	Myrtaceae	Fruits, timbers, fuel, medicinal plants, dyes and tannins
Tectona grandis (L.f.)	Bankok teak	Verbenaceae	Timbers, ornamentals, fruits, dyes and tannins.
Terminalia catappa (L.)	Indian almond	Combretaceae	Timber, ornamentals, fruits, essential oils, medicinal plants.
Terminalia ivorensis (A. Ghev.)	Black afara	Combretaceae	Timber, dyes, tannins and medicinal uses
Roystonea regia (Kunth)	Royal palm	Arecaceae	Timbers, vegetables, fruits, fibres, ornamentals

Table 2: Families and their number of tree species

Families	Number of tree species
Anacardiaceae	1
Annonaceae	1
Arecaceae	3
Bignoniaceae	1
Caricaceae	1
Combretaceae	2
Euphorbiaceae	2
Fabaceae	3
Moraceae	2
Myrtaceae	2
Pinaceae	1
Verbenaceae	1

Table 3: Total count of treeflora within the study area

Tree species	Site A	Site B	Total
Albizia zygia	1	-	1
Areca catechu	9	-	9
Carica papaya	5	-	5
Cocos nucifera	34	-	34
Delonix regia	1	-	1
Elaeis guineensis	-	49	49
Eucalyptus camaldulensis	-	1	1
Ficus benjamina	2	-	2
Ficus umbellata	1	-	1
Greenwayodendron suaveolens	11	-	11
Hura crepitans	1	-	1
Jacaranda mimosifolia	2	4	6
Mangifera indica	2	8	10
Peltophorum pterocarpum	-	1	1
Pinus sylvestris	-	34	34
Psidium guajava	-	1	1
Tectona grandis	-	1	1
Terminalia catappa	29	4	33
Terminalia ivorensis	2	-	2
Roystonea regia	-	11	11
Total tree species	**99**	**115**	**214**

A total of 20 tree species were recorded from both study sites. The species were dominated by timber producing trees. Other economic roles of these tree species include medicinal and auxiliary purposes, food use as fruits, vegetables, edible oils and animal fodder. Biofuels may also be extracted from some of them while others are used to beautify the environment. Table 2 presents the families of the trees encountered in the study area and the number of tree species belonging to each family. A total of 12 families were encountered. The Arecaceae and Fabaceae families were the most abundant family with 3 individual tree species each. The results in Table 3 represent the total count of tree flora in the study area. The Arecaceae family had the highest individuals with a total number of 69. Table 4 represents the tree species in the study area and their respective relative densities (RD), relative abundance (Pi), Margalef species richness index (d) and Shannon-Wiener diversity (H). *Elaeis guineensis* had the highest relative density of 22.07 while *Cocos nucifera* and *Pinus sylvestris* closely follow with 15.32 respectively.

Table 4: Tree species, their relative density, relative abundance, Margalef species richness and Shannon- wiener diversity indices.

Tree species	RD	Pi	d	H
Albizia zygia	0.45	0.004	0	1
Areca catechu	4.05	0.041	1.481	0.984
Carica papaya	2.25	0.022	0.74	0.993
Cocos nucifera	15.32	0.153	6.108	0.9
Delonix regia	0.45	0.004	0	1
Elaeis guineensis	22.07	0.221	8.884	0.841
Eucalyptus camaldulensis	0.45	0.004	0	1
Ficus benjamina	0.9	0.009	0.185	0.999
Ficus umbellata	0.45	0.004	0	1
Greenwayodendron suaveolens	4.95	0.049	1.851	0.978
Hura crepitans	0.45	0.004	0	1
Jacaranda mimosifolia	2.7	0.027	0.925	0.991
Mangifera indica	4.5	0.045	1.666	0,981
Peltophorum pterocarpum	0.45	0.004	0	1
Pinus sylvestris	15.32	0.153	6.108	0.9
Psidium guajava	0.45	0.004	0	1
Tectona grandis	0.45	0.004	0	1
Terminalia catappa	14.86	0.149	5.923	0.904
Terminalia ivorensis	0.9	0.009	0.185	0.999
Roystonea regia	4.95	0.049	1.851	0.978

Keys: RD = Relative density, Pi =Relative abundance
d = Margalef species richness index, H = Shannon-wiener diversity

Table 5: Families, their relative density, relative abundance, Margalef species richness index and Shannon- wiener diversity.

Family	RD	Pi	D	H
Anarcadiaceae	7.69	0.077	0	1
Anonaceae	7.69	0.077	0	1
Arecaceae	23.08	0.23	0.657	0.948
Bignonaceae	7.69	0.077	0	1
Caricaceae	7.69	0.077	0	1
Combretaceae	15.38	0.153	0.328	0.978
Euphorbiaceae	15.38	0.153	0.328	0.978
Fabaceae	23.08	0.23	0.657	0.948
Moraceae	15.38	0.153	0.328	0.978
Myrtaceae	15.38	0.153	0.328	0.978
Pinaceae	7.69	0.077	0	1
Verbenaceae	7.69	0.077	0	1

Keys: RD = Relative density, Pi =Relative abundance
d = Margalef species richness index, H = Shannon-wiener diversity

Table 6: The origin and groups of tree species encountered in the study area

Tree species	Origin	Plant group
Albizia zygia	E	D
Areca catechu	E	M
Carica papaya	E	D
Cocos nucifera	E	D
Delonix regia	E	D
Elaeis guineensis	N	M
Eucalyptus camaldulensis	E	D
Ficus benjamina	E	D
Ficus umbellata	N	D
Greenwayodendron suaveolens	E	D
Hura crepitans	E	D
Jacaranda mimosifolia	E	D
Mangifera indica	E	D
Peltophorum pterocarpum	E	D
Pinus sylvestris	E	G
Psidium guajava	E	D
Tectonia grandis	E	D
Terminalia catappa	E	D
Terminalia ivorensis	N	D
Roystonea regia	E	M

Keys: E= Exotic, N= Indigenous. M= Monocot, D= Dicot, G= Gymnosperm

Table 7: Tree species and theirHPC

TREE SPECIES	HPC
Albizia zygia	A
Areca catechu	A
Carica papaya	A
Cocos nucifera	A
Delonix regia	A
Elaeis guineensis	A
Eucalyptus camaldulensis	A
Ficus benjamina	A
Ficus umbellata	A
Greenwayodendron suaveolens	A
Huracrepitans	A
Jacaranda mimosifolia	A
Mangiferaindica	A
Peltophorum pterocarpum	A
Pinus sylvestris	G
Psidium guajava	A
Tectonia grandis	A
Terminalia catappa	A
Terminalia ivorensis	A
Roystonea regia	A

Keys: HPC = Higher plant category, A = Angiosperm, G = Gymnosperm

Table 5 presents the families of the trees encountered in the study area and their respective relative densities (RD), relative abundance (Pi), Margalef species richness index (d) and Shannon-wiener diversity (H). The Arecaceae and Fabaceae families were the most abundant families. Table 6 presents the different groups of the tree flora and their origin. Monocot trees were more abundant in the study area with a total of 111 individual trees while dicots were 77. The exotic trees were also more abundant in the study area with a total of 169 individual trees while native trees were 53. The distribution of the tree species according to the number of cotyledons is represented in Figure 1. The results show that 111 (59.04 %) are monocots and 77 (40.96 %) are dicots. Table 7 presents categories of the tree species of the study area. Angiosperms were more abundant with a total of 180 (84.11 %) individual trees while gymnosperms were 34 (15.89 %). The results presented in table 8 shows the phytosociological characteristics of tree flora in the study sites. Table 8(i) represents the computed values of Margalef species richness and Shannon-Wiener diversity for site A and B. Table 8(ii) represents the comparison of level of diversity between sites A and B using t-test at 0.05 confidence level and computed values of Sørensen's coefficient for comparing their similarities.

Table 8 (i): Margalef species richness and Shannon-Wiener diversity indices for each site

Site	Margalef	Shannon-Wiener
A	2.568	0.836
B	2.108	0.675

Table 8 (ii): Comparison of level of diversity and Sørensen's coefficient for similarities between sites

Sites	Sørensen index (50 %)	Inference
A and B	25%	A is not similar to B

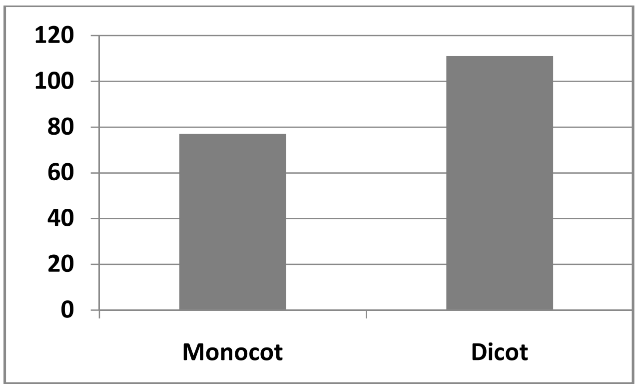

Figure 1: Distribution of the tree species based on the number of cotyledons

DISCUSSION

This study has documented the taxonomy, diversity and environmental relevance of tree flora in the University of Benin, Ugbowo campus. The urban forests, trees and woodlands in and around our environment play a vital role in promoting sustainable development within our communities. As an important component of green infrastructure, trees can provide several social, communal, psychological, economic and environmental benefits. They also contribute greatly to the health and welfare of everyone who lives and works in the environment. The result from this study shows that trees are diverse in the Ugbowo Campus of University of Benin. More so, they provide essential services to the inhabitants of the study area. Aigbokhan (2014) listed *Mangifera indica, Delonix regia, Elaeis guineensis e*tc. as some of the trees that are of great importance and these were encountered in this study area. The uses of these trees includes; shade, timber, fuel, ornamentals, vegetables, medicinal plants, dyes and tannins. However, the flora of the Ugbowo Campus of the University of Benin are under threat from infrastructural development and other anthropogenic activities. Similar findings have been reported by Sumina (1994) on plant communities that have been anthropogenically disturbed. As human population continue to grow, land use intensity increases and the negative effects of deforestation are likely to worsen (Chazdon, 2003). The attitude of the inhabitants of the study area towards conservation of trees is poor and as such requires urgent attention for their continuous existence. Conservation is basic to human welfare and indeed to human survival (Allen, 1980). Lack of conservation will increase the number of endangered species which after some time could go into extinction. Extinction is the gradual but sure elimination of taxa (Allaby, 1998). Extinction of tree species should be avoided because we simply do not know how to create species once it becomes extinct (Wardle *et al.*, 2004). Over exploitation of trees and sustainable management techniques are required to maintain the biodiversity and productivity of ecosystems (Reddy *et al.,* 2008).

All the trees in the study area are terrestrial due to the climatic condition of the study area. These results agree with the work of Osawaru *et al*. (2014) where mostly terrestrial weeds were found in the study site. The reason for the poor establishment of some families may be attributed to anthropogenic activities in the study area. Wardle *et al.* (2004) also recorded anthropogenic activities affecting the abundance of species. A total of 214 individual trees in twenty species belonging to 12 families were encountered in the study area. The Arecaceae family is the most abundant family in the study area with a total of 69 individual trees. The level of disturbance reported by Edet *et al*. (2012) when the tree species diversity in Afi Mountain Wildlife Sanctuary was studied is less than the disturbances recorded in this study. This is as a result of the rapid felling of trees for the erection of various buildings and structures in the institution.

The biodiversity indices applied in this study is in line with Edet *et al*. (2012). Most species had a relative density of less than 1.00 and as such may be considered threatened or endangered within the study area. These species are endangered and may soon be absent from the campus if sustainable management practices are not adopted such as massive replanting exercise and constituting a committee to oversee tree management. The disappearance of many plant species due to anthropogenic activities is depleting the world's genetic resources and is putting man's heritage of biodiversity under serious threat. There is urgent need to preserve genetic diversity including plant resources of known and unknown economic importance in order to guarantee the availability of their potentials in the interest of unborn children (Olowokudejo, 1987). Over-exploitation and replacement of forest ecosystems with human amenities results in the decimation of tree species (Iroko *et al.,* 2008). The most abundant family is

Arecaceae and Fabaceae, both having a relative density of 23.08. Iheyen *et al*. (2009) also reported the Fabaceae family as the most abundant family in Ehor Forest Reserve, Edo State. Predominance of this family may be as a results of their efficient seed dispersal mechanism. Most members of the Fabaceae family are wind dispersed, hence may account for their widespread occurrence. The Combretaceae, Euphorbiaceae and Moraceae closely followed having a relative density of 15.38 respectively. Most of the trees encountered were exotic and invasive. They could compete and displace the native trees. The dominance of exotic trees in the study area is as a result of their ornamental values. Also, most individual species encountered were dicots due to the climatic condition of the study area. During the dry season, the long tap roots of the dicotyledonous trees are used to source for water deep down in the soil. Most species in the Arecaceae family are monocots and were abundant in the study area. Angiosperms were more abundant in the study area with a total of 188 individual trees. The only gymnosperm encountered in the study area is *Pinus Sylvestris* with a total of 34 individual trees. The method used in determining the phytosociological characteristics of the tree flora in the study area is in line with the Bello *et al*.(2013) and Adekunle *et al*. (2013). Results suggest that site A had the highest species richness and more diverse when compared with site B. Species richness is often used to make quick assessment and comparison of different habitats (Wiens, 1989). The Sørensen's coefficient for similarity between sites A and B is 25% which implies that site A is not similar to site B. These species are endangered and might go into extinct in the study area very soon. Furthermore, the results from questionnaire suggest that 92 % of the respondents do not agree with continuous felling of trees in the study area. Their reasons include beautification, source of food, education, recreation, research, improving air quality and medicinal purposes. The constraints to tree availability in the study area as indicated by the respondents include; building constructions, urbanisation, unlawful felling of trees and lack of orientation of the inhabitants on the uses of trees.

CONCLUSION

The diversity and abundance of tree species in the University of Benin, Ugbowo campus have been documented. It has been shown that the diverse tree species are a necessary component of the institution. Anthropogenic activities are the major reasons behind the rapid decrease in the number of tree species in the institution. These diverse trees provide invaluable environmental and economic services and thus, are of great importance. Conservative measures should be put in place to checkmate their disappearance as well as promote cultivation of more trees. Awareness and orientation should be given to the inhabitants on the sustainable uses of trees as well as the negative effects of unlawful felling of trees to enable them appreciate the trees in their environment. Also, a unit should be created in the school that will be in charge of maintaining these trees.

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