Comparative Assessment of Fuel Wood Utilization and Floristic Degradation Along a Vegetational Gradient in Kogi Central, Kogi State, Nigeria.

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Abstract—* This study evaluated the comparative ecological effect of wood fuel utilization in-terms of floristic degradation of a natural vegetation gradient while identifying fuel wood species in common use in three locations at Lokoja –Kogi State capital. A total of 43 woody species classified into 22 families were identified in the three locations totaling 2,156 sampled. The Shanon-Weiner biodiversity index H' shows a gradual decrease in diversity from Kabawa to Ganaja village with a value of 1.438-1.171 while their species richness and evenness evaluated by Simpson's index of diversity (1-D) were essentially the same with a value of 0. 950.The natural forest evaluated for this study along Ajaokuta has 19 woody species in 10 families with H' value of 0.8575 and 1-D of 0.8191. In terms of vegetative productivity, only 7 families have species that are woody enough to become tree-like, all other families have species that are wildlings or saplings of a normal tree species at maturity, an indication of past evidence of heavy anthropogenic activities resulting in vegetative vulnerability of the study sites by reason of fuel wood utilization. Chi-square (χ^2) analysis of the result of number of woody species in the study sites taken along with herbaceous yield were highly significant ($p<0.001$) which shows that the lower number and poor yield is explainable by reason of higher woody species exploitation which was responsible for the consequent increase in the dominance of forbes Hiptis suaveolense and Pueraria phaseoloides against woody species, Farming is another dominant factor influencing this trend in the study area with evidence of slight grazing.

***Index Terms*- Wood Fuel, Woody Species, Energy, Biodiversity and Environment.**

I. INTRODUCTION

The global and national energy crisis has been fingered to lingering demand and supply gap of cooking energy in Nigeria. (Anthony and Angela 2012). This study was designed to assess qualitatively and quantitatively the nature and types of fuel wood consumption pattern in Lokoja- the Kogi State capital in relation to the floristic degradation of natural forest contiguous to the city. Studies have shown that among all tree products, fuel wood is the mostly utilized in Nigeria. Ebe (2006). The rural and sub-urban populations traditionally relies on the forest for various food products and fuel wood (Non Timber Forest Products), both for own consumption and for sales to the urban sector. Chukwu (2000) showed that over 70% of the population of Nigeria relies on fuel wood or charcoal as their major sources of energy for cooking and heating purposes. The National Energy Policy plan of Nigeria emphasized that the use of fuel wood should be discouraged by promoting the use of alternative energy sources to fuel wood. Anozie *et al*., (2007). However, this is hampered by the unreliability in the supply of other energy options in the country.

Sambo (2009), maintained that several factors ranging from population growth to low technical efficiency of the traditional cooking style are partly responsible for Nigeria's high dependence on fuel wood. However, one other key factor that is lacking from Sambo's observation is the unreliability in the supply of alternatives to fuel wood in the country, which is linked to major allegations of corruption and irregularities from both the government and marketers of fossil fuels. (Maconachie *et al.*, 2009) and (Naibbi *et al.*, 2013).

Adetunji (2007), opined that energy option of any country is influenced by national economic condition, individual level of income, technological advancement, the state of energy infrastructure as well as the rate of population growth. Iwayemi (2008), opined that Nigerian energy sector is probably one of the most inefficient in meeting the energy needs of its people, this is most evident in persistent disequilibrium in the market for electricity and petroleum products, especially kerosene and premium motor spirit (PMS).

Fuel wood available on sustainable basis from forest reserves and natural woodland is estimated at between 11-17 million m^3 per annum (FAO 1991). The annual consumption of wood in Nigeria is estimated to range between 80-88 million m^3 of which about 80% is consumed as fuel wood (FAO 1991). The dependence of the rural and sub-urban populations on fuel wood for energy needs and the inefficient utilization of fuel wood have contributed to the supply/demand in – balance of the forest stock, which is more noticeable in the arid and semi-arid regions of the country. The rapid rate of deforestation in the country (approximately 3.5% per annum) translates into an average loss/degradation of 350,000 ha- 400,000 ha of forest cover per year (FAO 1991). This trend is not in accordance with government policy of maintaining 20-25% of land area under forest cover for the well-being of national, regional and global environment. There is therefore the need to evolve strategies to address this issue. The use of fuel wood for meeting domestic energy needs has several ecological implications, which in turn have significant impact on man’s social life as human greatly depends on his environment. It is common knowledge that environmental resources have several implications on human life quality-health, economy and social life.

The environmental effects of fuel wood consumption include: desertification- to the extreme, soil erosion, high rate of soil fertility loss and biodiversity degradation. ’Recent’ human population census in Nigeria has put Nigeria’s population at about 140million (NPC, 2006). This represents a huge increase over the 1991 figure of 88,514,501. At present Nigeria’s population is believed to be about 170-180million, the fact that, the land area (extent) of Nigeria had remained constant or even reduced by virtue of secession of the ‘bakassi’ to Cameroun means that the same physical environment- land and air has to be stretched an extra 52.06% or more. By virtue of this exponential increase in the national population, the rate of fuel wood consumption far exceeds reforestation rate. The current economic condition of the country greatly favors continuous utilization of fuel wood for domestic and other energy sources. (Momodu, 2013). Sambo (2006) estimated that about 350,000 ha of forest and natural vegetation are lost annually due to various factors with a much lower afforestation rate of 50,000 ha/year. Without doubt, fuel wood consumption is one of the major factors accounting for deforestation in Nigeria, while deforestation in turn lead to desertification- the making of a deserts

According to Tiseer (2009) and Macauley (2014), the natural vegetation of many areas in northern Nigerian appears park-like. This condition is maintained by the interplay of use, climate, Soil, animals and fire. Recurrent dry season fires are usual of ecosystems with copious grass matrix even as the fires can be said to open up the areas for the grass. Badejo (1998) showed that the Savanna is creeping into the rainforest in Nigeria. Also, a study by Nobre *et al.,* (1991) predicted that climate change due to deforestation may cause tropical savanna to creep into tropical rainforests stretching 500 to 1000 km into the zone whilst the savanna will in turn be encroached by the Sahara. This is what many authors have arguably term desertification. Many studies (Bonan *et al*., 1992; Xue and Shukla 1993; Zhang *et al.*, 1996) have shown that the climate is altered when deforestation (mostly caused by human activities) occurs, due to land-atmospheric feedbacks. Charmey (1995) argued that bare soils have a higher albedo than vegetation surface, therefore, a decline in rainfall following increased deforestation is a possibility.

II. MATERIALS AND METHODS

STUDY (SITES AND) AREAS

Three randomly designed plots measuring 50mx50m were set up on a vegetational gradient covering a stretch between Ganaja Village and Ajaokuta town in Ajaokuta Local Government Area of Kogi State. The latitudinal position of the study sites ranges from Lat. $7^0 40^1 33^{11}$ N and Long. $6^0 43^1 10^{11}$ E to Lat $7^0 41^1 08^{11}$ N and Long $6^0 43^1 16^{11}$E this area has been observed to have undergone different levels of human interference such as farming activities of different sort coupled with high degree of vegetal exploitation.

The study also attempted identifying to species level, the types of woods commonly consumed in form of wood fuel in Lokoja, a city which is contiguous to the vegetation cover of these area, where most expectedly all farm and forest produce are marketed by virtue of its population- being State capital. The study area has an average minimum temperature of 22.8^0C and average maximum temperature of 33.2^0C. The state has two distinct weathers-dry season which last from November to February and rainy season that normally last from March to October. Annual rainfall ranges from 1016mm to 1524mm. The fuel wood study was undertaken in three predetermined selling point "depots'' in Lokoja: One major-Kabawa along river Niger, and two other supporting mini-depots at Zariagi and Ganaja villages.

STUDY LAYOUT (FIELD STUDIES)

The study design was a Complete Randomized Block Design.(CRBD) All evaluations were conducted along a transect with three segments (Blocks) that extend from open areas (seriously disturbed) by consisted farming through partially disturbed (encroached forest with evident) human activities such as wood logging and fires to relatively undisturbed, unencroached area of the naturally forested area.

A plot each measuring 0.5 km x 0.5 km was mapped out in the disturbed, encroached and unencroached areas representing segments of vegetal exploitation in the study sites. Within each of these plots, two clusters of 50 m x 50 m (0.25 ha) were set up avoiding the edges of the larger plot by at least 50m.

FLORISTIC STUDIES

Studies on floristic parameters were conducted between late July –early October 2021 and it was repeated in July –September 2022. The 2500 m^2 plots (0.25 ha) was sectioned into five strips of 10 mx50 m. Within each strip, total woody plants identification and enumeration was carried out. Each plant was identified and the basal diameters of each woody plant (except wildlings) were measured with a measuring tape. Each plant was identified using alpha identification method with the help of Flora of West Tropical Africa (3^{th} Edition) and Hausa, Fulfulde and Scientific names of plants by E C Agishi and Yahaya Shehu.

Herbaceous plant population and identification were carried out in each of the plot by using; five randomly placed one square meter quadrats. The herbs were harvested, weighed fresh on the field, and sub-sampled for dry matter (biomass) determination. (Tiseer 2009)

FLORISTIC DATA TREATMENT

WOODY PLANTS: The populations of plant in each location were recorded in raw field table by plot/segments, which were later converted into a synthesis table to show constant species and social groups. Plants frequencies, similarities and diversity for transect segments and locations were determined.
For diversity study, the Simpson's index of diversity was used, which is a measure of species richness of a plot while taken into account the degree of evenness of all the species present simultaneously.

This is given by 1-D

$$D = 1 - = \frac{\sum n \quad (n-1)}{N(N-1)} e$$

The Shannon-Weiner diversity Index was used to determine the degree of entropy of sites diversity, it describes the level of sites dissimilarity that is, the probability that when two species are taken at random they will belong to different species. It is calculated manually thus;

H' = ƐPi£nPi where

H' = Diversity index

Where ni= number of particular species.

N= Total number of individuals in the plot.

Pi= proportion of any individuals in the plot.

LnPi= Log_n of Pi.

The similarity between plots was worked upon using Gleason's modification of the Jaccards index as follows;

$I_{SG =}$ 2C/A+Bx100

Where C= number of species common to both plot.

A= Total number of species in the first plot.

B= Total number of species in the second plot. (Condit.1998)

The basal circumference of woody plant boles will be converted to radii and diameter, with the unit in meters.

Basal area (BA) = πr^2 (m^2)
$C=2\pi r$, $r=C/2\pi$
The unit of the radius/diameter is meter. The derivation was necessary to work out the stem cover per hectare using the basal area index.

The basal area of woody trees species shall be taken as dominance value of the species as well as production parameter of the study site.

HERBACEOUS PLANTS
The herbage yield was assessed by evaluating proportion of sub-sampled that constitutes the herbage dry weight as follows;

Percentage dry matter= sub-sample dry weightx100/subsample fresh weight.

The dry weight of herbaceous plant in each location was reported separately as herbaceous dry matter.

FUELWOOD STUDIES
Three fuel wood depots in Lokoja were visited, from each depending on the volume of available fuel wood. A total of 200 wraps of fuel wood were randomly selected and observed. Each species in the wrap were identified and recorded.

TREATMENT
The data collected were summarized in a synthesis table, the frequency of species in various (families) and relative frequencies were determined in relation to others.

Simpson's Index of diversity was used to determine the diversity of woody plants already converted to firewood. The value of diversity index was compared to indexes of different plant species (woody) in different field plots.

The major vendors/dealers at this large collection depot were Northerners whose major language is 'Hausa' while the names of the plants were later converted to botanical names using appropriate manual such as the compendium put together by Agishi and Shehu (2004).

STATISTICAL ANALYSIS
Other than the Simpson's Index of diversity and Shannon-Weiner diversity index, Chi-square analysis was used to analyze the level of similarity and herbage (biomass) yield of different field plot under study. Multiple bar-chats were used to analysis possible relationship between fuel wood consumption and alpha/beta diversities of studied sites on family basis.

III. RESULTS

Wood fuel Diversity
A total of 43 different woody species were seen in site 1 (Kabawa), 37 in site 2 (Zariagi) and 33 in site 3 (Ganaja Village). The total number of identifiable fuel wood species in the three sites were 1096,640 and 420 respectively giving the sum total of 2156 sampled. The number of each species was recorded together with their relative frequencies. All the species observed as fuelwood and in field studies were summarized in to 22 plant families for futher comparison. It was observed that Kabawa with the largest wood collection has the greatest Shanon diversity of 1.438, followed by Zariagi with a value of 1.399 and Ganaja 1.171 their Simpson index of diversity was calculated as 0.959 for Kabawa, 0.950 for Zariagi and 0.944 for Ganaja. This result implies that the evenness and floristic richness of this selling point are essentially the same. Fuel wood species in these area would face the same level of threat as they have the same general level of distribution.

FLORISTIC ANALYSIS OF WOODY SPECIES IN THE STUDY AREA
A total of 377 woody species were enumerated classified into 19 species and 10 Families, analysis of the result showed that the H'= 0.8575 which was observed to be less than the least value of the third fuel wood study site (Ganaja village) of 1.171 which means that the wood fuel species have a higher diversity value than vegetational diversity of the study sites. Considering the species richness and eveness of distribution it was also less than woodfuel species observed 0.8191 as opposed to average value of 0.951 of the three sampling sites. Critical observation of the data showed that 10 families of woody species were encountered during the study in the field while additional 12 families were observed in fuel wood sampling making it a total of 22 families

COMPARATIVE ANALYSIS OF WOODFUEL SPECIES AND FIELD SPECIES ON FAMILY BASIS.

This analysis showed the comparison of families of woody species found in the study, the number of each species representing each of the families both in the woodfuel depot and in the study field, for the woodfuel species, the total summation of all the relative frequncies were compared to the Importance value (IV=relative frequncy+ relative density+relative dominance) of the woody species in the field, of the ten families that were enumerated in the field only seven (7) have members that were actually tree-like with measurable diameter at breast height DBH making estimation of dominance value possible. These families include *Combretaceae, Apocynaceae, Annonaceae, Rubiaceae, Caesalpinioideae, Verbanaceae, Mimosoideae.* Other families that were represented by only wildlings include members of *Papilionoideae, Ebenaceae and Polygalaceae,* this is indication of threat of some sort to this group. Although, some members were properly represented in terms of their frequencies, many of them exist as wildlings a sign of slow regeneration of such species members of these category include the families *Apocynaceae, Caesalpinioideae and Combretaceae*. Further analysis shows that some familes that were represented in form of fuel wood were not seen in the field, this incursion might have been due to the importation of fuel wood from other part of the neighbouring state such as Niger,Nasarawa and the suburb of FCT.

Table 1: Comparative Results of woodfuel species and field species on family basis.

Family Name	Fuelwood ni		Field species	IV
Olacaceae	*1*	*0.031*	-	-
Verbenaceae	*3*	*0.067*	*2*	*0.049*
Combretaceae	*9*	*0.889*	*4*	*2.008*
Myrtaceae	*1*	*0.017*	-	-
Dipterocarpaceae	1	0.028	-	-
Bignoniaceae	2	0.128	-	-
Meliaceae	1	0.270	-	-
Hymenocardiaceae	1	0.150	-	-
Apocynaceae	2	0.142	1	0.694
Anarcadiaceae	1	0.014	-	-
Caesalpinoideae	4	0.393	2	0.146
Loganiaceae	1	0.006	-	-
Burseraceae	2	0.065	-	-
Mimosoideae	3	0.369	1	0.080
Polygalaceae	1	0.008	1	-
Papilionoideae	3	0.181	1	-
Sapotaceae	1	0.072	-	-
Rubiaceae	2	0.048	4	0.035
Euphorbiaceae	3	0.106	-	-
Rhamnaceae	1	0.005	-	-
Annonaceae	-	0.00	1	0.399
Ebenaceae	-	0.00	1	0.00

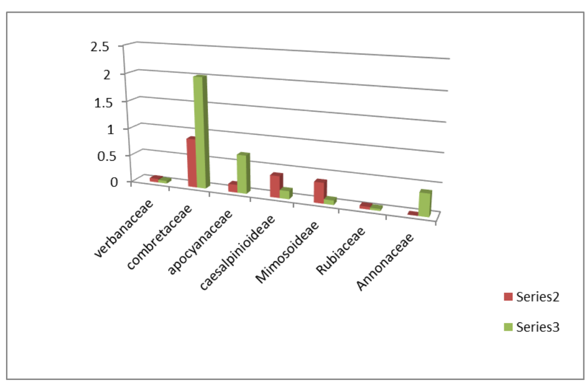

Figure 1: Multiple bar chart comparing seven families of fuelwood and field species

The result of the analysis of different plots in terms of number of woody species in relation to their plot similarity caculated on the basis of Gleason modification of Jaccard's Index. It was observed that, the Similarity index between plots 1 and plot 2 is 47.6%, plots 2 and plot 3 have higher index of 59.3%. it is quite interesting to note that plots 1 and plot 3 have similarity index of 58.3% which implies that plots 1 and 3 have more species in common and higher level of floristic degradation as a result of higher proximity to the highway and farming activites.

The average herbaceous yield of the plots have a range of 139.4gm^{-2}, while the result of the field studies showed that plot 3 possessed avaerage herbage yield of 335.2gm^{-2}. The grass population in the study area is generally low giving way to Forbes species such as *Pueraria phseoloide*s and *Chromolena odorata* as the dominant botanical features of the forbe/grass matrix stratum. The result of the herbage biomass yield is in consonance with number of woody species enumerated in the study area, which suffice further evidence of foristic degradation. Chi-square analysis of the result showed a very high significant difference in the figures obtained, this implied that the three parameters under consideration- number of woody species, similarity between plots and herbage biomass yield values are independent of the locations of the plots but on general human activities across the study area.

The relative productivity of various families (mha^{-2}) in the study area with reference to their basal area index in square meter showed that, *Combretaceae* have the highest total basal area of all the members,with a value of 7.718m^{-2} and a total corresponding productivity value of 65.11mha^{-2} followed by the family *Caesalpinodeae and Mimosoideae* with a total family productivity values of 11.51mha^{-2} and 2.571mha^{-2} respectively. Three families *Papilionoideae, Ebenaceae, Polygalaceae* only existed as wildlings.

IV. DISCUSSION

From this study, it was observed that farming activities and fuel wood harvesting were the overwhelming causes of deforestation in the entire study area. As a result of increase in population in the Local Government Area, people resorted to the clearing of forest to provide shelter and also to plant crops either for subsistence or for sale in the markets in order to augment a living. The implications of these findings were that farming activities when not practiced in a sustainable way can lead to the destruction of tree species. This is supported by the earlier findings of Myers (1991), Vanclay (1993), Marcoux (2000), as cited by Abiola *et al* (2016). The study noted heaps of fuel wood for sale in most of the farmlands contiguous to the field plot studied. The reason could be attributed to the high cost of alternate energy sources which is beyond the reach of the rural poor as observed by (Sambo 2005). Grazing activities was found to be prevalent in the study area which is worsening the floristic poverty of the study area. The species richness and evenness of distribution of the sampling sites for fuel wood analysis have the same level of diversity; this is in conformity with similar number of distribution of species. The result of the field studies revealed *Linnea acida, Annona senegalensis, Daniella oliveri, Combretum ghaselense, Piliostigma thoningii and Combretum glutinosum* as dominant species in terms of numerical representation, although many of the species present exist only as wildlings and saplings of normally tall mature woody species, which account for low basal area index of would be tall woody trees species. Only ten families could be worked upon to determine their productivity and dominance (degree of cover) in meter square per hectare. Families with basal area and corresponding measurable production parameter (mha^{-2}) are: Combretaceae, Caesalpinoideae, Mimosoideae, Rubiaceae, Apocyanaceae, Annonaceaea, Verbenaceae, Papilionoideae, Ebenaceae and Polygalaceae, with the last three families existing only as wildlings and saplings, an indication of former degradation of these families whose member are under recovery if left undisturbed for a reasonable number of years.

Comparative analysis of these species showed that, the family *Rubiaceae, Mimosoideae, Verbenaceae , Caesalpinoideae and Combretaceae* were vulnerable to more degradation, while members of *Sapotaceae, Olacaceae, Bignoniaceae, Meliaceae, Hymenocardiaceae, Anarcadiaceae, Myrtaceae, Dipterocarpaceae, Polygalaceae, Burseraceae* were found in the fuel wood sampling sites but totally absent in the field a symbol of vegetative vulnerability of this species in the wild. This is in accordance with the findings of Isichie (2010), who identified the distribution of different endangered species on family bases using FMAWR&RD 1986 as a criterion, thirteen families were found to fall in line with this study these are, *Apocynaceae-19, Anarcadiaceae-7, Annonaceae-15,Burseraceae-1, Olacaceae-1, Moraceae-9, Mimosaceae-3, Combretaceae-9, Ebenaceae-7,Papilionaceae-2, Rubiaceae-16*, *Sapotaceae-2* and *Verbanaceae-2.* In the same manner, Akinsoji *et al.,* (2016), using the IUCN status showed that the following species requires urgent attention while many tropical species are yet to be ecologically assessed to determine their status- *Afzelia africana-Vulnerable, Irvingia gabonensis- Threatened, Khaya grandiflolia-Vulnerable, Khaya senegalensis-Vulnerable, Milicia excelsa- Threatened, Entandrophragma angolense- Vulnerable, Annona senegalensis- Not assessed and Burkea africana- Not assessed.* The result of the field work did not document any member of *Khaya sp, Milicia sp, Irvingia sp, Entandrophragma sp and Afzelia africana* except for wildlings of *Annona senegalensis* an evidence of their true vegetative vulnerabilities – a sure pathway to near future extinction. Orimoogunje (2015) established from his studies in South-Western Nigeria, that the ecological implications of fuel wood use largely depend on the method of fuel wood harvesting. When carried out on a sustainable basis, in the tropical South-Western rain forest, fuel wood harvesting provides benefits, like the reduction in the probability of forest fires, reduction in forest pests and diseases, and even the acceleration of tree growth (that is, acting like a selective pruning) to local forests. Over-harvesting of fuel wood, on the other hand, leads to a wide range of local and global environmental impacts, including forest degradation, loss of biodiversity leading to soil erosion, changes in nutrient cycles, and emissions of greenhouse gases.

His findings also showed that, all the indigenous trees noted for the area, such as *Milicia exclesa*, *Triplochiton scleroxylon*, *Nesogordonia papaverifera*, and *Cordia sp.* have disappeared and the whole area is currently dominated by exotic species such as *Gmelina arborea*, *Tectona grandis*, a somewhat similar floristic situation of Kogi – the most centrally located State in Nigeria's Guinea Savanna. Chi-square analysis of the similarity and dry matter yield of herbaceous species showed a very high significance difference P<0.01 in comparison on the basis of the number of individual species found per sampling plot. The result of the analysis showed that, the degradation of tree species in the study plot is occurring at the same rate and the values obtained for the similarities and herbaceous matter is dependent on woody species degradation, the disappearance of the woody species explains the gradual giving way for the dominance of two forbe species; *Hiptis suaveolense and Pueraria phaseoloides.*

Nigeria is blessed with renewable energy sources if harnessed judiciously will reduce the dependence on fuel wood usage as an energy source. Hence, the problems associated with solid fuel will be greatly minimized

PLATE1:Collection of fuelwood

PLATE 2: Villagers sighted hunting

PLATE 3: Stump of fresh woody species cut down seen in a study site

Table 2 FLORISTIC ANALYSIS OF WOODY SPECIES IN STUDY AREA (SUMMARY)

	Botanical Names	Family Names	n1	Pi	Density	r.density	Mha^{-2} dominance	r.dominance	$P_iL_nP_i$	IV
1.	*Anogeisus leiocarpus*	Combretaceae	14	0.037	0.011	0.036	2.122	0.026	-0.053	0.099
2.	*Linnae acida*	Apocynaceae	131	0.347	0.106	0.347	0.024	0.0003	-0.159	0.694
3.	*Annona senegalensis*	Annonaceae	75	0.198	0.061	0.200	0.131	0.0016	-0.139	0.399
4.	*Gardenia erubescens*	Rubiaceae	2	0.0053	0.001	0.0003	-	-	-0.012	-
5.	*Daniella oliveri*	Caesalpinoideae	25	0.066	0.020	0.065	11.510	0.014	0.078	0.146
6.	*Combretum ghaselense*	Combretaceae	28	0.0742	0.022	0.072	53.71	0.673	-0.084	0.819
7.	*Vitex doniana*	Verbenaceae	6	0.0159	0.0049	0.016	-	-	-0.029	-
8.	*v. simplicifolia*	Verbenaceae	9	0.0238	0.0073	0.023	0.179	0.0022	-0.0386	0.049
9.	*Combretum nigericans*	Combretaceae	1	0.0026	0.0008	0.0003	0.187	0.0023	-0.0067	0.0079
10.	*Piliostigma thoningii*	Caesalpinoideae	26	0.069	0.021	0.069	-	-	-0.0800	-
11.	*Combretum glutinosum*	Combretaceae	25	0.066	0.020	0.065	4.775	0.0598	-0.0781	0.1911
12.	*Acacia subterreana*	Mimosoideae	7	0.0186	0.0057	0.018	-	-	-0.032	-
13.	*Gardenia aqualla*	Rubiaceae	3	0.0079	0.0024	0.0079	-	-	-0.0166	-
14.	*Pterocapus erinaceus*	Papilionoideae	5	0.0133	0.0041	0.013	-	-	-0.0250	-
15.	*Sarcocephalus sp*	Rubiaceae	6	0.0159	0.0048	0.016	0.220	0.0028	-0.0290	0.035
16.	*Parkia biglobossa*	Mimosoideae	9	0.0239	0.0073	0.024	2.57	0.0322	- 039	0.080
17.	*Diospyros sp*	Ebenaceae	3	0.0079	0.0024	0.007	-	-	-0.0166	-
18.	*Gardenia ternifolia*	Rubiaceae	1	0.0026	0.0008	0.0026	-	-	-0.0067	-

19	*Combretum reticulosum*	Combretaceae	1	0.0026	0.0024	0.0070	4.326	0.054	-0.0067	-

N=377, H'=0.8575,1-D=0.81

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