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An Assessment of the Shrub Species of Kanawa Forest Reserve (KFR), in Gombe State, Nigeria

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ABSTRACT

The aim of this paper is to present the results of the assessment of shrub species in Kanawa forest reserve in Gombe State, Nigeria. The study was conducted between 2009-2011 in Kanawa Forest Reserve in order to obtain a shrub diversity data. The Point Centered Quarter method for Sampling grassland and woodland was employed for the study. Six sites were selected and three transects measuring 100m were laid within each site, and data obtained were analyzed for relative density, relative frequency, relative dominance, and importance value index. 24 shrub species belonging to 7 families and 19 genera were identified. The family Leguminosae: Fabaceae had the highest number of thirteen species; malvaceae was represented by four species, while combretaceae had three species. The other four families namely: Rhamnaceae, Polypodiaceae, Sterculiaceae and Olacaceae were represented by one species each. Simpson Index of diversity and Shannon Wiener Index for shrubs were 0.948 and 4.41. Only site I and IV was positively associated among six different sites using and tested for significance of differences. It was concluded that based on their low importance value index, *Combretum nigricans*, *Tephrosia linearis* and *Indigofera arrecta* require more efforts on conservation.

Keywords: Shrubs, Diversity, Kanawa Forest Reserve, Inventory.

INTRODUCTION

In Africa and Asia, the value of shrubs has long been appreciated and often over used. [1]At least 75% of the shrubs of Africa and Asia serve as browse plants and many of these are leguminous[2]. Unfortunately, due in large part to over-usage by people and livestock, valuable shrub resources over vast areas in arid and semi-arid regions have been destroyed in the last few decades. In West Africa, firewood is the major source of energy used for cooking, heating, and other domestic purposes, and woodfuel, including fuelwood and charcoal, accounts for about 90% of the total energy consumption[3].The main vegetation cover used by the households to produce woodfuel is obtained from natural forests, and management strategies are expected to make this ecosystem sustainable by ensuring good regeneration after harvesting. Local businesses in surrounding environment of Kanawa forest reserve depend largely on illegal cultivation of the forest shrubs as a means of livelihood. Shrubs like *Combretum nigricans* and *Combretum micranthum* were good sources of fuelwood. *Senna alata*, *Senna tora* and *Senna occidentalis Guirea senegalensis, Senna singuena* are highly sought for their medicinal uses, while *Ximenia americana, Ziziphus mauritiana* are sought for their dietary properties while *Crotalaria retusa* are used as ornamentals. Shrubs have been overlooked in proportion to the research effort devoted to agricultural cropland, pasture grasses and fruit tree crops. [4]McKell pointed out that shrubs and trees are the most visible plant forms in many landscapes. Shrubs have been neglected in almost all scientific research[5], mostly land management policies, ecology, silviculture, Agriculture and forestry [6].

[1] Badresa and Moore,(1982) Cloudsley-Thompson, (1974)
[2] Skerman (1977).
[3] (Brocard et al. 1998; Nygard et al. 2004).
[4] Mkell (1980)
[5] McKell, (1974)
[6] Le Houérou in Mckell, 1972

Motivated by a desire to increase livestock forage and reduce the density of low palatablity shrubs, numerous research efforts have concentrated on methods for shrub eradication[7] or control[8]. The magnitude of these efforts have inclined many students, research workers and land managers toward the biased view that most, if not all, shrubs are of low-value and only by converting shrub lands to grasslands can a productive system be obtained. This approach overlooks opportunities for making multiple use of shrubs for grazing, firewood, control of desert encroachment, medicinal and industrial products, landscaping, construction, wind breaks, wildlife habitat, maintaining soil fertility and soil stability, and balancing forage nutrient quality during the dormant season of grasses. An international symposium on the biology and utilization of wildland shrubs [9] attempted to overcome this bias against useful shrubs. Certainly there must be agreement that worldwide problems in energy supply and cost have implications for the way in which low-value natural resources of arid and semi-arid lands can best be managed in the future and make urgently necessary the implementation of knowledge presently available.

It is in view of these factors that it became necessary to take stock of the status of the shrub vegetation of kanawa forest reserve. The data obtained could be used as a baseline study and also used to develop conservation strategies in order to ensure sustainability of Kanawa forest. Unfortunately the forest has been neglected by the relevant authorities, hence giving rise to loss of vegetation, something which these authors are determined to raise awareness on.

MATERIALS AND METHODS

The Study Area

Kanawa Forest Reserve is located in the North Eastern part of Nigeria in Yamaltu/ Deba Local Government Area of Gombe State, Nigeria, and it lies in the Southern part of the Sudan Savanna between latitude 10^{o} 16'N and 10^{o} 18' 30''N longitude 11^{o} 18'10'' E and 11^{o} 22' 09'' E. The size of the forest was 41 hectares[10]. Kanawa Forest was gazetted as a forest reserve on the 26th day of February, 1953 by the Governor of the then Northern region in Kaduna state, Nigeria. It is presently under the management of ministry of environment Gombe State, Nigeria. The study area is at an altitude of 336m-390m above sea level with dendritic shallow V-shaped drainage[11]. The soil types were loamy sand, sandy and sandy loam types[12]. The climate of the area is characterized by two distinct seasons: The rainy season lasts from April through October and the dry season lasts from November through March. The rainfall pattern is bimodal with an annual total which ranges from 658- 923 mm. The mean annual temperature ranges from 32.2 ^{0}C to 32.8^{0}C. The vegetation of Kanawa Forest Reserve is a mosaic made up of dense sudan savanna vegetation especially around the hilly part of the reserve (Site V1). Marshy(Site 1V), riparian (Site1), lowland rainforest vegetation near the Poli stream (Site 11) grassland with tall grasses (Site 111) and thorn vegetation in the drier part of the forest (Site V) (Fig 1). The entire forest reserve is presently (53 hectares plot) because of acquired farmlands by the Gombe state government. It was then divided into six (6) sites for vegetation sampling. In each site, three sampling locations were identified (Fig 1).The criteria for selecting the sites were topography, soil types and vegetation types.

[7] Cook (1958)

[8] Scifres *et al.*, (1973)

[99] Le Houérou in Mckell, (1972)

[10] Gombe Native Authority (1945)

[11] Samaila (2011)

[12] Abba *et al*., (2013a)

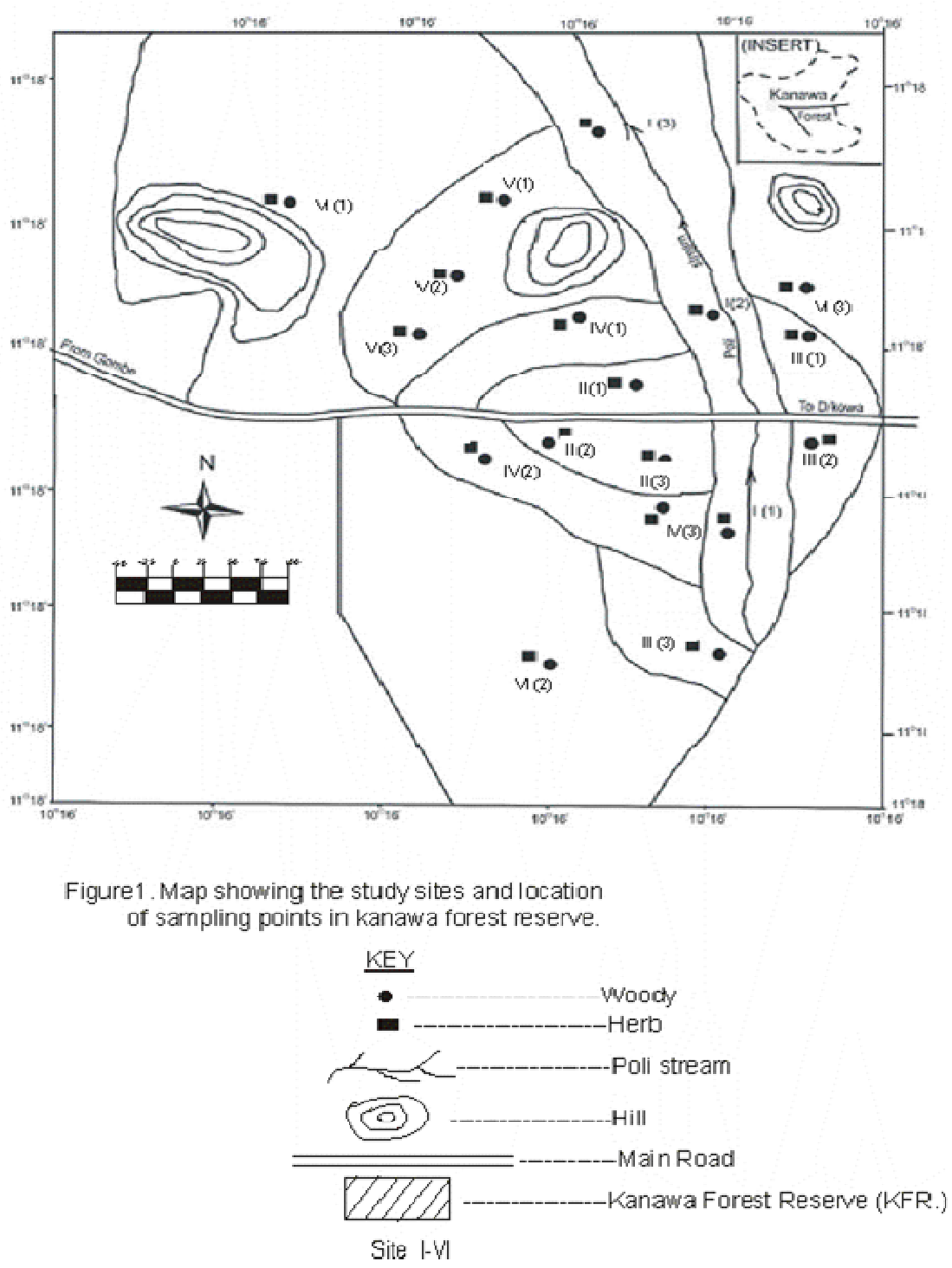

Figure1. Map showing the study sites and location of sampling points in kanawa forest reserve.

Sampling procedure and Methodology

Systematic method of sampling of vegetation was employed for the present study. In this method, the main units were selected according to a predetermined pattern with the selection of the sampling grid as the only element of randomization. This is commonly used in forest inventory[13]. A starting point was selected at random along each

[13] (Dix,1971)

transect of 100 m long[14] and a steel pin was pushed into the soil to act as a marker. A tape was attached to this point and four quarters were demarcated and the nearest plant in terms of distance to the point was recorded in meters in each quarter. This was done for all the sampling points on each transect. There were 10 sampling points on each line transect. With Three transects (1, 2, 3) of 100m long each laid per site, a total of 30 sampling points were identified with 120 species in each site. There were six sites for the shrub vegetation.

Data collection and Analysis.

In each sampling point all nearest shrub species encountered were listed. In each site, all living shrubs with diameter at breast height (DBH ≥ 4.5 cm) were measured with measuring tape in each quarter and recorded. Species encountered were identified on site with the help of field guides and floras and texts containing coloured photographs [15] The specimens were collected and compared with herbarium specimens of the Biological Sciences Programme Tafawa Balewa University, Bauchi, Nigeria. Nomenclature of the species follows[16]

Data obtained were quantitatively analyzed for Relative density, Relative frequency, Relative dominance following [17] and the relative values were summed up to represent Importance value index(IVI) as per[18] The formulas used to calculate RD, RF,RDo and the importance value index (IVI) are as follows [19]

RD = (number of individuals of a species)/ (total number of individuals of all species) x 100.
RF= (frequency of one species)/ sum of all frequencies) x 100
RDo = (combined Ba of single species)/ (total Ba of all species x 100)

The sum of the above three relative measures for a species is an index called the Importance Value (IV1). IVI = sum of (RF+ RD + RDo) /3

The value of IV1 may range from 0 to 3.00 (or 300%). Dividing IV1 by 3 will result in a figure that ranges from 0 to 1.00 (or 100%). This value is referred to as the importance percentage.

Species diversity was calculated using Simpson's index[20]

D = (N (N-1)) / (summation of n (n-1)). D is the diversity index, N is the total number of organisms of all shrub species found, n is the number of individuals of a particular species.

Species diversity index was also calculated using the Shannon-Weiner index [21]

$$H' = -\sum_{i=1}^{R} p_i \ln p_i$$

Where H'= Shannon –Weiner diversity index
pi **=** is the proportion of each species in the sample.
R =total number of species
∑ = Sum.

Chi-Square analysis was calculated using the following formulas:

$\chi = n (ad-bc)^2 / (a+b) (c+d) (a+c) (b+d)$ ----------i
$r = ad-bc / \sqrt{\{(a+b) (c+d) (a+c) (b+d)\}}$ ----------ii

[14] (Cottam and Curtis 1956; Dix, 1971, Smith and Smith, 2001)

[15] (Von Maydell, 1990: Hawthorne, 2006).

[16] Hutchinson and Dalzeil (1972).

[17] Cottam and Curtis (1956) ; Dix (1971)

[18] Curtis (1959).

[19] (Misra,1968, Dallmier,1992; Sabogal,1992; Abdullahi, 2010):

[20] (Simpson, 1949).

[21] (Shannon, 1948).

for chi-square and correlation coefficient[22]

From the above equations;

n = number of species in the data set
a = number of species common to sites A and B
b = number of species present in site A but not B
c = number of species present in site B but not A
d = number of species absent in site A and B
χ = chi-square
r = correlation coefficient.

RESULTS AND DISCUSSIONS

A total of 24 species belonging to 19 genera and 7 families were identified in Kanawa Forest Reserve within an area of 53 hectares (Table 1) of which 11, 11, 11 ,12, 9.12 species were encountered in the riparian (site1), lowland rainforest vegetation near the Poli stream (Site 11), grassland with tall grasses (site 111), Marshy (site 1V), and thorn vegetation in the drier part of the forest (site V), dense Sudan savanna vegetation especially around the hilly part of the reserve (Site V1) respectively.The family Leguminosae:Fabaceae had the highest number of species (13). Malvaceae was represented by four species. Combretaceae had three species. The other four families namely: Rhamnaceae, Polypodiaceae, Sterculiaceae and Olacaceae were represented by one species each. Leguminosae: Fabaceae and Malvaceae were families known to be native species in most savannah-woodland mosaics in Africa and are important familes in tropical deciduous forests[23] A similar report was presented by[24] in Kalfou Forest Reserve, Cameroon and Tiogo forest in Burkina- Faso.

A study was carried out by [25] in a 7.2 ha in Ukpom Community forests in Akwa Ibom State and obtained 13 shrub species and in a 6.84 ha at Ikot Annang Community forests in Akwa Ibom State obtained 10 species of shrubs.[26]also carried out a similar study at IITA Forest Reserve and identified 14 shrub species. The number of species obtained for the above studies were lower than that of the present study mainly because of differences in the size of the reserves or high disturbance together with abiotic/ climatic factors.

Another study was also carried out by[27] and obtained 14 species of shrubs belonging to 12 families in the forested north- eastern region of Bangladesh. The number of species for the present study was higher probably because of the soil type, high moisture content and its position as a forest reserve. Another study was carried out by[28] in Sandwip upazila (subdistrict; administrative entity) of Chittagong district and recorded 25 species of shrubs. Another study conducted by[29] in Khadimnagar National Park of Bangladesh where 17 shrub species were obtained.[30] carried out a similar study in Tiogo forest in Burkina Faso in West Africa and obtained a total of 89 woody species (trees and shrubs) representing 29 families and 66 genera of which 67 species were recorded in the dense woodland, 60 species were recorded in the open woodland, 35 species were recorded in the fallow, and 23 species were recorded in the gallery forest, respectively. Also a total of 86 woody species (trees and shrubs) representing 58 genera and 28 families were found in the Kalfou Forest Reserve, of which 68, 76, 76, 79, and 83 species were identified in the Barodewol, Hadande, Saroudja, Doulouk, and Gonoray parts, respectively.

Table 2 shows relative density for shrubs. The shrub species *Senna tora* (67.00%) had the highest relative density in the reserve. This shows that *Senna tora* was the most abundant and has a wide range of geographical distribution in the reserve and could be known as a cosmopolitan plant. This abundance could be due to the fact that *Senna tora* belongs to the Fabaceae, in the Leguminosae family whose seeds are dispersed through explosive mechanism and by the help of ants and in the dry season they shed many seeds from their pods. Some of them may

[22] (Causton, 1988).

[23] (Ceccon *et al.,* 2002).

[24] Moksia *et al*., (2012); Sawadogo *et al*., (2007)

[25] Olajide and Udo (2011)

[26] Ariyo *et al.,* (2011)

[27] Al Amin *et al.,* (2007)

[28] Alam and Masum (2005)

[29] Rahman and Sobuj (2011)

[30] Sawadogo *et al*., (2007) and Moksia *et al*., (2012)

germinate sporadically in the field[31] *Senna alata* was the least species in the forest mainly because it was highly sought for medicinal purposes. Local people prefer medicinal plants due to their easy availability and cheap therapy as compared to costly pharmaceuticals. Local people have also discovered the therapeutic activity of medicinal plants against certain diseases through their indigenous experiences transferred to them from their ancestors[32]. Another reason could be the lack of wide geographical distribution of the plant. The shrub species with the highest relative density at site I was *Dathura arborea* (15.33%).This was due to the high moisture contents and high nutrient status at site I[33] and, the plants tend to reseed themselves and may become invasive hence the high value. The shrub species with the lowest relative density was *Desmodium velutinum* (5.00%) and *Urena lobata* (5.00%) at site I. *Dathura arborea*, *Dichrostachys cineria* and *Urena lobata* at site II. *Piliostigma reticulatum* (5.00%) at site III, *Chamaecrista mimosoides* and *Tephrosia linearis* (5.00%) at site 1V. *Combretum nigricans* and *Piliostigma reticulatum* (7.50) at site V. *Combretum micranthum*, *Piliostigma reticulatum* (5.00%) at site VI. They were low because of the presence of engine oil which polluted the soil around site I near Poli stream due to car washing close to the main road. The presence of motor road which cut across the forest also encouraged trespass by man and animals which could be another factor causing the low values.

The relative frequency for shrubs is presented in (Table 3). *Senna tora* had the highest relative frequencies (58.54%) in the reserve.This shows that the distribution of *Senna tora* in the reserve was random mainly due to their ability to grow well in a wide range of sites. The lowest relative frequency in the reserve was recorded for *Combretum nigricans* (6.67%). *Combretum micranthum* (19.75%) had the highest relative density at site V while the lowest relative frequency (4.18%) was recorded for *Dichrostachys cineria* at site II. They all showed clumped distributions due to unequal distribution of mineral nutrients.This study was in line with the findings of[34] who investigated woody shrub species at Tiogo forest in Burkina faso, West Africa.

The relative dominance of shrubs in the reserve are presented in Table 4. The shrub species with the highest relative dominance in the reserve was *Ximenia americana* (72.95%), mainly due to their large size. The shrub species with the lowest relative dominance in the reserve was *Pavonia hirsuta* (5.12%) with their small size. The shrub species *Senna alata* (44.8%) had the highest relative dominance at site III, mainly due to their size , soil type and moisture contents. The species *Senna italica* (0.16%) had the lowest relative dominance at site I due to due its small size, grazing pressure and human disturbance.

Table 5, presents the importance value index of shrubs in the reserve. *Senna alata* (45.64%) had the highest importance value in the reserve. *Ximenia americana* (22.30%) had the highest importance value at site V. This indicates that they are the most important shrubs in the reserve. According to [35], high importance value index (IVI) of a species gives an overall estimate of the influence of importance of a plant species in the community, its dominance and ecological success, greater ecological amplitude and shows that the shrub species had greater influence in the community. These plants therefore need only monitoring managements. *Tephrosia lnearis* (7.77%) had the lowest importance value in the reserve which indicates that it is the least important shrub in the reserve. *Piliostigma reticulatum* and *Pavonia hirsuta* (4.19%) had the lowest importance value at site VI. Generally within the forest *Dichrostachys cineria* (4.33),*Desmodium velutinum* (4.85), *Combretum micranthum* (4.35), *Piliostigma reticulatum, Pavonia hirsuta* (4.19), *Urena lobata* (4.99) were the species that were grouped as having low importance value index and were rare and therefore need high conservation efforts.

The results of Simpson's index of diversity (1-D) was (0.95), while Shannon- Weiner index of diversity for the study area was (4.41) for shrubs. The values were high indicating a more complex and healthier community because a greater variety of species allows for more species interactions, hence greater system stability, and indicates good environmental conditions. The high diversity could also be due to the high fertility related parameters and high moisture contents in some sites [36].

The results of the association, similarity and correlation between sites for shrub species (Table 6) revealed that site I and IV had the highest values of association (5.92) between two sites for both positive and negative associations which indicates higher associations between the two sites while site III and VI had the lowest values of association (0.01) indicating lower associations between the two sites. Eight sites had positive associations; these were site I and III, II and IV, II and III, II and IV, III and V, V and VI.

[31] (Etejere and Ajibola,1990).

[32] (Qureish, 2004)

[33] (Abba *et al.,* 2013a)

[34] Sawadogo *et al.,* (2007)

[35] Curtis and McIntosh, (1951; Cumming, (1990); Cox *et al.,* (1994); and Abdullahi, (2010)

[36] (Abba *et al.*, 2013a)

Site 1/111, site 11/111, site 11/1V, site 111/V had highest correlation between two sites indicating high correlation between the two sites while site 111/V1 had lowest correlation between the sites at ($P<0.01$). There was only one significant positive association for site I and IV.

The S_x (sum of chi-square) values were similarly less than the total number of species in the data set (24) showing dissimilarity between the sites and and S_r (sum of correlation) was ≤ 1 except for the eight positive relationships depicting similarities between the sites and heterogeneity of the shrub flora of Kanawa Forest Reserve. According to [37] species distribution in areas with high diversity is always heterogeneous.

CONCLUSIONS AND RECOMMENDATIONS

Twenty four (24) shrub species were identified at Kanawa forest reserve in Gombe State, Nigeria. These shrubs belonged to 19 genera and 7 families. The family Leguminosae: fabaceae had the highest number of 13 species. The frequent species in the reserve were *Senna tora* (67.00).The dominant ones included *Senna alata* (84.51).The densely populated species enumerated were *Senna tora* (67.00). Based on the Importance Value Index (IVI), species *Senna tora, Senna alata* and *Ximenia americana* were the most important shrubs species of the forest. Those with lower IVI values such as *Combretum nigricans* (Site V), *Tephrosia linearis* (Site IV), *Indigofera arrecta* (Site VI) must be conserved. Analysis of Species index of diversity was (0.95) while Shannon Weiner index values were 4.41.This was quite high indicating that the vegetation was complex. Kanawa Forest Reserve could be best described by the following shrub types *Senna tora- Senna alata - Ximenia americana* complex.

Table 1: Families and species of shrubs, identified in Kanawa Forest Reserve, Gombe State, Nigeria

S/No	Family	Species
1	Leguminosae: Fabaceae	*Senna alata L.*
		Senna tora Linn
		Senna italica (Mill.) Spreng. *Italica* (mill)
		Senna occidentalis L.
		Senna singuena (Del.) Lock
		Chamaecrista mimosoides L.
		Crotalaria retusa L.
		Datura arborea (Willd.) Pers
		Desmodium velutinum (Willd.) DC
		Dichrostacys cinerea Wight et Arn
		Indigofera arrecta Hochst.ex A.Rich
		Piliostigma reticulatum (DC.) HOCHST.
		Tephrosia linearis (Willd.) Pers
2	Combretaceae	*Combretum micranthum* G.Don
		Combretum nigricans Lepr.ex.Guill et Perrott
		Guiera senegalensis J.F. Gmel.
3	Malvaceace	*Hygrophila auriculata* (Schumach.)
		Malvastrum coromondelianum (L.) Garcke
		Pavonia hirsuta Guill.& per
		Urena lobata L.
4	Olacaceae	*Ximenia americana* L.
5	Polypodiaceae	*Dryopteris fillix-mas* (L.) schott.
6	Rhamnaceae	*Ziziphus mauritiana* Lam
7	Sterculiaceace	*Waltheria indica* L.

[37] Kumar *et al.*, (2006); Hussain *et al.*, (2000)

Table 2: Relative density of shrubs identified in Kanawa Forest Reserve, Gombe State, Nigeria

		Relative density (%)						
		Site						
S/No	Species	I	II	III	IV	V	VI	KFR (Total)
1	*Senna alata*		12.50	10.00	12.50			35.00
2	*Senna italica*	10.83	10.00	12.50	12.50			45.83
3	*Senna occidentalis*	6.67		15.00		10.00	10.75	42.42
4	*Senna singuena*		10.00	7.50	7.50			25.00
5	*Senna tora*	12.00	10.00	10.00	7.50	15.00	12.50	67.00
6	*Combretum micranthum*					10.00	5.00	15.00
7	*Combretum nigricans*					7.50		7.50
8	*Chamaecrista mimosoides*	5.83	10.00		5.00			20.83
9	*Crotalaria retusa*			10.00	7.50			17.50
10	*Dathura arborea*	15.33	5.00	7.50				27.83
11	*Desmodium velutinum*	5.00	12.50				7.50	25.00
12	*Dichrostachys cineria*	14.50	5.00			10.00		29.50
13	*Dryopteris fillix-mas*	10.83			10.00			20.83
14	*Guirea senegalensis*				10.00		12.50	22.50
15	*Hygrophilla auriculata*		10.00	6.67		12.50		29.17
16	*Indigofera arrecta*				7.50		5.75	13.25
17	*Malvastrum coromondelianum*	6.51	10.00					16.51
18	*Piliostigma reticulatum*	7.50		5.00	7.50	7.50	5.00	32.50
19	*Pavonia hirsuta*			6.67			6.00	12.67
20	*Tephtosia linearis*				5.00			5.00
21	*Urena lobata*	5.00	5.00	9.16			7.50	26.66
22	*Waltheria indica*				7.50		10.00	17.50
23	*Ximenia americana*					12.50	10.00	22.50
24	*Ziziphus mauritiana*					15.00	7.50	22.50

KFR= Kanawa Forest Reserve.

Table 3: Relative frequencies of shrubs identified in Kanawa Forest Reserve, Gombe State, Nigeria

		Relative frequency (%)						
		Site						
S/No	Species	I	II	III	IV	V	VI	KFR (Total)
1	*Senna alata*		16.67	10.00	4.55			31.22
2	*Senna italica*	13.01	8.33	5.00	4.55			30.89
3	*Senna occidentalis*	8.70		15.00		6.67	9.09	39.46
4	*Senna singuena*		8.33	5.00	4.73			26.21
5	*Senna tora*	8.70	8.33	10.00	9.09	13.33	9.09	58.54
6	*Combretum micranthum*					19.75	4.55	24.55
7	*Combretum nigricans*					6.67		6.67
8	*Chamaecrista mimosoides*	4.35	8.33		4.55			17.23
9	*Crotalaria retusa*			5.00	9.09			14.09
10	*Dathura arborea*	17.39	4.17	10.00				31.56
11	*Desmodium velutinum*	8.70	12.50				4.55	25.75
12	*Dichrostachys cineria*	8.70	4.18			13.33		26.20
13	*Dryopteris fillix-mas*	8.70			13.64			22.34
14	*Guirea senegalensis*				9.09		9.09	18.18
15	*Hygrophilla auriculata*		12.50	10.00		6.67		29.17
16	*Indigofera arrecta*				9.09		4.55	13.64
17	*Malvastrum coromondelianum*	8.70	8.33					17.03
18	*Piliostigma reticulatum*	8.70		10.00	13.44	6.67	4.55	43.36
19	*Pavonia hirsuta*			10.00			4.55	14.55
20	*Tephrosia linearis*				9.09			9.09
21	*Urena lobata*	4.35	8.33	10.00			9.09	31.77
22	*Waltheria indica*				9.09		13.64	22.73
23	*Ximenia americana*					13.61	13.61	27.22
24	*Ziziphus mauritiana*					13.33	13.64	26.97

KFR = Kanawa Forest Reserve

Table 4: Relative dominance of shrubs identified in Kanawa Forest Reserve, Gombe State Nigeria

		Relative dominance (%)						
		Site						
S/No	Species	I	II	III	IV	V	VI	KFR
1	*Senna alata*		12.1	44.8	13.8			84.51
2	*Senna italica*	10.90	16.2	3.38	7.01			33.60
3	*Senna occidentalis*	6.69		6.02		3.49	3.64	13.15
4	*Senna singuena*		15.4	15.9	6.32			43.90
5	*Senna tora*	8.16	3.83	3.30	6.58	5.08	2.52	27.89
6	*Combretum micranthum*					4.66	3.49	8.15
7	*Combretum nigricans*					4.66		4.66
8	*Chamaecrista mimosoides*	5.85	7.67		9.25			26.17
9	*Crotalaria retusa*			3.38	7.79			11.17
10	*Dathura arborea*	15.00	19.2	5.27				24.47
11	*Desmodium velutinum*	5.02	5.75				2.51	8.26
12	*Dichrostachys cineria*	16.30	3.83			2.24		6.07
13	*Dryopteris fillix-mas*	12.22			5.81			11.62
14	*Guirea senegalensis*				9.14		12.8	31.11
15	*Hygrophilla auriculata*		9.62	3.99		3.82		17.43
16	*Indigofera arrecta*				8.20		1.96	18.36
17	*Malvastrum coromondelianum*	7.32	3.20					3.20
18	*Piliostigma reticulatum*	7.52		2.42	10.3	22.6	3.02	48.64
19	*Pavonia hirsuta*			3.11			2.01	5.12
20	*Tephtosia linearis*				9.22			18.44
21	*Urena lobata*	5.02	3.20	8.43			3.35	14.98
22	*Waltheria indica*				6.58		3.35	16.51
23	*Ximenia americana*					40. 75	32.2	73.0
24	*Ziziphus mauritiana*					12.70	29.1	41.8

KFR=Kanawa Forest Reserve

Table 5: Importance value index of shrubs identified in Kanawa Forest Reserve (KFR), Gombe state, Nigeria

		Importance value index (%)						
		Site						
S/No	Species	I	II	III	IV	V	VI	KFR (Total)
1	*Senna alata*		13.73	21.61	10.28			45.62
2	*Senna italica*	11.38	11.51	6.96	8.01			34.49
3	*Senna occidentalis*	7.35		12.01		6.72	7.83	34.18
4	*Senna singuena*		11.24	9.47	6.12			26.83
5	*Senna tora*	9.62	7.39	7.77	7.72	11.14	8.17	53.59
6	*Combretum micranthum*					11.55	4.35	15.90
7	*Combretum nigricans*					6.28		6.28
8	*Chamaecrista mimosoides*	5.34	8.67		6.26			20.51
8	*Crotalaria retusa*			6.13	7.79			13.92
10	*Dathura arborea*	15.91	9.46	7.59				33.48
11	*Desmodium velutinum*	6.24	10.25				4.85	21.54
12	*Dichrostachys cineria*	13.17	4.33			8.52		26.02
13	*Dryopteris fillix-mas*	10.58			9.82			20.40
14	*Guirea senegalensis*				9.41		11.46	20.87
15	*Hygrophilla auriculata*		10.71	6.89		7.66		25.26
16	*Indigofera arrecta*				8.26		4.09	12.34
17	*Malvastrum coromondelianum*	7.51	7.18					14.69
18	*Piliostigma reticulatum*	7.91		6.47	10.00	12.26	4.19	38.67
19	*Pavonia hirsuta*			5.90			4.19	10.09
20	*Tephrosia linearis*				7.77			7.77
21	*Urena lobata*	4.99	5.51	9.20			6.65	26.35
22	*Waltheria indica*				8.56		8.16	16.72
23	*Ximenia americana*					22.30	18.60	40.90
24	*Ziziphus mauritiana*					13.68	16.75	18.78

Table 6: Site vegetative association, similarity and correlation between sites for shrub species in Kanawa Forest Reserve, Gombe State, Nigeria

Site (P<0.05).	P- values	Chi-Square	Correlation	ad/bc	Sx	Sr
Site I/II		0.167832	-0.08362	-	23.83217	1.083624
Site I/III		0.167832	0.083624	+	23.83217	0.916376
Site I/IV		5.916377	0.496503	+	18.08362	0.503497
Site I/V		0.167832	-0.08362	-	23.83217	1.083624
Site I/VI		0.045714	0.043644	+	23.95429	0.956356
Site II/III		0.167832	0.083624	+	23.83217	0.916376
Site II/IV		0.167832	0.083624	+	23.83217	0.916376
Site II/V		0.666667	-0.16667	-	23.33333	1.166667
Site II/VI		4.444444	-0.43033	-	19.55556	1.430331
Site III/IV		2.592596	0.328671	+	21.4074	0.671329
Site III/V		0.167832	0.083624	+	23.83217	0.916376
Site III/VI		0.011189	-0.02159	-	23.98881	1.021592
Site IV/V		4.195804	-0.41812	-	19.8042	1.418121
Site IV/VI		0.906294	-0.19433	-	23.09371	1.194325
Site V/VI		0.177778	0.086066	+	23.82222	0.913934

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