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Variation of floral diversity of Baturiya wetland game reserve Hadejia Jigawa state, Nigeria

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Abstract
This study aimed at determining the variation of floral diversity of Baturiya wetland game reserve. Three (3) sample plots of 100m x 100m were located in the reserve using stratified sampling method, a sub-plot of 50m x 50m were randomly laid in each of the plot. All floral species were identified and enumerated. Shannon weiner diversity index was use to determine plant species diversity. The results showed that plot 2 has the highest plant diversity index of 3.189 followed by plot 3 having 2.647 and plot 1 with 2.396. The similarity index calculated was 1.074 which shows that there is overlapping of species among the sampled plots. Analysis of Variance (ANOVA) result conducted shows no significant relationship among the sampled plots (P>0.05). This calls for among others the need to preserve the wetland game reserve and the use of its resources sustainably.

Keywords: Variation, floral diversity, wetland

Introduction
Wetland is an area of land where the soil is sutured with moisture either permanently or seasonally such areas may also be covered partially or completely by shallow pools of water. Wetlands are also defined as transitional land between terrestrial and aquatic system that are characterized by certain water regimes, plant species and soil characteristics (Winter, 2013) [17]. Douglas (2009) [3] defined wetland as geographic area with characteristics of both dry land and bodies of water. Wetland typically occur in low lying areas that receive fresh water at edges of lakes, ponds, streams, rivers or salt water from tides in coastal areas protected from waves. In wetlands, water level called the water table is usually at above or just below the soil surface for enough time to restrict the growth of plant to those adapted to wet condition and promote the development of soil characteristics of wet environment Hadejia Nguru wetlant conservation project (HNWCP, 1999) [5].

Wetlands are essential for hydrological and ecological process and they support a rich flora and fauna, they have different habitats and are places were different species of flora and fauna live. Wetlands act as a water filter, nutrients and sediments are abundant and that makes it possible for many species to live (HNWCP, 1999) [5]. Wetlands are found on every continent (except Antartica) and in climates ranging from tropic to the tundra. They occupy about six percent (6%) of the land surface of the world or approximately 890 million hectares and vary in location and size (Douglas, 2009) [3]. Some wetlands cover a few million hectares while others are only a few thousand square meters, International Union for Conservation of nature (IUCN, 1980) [7]. They are found in many countries such as the United Kingdom, Iraq, South Africa and the United States. Wetlands are the subject of National Conservation Foundation (NCF, 2010) [11]. Notable African wetlands Indicated on the map of Africa are Logon flood plain in Cameroon, Amsuri wetland of Ghana, Baobalon wetland in Gambia, Seri wetland in Mali and Hadejia Nguru wetlands in Nigeria.

Nigeria is uniquely bestowed with fresh water wetlands and the coasted saline wetlands. They produce numerous products for man and wildlife. They provide economic and good opportunities to observe wildlife and also educate people during field and school practical on ecology. Indeed, wetlands are considered as the most biologically diverse of all ecosystems (HNWCP, 1999) [5].

The wetlands also support over 250,000 herds of cattle which encourage cattle which encourage cattle traders, with an annual turnover of 416 million naira (HNWCP, 1999) [5]. Ecologically, the wetlands serve as a natural barrier to the process of desertification and play a major role in the recharge of ground water in the basin (HNWCP, 1999) [5]. Baturiya wetland game reserve focuses on protecting the forest and conserving its natural resources in their domain. It also serve as a center for recreational services, tourism, excursion and scientific researches (Kabir, 2006) [9].

Nigeria wetland resources are currently being threatened by certain anthropogenic and bio-geophysical factors. Notable among such factors are population pressure, logging, dredging, unprecedented land reclamation, construction of dams, transportation routes and other infrastructures (Anonymous, 2006) [1]. Olubode *et al.*, (2002) [12] in their study on floral diversity of wetlands of Apete and Aleye River Ibadan, Nigeria indicated that a total of thirty eight (38) plant species belonging to nineteen (19) families were enumerated. Continued perturbation of the wetlands encouraged proliferation and dominance of some invasive species at the expense of native species populations, leading to subtle biodiversity erosion.

This study aims to provide a checklist, composition, similarity and variation of floral diversity among the sampled plots of the game reserve, with a view of providing a baseline data for good management of the entire wetland game reserve.

Materials and Methods

Baturiya Hadejia-wetlands is a wide expense of flood plain wetlands situated in the northeast Nigeria, the location lies in the Sudano-Sahelian zone, which is the zone between the Sudano-Savanna in the South and the Sahel in the North. The wetland is found in Yobe State, located in the Northern part of Nigeria, which include the Nguru Lake (Eatol and Sarah, 1997) [4]. According to Ramsar, (1994) [14], Baturiya which is a section of the Hadejia Nguru wetlands, is located on the Latitude 12º 20' 0" N to 12º 40' 0"N and longitude 10º 10' 0" E to 10º 30' 0" E. The topography is characterized by mostly low-lying flat surfaces on the North Eastern side of the reserve and limited local relief in the Southern and Western parts that provide sites for settlement. The alluvial soil of Baturiya have been describe by Kolawale (1991) [10] as deep (1.5m) and hydromorphic, with high water retention capacity and poor drainage. Rainfall Pattern in the reserve has not been stable over the years but in most cases rainfall starts from May to September. The mean annual rainfall ranges from 600mm to 850mm (Ramsar, 2008) [13]. Dry season usually extend from October to April and temperature in the reserve vary with the time of the year, usually reaching about 45^{0}C between April and May and less than 19ºC during hammatan season (Bdliya, 1998) [2]. The vegetation of the study area comprises varieties of *Acacia spp, Adansonia spp, Tamarindus spp, Mitrogynus spp, Diospyrus spp, Faidhebia spp, Ficus spp* and *Hyphaene spp*

Survey and Sampling Procedure

Reconnaissance survey was carried out in the study area to accessed the general features of the wetland. Three (3) sample plots of 100m x 100m were located using stratified sampling method, a sub-plot of 50m x 50m were randomly laid in each of the plot. All floral species were enumerated by direct counting and a checklist of floral species (trees, shrubs, etc) in the sample plots was made as adopted by Kwaga *et al*., [8].

Data Analysis

Shannon-weiner (1949) [15] diversity index was use to determine the diversity of floral species in the sampled plots

$$H' = - \sum Pi \ In \ Pi$$

Where;
Pi = proportion of each species
ni = Number of Individual species
N = total number of Individuals in the plot
Equitability of floral species was calculated as;

$$J = H'/Hmax = - \sum Pi \ Ln \ Pi / InN$$

Sorenson's Coefficient (CC) was use to estimate the similarity index among sampled plots

Where;

$$\text{Sorensons Coefficient (CC)} = \frac{2C}{Pi+P2+P3}$$

C = number of species the three plots have in common
P_1 = total number of species found in plot 1
P_2 = total number of species found in plot 2
P_3 = total number of species found in plot 3
Analysis of variance (ANOVA) was also use to test for the variation among the sampled plots.

Results and Discussion

Floristic composition and diversity

The checklist of floral species in Baturiya wetland game reserve showed a total of 901 individual species belonging to 42 families and 95 different species (Table 1, 2 and 3). A total of 39 species were enumerated in sample plot 1, the diversity was 2.396 with an equitability (evenness of distribution) measured by J value as 0.419. The specie that has the highest population is *Azadiractha indica* having a frequency of 114 and relative frequency of 37.5% followed by *Hyphaene thebatica* having 50 and relative frequency of 16.4% while *Saba florida, Eclipta prostratara, Vicoa leptoclatda, Ipomoea carneat, Desmodium scorpiurus, Indigofera ardecta, Mimosa pigra, Mucuna prurient, phyillanthus nitruri, Piliostigma thonningii, Senna occidentalis, Tamarindus indica, Leucas martinitcensis, Mollugo nudicatulis, Pennisetum recticulatum, and Ziziphus abyssinica* has the lowest frequency of 1 and relative frequency 0.33% (Table 1). In sample plot 2 *Hyphaene thebatica* has the highest population of 59 with relative frequency of 20.3% followed by *Bauhinia Monandra* having 30 and relative frequency of 10.3% while *cyathula prostrate, Anona senegalensis, Plumeria rubra, Rauvolfia caffra, Saba florida, Strophanthus gratus, Maerua angolensis, Anogeissus leiocarpus, Guiera senegalensis, Ipomea involucrata, Cyperus difformis, Acacia senegal, Desmodium barbatum, Dichrostachys glomerata, Erythrina senegalensis, Erythropleum suaveolens, Tamarindus indica, Onhcoba spinosa, Strychnos spinosa, Hibiscus linearifolia, Pseudocedrela kotschyi, Moringa oleifera, Feretia apodenthera, Gardenia aqualla,* and *Mimosa pigra* has the least frequency of 1 with relative frequency of 0.34% (Table 2). The diversity index of sample plot 2 was the highest with 3.189 with evenness range of distribution of 0.562. *Albizia lebback* in sample plot 3 has the highest population with a frequency of 99 and relative frequency of 32.4% followed

by *Bauhinia rufestcens* having a frequency of 30 and relative frequency of 9.80% while *Rauvolfia caffra, Combretum lamprocapum, Luffa aegyptiaca, Cusas circinalis, Cyperus rotundus, Feretia apodenthera, Discrostachys glomerata, Acacia nilotica, Acacia albida, Psidium guajava, Taxscan apiculata, Mitragyna inermis, Lantana camara* and *Cissus quadrangularis* has the lowest frequency of 1 and relative frequency 0.33%. The diversity index of sample plot 3 was 2.647 with an evenness of distribution value is as 0.463 (Table 3). The slight high population of few floral species recorded in the sample plots in the study area may be attributed to availability of viable seeds of trees to sustain regeneration or favorable microclimate within the forest. The dominance of *Azadiractha indica*, *Hyphaene thebatica*, and *Albizia lebbeck* in sample plot 1, 2 and 3 may be attributed to their efficiency in seed dispersal mechanism (Udo *et al*,. 2007) [16] while the low species representation could be due to poor regeneration abilities and/or anthropogenic activities (Zhigila *et al*., 2016) [18]. The high flora species diversity recorded in sample plot 2 is an indicator of a healthy reserve particularly in the area and lesser or no anthropogenic activities while the lower diversity index of flora species in sample plot 1 and 3 indicates that these floral species are low in their distribution; similar findings were reported by Udo *et al.*, (2007) [16]. Also over exploitation and total alteration of forest ecosystems lead to the destruction of tree species (Iroko *el al.*, 2008) [6]. The low diversity index in some sample plots may be as a result of tree logging for timber and fuelwood collected /harvested in the sample plot areas. In view of such needs, a number of these floral species evolve into rare and threatened. If forest are over-exploited, the different usage and functions connected with them can be lost. However, it ought to be well known that major quantitative consideration of species varieties connecting forest environments are dependent on plot size, sample size, climatic factors, as well as other site components.

Table 1: Family, species composition and diversity of sample plot 1

s/n	Family	Species	Frequency	Pi	Pilnpi	-PiInPi
1	Apiaceae	*Centella astiatica*	2	0.007	-0.033	0.033
2	Apocynaceae	*Saba florida*	1	0.003	-0.019	0.019
3	Asteraceae	*Eclipta prostratara*	1	0.003	-0.019	0.019
		Vicoa leptoclatda	1	0.003	-0.019	0.019
4	Capparidaceae	*Capparis polymtorpha*	2	0.007	-0.033	0.033
5	Convulacceae	*Ipomoea carneat*	1	0.003	-0.019	0.019
6	Euphorbiaceae	*Uzoroa insignits*	3	0.010	-0.046	0.046
7	Fabaceae	*Acacia nilotica*	3	0.010	-0.046	0.046
		Acacia albida	5	0.016	-0.068	0.068
		Acacia ataxacantha	17	0.056	-0.161	0.161
		Acacia sieberitana	10	0.033	-0.112	0.112
		Bauhinia refestcens	6	0.020	-0.077	0.077
		Cheamacrista rotundifolia	3	0.010	-0.046	0.046
		Desmodium scorpiurus	1	0.003	-0.019	0.019
		Detarium microcarpum	2	0.007	-0.033	0.033
		Dichrostachys cinerea	2	0.007	-0.033	0.033
		Indigofere artecta	1	0.003	-0.019	0.019
		Mimosa pigra	1	0.003	-0.019	0.019
		Mucuna prurient	1	0.003	-0.019	0.019
		Phyllanthus niruri	1	0.003	-0.019	0.019
		Piliostigma thonningii	1	0.003	-0.019	0.019
		Senna sinquteana	9	0.030	-0.104	0.104
		Senna occidentalis	1	0.003	-0.019	0.019
		Tamarindus indica	1	0.003	-0.019	0.019
8	Flacourtiaceae	*Onchoba spinosa*	2	0.007	-0.033	0.033
9	Lamiaceae	*Laucasmartinitcenis*	1	0.003	-0.019	0.019
10	Malvaceae	*Urena lobata*	2	0.007	-0.033	0.033
11	Meliaceae	*Azadiractha indica*	114	0.375	-0.368	0.368
12	Molluginaceae	*Mollugo nudicatilis*	1	0.003	-0.019	0.019
13	Onagraceae	*Jussiea ervicotsa*	7	0.023	-0.087	0.087
14	Palmea	*Hyphaene thebatica*	50	0.164	-0.297	0.297
15	Phyllanthaceae	*Pennisetum recticulatum*	1	0.003	-0.019	0.019
16	Poaceae	*Banbusa vulgaris*	10	0.033	-0.112	0.112
		Pennisetum recticulatum	2	0.007	-0.033	0.033
17	Rhamnaceae	*Ziziphus abbyssinica*	1	0.003	-0.019	0.019
18	Rubiaceae	*Feretia apodenthera*	2	0.007	-0.033	0.033
		Mitragyna inermis	2	0.007	-0.033	0.033
19	Scrophulariaceae	*Striga hermonthica*	3	0.010	-0.046	0.046
20	Suphorbiaceae	*Chrozophora*	30	0.099	-0.229	0.229
		Total	304			

H = -∑pilnpi 2.396
J = H/Hmax 0.419

Table 2: Family, species composition and diversity of sample plot 2

s/n	Family	Species	Frequency	Pi	Pilnpi	-PiInPi
1	Amaranthaceae	*Alternanthera nodiflora*	2	0.007	-0.034	0.034
		Cynthula prostrate	1	0.003	-0.019	0.019
2	Annonaceae	*Annona senegalensis*	1	0.003	-0.019	0.019
3	Apocynaceae	*Carissa edulis*	8	0.027	-0.099	0.099
		Plumeria rubra	1	0.003	-0.019	0.019
		Rauvolfia caffra	1	0.003	-0.019	0.019
		Saba florida	1	0.003	-0.019	0.019
		Strophanthus gratus	1	0.003	-0.019	0.019
4	Bignoniaceae	*Newbouldia laevis*	14	0.048	-0.146	0.146
		Stereospermum kunthianum	2	0.007	-0.034	0.034
5	Capparidaceae	*Maerua angolensis*	1	0.003	-0.019	0.019
6	Combretaceae	*Anogeissus leiocarpus*	1	0.003	-0.019	0.019
		Grewia mollis	6	0.021	-0.080	0.080
		Guiera senegalensis	1	0.003	-0.019	0.019
7	Convulaceae	*Ipomea involucrata*	1	0.003	-0.019	0.019
8	Cyperaceae	*Cyperus difformis*	1	0.003	-0.019	0.019
9	Ebenaceae	*Diospyros mespiliformis*	8	0.027	-0.099	0.099
10	Euphorbiaceae	*Bridelia ferruginea*	5	0.017	-0.070	0.070
11	Fabaceae	*Acacia ataxacantha*	8	0.027	-0.099	0.099
		Acacia nilotica	1	0.003	-0.019	0.019
		Acacia senegal	1	0.003	-0.019	0.019
		Acacia sieberitana	7	0.024	-0.090	0.090
		Bauhinia monandra	30	0.103	-0.234	0.234
		Calliandra portoricensis	2	0.007	-0.034	0.034
		Desmodium barbatum	1	0.003	-0.019	0.019
		Desmodium tortosum	3	0.010	-0.047	0.047
		Dichrostachys glomerata	1	0.003	-0.019	0.019
		Erythrina senegalensis	1	0.003	-0.019	0.019
		Erythropleum suaveolens	1	0.003	-0.019	0.019
		Parkia biglobosa	2	0.007	-0.034	0.034
		Piliostigma thoningii	5	0.017	-0.070	0.070
		Senna occidentalis	2	0.007	-0.034	0.034
		Senna sieberiana	13	0.045	-0.139	0.139
		Tamarindus indica	1	0.003	-0.019	0.019
12	Flacourtiaceae	*Onhcoba spinosa*	1	0.003	-0.019	0.019
13	Lemnaceae	*Lemna trisulca*	5	0.017	-0.070	0.070
14	Loganiaceae	*Strychnos spinosa*	1	0.003	-0.019	0.019
15	Malvaceae	*Habiscus linearifolia*	1	0.003	-0.019	0.019
16	Meliaceae	*Azadiractha indica*	12	0.041	-0.131	0.131
		Pseudocedrela kotschyi	1	0.003	-0.019	0.019
17	Moringaceae	*Moringa oleifera*	1	0.003	-0.019	0.019
18	Myrtaceae	*Psidium guajava*	5	0.017	-0.070	0.070
19	Ochnaceae	*Ochna afzelia*	17	0.058	-0.166	0.166
20	Palmae	*Hyphaene thebatica*	59	0.203	-0.324	0.324
21	Phenocleaceae	*Dysphania antelminthica*	2	0.007	-0.034	0.034
22	Phyllanthaceae	*Phyllanthus muellerianus*	3	0.010	-0.047	0.047
		Phyllanthus niruri	10	0.034	-0.116	0.116
23	Rhamnacea	*Ziziphus spinachristi*	16	0.055	-0.159	0.159
24	Rubiaceae	*Feretia apodenthera*	1	0.003	-0.019	0.019
		Gardenia aqualla	1	0.003	-0.019	0.019
		Mimosa pigra	1	0.003	-0.019	0.019
		Mitragyna inermis	15	0.052	-0.153	0.153
		Pavetta corymbosa	2	0.007	-0.034	0.034
25	Sapindaceae	*Blighia sapida*	2	0.007	-0.034	0.034
		Total	291			

H = -∑pilnpi 3.189
J = H/Hmax 0.562

Table 3: Family, species composition and diversity of sample plot 3

s/n	Family	Species	Frequency	Pi	Pilnpi	-PiInPi
1	Anacardiaceae	*Mangifera indica*	14	0.046	-0.141	0.141
2	Apocynaceae	*Carissa edulis*	6	0.020	-0.077	0.077
		Rauvolfia caffra	1	0.003	-0.019	0.019
3	Bignoniaceae	*Newbouldialaevis*	12	0.039	-0.127	0.127
4	Combretaceae	*Combretum lamprocapum*	1	0.003	-0.019	0.019
5	Cucurbitaceae	*Luffa aegyptica*	1	0.003	-0.019	0.019
6	Cycadaceae	*Cycas circinalis*	1	0.003	-0.019	0.019
7	Cyperaceae	*Cyperus rotundus*	1	0.003	-0.019	0.019
8	Euphorbiaceae	*Diospyrus mespilliformis*	11	0.036	-0.120	0.120
		Feretia apodenthera	1	0.003	-0.019	0.019
9	Fabaceae	*Acacia ataxacantana*	6	0.020	-0.077	0.077
		Acacia sieberita	15	0.049	-0.148	0.148
		Albizia lebbeck	99	0.324	-0.365	0.365
		Bauhinia refestcens	30	0.098	-0.228	0.228
		Desmodium tortosum	14	0.046	-0.141	0.141
		Discrostachys glomerata	1	0.003	-0.019	0.019
		Acacia nilotica	1	0.003	-0.019	0.019
		Acacia albida	1	0.003	-0.019	0.019
		Parkia biglobosa	2	0.007	-0.033	0.033
		Senna abtusifolia	12	0.039	-0.127	0.127
		Senna sieberiana	3	0.010	-0.045	0.045
10	Meliaceae	*Azadiractha indica*	17	0.056	-0.161	0.161
		Pseudocedrela kotschyi	2	0.007	-0.033	0.033
11	Myrtaceae	*Psidium guajava*	1	0.003	-0.019	0.019
12	Nymphaceae	*Nymphea lotus*	19	0.062	-0.173	0.173
13	Periploceae	*Taxscan apiculata*	1	0.003	-0.019	0.019
14	Phyllanthaceae	*Phyllanthus niruri*	3	0.010	-0.045	0.045
15	Paaceae	*Digitaria debilis*	2	0.007	-0.033	0.033
		Sporobolus pyramidalis	5	0.016	-0.067	0.067
16	Rhamnaceae	*Ziziphus abyssinica*	3	0.010	-0.045	0.045
17	Rubiaceae	*Mitragyna inermis*	1	0.003	-0.019	0.019
18	Tiliaceae	*Melochia corchorifolia*	2	0.007	-0.033	0.033
19	Verbenaceae	*Gmelina arborea*	13	0.042	-0.134	0.134
		Lantana camara	1	0.003	-0.019	0.019
		Vitex doniana	2	0.007	-0.033	0.033
20	Vitaceae	*Cissus quadrangularis*	1	0.003	-0.019	0.019
		Total	306			

H = -∑pilnpi 2.647
J = H/Hmax 0.463

Similarity index and variation of floral species

Using the Sorenson's coefficient formula, the similarity index of Baturiya wetland game reserve calculated was 1.074. Since the result is greater than 1 this shows that there is overlapping of species among sampled plots.

The Analysis of Variance (ANOVA) result conducted shows that there is no significant relationship among the sampled plots (P>0.05) (Table 4).

Table 4: ANOVA for the sample plots

Source of variation	SS	Df	MS	F_{cal}	P-val	Fcrit	Remark
Plots	44.85337	2	22.42668	0.43878	0.645804	3.0681	N.S
Error	6440.043	126	51.11145				
Total	6484.896	128					

N.S = Not significant

Conclusion

The checklist of Baturiya wetland game reserve showed a high biodiversity presence. The wetland game reserve is highly significant to the livelihood of the people living in the surrounding communities as it performs a lot of ecological and economic functions. However, it was observed that the wetland is currently been threatened by some anthropogenic factors such as logging, over grazing, dredging, fuel wood collection etc hence the need to conserve the wetland game reserve and use of its resources sustainably. This will ensure that the source of livelihood of the communities continue to exist for future generations.

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