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SOIL VEGETATION STATUS OF A FOREST FRAGMENT IN AKWA IBOM STATE, NIGERIA

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ABSTRACT

As efforts are geared towards preventing the utter destruction of our ecosystem and ensuring the conservation of our rich biodiversity, adequate quantitative and qualitative ecological data of the flora and fauna species are imperative. Accordingly, the status of phytodiversity and pedological properties were assessed in a tropical forest fragment namely Mkpok Village Forest (MVF) in Akwa Ibom State (AKS). This was with a view to providing insights into its environmental determinants; as well as baseline for the management and conservation of the forest fragment. Systematic sampling method was used to sample the vegetation using a quadrat size of 10 m x 10 m. The frequency, density, height, basal area and crown cover of plant species encountered were determined. Twelve composite soil samples were collected and analyzed for pedological properties (soil pH, texture and chemical constituents) using standard analytical procedures. Forty-two plant species belonging to thirty families were encountered. Family Fabaceae had the highest number of 6 plant species followed by Meliaceae, Arecaceae, and Euphorbiaceae with 3 plant species each. The tallest and shortest tree species were *Piptadeniastrum africanum* (22.91 ± 2.33 m) and *Cannarium schweinfurthii* (2.00 ± 0.51 m). Shannon-Wiener and Simpson diversity indices of 2.88 and 0.90 were recorded respectively. Pedological analyses revealed that in MVF the soils were moderately acidic and highly sandy, having low concentrations of some plant nutrients. Correlation analysis indicated relationships between some vegetation parameters and soil chemical constituents (p=0.05). It is concluded that the forest was not structurally complex as expected of a tropical rainforest partly due to anthropogenic activities but possessed attributes of a typical rainforest of Nigeria thus reinforced the hope that this forest fragment if preserved can return to its primary status.

KEYWORDS: Phytodiversity *Piptadeniastrum africanum*, pedological properties, conservation

INTRODUCTION

Hundreds of definitions of forest are used throughout the world, incorporating factors such as tree density, tree heights, land use, legal standing and ecological functions etc. However, a forest may simply be defined as a biological community dominated by trees and woody vegetation. According to FAO (2001), forested lands are those areas having an extent of at least 0.5 ha with tree crown cover of more than 10%. The size and longevity of trees confer on them the ability to dominate other plant types by expropriating light and soil resources. This enables trees to control the major ecological processes, to determine the habitat for animals, microbes and other plant types, and to play a major role in determining the abundance of these other organisms in the forest. Forests can also be dominated by large plants with woody stems that are not strictly trees, such as bamboo or tree ferns. On the other hand, plantation is different from natural forest as these planted species are often of same type and do not support a variety of natural biodiversity. Also, forest does not include land that is predominantly under agricultural or urban land use (FAO, 2001). There is no stage of forest ecosystem development, no structure, no level of function, no level of complexity and no pattern of interactions of ecosystem components that is any better or worse than any other. A young forest is not better or worse than an old forest. A forest with high productivity is not better or worse than one of low productivity. A forest with high species or structural diversity is not better and not worse than a forest with low levels of these measures of diversity. Human value systems, which have nothing to do with the science of forest ecology, provide the basis for human preferences concerning these different ecosystem attributes (Kimmins, 1997). However, the role of forest ecology is to describe and provide an explanation for, and an understanding of, the differences between forest ecosystems in different places, and the changes in any one forest over time.

Forests are seen as having productive, protective and regulative functions (Singh *et al*., 2008). Agbogidi and Eshegbeyi (2008) noted that forests and forest products play vital roles in human life from the cradle to the grave. For millennia before the industrial revolution, forests, woodlands, and trees were the source of land for settlement and cultivation, products and materials for construction, woody biomass for fuel and energy, and indeed, directly for food and nutrition as well. The contributions of forests to global biodiversity, to the fertility of agricultural lands, and to the welfare of those who depend on them mean that forests are immensely valuable for sustainability (FAO, 2011). Furthermore, a forest is a natural resource of multiple values, oftentimes, estimated from the stand point of population density or standing volume of timber tree species present, while ignoring the more valuable non-timber species (Udo *et al*., 2009). Plant growing together have a mutual relationship with the environment; and as an important part of the ecosystem, vegetation reflects the effects of the entire environment. For instance, soil provides support, in the form of anchorage, nutrient, moisture and habitat for vegetation to grow successfully, while vegetation provides protective envelop for soil against soil erosion and helps to maintain soil nutrient through nutrient recycling via litter accumulation and subsequent mineralization. Thus, vegetation and soil are interconnected and display synergistic effects on each other. Vegetation performs important functions in an ecosystem at different spatial scales and vegetation strongly affects soil characteristics, including soil volume, chemistry, and texture, which in response affect various vegetation characteristics, including productivity, structure, and floristic composition (Brant *et al*., 2006).

In Nigeria, it is an obvious fact that factors such as the soil temperature, soil nutrient status and texture could be used to investigate the different levels of tolerance and productivity of the plant species in any vegetation; and the level of response and adaptation of the properties of the soil create a distribution pattern for the vegetation (Ukpong 1994). Ubom *et al*. (2012) reported that using linear regression, the relationship between soil parameters and plants density, height, crown cover and basal area were positive; indicating that soil parameters form part of constellation of factors determining the existence of plants in a freshwater swamp forest. Also, in the work of Ichikogu (2014), the result of multiple linear regression showed that soil organic matter, total porosity, water holding capacity, available phosphorus and ECEC were the most outstanding soil factors influencing the regenerative capacity of the vegetation structural properties in secondary forests. Based on these results, it was concluded that in the management of secondary forest specific consideration should be given to changes in soil physicochemical properties. Thus, it becomes imperative to consider soil in the study of forests for conservation and management purposes. As efforts are geared towards preventing the utter destruction of our ecosystem and ensuring the conservation of our rich biodiversity, adequate quantitative and qualitative ecological data of the flora and fauna species are imperative. These data are needed for effective and realistic conservation strategies. By understanding the status of the natural forest in terms of tree species composition, richness, structure, diversity and the environmental dynamics, recommendations can be made for the restoration and future management of the forest. This can be achieved if adequate vegetation inventory and description come to play. In recent years, AKS forest estate had suffered great perturbations due to rapid urbanization, increased infrastructural development, high population density and traditional farming practices resulting in unprecedented deforestation and environmental degradation (Akpan-Ebe, 2015). Mkpok forest in Eket is seriously impacted by human settlement at a rate that if no appropriate measure is taken, the forest fragment would be completely removed. Upon this premise, this research aims at assessing the plant species diversity status, structure and soil physicochemical properties of the forest so as to provide basis for formulating strategies for sustainable management.

Method of Study

The study was conducted in Mkpok village forest (Latitude 4°40'01" N and Longitude 7°57'32" E) in Eket Local Government Area of AKS. There are two seasons: rainy (April - October) and dry (November - March). The average relative humidity is about 80% with up to 95% occurring during the rainy season (AKSG, 2008). Usoro and Akpan (2010) reported that the soils in the state are mainly underlain by sandstone, siltstone/shale and alluvial parent materials. The state has four eco-vegetation zones - mangrove swamp forest, fresh water swamp forest, Lowland rainforest and moist savanna woodland (Itina *et al*., 2013).

Vegetation and Soil Sampling

Systematic sampling technique was employed in sampling the vegetation using transects (plots). Each plot contained four quadrats. A quadrat size of 10 m x 10 m was used to sample the vegetation and soil, spaced at regular interval of 20 m according to the methods of Knight (1978). Plant identification and naming were done using relevant texts (Aigbokhans, 2014; Hutchinson *et al*., 2014). Plants that could not be identified on the field were collected and taken to Department of Botany and Ecological Studies Herbarium for identification and their features photographed so that they could be given future attention. Vegetation parameters measured were frequency of plant species, height, density, girth at breast height, and crown cover. Also, relative frequency, relative density, relative dominance and important value index were evaluated using a formula recommended in Mandal and Joshi (2014). Using a soil auger in each of the quadrats, soil samples were obtained at a depth of 0-30 cm. Twelve composite soil samples were collected according to (Mbong and Ogbemudia, 2013). The soil samples were air-dried and preserved for laboratory analysis. Soil pH and electrical conductivity were determined using Hanna hand held multimeter. Total nitrogen was determined by Micro-Kjedahl method (Ibia and Udo, 2009), Available phosphorus was determined using Bray No. 1 method while Exchangeable Ca and K was determined using Flame photometry (Adepetu, 1984). Organic Carbon was determined using the Walkey-Black method (Black, 1965). Particle size distribution was determined using hydrometer meter. ECEC and Base saturation were computed according to the methods of (Ubom, 2006).

Statistical and data analysis

Mean and standard error were computed from three replicates of soil physicochemical properties. The relationships between soil variables and vegetation variables within the study area were established by multivariate correlation technique using Statistical Package for Social Sciences (SPSS, version 18.0). species diversity indices such as Shannon-Wiener, Simpson, Dominace, were used to assess plant species population in the forest using Paleontological software (PAST 3).

Results

Forty-two plant species belonging to thirty families were encountered (Table 1). Family Fabaceae had the highest number of species (6), followed by Meliaceae (3), Euphorbiaceae (3) and Arecaceae (3). *Piptadeniastrum africanum* had the highest crown cover and was the tallest plant species. *Palisota hirsuta* dominated with the highest IVI value of 33.63 (Table 2). The forest had high values for silt (5.80 ± 1.04 %), organic carbon (9.91 ± 0.90 %), available phosphorus (19.65 ± 1.57 mg/kg), Na (0.07 ± 0.005 cmol/kg), K (0.13 ± 0.02 cmol/kg), base saturation (76.15 ± 3.67 %), Pb (1.63 ± 0.08 mg/kg) and Cd (1.54 ± 0.01 mg/kg) (Table 3). The diversity profile of the forest revealed a total of 42 splant species comprising of 4063 individuals with high values for Simpson, Shannon and evenness indices (Table 4). The correlation matrix between soil variables and vegetation parameters in the forest is presented in Table 5. From the results those were significant, density associated positively with organic carbon ($r = 0.925$, $p = 0.05$) and Fe ($r = 0.931$, $p = 0.05$), height associated positively with total nitrogen ($r = 0.910$, $p = 0.05$) and negatively with Ca ($r = 0.915$, $p = 0.05$). Basal area of species had a positive association with Cu ($r = 0.982$, $p = 0.01$) while crown cover had a positive relationship with Zn ($r = 0.901$, $p = 0.05$).

Table 1: Floristic inventory of Mkpok forest

***Plant species**	**Family**	**Habit**	**Frequency (%)**	**Density (stems/ha)**	**Height (m)**	**Crown cover (m^2/ha)**	**Basal area (m^2/ha)**
Aframomum daniellii (Hook.) Schum.	Zingiberaceae	Herb	40	420.00 ± 32.01	-	-	-
Afzelia bipindensis Harms.	Fabaceae	Shrub	40	168.00 ± 6.72	11.50 ± 3.50	-	-
Albizia zygia (Dc.) J. F. Macbr.	Fabaceae	Tree	20	10.00 ± 0.47	5.83 ± 0.63	9.71 ± 1.02	4.24 ± 1.20
Alchornea cordifolia (Schum. & Thonn.) Mull.-Arg.	Euphorbiaceae	Shrub	20	214.00 ± 17.20	3.17 ± 0.50	-	-
Allanblackia floribunda Oliv.	Clusiaceae	Tree	10	10.00 ± 0.99	7.20 ± 0.85	3.02 ± 0.24	1.21 ± 0.07
Anchomanes difformis (Bl.) Engl.	Araceae	Herb	60	420.00 ± 32.31	2.81 ± 0.43	-	-
Anthocleista djalonensis A. Chev.	Loganiaceae	Tree	10	10.00 ± 0.69	4.21 ± 0.60	1.08 ± 0.37	1.10 ± 0.04
Anthonatha macrophylla P. Beauv.	Fabaceae	Shrub	20	55.00 ± 6.30	4.50 ± 0.54	0.81 ± 0.00	0.54 ± 0.01
Baphia nitida Lodd.	Fabaceae	Shrub	20	10.00 ± 1.00	5.00 ±1.20	1.02 ± 0.09	0.74 ± 0.02
Barteria nigritiana Hook.	Passifloraceae	Shrub	10	10.00 ± 0.01	5.03 ± 0.89	4.17 ± 0.96	1.27 ± 0.54
Calamus deerratus Mann. & Wendl.	Arecaceae	Climber	60	230.00 ± 18.10	8.15 ± 1.51	1.30 ± 0.60	0.06 ± 0.004
Cannarium schweinfurthii Engl.	Burseraceae	Tree	10	10.00 ± 1.02	2.00 ± 0.51	1.55 ± 0.06	1.20 ± 0.08
Cissus quadrangularis Linn.	Vitaceae	Climber	20	10.00 ± 0.23	-	-	-
Coelocaryon preusii Warb.	Myristicaceae	Tree	50	100.00 ± 4.31	12.02 ±2.68	8.99 ± 3.21	4.30 ± 0.12
Costus schlechteri Winkl.	Costaceae	Herb	40	160.00 ± 6.30	5.00 ± 0.00	-	-
Dissotis rotundifolia (Sm.) Triana	Melastomataceae	Herb	20	28.00 ± 4.30	-	-	-
Elaeis guineensis Jacq.	Arecaceae	Tree	40	70.00 ± 0.83	12.50 ± 2.00	7.12 ± 1.02	3.26 ± 0.68
Entandrophragma cylindricum (Sprague) Sprague	Meliaceae	Tree	10	15.00 ± 0.30	12.20 ± 1.73	9.81 ± 0.89	1.99 ± 0.01
Fagara macrophylla (Oliv.) Engl.	Rutaceae	Tree	30	50.00 ± 2.30	4.80 ± 0.50	6.84 ± 0.40	2.81 ± 0.32
Guarea cedrata (A. Chev.) Pellegr.	Meliaceae	Tree	10	10.00 ± 0.11	7.91 ± 2.01	5.23 ± 1.45	4.23 ± 0.87
Harungana madagascariensis Lam. ex Poiret	Hypericaceae	Shrub	10	10.00 ± 0.30	4.02 ± 0.30	1.04 ± 0.09	1.00 ± 0.01
Irvingia gabonensis (Aubry-Lacomte) Baill.	Irvingiaceae	Tree	20	30.00 ± 3.38	4.27 ± 0.46	5.30 ± 1.00	4.08 ± 1.11
Khaya ivorensis A. Chev.	Meliaceae	Tree	10	10.00 ± 0.75	7.81 ± 0.87	15.27 ± 2.08	3.05 ± 0.40
Lonchocarpus griffoneanus (Baill.) Dunn.	Asteraceae	Shrub	10	10.00 ± 0.58	6.40 ± 0.41	2.01 ± 0.00	1.02 ± 0.04
Maesobotrya barteri (Baill.) Hutch.	Euphorbiaceae	Shrub	10	32.00 ± 0.55	8.10 ± 1.36	4.95 ± 0.37	1.15 ± 0.06
Manniophyton fulvum Mull.-Arg.	Euphorbiaceae	Shrub	20	10.00 ± 0.20	5.20 ± 1.09	3.65 ± 0.05	1.06 ±0.09
Mansonia altissima (A.Chev) A.Chev	Sterculiaceae	Tree	30	50.00 ± 4.02	8.18 ± 1.20	12.88 ± 2.02	2.23 ± 0.99
Marantochloa cuspidata (Rosc.) Milne-Redh	Marantaceae	Herb	20	230.00 ± 12.30	-	-	-
Microdesmis puberula Hook. ex Planch.	Pandaceae	Shrub	40	10.00 ± 0.00	1.50 ± 0.05	-	-
Mitragyna ciliata Aubr. & Pellegr.	Rubiaceae	Tree	20	20.00 ± 1.63	6.50 ±1.50	2.41 ± 050	1.40 ±0.00
Momordica charantia Linn.	Cucurbitaceae	Climber	20	30.00 ± 1.33	4.10 ±0.08	-	-
Musanga cecropiodes R. Br.	Cecropiaceae	Tree	40	50.00 ± 1.02	6.52 ± 0.59	5.00 ± 0.42	2.48 ± 0.89
Myrianthus arboreus P. Beauv	Cecropiaceae	Tree	20	25.00 ± 0.50	8.11 ± 2.50	1.77 ± 0.04	1.27 ± 0.07
Nephrolepis cordifolia (Linn.) Presl.	Nephrolepidaceae	Fern	40	25.00 ± 2.53	-	-	-
Newboldia laevis (P. Beauv.) Seemann ex Bureau.	Bignoniaceae	Tree	10	30.00 ± 2.03	8.33 ± 0.66	1.13 ± 0.01	0.08 ± 0.003
Palisota hirsuta (Thunb.) Schum.	Commelinaceae	Herb	80	1081 ± 57.00	5.98 ± 3.02	-	-
Pentaclethra macrophylla Benth.	Fabaceae	Tree	60	50.00 ± 3.02	19.67 ± 6.80	6.75 ± 1.60	7.27 ± 2.10
Phoenix reclinata Jacq.	Arecaceae	Tree	10	30.00 ± 7.30	2.70 ± 0.63	-	-
Piptadeniastrum africanum (Hook.) Brenan.	Fabaceae	Tree	30	30.00 ±4.11	22.91 ± 2.33	19.80 ±2.15	2.20 ±0.31
Platycerium stemaria (P. Beauv.) Desv.	Polypodiaceae	Fern	20	70.00 ± 6.30	-	-	-
Rauvolfia vomitoria Afzel.	Apocynaceae	Shrub	40	35.00 ± 4.10	2.32 ± 0.12	-	-
Smilax anceps Willd.	Smilaceae	Climber	40	185.00 ± 7.06	-	-	-
TOTAL				4063		142.61	55.24

* **Mean (± S. E) of replicates**

Table 2: Ecological dominance of plant species in Mkpok forest

Plant Species	Relative frequency (%)	Relative density (%)	Relative dominance (%)	IVI
Aframomum daniellii	3.51	10.34	-	13.85
Afzelia bipindensis	3.51	4.13	-	7.64
Albizia zygia	1.75	0.25	7.68	9.68
Alchornea cordifolia	1.75	5.27	-	7.02
Allanblankia floribunda	0.88	0.25	2.19	3.32
Anchomanes difformis	5.26	10.34	-	15.6
Anthocleista djalonesis	0.88	0.25	1.99	3.12
Anthonatha macrophylla	1.75	1.35	0.98	4.08
Baphia nitida	1.75	0.25	1.34	3.34
Barteria nigritiana	0.88	0.25	2.30	3.43
Calamus deerratus	5.26	5.66	0.11	11.03
Cannarium sweinfurthii	0.88	0.25	2.17	3.3
Cissus quadrangularis	1.75	0.25	-	2.00
Coelocaryon preusii	4.39	2.46	7.78	14.63
Costus schlechteri	3.51	3.94	-	7.45
Dissotis rotundifolia	1.75	0.69	-	2.44
Elaeis guineesis	3.51	1.72	5.90	11.13
Entandrophragma cylindricum	0.88	0.37	3.60	4.85
Fagara macrophylla	2.63	1.23	5.09	8.95
Guara cedrata	0.88	0.25	7.66	8.79
Harungana madagascariensis	0.88	0.25	1.81	2.94
Irvingia gabonensis	1.75	0.74	7.39	9.88
Khaya ivorensis	0.88	0.25	5.52	6.65
Lonchocarpus griffoneanus	0.88	0.25	1.85	2.98
Maesobotrya barteri	0.88	0.79	2.08	3.75
Manniophyton fulvum	1.75	0.25	1.92	3.92
Mansonia altissima	2.63	1.23	4.04	7.9
Marantochloa cuspidate	1.75	5.66	-	7.41
Microdesmis puberula	3.51	0.25	-	3.76
Mitragyna ciliate	1.75	0.49	2.54	4.78
Momordica charantia	1.75	0.74	-	2.49
Musanga cecropiodes	3.51	1.23	4.49	9.23
Myrianthus arboreus	1.75	0.62	2.30	4.67
Nephrolepis cordifolia	3.51	0.62	-	4.13
Newboldia laevis	0.88	0.74	0.14	1.76
Palisota hirsute	7.02	26.61	-	33.63
Pentaclethra macrophylla	5.26	1.23	13.16	19.65
Phoenix reclinata	0.88	0.74	-	1.62
Piptadeniastrum africanum	2.63	0.74	3.98	7.35
Platycerium stemaria	1.75	1.73	-	3.48
Rauvolfia vomitoria	3.51	0.86	-	4.37
Smilax anceps	3.51	4.55	-	8.06

Table 3: Physicochemical characteristics of the soil in Mkpok forest

Sand (%)	87.54 ± 2.50
Silt (%)	5.80 ± 1.04
Clay (%)	5.39 ± 1.08
Textural class	Loamy Sand
pH	5.23 ± 0.11
EC (ds/m)	0.01 ± 0.008
Organic carbon (%)	9.91 ± 0.90
Total Nitrogen (%)	0.16 ± 0.01
Available phosphorus (mg/kg)	19.65 ± 1.57
Ca (cmol/kg)	8.83 ± 0.99
Mg (cmol/kg)	1.72 ± 0.19
Na (cmol/kg)	0.07 ± 0.005
K (cmol/kg)	0.13 ± 0.02
EA	1.98 ± 0.10
ECEC (cmol/kg)	11.54 ± 0.39
Base saturation (%)	76.15 ± 3.67
Zn (mg/kg)	64.99 ± 7.03
Cu (mg/kg)	7.89 ± 1.62
Pb (mg/kg)	1.63 ± 0.08
Cd (mg/kg)	1.54 ± 0.01
Fe (mg/kg)	523.31 ± 129.64

* **Mean (± S. E) of replicates**

Table 4: Diversity profile of Mkpok forest

Taxa	42
Individuals	4063
Dominance	0.10
Simpson	0.90
Shannon	2.88
Evenness	0.78

Table 5: Correlation matrix between soil variables and vegetation parameters in Mkpok forest

	Density	**Frequency**	**Height**	**Basal area**	**Crown cover**
Sand	.197	.393	-.152	.872	.656
Silt	-.275	-.347	.472	-.759	-.446
Clay	-.527	-.079	.394	-.188	-.632
pH	.287	.591	-.775	.260	-.278
EC	-.689	.860	.115	-.410	-.542
Org.C	.925*	-.169	-.606	.454	.077
Tot.N	-.044	-.457	.910*	.082	.533
Av.P	-.086	.633	-.716	-.282	-.730
Ca	.203	-.157	-.915*	-.337	-.597
Mg	-.072	.645	.436	.609	.507
Na	-.268	.462	.238	.646	.649
K	.737	.198	-.250	.831	.480
EA	.821	-.725	.054	.211	.264
ECEC	.520	-.199	-.553	.095	-.238
B.sat	-.290	-.022	.620	.482	.789
Zn	.264	-.551	.413	.600	.901*
Cu	.649	.009	.039	.982**	.829
Pb	-.306	-.016	.480	.469	.743
Cd	.678	.018	.164	.868	.724
Fe	.931*	-.644	-.042	.551	.530

* Significant at p = 0.05; ** Significant at p = 0.01

Discussion

The floristic inventory of the forests revealed marked variations and heterogeneities in species composition and abundance. This may be an indication of varying levels of adaptation and differential responses of plant species to environmental and pedological factors. Favourable microsites or safe sites might have also accounted for the high density and frequency values recorded by some species in the forest. Oswald and Neuenschwander (1993) and Titus and Del Moral (1998) reported that spatial distribution of safe sites can often determine where establishment occurs, strongly influencing colonization and successional patterns in species. They went further to expound that microsite conditions can affect patterns of seed germination and seedling establishment in many communities. Be that as it may, the good reproductive strategies and high regeneration potentials of these species may not be overlooked as a contributor to their high density and frequency. This is quite true as Santamaria (2002) opined that efficient dispersal abilities and good reproductive strategies are compendium of factors that could also explain dominance and rarity of species in diverse ecosystems. In the same vein, the low density and frequency values observed in most species in the forest are not far-fetched from the premise that they were unable to fully adapt to the soil conditions which is a prerequisite for their establishments. It can also be attributed to selective exploitation (as evidenced in Mkpok forest) of these plant species which may have led to slow rate of regeneration and low ecological tolerance (Kabir *et al*., 2008). Furthermore, the species composition in the forests corroborates with the findings of (Onyekwelu *et al*., 2005; Ukpong *et al*., 2012; Udoakpan *et al*., 2013; Daniel *et al*., 2015 and Jacob *et al*., 2015). These researchers reported that within the southern rainforests, a number of forest types can be recognized, some are rich in species of family Sterculiaceae, Moraceae, Meliaceae, Euphorbaceae, Mimosaceae (Fabaceae) and Apocynaceae with a middle storey of dense-crowned, wide-spreading trees and a ground flora that is mainly herbaceous and characterized by an abundance of creepers, mostly *Acacia sp*. and rattan (*Calamus deerratus*). In Mkpok forest, a total of forty-two (42) plant species belonging to thirty (30) families were encountered. Family Fabaceae had the highest number of species (6), followed by Meliaceae (3), Euphorbiaceae (3) and Arecaceae (3); and the ground flora had herbs and climbers in abundance as depicted by their IVI.

The variations observed in IVI values among species may depict their various levels of adaptations in the forests as well as the different ecological importance of each species in the forest. The high IVI values recorded by *Pentaclethra macrophylla* (19.65) and *Coelocaryon preusii* (14.63) among the trees in the forest may invariably suggest that these species were the most ecologically dominant and adaptive species. This may be attributed to the abundance of propagules or seeds that facilitated ecological succession (Aweto, 2001; Iwara *et al.*, 2012). Furthermore, Olajide *et al*., (2008) stated that the existence and population density of a plant species in a tract of a rainforest is a function of the availability of its seeds or propagules and the existence of favorable micro-climate for the seed germination and growth. Furthermore, the abundance and rarity of a plant species, especially those of great economic value, is a function of the intensity and pattern of exploitation (for example selective exploitation of highly priced tree species for fuel wood) which the forest is genrally subjected to (Udo *et al*., 2009). Anthropogenic intrusions (selective exploitation) and slow regenerative ability might also be responsible for low values in heights of some plant species (Remegie and Yansheng, 2008). Also, plant species with low values in height but large girth sizes and coverages might be said to be a reflection of their growth forms or habits. The presence of *Musanga cecropiodes* and *Elaeis guineensis* is suggestive of the fact that the forest is a secondary forest which enjoys a reasonable level of impact. This view is in synchrony with the earlier report by Ubom *et al*. (2012).

The phytodiversity indices showed clearly that the Mkpok forest supported a good number of plant species. Shannon-Wiener and Simpson diversity indices of 2.88 and 0.90 were recorded respectively. These values fell between the range of 1.5 and 3.5 for forest as reported by Kent and Coker (1992). However, these values are slightly higher when compared with the 2.20 by Sundaranpandian and Swamy (2000) in tropical forest of Kodayar, Western Ghats of Southern India. Dominance value was low in the forest implying that a monospecific picture or pure stands in terms of species composition was not created in the forest. Furthermore, the high diversity and low dominance values obtained in the study reveal a healthy inter-specific competition among species in the forest. Evenness value was high. This may suggest equitability distribution of components species in the forest.

Soil properties especially nutrients are known to influence primary productivity and plant species richness. At the very least, the presence and availability of nutrients may, or may not, meet the nutrient requirements of different species and therefore defines a species' potential to survive in a given area (Ibia and Udo, 2009). The soil pH was acidic as in a typical forest. Texturally, the soils were highly sandy resulting in their poor structural stability, nutrients and water retention capacities. This may justify the low levels of some vital soil nutrients such as total nitrogen, available phosphorus, and potassium recorded in this study. This agrees with the findings of Jones and Wild (1973) that low soil nutrients were attributed to high sand with low clay and silt contents as well as the level of litter availability. Nitrogen is a limiting nutrient for plant growth in many natural and semi-natural ecosystems. According to Brady and Wiel (1996), nitrogen is the most commonly lacking nutrient in soils and this affects productivity of most ecosystems. Nitrogen content in surface mineral soils ranges between 0.02 and 0.5 % and that soil nitrogen occurs as part of organic molecule (Shukla and Chandel, 2008). This corroborates with the findings of this study as 0.16 % was recorded for nitrogen. The levels of basic cations in the soil such as Ca, Mg and Na recorded in the study may substantiate that the soils had low sinks for these nutrients. Similar instance had been reported by Ubom (2006) and Ita *et al*., (2017). The high values recorded for heavy metals such as Fe, Cd, Cu, Zn, Pb may underscore the various intensities of anthropogenic perturbations going on in the forests.

Correlation techniques are often used to examine the strength of the relationship between two variables that may be unevenly distributed over an area (Dalton, 1972). The correlations between vegetation and soil variables were used to assess the nature of these relationships and to identify the key soil variables that strongly influenced the vegetation. The current result furnishes evidences showing some significant soil-plant relationships in the forest. Density associated positively with organic carbon and Fe. This is not unprecedented as the roles of organic carbon and Fe in increasing productivity and density of species is well documented (Brady and Weil, 1996). The height of species associated positively with total nitrogen and negatively with Ca. While the positive correlation between height and total nitrogen entails affinity of woody species for this nutrient for growth, the negative correlation of height and Ca is likely attributed to the fact that Ca being a structural element is locked up in plant biomass leading to depletion of soil Ca. This negative association may also depict interspecific competition among tree species for Ca owing to the fact that Ca aids in cell growth, division, elongation and other essential biological functions (Berridge *et al*., 2000; Hirschi, 2004). Basal area of species had a positive association with Cu while crown cover had a positive relationship with Zn. These direct relationships may denote that woody species in the forest were tolerant to the high infiltrations of these heavy metals in the soil. These positive associations may also point to the fact these metals (Cu and Zn) play beneficial roles in plants. In line with this, Hardy (2007) stated that Zn availability increases the growth and yield potentials of plants species. Marschner (1995) and Raven *et al*. (1999) reported that Cu acts as a structural element in regulatory proteins and participates in photosynthetic electron transport, mitochondrial respiration, oxidative stress responses, cell wall metabolism and hormone signaling.

Conclusion

The results revealed variations in the floristic composition as well as heterogeneity of species which were an indication that the species adapted differently to the environmental factors (soil conditions) of the forest. The forest supported a good number of plant species as revealed by the diversity indices and that there was a complex relationship existing between the vegetation characteristics and the soil properties. However, in terms of profile, the forests displayed the attributes of lower storey plant species with open canopies comprising of mainly mesophanerophytes. Thus, the forests though structurally not complex as expected of a tropical forest, possessed some features of a typical southern Nigeria forest plant species composition and diversity that give prospects that the forest could possibly return to its primary status in the nearest future if adequate conservative and management measures are put in place. It is recommended that time series evaluation should be done to understand and monitor the floristic and soil dynamics in order to have adequate and up-to-date quantitative ecological data for successful management and conservation of MVF; and since physical observation in MVF forest revealed encroachment for human settlement which negates the essence of preservation, much attention is required to avoid the forest been completely removed. The information obtained in this research is expected to serve as a baseline data for other ecological studies and conservation activities within MVF.

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