VEGETATION ANALYSIS OF HERBACEOUS SPECIES IN THE UNIVERSITY OF LAGOS, NIGERIA

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ABSTRACT
Vegetation is under increasing pressure by critical factors of urbanization and climate change in most industrialized parts of the world. Thus, vegetation inventory and analysis is important to reveal the species richness and abundance in a given locality for biodiversity conservation and management. This study measured the herbaceous species diversity in the University of Lagos (UNILAG) Akoka campus using simple random sampling. Vegetation data was collated from five different sites: Faculties of Social Science, Management Science, Science, Distance Learning Institute (DLI), and New Hall. Five grid plots of 1 x 1 m each were laid per site in the five different sites. Data analysis estimated species richness and abundance, frequency and relative frequency, density and relative density of species per site. A total of 47 herbaceous species with 9353 individuals were found across the sites. Vegetation composition was significantly different across all sites ($p < 0.001$). Dominant herbaceous species were Cyperus difformis (11.6%) and Tridax procumbens (11.4%), whereas species with low abundance were Lycopersicum esculentum (0.09%) and Chromolaena odorata (0.07%). Herbaceous species richness and abundance was highest in the Faculty of Science, whereas Management Science had the least species richness and density across the sites. In conclusion, various anthropogenic pressures affected the abundance and diversity of herbaceous species across the sites. High species richness and abundance around Faculty of Science strongly indicates the minimally disturbed condition of this site, in contrast to Management Science with new construction sites. Sites with low species diversity, such as Management Science and New Hall can be improved by greening these areas.

***KEYWORDS**: Herbaceous Species, Random Sampling, Unilag, Vegetation.*

INTRODUCTION
Herbaceous species are plants with soft, flexible and tender stems (Sahdu, 1999). They contribute to the green infrastructure and plant biodiversity of a region. Herbaceous species function as primary producers that support the herbivore populations of several ecosystems around the world (Pardo *et al.*, 2011). Herbaceous species limit soil erosion, improve water penetration into soils and add organic matter that improves plant's growth and moisture holding capacity (Mohammed *et al.*, 2015). Because of their ecological role, they deserve equally

potent conservation efforts to ensure their existence (Ahmad and Ehsan, 2012). Herbaceous vegetation inventory and analysis may aid in this important role.

Vegetation analysis encompasses plant species inventory and measurements. It seeks to understand relevant biological features of a plant community (Partosa and Delos, 2013). Several measurements are used to determine plant species diversity. They include species richness, species abundance, species density, relative density, frequency, relative frequency, and Importance Value Index (IVI). Species richness refers to the count of unique species in a community. Species abundance measures the number of individuals of a species in a community (Causton, 1988; Magurran, 2004). Species density is a ratio of the number of individuals of a species per sample area, while frequency measures the probability of finding a species in a sample area (Kent, 2012). Lastly, IVI measures the ecological significance of species by the dominance of the species in a given vegetation structure (Misra, 1968; Mohammed *et al.*, 2015).

This is the first study to critically assess the herbaceous plant species diversity and distribution in five important sites on the University of Lagos (UNILAG) Akoka campus using five different vegetation parameters. The aim of this study is to determine the identity and numbers of herbaceous species present in UNILAG to better inform species management and the greening of the campus. Therefore, we propose to: (i) Estimate the herbaceous species richness and abundance, and (ii) Evaluate the density, frequency and IVI of the herbaceous vegetation in UNILAG.

MATERIALS AND METHODS

STUDY AREA: The University of Lagos (UNILAG) is situated in the southwest of Nigeria at 6º30'N latitude and 3º24'E longitude. The climate is tropical with an average annual rainfall of 1250 mm to 2500 mm. The average annual temperature is 28ºC (Odjugo, 2010). The area lies within the coastal rainforest vegetation belt (0 – 40 m a.s.l). UNILAG is bordered to the South by the Lagos lagoon adjacent to the Atlantic Ocean (Fig. 1). The University was established in 1962 with 3 faculties at a temporary site, but moved to the main campus at Akoka in 1965. Currently, there are 12 faculties with 8 of them located in the UNILAG Akoka campus.

SAMPLING PROCEDURE: Herbaceous species data was collected from the field using simple random sampling. Five different sites that encompassed a comprehensive coverage of UNILAG were sampled: Faculty of Social Science, Faculty of Management Science, Faculty of Science, Distance Learning Institute (DLI), and New Hall. In each site, we randomly selected 5 different areas and used a 1 x 1 m grid quadrat to measure herbaceous species richness, abundance, density

and relative density, frequency and relative frequency, and the Importance Value Index (IVI). Herbaceous species captured within the quadrat were identified, counted and recorded on site with the guidance of a taxonomist from the UNILAG Herbarium, and using the flora guide of Ndiribe and Iloh (2017).

STATISTICAL ANALYSIS: Species richness was estimated from a direct count of each species across the sites. Species abundance was estimated by counting the number of individuals of each species following Magurran (2004). Density was estimated by dividing the total species found by the area of the quadrat. The frequency of occurrence of each species was measured by simply counting the species encountered (Kent, 2012). The IVI was estimated using the formula introduced by Misra (1968).

The formula for the diversity measurements are:

1) Density: $$d = \frac{\text{Number of stems counted per species}}{\text{Total sampled area}}$$

2) Relative Density: $$\text{Rd} = \frac{\text{Number of stems counted per species}}{\text{Total number of stems counted for all species}} \text{ x } 100$$

3) Frequency: $$\text{f} = \frac{\text{Total number of subplots of occurrence per species}}{\text{Total number of subplots sampled}}$$

4) Relative Density: $$\text{Rf} = \frac{\text{Frequency per species}}{\text{Sum of frequencies of all species}} \text{ x } 100$$

5) Importance Value Index: $$\text{IVI} = \frac{Rd + Rf}{2}$$

6) Shannon − Wiener Index: $$H^1 = \sum_{i=1}^{S} P_i \log_e P_i$$

Where: H^1 = Shannon-Wiener Diversity Index, S = total number of species in each sampled site, P_i = the relative abundance of individual species.

Finally, we used linear regression to determine the statistical relationship between species richness and species abundance across the 5 sites. The mean and standard deviation of the herbaceous vegetation was estimated for each site. Plots of herbaceous species richness and abundance were generated across the 5 sites, including a relative abundance curve (RAC). All statistical analyses were performed using Microsoft Excel and the R programming software (R Development Core Team, 2018).

RESULTS

The result of the analyses of herbaceous vegetation in the University of Lagos (UNILAG) was estimated from 5 sites. The evaluation of species richness, species abundance, species density and relative density, frequency and relative frequency, and Importance Value Index (IVI) showed a total of 47 herbaceous species with 9353 individuals belonging to 20 different plant families across the sites.

There was a significant difference ($p < 0.001$) between herbaceous species richness and abundance across the sites. Herbaceous species richness was highest in the Faculty of Science 38 (24.68%), but was least in the Faculty of Management Science 26 (16.88%). Herbaceous species abundance was also highest in the Faculty of Science 2444 (26.13%) and least in the Faculty of Management Science 1402 (14.99%). The most dominant species were *Cyperus difformis* 1081 (11.6%) and *Tridax procumbens* 1062 (11.4%), whereas *Lycopersicum esculentum* 8 (0.09%) and *Chromolaena odorata* 7 (0.07%) had the least occurrence and were found in only one site (Table 1-2, Fig. 2-4).

Herbaceous species diversity was found to vary across the sites. Faculty of Social Science had a total of 31 species with 1902 individuals. The most abundant species was *Cyperus diffiormis* (14.04%), whereas *Lycopersicum esculentum* (0.01%) had the least occurrence. Faculty of Management Science had a total of 26 species with 1402 individuals. The most abundant species was *Cyperus difformis* (35.82%), whereas *Euphorbia hyssopifolia* (0.01%) had the least occurrence. Faculty of Science had a total of 38 species with 2444 individuals. The most abundant species was *Syndrella nodiflora* (12.15%), whereas *Laportea aestuans* (0.01%) had the least occurrence. DLI had a total of 33 species with 2059 individuals. The most abundant species was *Tridax procumbens* (15.71%), whereas *Luffa cylindrica* (0.01%) had the least occurrence. Lastly, New Hall had a total of 26 species with 1546 individuals. The most abundant species was *Tridax procumbens* (21.18%), whereas *Vernonia cinerea* (0.01%) had the least occurrence (Fig. 3). Mean and standard deviation values of species abundance across the sites were: Faculty of

Social sciences (62.19 ± 78.88), Faculty of Management Sciences (54.31 ± 68.48), Faculty of Science (64.32 ± 75.71), DLI (62.70 ± 89.89) and New Hall (59.46 ± 74.58).

The density of herbaceous species across the sites was highest in the Faculty of Science (488.8 species/ m^2), whereas it was least in the Faculty of Management Science (280.4 species/ m^2). The frequency of herbaceous species was highest in the Faculty of Science (6.52), whereas it was least in the Faculty of Social Science (3.96). The herbaceous species with the highest IVI across all sites was *Cyperus difformis* (54.30%), whereas *Ipomoea aquatica* had the least IVI (0.66%). *Cyperus difformis* (17.92%) also had the highest IVI from the Faculty of Management Science, whereas *Ipomoea aquatica* (0.13%) from New Hall had the least IVI.

DISCUSSIONS

The results of this study suggest that herbaceous species are widely abundant on UNILAG campus, but with low to average species richness representation. This corroborates the reports from the work of several authors in various locations across Nigeria, such as Abdullahi *et al.* (2009), Iwara *et al.* (2014), and Sanyaolu (2015). Abdullahi *et al.* (2009) found a high number of individuals for a few herbaceous species in Yankari game reserve, Bauchi state. Similarly, Iwara *et al.* (2014) found a high number of individuals for a few herbaceous species in Agoi-Ekpo area of Cross River state. Sanyaolu (2015) found many individuals for a few herbaceous species in Lagos state polytechnic, Ikorodu, Lagos state.

Most of the herbaceous species encountered belonged to the Poaceae family. This monocot plant family is resilient with beneficially evolved strategies for efficient water storage and conductivity that enhance the survival and longevity of members of this group (Mohammed *et al.*, 2015; Linder *et al.*, 2017). The Asteraceae family ranked second in high species richness and abundance, similar to the Poaceae. Members of the Asteraceae have developed resistance to harsh ecological and environmental conditions, with some species possessing leaves that are resistant to herbivory, and other forms of predation (Strauss and Agrawal, 1999). This feature may be responsible for the ecological success of Asteraceae in diverse environments, which in comparison to older plant groups that evolved more than 60 million years ago, such as Fabaceae (Wikstrom *et al.*, 2001) is more recently evolved from about 30 million years ago (Jansen *et al.*, 1991). These strategies likely explain the high abundance of these species in the study area.

Herbaceous species are confronted by different anthropogenic pressures and threats in different locations (Elliot *et al.*, 2011). In UNILAG, some of the most important

disturbances to vegetation are constant grass clearing, burning, human-related pressures from trampling and construction activities. These activities most likely maintain low herbaceous species richness and increase species homogenization in the area, so that a few species contain a high number of individuals. The reason for this trend may be likely due to the differences in human population on each site.

Faculty of Science had the highest value for species richness, abundance and the other diversity measurements. This result buttressed the minimally disturbed condition of this site. There are more green and inaccessible areas in this site, particularly wetlands. In contrast, the Faculty of Management Science had the least value for species richness, abundance, and the other measurements. This is an indication of the boisterous condition of this site, which in addition to higher human population has new and on-going construction projects. Based on our research findings, we suggest a more exhaustive herbaceous species inventory in UNILAG to understand if there are underlying environmental and physiological variables responsible for the disparity in species diversity. A more thorough analysis may also inventory the number of people that work and visit each site, for correlations with vegetation measurements. The sites with low herbaceous species diversity, such as the Faculty of Management Science and New Hall can be improved, where future greening projects are planned.

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Table and Figures

Table 1: Species richness and abundance across the five sites in the University of Lagos.

		Species Abundance				
S/N	Species Richness	Social Sciences	Management Sciences	Sciences	DLI	New Hall
1	*Acalypha indica*	0	30	0	9	77
2	*Alternanthera pungens*	244	33	208	152	41
3	*Amaranthus viridis*	1	20	8	1	3
4	*Aspilia Africana*	0	0	42	0	0
5	*Asystasia gangetica*	72	65	61	75	46
6	*Axonopus compressus*	0	59	232	320	152
7	*Boerhavia diffusa*	21	2	23	21	32
8	*Centrosema pubescens*	171	4	10	44	28
9	*Chloris pilosa*	0	0	18	0	20
10	*Chromolaena odorata*	7	0	0	0	0
11	*Chrysopogon aciculatus*	0	0	5	4	0
12	*Cleome rutidosperma*	21	0	48	20	8
13	*Commelina diffusa*	210	130	140	167	47
14	*Corchorus olitorius*	16	10	8	2	0
15	*Cyperus difformis*	263	319	114	254	131
16	*Cyperus iria*	0	0	62	0	0
17	*Digitaria nuda*	0	0	11	0	0
18	*Eleusine indica*	2	0	0	0	54
19	*Emilia coccinea*	11	0	0	13	0
20	*Eragrostis tenella*	9	6	2	9	38
21	*Euphorbia heterophylla*	5	0	41	0	0
22	*Euphorbia hirta*	0	51	8	43	61
23	*Euphorbia hyssopifolia*	16	2	19	7	0
24	*Euphorbia prostrate*	0	0	0	136	0
25	*Gomphrena celosioides*	9	51	120	26	15
26	*Ipomoea aquatic*	0	0	8	0	0
27	*Ipomoea cairica*	0	0	28	0	0
28	*Ipomea involucrate*	51	0	6	0	0
29	*Lycopersicum esculentum*	1	0	0	0	7
30	*Laportea aestuans*	0	0	1	0	7

31	*Luffa cylindrical*	0	14	0	1	0
32	*Mimosa pudica*	44	0	2	7	0
33	*Nelsonia canescens*	169	109	85	52	181
34	*Oxalis corniculata*	11	71	140	149	0
35	*Panicum laxum*	21	0	25	0	0
36	*Panicum maximum*	53	14	28	30	0
37	*Paspalum vaginatum*	163	0	0	7	12
38	*Peperomia pellucid*	22	0	0	0	0
39	*Phyllantus amarus*	56	85	49	57	132
40	*Portulaca oleracea*	0	6	26	31	103
41	*Setaria barbata*	121	78	59	7	2
42	*Sida acuta*	0	26	49	32	10
43	*Spigelia anthelmia*	5	0	6	5	0
44	*Syndrella nodiflora*	78	17	297	14	11
45	*Talinum triangulare*	0	39	109	11	0
46	*Tridax procumbens*	7	156	251	321	327
47	*Vernonia cinerea*	22	5	95	32	1
	Total	1902	1402	2444	2059	1546

Table 2: Herbaceous species family, abundance and relative abundance across five sites in the University of Lagos.

S/N	Herbaceous species	Family	Number of Individuals	Relative Abundance (%)
1	*Acalypha indica*	Euphorbiaceae	116	1.24
2	*Alternanthera pungens*	Amaranthaceae	678	7.25
3	*Amaranthus viridis*	Amaranthaceae	33	0.35
4	*Aspilia Africana*	Asteraceae	42	0.45
5	*Asystasia gangetica*	Acanthaceae	319	3.41
6	*Axonopus compressus*	Poaceae	763	8.16
7	*Boerhavia diffusa*	Nyctanginaceae	99	1.06
8	*Centrosema pubescens*	Fabaceae	257	2.75
9	*Chloris pilosa*	Poaceae	38	0.41
10	*Chromolaena odorata*	Asteraceae	7	0.08
11	*Chrysopogon aciculatus*	Poaceae	9	0.1
12	*Cleome rutidosperma*	Cleomeaceae	97	1.04

13	*Commelina diffusa*	Commelinaceae	694	7.42
14	*Corchorus olitorius*	Malvaceae	36	0.38
15	*Cyperus difformis*	Cyperaceae	1081	11.56
16	*Cyperus iria*	Cyperaceae	62	0.66
17	*Digitaria nuda*	Poaceae	11	0.12
18	*Eleusine indica*	Poaceae	56	0.6
19	*Emilia coccinea*	Asteraceae	24	0.26
20	*Eragrostis tenella*	Poaceae	64	0.68
21	*Euphorbia heterophylla*	Euphorbiaceae	46	0.49
22	*Euphorbia hirta*	Euphorbiaceae	163	1.74
23	*Euphorbia hyssopifolia*	Euphorbiaceae	44	0.47
24	*Euphorbia prostrate*	Euphorbiaceae	136	1.45
25	*Gomphrena celosioides*	Amaranthaceae	221	2.36
26	*Ipomoea aquatic*	Convulvulaceae	8	0.09
27	*Ipomoea cairica*	Convulvulaceae	28	0.3
28	*Ipomea involucrate*	Convulvulaceae	57	0.61
29	*Lycopersicum esculentum*	Solanaceae	8	0.09
30	*Laportea aestuans*	Uriticaceae	8	0.09
31	*Luffa cylindrical*	Curcubitaceae	15	0.16
32	*Mimosa pudica*	Fabaceae	53	0.57
33	*Nelsonia canescens*	Acanthaceae	596	6.37
34	*Oxalis corniculata*	Oxalidaceae	371	3.97
35	*Panicum laxum*	Poaceae	46	0.49
36	*Panicum maximum*	Poaceae	125	1.34
37	*Paspalum vaginatum*	Poaceae	182	1.95
38	*Peperomia pellucid*	Piperaceae	22	0.24
39	*Phyllantus amarus*	Phyllanthaceae	379	4.05
40	*Portulaca oleracea*	Portulacaceae	166	1.77
41	*Setaria barbata*	Poaceae	267	2.85
42	*Sida acuta*	Malvaceae	117	1.25
43	*Spigelia anthelmia*	Longaniaceae	16	0.17
44	*Syndrella nodiflora*	Asteraceae	417	4.46
45	*Talinum triangulare*	Portulacaceae	159	1.7
46	*Tridax procumbens*	Asteraceae	1062	11.35

47	*Vernonia cinerea*	Asteraceae	155	1.66
		Total	9353	100

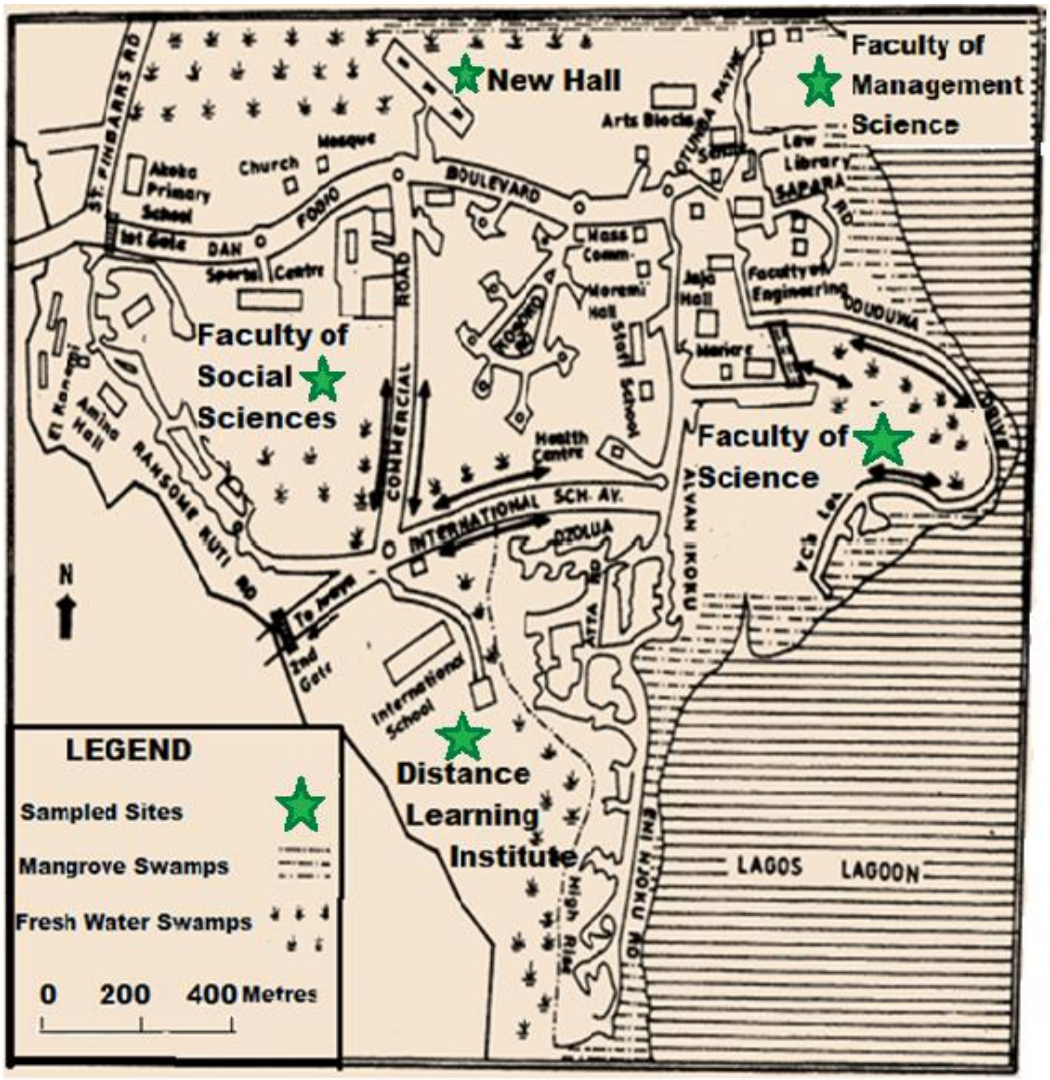

Fig. 1: Map of the University of Lagos (Unilag), Akoka campus showing the five sites.

Source: Shonubi and Okusanya (2007).

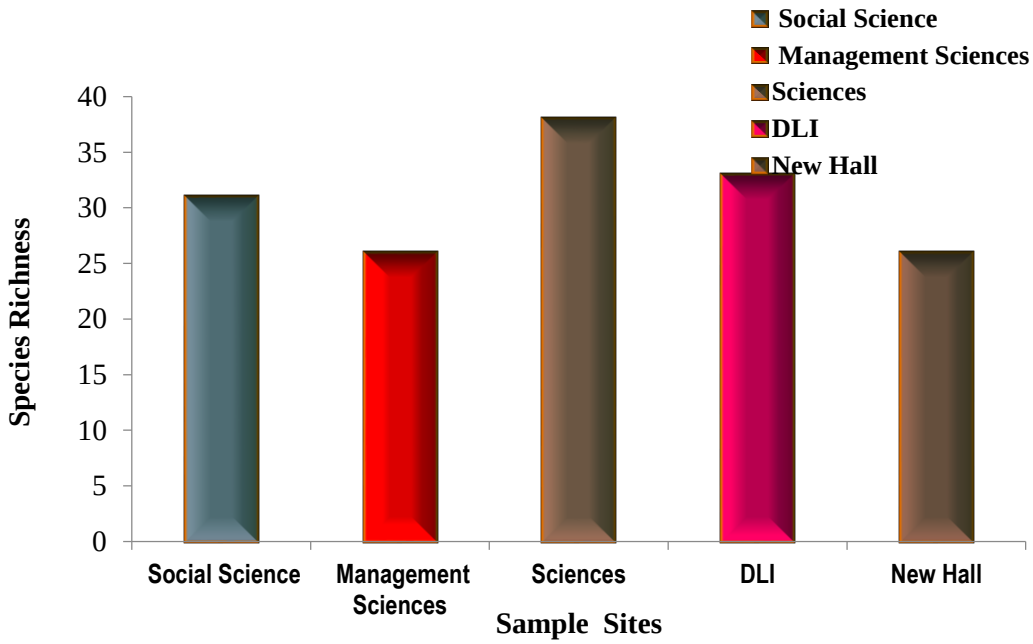

Fig. 2: Species richness of the five sites in the University of Lagos, Akoka campus.

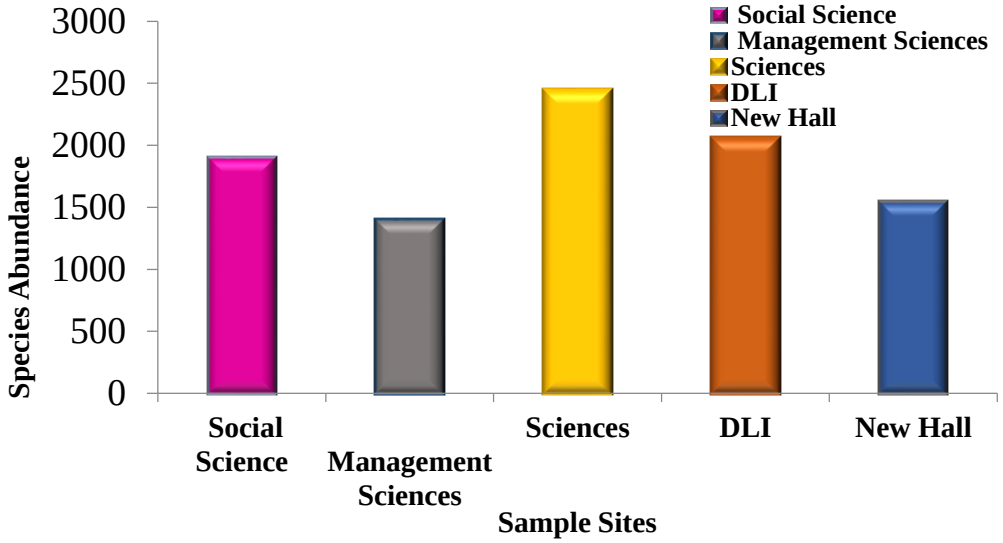

Fig. 3: Species abundance of the five sites in the University of Lagos, Akoka campus.

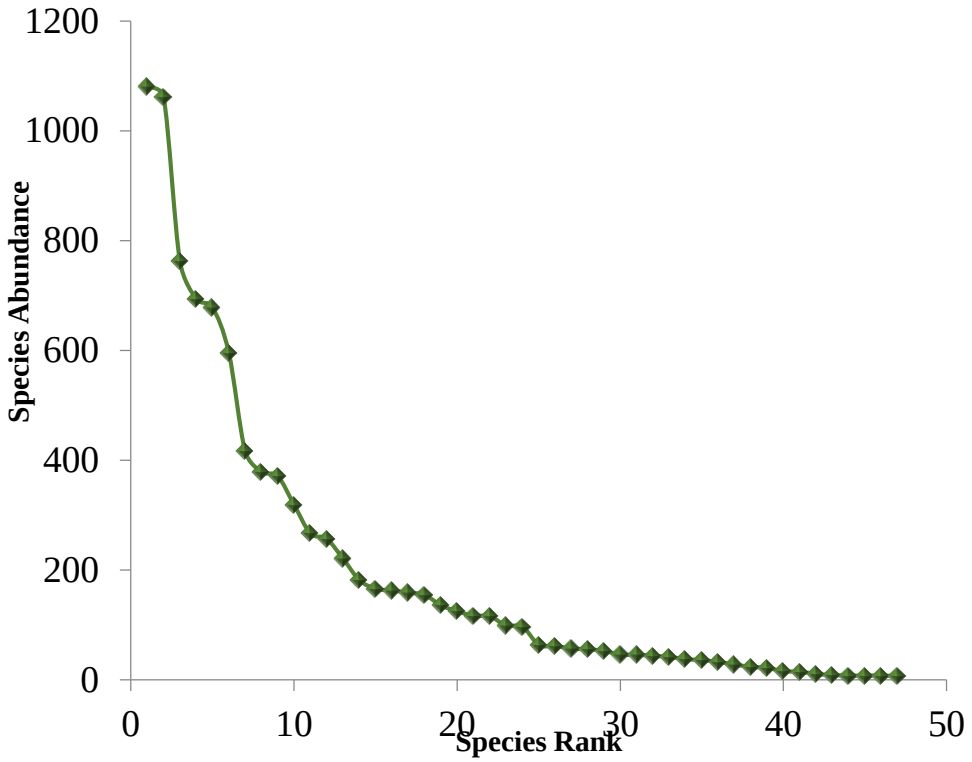

Fig. 4: Rank Abundance Curve (RAC) of herbaceous species found in five sites of the University of Lagos, Akoka campus.

