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Floristic Composition of an Artificial Pond Adjoining Ogba Zoo and Nature Park, Benin-City, Edo State, Nigeria

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ABSTRACT: Ponds are aquatic ecosystems that support macrophytic vegetation that play vital ecological roles, but are often ignored and interrupted by developmental activities which put the macrophytic communities at risk of being faced out. This study therefore describes the floristic composition and diversity in an artificial pond adjoining Ogba Zoo, Benin-City, in a bid to harness its conservation potentials. Floristic composition and structure at different sides of the pond were obtained from visual inspection and five replicates of sampling quadrats measuring 50cm x 50cm (2500 cm2). A total of 30 plant species belonging to 19 families were enumerated. The families Cyperaceae (21.05%), Fabaceae (21.05%), and Poaceae (15.79%) were the most abundant. The growth form distribution had herbs (36.6%), trees (16.67%), sedges (13.33%), vines (13.33%), grasses (10%) and shrubs (10%). Phytogeographically, the highest prevalence was observed among native plants (53.33%), exotic plants (36.67%) and Cosmopolitan (10%). The West was the most species rich and diverse section, while the North facing section recorded the least number of species and diversity. Both the spatial and scatter plots revealed the distinctness of the various sections of the pond with the West section being most uniquely different from the other sections reflecting anthropogenic influence while the least accessible North and East sections were most similar in their composition. This study demonstrates that ponds in urban centres can serve as refugia for native, rare or vulnerable species, thus, a regular survey of these ecosystems and making efforts for their conservation is crucial.

KEYWORDS: Wetland, Floristic composition, artificial pond, diversity, conservation.

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INTRODUCTION

Wetlands areas within the Ecosystem that makes up part of the most important and productive environment globally [1]. The productive nature of wetland is due to the diverse ecosystem function they render to plant species, organism, man and the environment generally. These functions include habitat for most plant species who originally cannot exist outside wetland environment. Wetland also provide numerous nutrients to plant species and other organisms found in them. This plant species depends mostly on the wetland environment for their survival and also suffer a lot when there is a habitat loss [2].

Wetland play critical role in creating maintainance in regional water supplies, controlling climate change and also improving the environment [3]. These functions not only balance the ecosystem, but are also important in playing critical roles such as provision of natural resources and environmental protection for human sustainability.

Floristic composition is the description of plant species in any region, and it is one of the most essential means by which the vegetation type and structure of a particular place at any period in time can be assessed. Corroborating this viewpoint, [4] asserted that there are several reasons for recording the species composition of freshwater plant communities. These reasons which often overlap include: assessment of the biological productivity of freshwaters, the use of aquatic macrophytes as indicators of pollution, the biological delineation of rivers and lakes, assessment of the natural management value of freshwater habitats, and the recognition of spatial and temporal changes in freshwater ecosystems.

According to [5], researchers for the British Charity Pond Conservation, describes a pond to be a man-made or natural water body that is between $1m^2$ – $20,000m^2$ in an area which holds water for about four months of the year or more. Ponds generally support biodiversity and this in turn, is influenced by a number of factors such as water level regime, that is, the depth and duration of flooding, the nutrient levels, presence or absence of streams as well as the effects of grazing animals and salinity [6], [7]. Aquatic plant composition may also be affected by the depth of light penetration through the water column and as such, in productive eutrophic waters, plants may grow just about 3 metres deep, however, in oligotrophic water, plants may grow to depths of 10 metres or more [8].

An aquatic ecosystem is generally made up of floral and faunal products that have the potential to meet human needs through agriculture, industry, medicine and energy [9]. According to [10], the macroscopic forms of aquatic vegetation described as aquatic macrophytes include macroalgae as well as some ferns and angiosperms that inhabit the wetland environment. [11] noted that aquatic plants are those plants that normally stand in water and grow at least a part of their life cycle in water, either completely submerged or emerged. An analysis of aquatic vegetation is useful in revealing other relevant information about the other components of the ecosystem [12]. Supporting this assertion, [13], pointed out that the macrophytic vegetation in wetlands performs essential ecological roles in determining the structure and function of these ecosystems.

Although many individuals see aquatic macrophytes as weeds with potential to infest waterways and interfere with navigation, irrigation, fisheries production and water quality, research reports have revealed that aquatic macrophytes can act as efficient indicators for water quality. This owes to the fact that their presence tends to enhance the absorption of excessive loads of nutrients and heavy metals, thereby purifying water [9]. Aquatic plants also serve as food for other aquatic animals and are as well cherished for their aesthetic value in bringing about atmospheric equilibrium.

However, for several decades, no substantial research work has been done to assess the floristic composition of this ecosystem in West Africa, particularly in Nigeria, to ascertain the threats to this relevant ecosystem and draw up a sustainable roadmap for its preservation and conservation. This research is therefore an attempt to bridge the gap by assessing the flora of an artificially excavated pond within Benin metropolis to find out its ecological impacts as well as to recommend solutions and draw up a roadmap for its sustenance.

MATERIALS AND METHODS

Description of Study Area

This study was conducted in an artificial pond adjoining Ogba Zoo and Nature Park, Benin-City, Edo State. The pond is about 350 metres away from the main Ogba Road, which lies 5km along the Airport Road axis of Benin-City. The study area is situated within Latitude $06^0 17.650'$ North and Longitude $005^0 34.99'$ East. It has an altitude of 21.2m asl. As an artificially excavated pond, the depth is not uniform across all sections of the pond. The shallowest area of the pond is about knee deep while the deepest part is about 4 metres deep. The pond is accessible through the west wing, which adjoins Ogba Zoo and Nature Park. The east wing faces a residential quarter, but is not subjected to trampling because of its depth, though there is some form of indiscriminate dumping of refuse on this section. The south wing faces a farm site while the north axis is totally inaccessible because of its proximity with the bush path and it has the highest water depth. Although the pond has no direct link with the Ogba River, it is believed to be receiving underground seepage from the Ogba River, hence, it has water all through the year as opposed to similar ponds in urban centres that dry out at certain times of the year. By size, the study area measures about $100m^2$ X $75m^2$.

Sampling Design

A systematic sampling design was used in collecting vegetation data in the pond. Rectangular quadrats measuring 50cm x 50cm were randomly laid in five replicates along each of the four sections of the pond with the following tags: (West=A, B, C, D, E; South=F, G, H, I, J; East=K, L, M, N, O; North=P, Q, U, R, S). The presence or absence of each plant at the different sections of the pond was also used to produce an additional data matrix. Spatial dispersion and degree of variability was determined from ordination and cluster analysis on both the phytosociological and presence or absence data matrices using var-corr matrix on Principal Component Analysis (PCA). Similarity clusters were generated using algorithms based on Unweighted pair-group average (UPGMA) based on Simpson's similarity measure. Before analysis, the presence of a plant on the data matrix was denoted by 1 and absence by 0. Eigenvector loadings from the PCA were used to spot the species exacting the most influence in determining the spatial dispersion pattern among the various sections, while hierarchical cluster analyses were used to determine the degree of similarities between the different sections of the pond.

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Data Collection

Bi-weekly reconnaissance survey was conducted around the pond from September 2016 to July 2017. All plant species in each quadrat at the different sections of the pond were recorded and their growth habits were described. All other additional plants occurring outside the quadrats but within the pond were also recorded as "present," and these were used in principal component analysis to determine the spatial distribution of plant species. All the plants were identified, classified and catalogued according to their taxonomic names, growth habits and chorological status (native or exotic) using the following literature: [14], [15], [16] as a guide. A checklist of all the plant taxa grouped by family and indicating presence or absence at each of the four sections of the pond was also generated.

Data Analysisis

Floristic composition, abundance, diversity and distribution of the plant species were determined using the following: species richness, diversity indices; Shannon –Wiener index, and species evenness (E). Shannon-Wiener diversity index (H') was used to compare the diversity in species composition of the four sections of the pond. The Simpson index of similarity (Qs) was used to compare the species composition in all the sections. Species evenness in each section was calculated using Shannon's equitability. All the analyses were performed on Paleontological Statistics Software Package for education and data analysis (PAST) version 1.97.

RESULTS

Composition of Plant Families

An inventory of the plants in the study area had a total of 30 plant species, distributed across 19 plant families. The families, Cyperaceae and Fabaceae were the most represented with 4 members each accounting for 21.05% followed by Poaceae with 3 species (15.79%). Euphorbiaceae, Melastomataceae and Onagraceae had 2 species each (10.53%), while the remaining plant families had 1 species each (5.26%) as shown in (Figure 1)

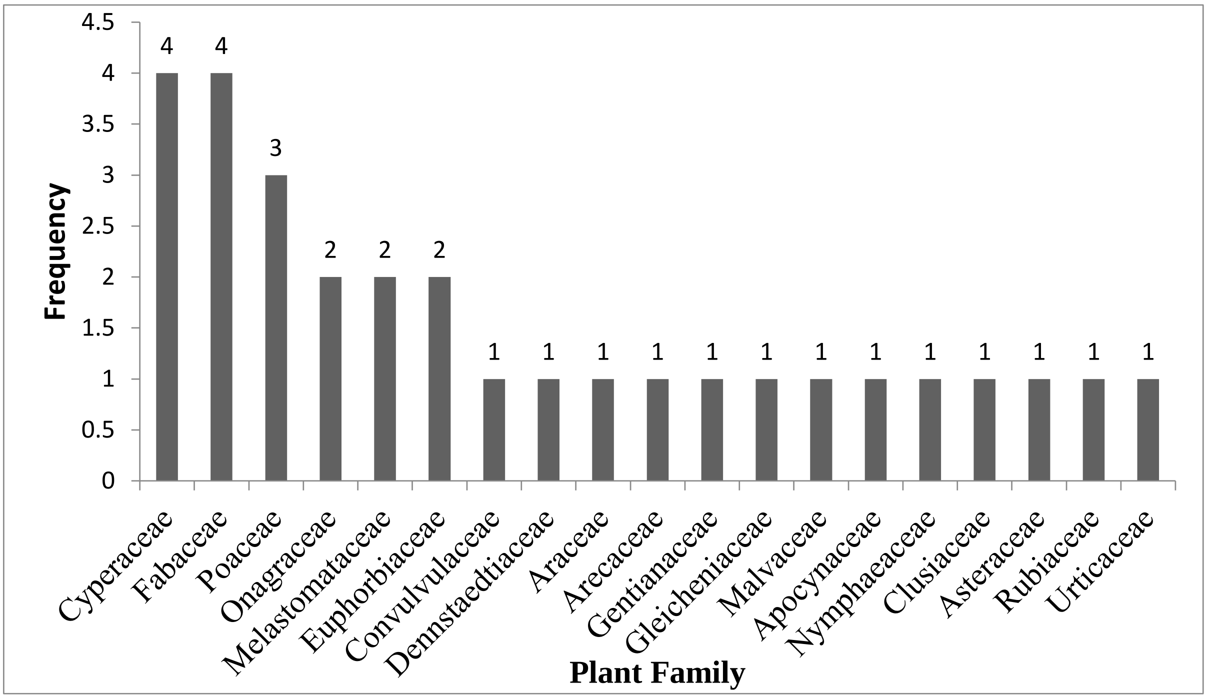

Fig. 1 Frequency distribution of family groupings of plants found across the various sections of the pond.

Growth Form Distribution

Analysis of growth forms of plants in the study area revealed that herbs had the highest number with 11 individuals accounting for 36.6% of the total plant cover. This was followed by trees with 5 species representing 16.67%. Sedges and vines had 4 species each, representing 13.33%, while grasses and shrubs had 3 members each with 10% cover of the overall species composition of the study area. This is represented in Table 1.

Table 1 Distribution of growth forms of vegetation found in the pond.

Growth form/habit	No. of Species	Relative %
Vine	4	13.33
Sedge	4	13.33
Grass	3	10
Herb	11	36.67
Shrub	3	10
Tree	5	16.67
Total	30	

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Community Profile Analysis

Analysis of the growth forms of plant communities at different sections of the pond revealed that herbs were the most represented with 5 species each at the South and West wings, and 4 and 2 species in the East and North wings respectively. Sedges were more represented in the South and East wings with 4 members each, while 2 individuals each were represented in the North and West. 4 trees species were recorded in the west wing, with 3 and 2 species in the South wings respectively, but these were completely absent in the North wing. Shrubs had 3 members each in the West and East sections, and 2 species each in the North and South sections. 3 grasses each were recorded in the North, South and East wings while only 1 grass species was recorded in the West wing. Vines had the highest occurrence in the South wing with 3 species, but had 2 species in the west section and1 species each in the North and East sections of the pond as shown in (Figure 2).

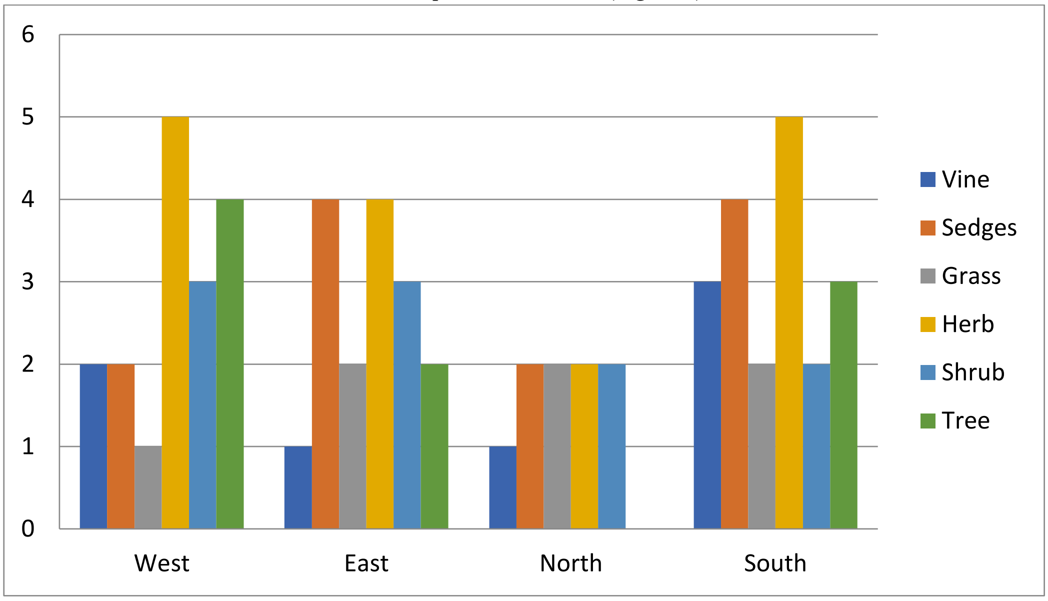

Fig. 2 Plant growth-form distribution at different sections of the pond.

Diversity Species

Estimates of ecological indices revealed that fewer taxa (7) and fewer individuals (76) were recorded in the North facing section of the pond. The highest number of plant taxa (12) and the highest number of individuals were recorded in the West wing. This was closely followed by the South section with 165 individuals and 10 plant taxa, while the East section had 151 individuals and 8 plant taxa. Shannon-Wiener and Simpson's indices indicate that the highest diversity (2.237) and (0.8803) was evident in the West facing section. Both indices also indicated that the North wing had the lowest diversity (1.526) and (0.7223) respectively. However, the North section recorded the most dominance (0.2777). This might be as a result of the pressure exerted by a certain plant taxa. Species were most evenly distributed in the West facing side of the pond with evenness index of 0.7804. The least evenness value (0.657) was also recorded for the North wing. This is represented in (Table 2).

Table 2 Summary of the mean estimates of different ecological indices derived from five quadrat samples laid randomly at different sections of the pond.

Vegetation Indices	West	East	North	South
Taxa_S	12	8	7	10
Individuals	177	151	76	165
Dominance_D	0.1197	0.2117	0.2777	0.1808
Shannon_H	2.237	1.788	1.526	1.98
Simpson_1-D	0.8803	0.7883	0.7223	0.8192
Evenness_e^H/S	0.7804	0.7475	0.657	0.7239

Chorological Profile

An analysis of the chorological profile (spatial distribution) of the plants found in the study area revealed that native plants were the most represented with 16 species accounting for 53.33%. Exotic plants were 11 representing 36.67%, while plants with cosmopolitan origin numbered 3 (10%). This is shown in (Figure 3).

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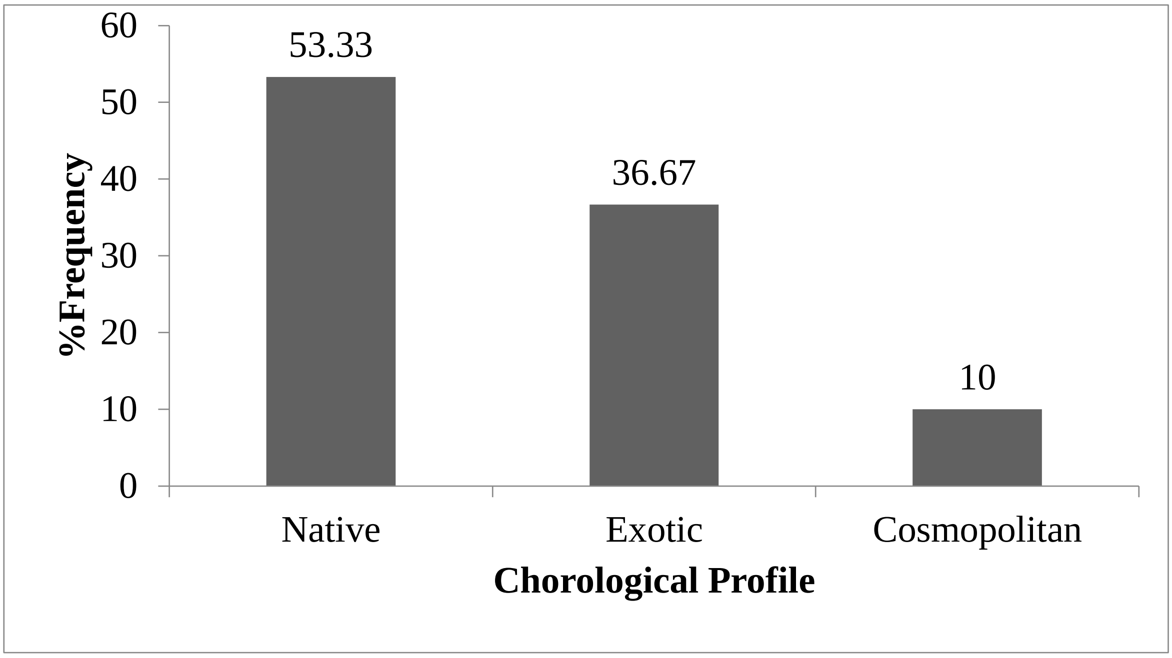

Fig. 3 Chorological profile of the plants found in the pond.

Spatial Dispersion

The scatter plots of the sampling quadrats of phytosociological data and binary (presence and absence) data obtaind from species composition projected onto the principal components are shown in Figure. Dispersion among sampling quadrats collectively accounted for 80% of the variation (PC1 = 45.7%, PC2 = 34.3%). The dispersion pattern shows a clear cut distinction among the different sections of the pond. The PCA loadings indicate that dispersion along PC1 was influenced by the presence or absence of eight plant species: *Elaies guineensis, Cyrtosperma senegalense, Sacciolepis africana, Abrus pulchellus, Mimosa pudica* (0.2633), *Frimbristylis littoralis, Panicum repens,* and *Sporobolus pyramidalis* (-0.2633), while the presence or absence of three plant species: *Ludwigia abyssinica* (-0.2139), *Pteridium aquilinum* (0.3403) and *Musanga cecropioides* (0.3403) accounted for the pattern of dispersion seen along PC2 axis. The dispersal pattern shows that plant taxa in PC1 are more evenly distrbuted than those in PC2.

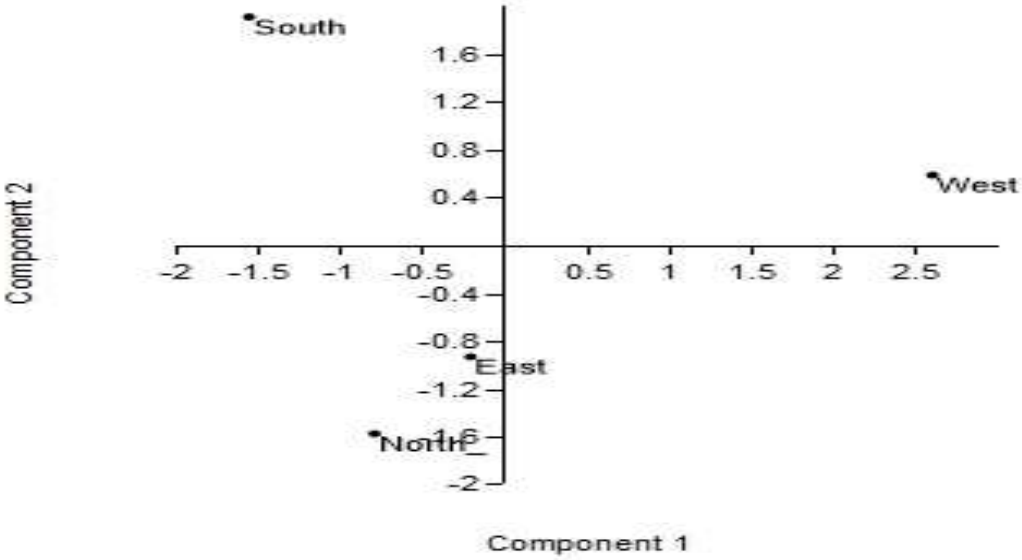

Fig. 4 Principal components analysis comparing spatial distribution of plant species at the different sides of the pond based on data matrix derived from phytosociological data of observed plant taxa. Percentage of total variation explained is 80% (45.7% for component 1 and 34.3% for component 2).

Similarity Profile

Similar clustering pattern obtained from cluster diagram using matrices derived from presence or absence of individual species revealed that both the East and North facing section were the most similar at the 0.89 similarity index level with the West facing side of the pond being the most

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unique and markedly different from all the other sections of the pond with shared similarity with other sections only at the 0.55 similarity index. The South facing wing was also distinctive with index of similarity to the East and North facing sides at the 0.38 level (Figure 5).

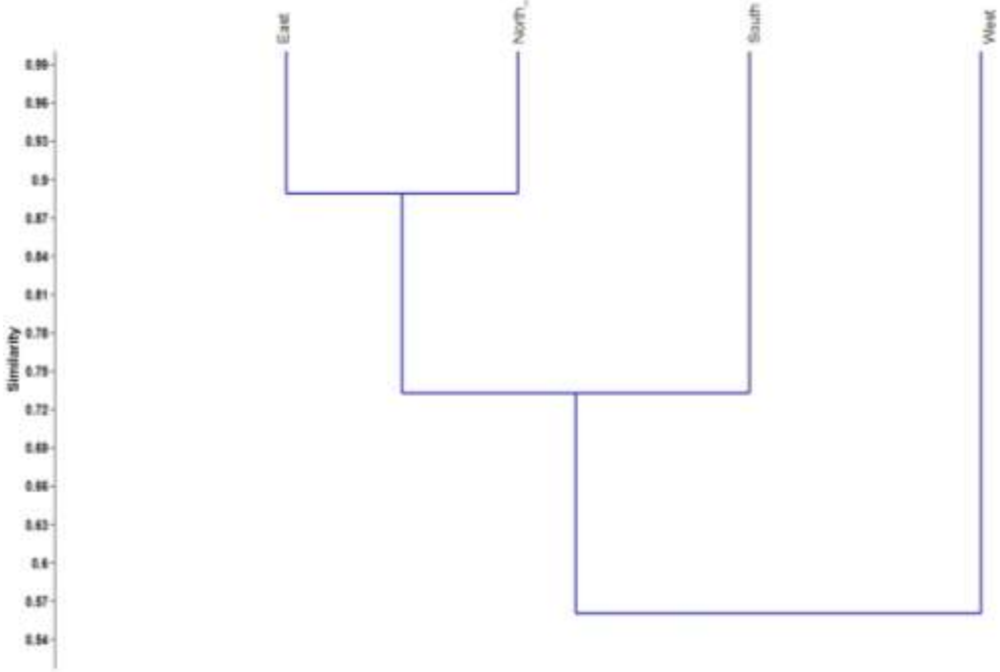

Fig. 5 A cluster diagram showing classification of different sites using presence or absence of cumulative species composition at each section of the pond based on similarity estimates on Simpson index using paired growth algorithm. The cut-off point is set at 0.5162.

DISCUSSION

Ponds in urban areas when left undisturbed for a considerable length of time or when disturbance rate is minimal, is capable of supporting aquatic biodiversity. This was supported by [17], who posited that ponds act as containers of biodiversity and provide a wide range of ecosystem services. Keeping track on changes in pond numbers, assessing the impacts of anthropogenic influences on pond quality, and assessing the relative importance of ponds, in comparison to aquatic biodiversity in other freshwater habitats, is necessary in developing pond conservation policies. This study was therefore undertaken to provide a checklist of typical plant species that could be found in ponds at urban areas and to offer suggestions on how to improve their quality and conservation for optimum utilization. A similar work was conducted by [18], on ponds in Britain and they reported that datasets generated during their work proved valuable in identifying new approaches to the practical management of ponds, developing strategies for their conservation and the development of policies for their protection.

Aquatic macrophyte composition in this study could be compared to the results obtained from Jebba Lake by [19], the Ebonyi River of Southeastern Nigeria by [7], and the wetlands of Ibeju-Lekki area of Lagos by [18]. Some of the plant species common to at least two of these study areas include *Elaeis guineensis, Nymphaea lotus, Ludwigia abyssinica, Alstonia congensis, Anthocleista vogelii, Musanga cecropioides* and *Pteridium aquilinum.*

In this study, it was revealed that herb was the most abundant growth form with 11 species accounting for 36.67% while shrubs and grasses were the least growth forms with 3 species each, representing 10%. This is in line with the results obtained from checklists of ponds in the United Kingdom by [4] and the wetlands of Ibeju-Lekki area of Nigeria by [18].

From a taxonomic standpoint, 30 plant species belonging to 19 families were inventoried at different sections of the pond. Of these, the families: Cyperaceae and Fabaceae were the most dominant families with 4 species each, which accounted for 21.05%. [7], had similar reports in their work in the Ebonyi River, where they recorded Cyperaceae and Poaceae to be the most dominant plant families. The presence in the study area of certain plant species such as *Abrus puchellus* and *Hevea brasiliensis* may not be unconnected with patches of land at some points within the pond which is suggestive of the fact that the pond was artificially excavated. Unlike other studies on aquatic macrophytes in other freshwater ecosystems, in this particular pond, almost all of the plant taxa recorded were emergents, except for *Nymphaea lotus* which is floating leaved, as well as *Abrus puchellus*, *Mimosa pudica*, *Dicranopteris linearis* and *Calopogonium mucunioides* which were more or less marginal plants, considering where they were found in the pond. The absence of either free-floating or submergent plants is attributable to two major factors: the isolation of the pond from a river system and the lentic nature of the water in the pond.

The prevalence of a higher percentage (53.33%) of native plants, a considerable number of exotic plants and very scanty cosmopolitan mix of plant species among the vegetation in the pond suggests that there are few exchanges with less biological immigration from all parts of the world or the inability of certain introduced species to propagate and thrive successfully. The occurrence of native plants such as *Nymphaea lotus, Sacciolepis africana, Musanga cecropioides,* and *Elaeis guineensis* in this study which was also recorded in earlier works by [19], [7], [18], is suggestive of the fact that these plants enjoy a relatively wider distribution across different aquatic ecosystems of Nigeria.

The unique dispersion of the different sections of the pond in both the cluster and PCA plots depicts their structural differences. The close relationship between the North and East facing sides which also happened to be the sections with the least exposure to anthropogenic alterations

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show that the analytical procedures used for both phytosociological and the species presence or absence data were responsive enough to precisely and accurately spot the differences within the species composition and structure at the various segments of the pond. Moreover, it was also able to detect with precision the most accessible (most disturbed) west facing section as the most unique than all the other sections. These evidences suggest that species found at the West section are more adapted to areas with relatively high disturbance rate or human interference.

Structurally, the vegetation in any ecosystem appears to be a reflection of the degree of exposure to anthropogenic influences. The West facing section and the South facing section of the pond recorded a relatively higher composition of species, a trend which may be linked to disturbance attributable to direct human impacts as these locations were more accessible which made them markedly different from the north and East facing sections which were not easily accessible and somewhat shielded from such human interferences. This agrees with the observations made by [20], [21], [22], and [18] who opined that increases in plant diversity was a product of habitat heterogeneity which arises from habitat alteration and disturbance-induced establishment opportunities having links with human activities such as land-use history, changing patterns of socio-economic activities, varying climatic conditions, as well as horticultural and agricultural practices. From the results of this study, it can be inferred that the composition and community structure of vegetation could be significantly interrupted when exposed directly to anthropogenic influences.

RECOMMENDATION FOR FURTHER STUDIES

Due to time and financial considerations, this study was restricted to the floristic composition of the Pond, without recourse to the physico-chemical conditions of the pond that influenced the type of plants inhabiting the ecosystem. Therefore, a further study to examine this aspect is hereby recommended to better understand the physico-chemical parameters that interact to influence the floral composition of the pond.

CONCLUSION

A pond whether natural or artificial when left undisturbed for a certain period of time, is capable of supporting a diversity of life, both plants and animals. The macrophytic communities in ponds and other allied aquatic ecosystems are useful as food and breeding grounds for other aquatic lives, bio-fertilizers for energy generation, curative medicine for local inhabitants, recreation and tourism centres and as agents for nutrient cycling and phytoremediation. However, a multiplicity of factors interacts to influence the biodiversity of these ecosystems, some of which are detrimental. These factors which can be natural or human induced; among others include habitat fragmentation, alteration of flow regime, nutrient concentration, over-harvesting, pollution and the introduction of invasive exotic species. Thus, keeping the public aware of the ecological functionality of these ecosystems and formulating policies and programmes to regulate the use of the macrophytic vegetation therein is crucial to ensure their continued existence and sustenance.

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