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Influence of Seasonality Gradients on Phytodiversity Richness in Rural and Urban Wetlands

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Abstract: The composition and distribution of flora species in wetlands are dependent upon several environmental variables and one of such is seasonality regimes. Seasonal gradients exert profound influence on seedling establishment, regeneration and reproduction of plant species. To this end, rural and urban wetlands were studied to assess the influence of seasonality gradients on phytodiversity richness. A ten 5m×5m quadrat was used to sample the vegetation for density of species with spacing at regular intervals. Flora species were taxonomically identified to their families, genus and species levels. The results revealed a total of 14 and 11 plant species in the rural and urban wetlands in the dry season. In the wet season, 19 species were found in the rural wetland while 13 plant species were found in the urban wetland. The most dominant species in both seasons were *Elaeis guineensis* (rural wetland) and *Persicaria senegalense* (urban wetland). High values for Shannon (2.76), Simpson (0.80) and evenness (0.97) were recorded in the wet season in the rural wetland while high dominance value was recorded in the dry season (0.22). In the urban wetland, high Shannon (2.19), Simpson (0.69) and evenness (0.88) values were recorded in the wet season while dominance value (0.32) was higher in the dry season. Conclusively, the results of this study is discussed with respect to ecological adaptability and stability of flora species to varying hydrological and anthropogenic regimes in wetlands and will provide a model information for effective and subsequent management and protection of this ecosystem.

Keywords: Seasonality Gradients, Phytodiversity Richness, Wetland, Rural, Urban, Density, Diversity Indices, Ecological Adaptation

1. Introduction

Wetland flora are the base of the wetland food chain, and so constitute a major conduit for energy flow into the system. They also provide habitat structure for epiphytic microbial communities, macro-invertebrates and fishes. They modify water and substrate chemistry, and influence the hydrology and sediment regime of wetland environments [7]. Thus, they are the key to understanding wetland ecology. The plant communities in wetland play important roles in monitoring the health status of wetlands. According to [13], vegetation study helps in the selection and implementation of appropriate conservation and management plans for sustainable use of ecosystems. Floristic data are useful in evaluating the present condition for environmental impact assessment and monitoring changes in species composition of an ecosystem [10].

Wetlands differ widely due to regional and local variations in hydrology (water regime) soils, climate, landscape (topography) and human disturbances [14]. Changes in hydrology together with seasonal gradients are considered important environmental variables influencing plant species composition and distribution in wetlands [15]. The plant species in wetlands often experience alternating wet and dry periods throughout the season, whose timing and duration may play an important role in the reproduction and regeneration of species [2]. The alternating wet and dry periods in wetland ecosystems naturally affect plant establishment by stimulating or inhibiting germination [4]. While prolonged flooding or desiccation of the wetland ecosystem eliminates some flora species, the growth and proliferations of others may be favoured. This has a pronounced effect on the establishment of flora species [5].

Anthropogenic activities around wetland also affect plant species composition. During the planting season, many wetlands become vulnerable to destruction with some being converted to agricultural fields, grazing terrain and dumpsites for municipal wastes. It is upon this premise, that this study seeks to assess the phytodiversity richness of rural and urban wetlands seasonally using standard ecological indices in other to address the myriads of anthropogenic challenges faced by this ecosystem.

2. Material and Methods

2.1. Description of Study Area

This study was carried out in a rural (7° 59' 9" E; 5° 0' 7" N) and urban (7° 55' 19" E; 5° 0' 35" N) wetlands (Figures 1 and 2) within Uyo metropolis in Akwa Ibom State, Nigeria. Akwa Ibom State located in Southern part of Nigeria is characterized by two distinct climate; dry and wet seasons. The total annual rainfall varies from 4000 mm along the coast to 2000 mm inland. The average humidity is about 75% to 95%. Mean annual temperature varies between 26°C to 36°C.

Figure 1. *Rural wetland.*

Figure 2. *Urban wetland showing burnt vegetation.*

2.2. Vegetation Sampling

Plant species were sampled seasonally (dry and wet seasons) in ten 5m×5m quadrat spaced at regular intervals. In each of the quadrats, species were identified to family, genus and species levels with the aid of manuals developed by [12] and [17]. The vegetation parameter considered was density and this was calculated using the method of [6].

2.3. Statistical Analysis

Mean and standard error of species were done using SPSS 20.0 while the diversity indices such as Shannon Weinner, Simpsons, dominance, evenness and Sorenson were computed using Paleontological Statistics (PAST 3.0).

3. Results

3.1. Dry Season Vegetation Characteristics of the Rural and Urban Wetlands

Table 1 shows the dry season vegetation characteristics of the rural wetland. A total of seventeen (14) plant species belonging to 12 (families) were identified. The vegetation characteristics revealed that *Elaeis guineensis* was the most dominant (3200 ± 0.20 stems/ha) while *Pentaclethra macrophylla* had the lowest density (160 ± 0.11 stems/ha).

The dry season vegetation characteristics of the urban wetland showed that eleven (11) plant species were identified belonging to ten (10) families and ten (Table 1). This wetland was dominated by *Persicaria senegalensis* with density of 1200 ± 0.13 stems/ha. *Commelina communis*, *Gliricidia sepium, Ludwigia erecta and Lagenaria breviflora* had the least density of 80 ± 0.40, 80 ± 0.11, 80 ± 0.10 and 80 ± 0.41 stems/ha, respectively.

3.2. Wet Season Vegetation Characteristics of the Rural and Urban Wetlands

The wet season vegetation characteristics of the rural wetland showed that fourteen (19) plant species were found belonging to twelve (13) families (Table 2). *Elaeis guineensis* had the highest density value (5067±3.80 stems/ha) while the least density values were associated with species such as *Crassocephalum crepidioides* (240±1.23 st/ha) and *Longocarpus griffoneonus* (240±0.20 st/ha).

The wet season vegetation characteristics of the urban wetland is presented in Table 2. Thirteen (13) plant species were found. *Persicaria senegalensis* had the highest density (1200 ± 30.70 stems/ha) while *Gliricidia sepium*, *Lageneria breviflora* and *Ludwigia erecta* had the least density of 80 ± 0.11 stems/ha, 80 ± 0.41 stems/ha and 80 ± 0.10 stems/ha, respectively.

Table 1. *Dry season vegetation characteristics (Mean±S.E) of the rural and urban wetlands.*

Rural wetland		
Plant Species	**Family**	**Density (st/ha)**
Alchornea cordifolia Muell. Arg.	Euphorbiaceae	640±0.00
Barteria nigritiana Hook f.	Passifloracaceae	960±0.00
Cnestis ferruginea DC	Connaraceae	240±2.13
Commelina lagosensis C. B. Clarke	Commelinaceae	320±0.50
Culcasia scandens P. Beauv.	Aracaceae	2400±5.32
Cyrtosperma senaglense (Schott) Engl.	Araceae	1040±1.23
Dissotis rotundifolia (Sm) Triana	Melastomaceae	1600±1.32
Elaeis guineensis Jacq.	Aracaceae	3200±0.20
Nephrolepis cordifolia (L.) K. Presl	Lomariopsidaceae	320±0.81
Palisota hirsuta (Thumb.) K. Schum	Commelinaceae	480±0.02
Pentaclethra macrophylla Benth.	Fabaceae	160±0.11
Raphia hookeri Mann & Wendland	Aracaceae	400±0.69
Sida acuta Burm. F.	Malvaceae	400±1.32
Synsepalum dulcificum (Schum & Thonn) Daniell.	Sapotaceae	240±0.10
Urban wetland		
Azolla africana L.	Salviniaceae	400±0.00
Commelina benghalensis L.	Commelinaceae	160±0.12
Commelina communis L.	Commelinaceae	80±0.40
Elaeis guineensis Jacq.	Aracaceae	240±0.30
Gliricidia sepium (Jacq.) Wall	Euphorbiaceae	80±0.11
Kyllinga brevifolia Rottb	Cyperaceae	240±0.30
Lagenaria breviflora (Benth) Roberty. [Adenopus breviflorus Benth.]	Curcubitaceae	80±0.41
Ludwigia erecta L.	Onagraceae	80±0.10
Nymphaea lotus L.	Nymphaeceae	240±0.24
Panicum maximum Jacq.	Poaceae	320±0.14
Persicaria senegalensis Mill	Polygonaceae	1200±0.13

±S.E = Standard error

Table 2. *Wet season vegetation characteristics (Mean±S.E) of the rural and urban wetlands.*

Rural wetland		
Plant Species	**Family**	**Density (st/ha)**
Albizia zygia (DC.) J. F. Macbr	Fabaceae	3200±0.20
Alchornea cordifolia Muell. Arg	Euphorbiaceae	2400±0.31
Andropogon gayanus Kunth	Poaceae	2400±0.23
Barteria nigritiana Hook f.	Passifloracaceae	3200±0.21
Chromolaena odorata (L.) King & Robinson	Asteraceae	4400±2.80
Costus afer Ker – Gawl	Costaceae	2667±0.91
Crassocephalum crepidioides (Benth) S. Moore	Asteraceae	240±1.23
Cyrtosperma senaglense (Schott) Engl.	Araceae	2240±1.23
Dioscorea bulbifera L.	Dioscoreaceae	1600±0.25
Elaeis guineensis Jacq.	Araceae	5067±3.80
Longocarpus griffoneonus (Schum. & Thonn) Benth	Fabaceae	240±0.20
Mallotus oppositifolius (Geisel.) Muell. Arg.	Euphorbiaceae	1600±2.21
Nephrolepis cordifolia (L.) K. Presl.	Lomariopsidaceae	4000±3.10
Palisota hirsuta (Thunb.) K. Schum	Commelinaceae	2400±1.12
Pentaclethra macrophylla Benth.	Fabaceae	1600±0.21
Podococcus barteri G. Mann & H. Wendl.	Arecaceae	1600±0.30
Sida acuta Burm. F.	Malvaceae	520±1.32
Synsepalum dulcificum (Schum & Thonn.) Daniell.	Sapotaceae	1600±0.20
Urena lobata L.	Malvaceae	320±2.10
Urban wetland		
Azolla africana L.	Salviniaceae	400 ± 0.00
Commelina benghalensis L.	Commelinaceae	160 ± 0.12
Commelina communis L.	Commelinaceae	80 ± 0.40
Cyperus rotundus L.	Cyperaceae	800±30.20
Elaeis guineensis Jacq.	Aracaceae	240 ± 0.30
Gliricidia sepium (Jacq.) Wall	Euphorbiaceae	80 ± 0.11
Kyllinga brevifolia Rottb	Cyperaceae	240±0.30
Lagenaria breviflora Benth) Roberty. [Adenopus breviflorus Benth.]	Curcubitaceae	80 ± 0.41
Ludwigia erecta L.	Onagraceae	80 ± 0.10
Nymphaea lotus L.	Nymphaeceae	240 ± 0.24
Panicum maximum Jacq.	Poaceae	320 ± 0.14
Persicaria senegalensis Mill.	Polygonaceae	1200 ± 70.01
Urena lobata L.	Malvaceae	700±25.10

±S.E = Standard error

3.3. Phytodiversity Indices

Table 3 shows the phytodiversity status of the study wetlands. Species richness was higher in the both wetlands during the wet season when compared with the dry season. Species richness in the wetlands followed this pattern: rural wetland (wet season) > rural wetland (dry season) > urban wetland (wet season) > urban wetland (dry season). For the rural wetland, high values for Shannon (2.76), Simpson (0.80) and evenness (0.97) were recorded during the wet season while high dominance value was recorded in the dry season (0.22). In the urban wetland, high Shannon (2.19), Simpson (0.69) and evenness (0.88) values were recorded in the wet season while dominance value (0.32) was higher in the dry season.

Table 3. *Phytodiversity status of the study wetlands.*

Wetland types	Rural wetland (dry season)	Urban wetland (Dry season)	Rural wetland (wet season)	Urban wetland (wet season)
Species richness	14	11	19	13
Shannon (H)	2.39	1.98	2.76	2.19
Dominance (D)	0.22	0.32	0.20	0.31
Simpson (1-D)	0.78	0.68	0.80	0.69
Evenness (E)	0.85	0.83	0.97	0.88

4. Discussion

The results obtained in this study revealed the dominating influence of seasonal regimes on plant species composition and richness in the wetlands. It also showed that the wetlands supported a good number of plant species. Similarly, these results confirm that plants species growing in the same environmental conditions showed marked variations in their response to seasons and nutrient limits.

Seasonal shift in floristic composition and taxonomic diversity was evidenced in these wetlands. The high and low species diversity in the wetlands may insinuate the influence of seasons on species establishment as well as inter-specific competition for environmental resources (nutrients, light, water and space) among plant taxa. Similar finding was reported by [11]. There were more plant species during the wet season than in the dry season in the wetlands. Similar finding was reported by [9]. This lends credence to the fact that high rainfall evidenced during the wet season favoured the establishment, growth and massive proliferation of many plant species. Also, this high species diversity may accentuate the inherent abilities of these species to withstand and adapt to increasing water table and anoxic conditions. Most plant species that were absent in the dry season but present in the wet season is believed to have arose on the basis that their seeds were carried through run off into the wetlands during precipitation. Equally, the presence of species in the dry season but absent in the wet season may hint the inabilities of these species to cope with a high water table. It may also be inferred that these species were selectively exploited or destroyed as a result of anthropogenic activities.

The low Shannon and Simpsons indices recorded in the dry season in both wetlands when compared with the wet season values may hint that receding water level did not favour the spread and establishment of more plant species in the wetland except for those species that could withstand this condition. Disturbances such as burning, selective exploitation, grazing and waste discharge especially in the urban wetland evidenced during the dry season might have contributed to low species richness in the wetland. In the same vein, the persistent invasiveness of *Persicaria senegalensis* in the urban wetland could have contributed also to low diversity of species, as invasive species can affect the soil seed banks negatively [3] [8], displace native species and form mono-specific stands [3], act as predators, competitors and hybridizers to the native plant species.

The dominance values recorded in these wetlands were high when compared with the values reported by [1] and [16] in an urban recreational pond and inlet streams, respectively. High dominance values were recorded in the dry season in the rural (0.22) and urban (0.32) wetlands. This may hint that the receding water levels in the dry season did not favour the growth and spread of some plant species as only species with high ecological adaptation and stability thrived in these wetlands and formed pure stands. This high dominance values are not unprecedented but rather create a monospecific picture of these two wetlands. This is consistent with this study as *Elaeis guineensis* and *Persicaria senegalense* dominated in density in the rural and urban wetlands, respectively.

Evenness values as computed showed that the plant species were evenly distributed during the wet season than in the dry season in the wetlands. This again is an attribute of rainfall. This, is not unprecedented but rather it accentuates the relevance of water as an important environmental resource in plants' growth and distribution.

5. Conclusion

The study revealed variations in phytodiversity richness of rural and urban wetlands as a function of seasonal regimes. These variations arose on the basis of the ecological adaptability and stability of species to hydrological regimes and anthropogenic perturbations. High species richness was observed in the wet season than in the dry season in both wetlands. Diversity indices also revealed a high Shannon, Simpson and evenness values in the wet season while high dominance value was recorded in the dry season. In conclusion, this study provides a baseline information on a better understanding of the adaptability and stability of flora species to seasonal regimes and other prevailing environmental conditions.

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