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Structure and Phytodiversity of Freshwater Swamp Forest in Oil-rich Bonny, Rivers State, Nigeria

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ABSTRACT

The freshwater swamp forest in Bonny Rivers State, Nigeria was investigated to determine the forest structure and phytodiversity. Four 250×40 m transects containing five (10×10 m) randomly laid quadrats were used in 1 hectare plot to increase the chances of encountering and inventorizing all species. Phytosociological data were collected and used to determine diversity of the forest. Ninety four plant species belonging to 40 families (14 shrubs, 26 trees and 54 herbs) were encountered which represents 14.89% shrubs, 27.66% trees and 57.45% herbs in the forest. The four most diverse families in descending order were Euphorbiaceae (10 species), Poaceae (8 species), Araceae (7 species) and Papilionoiaceae (4 species). 19 families were represented by only one species. Species density ranged from 30 species ha^{-1} in Icacinaceae to 3010 species ha^{-1} in Euphorbiaceae. Smilaceae and Icacinaceae with relative frequency value of 0.498 were the least frequent families while Dioscoreaceae Family Importance Value (FIV) of 0.016 was the least in the survey. Secondary forest tree species (*Anthocliesta vogelii*, *Elaeis guineensis*, *Harungana madagascariensis* and *Musanga cecropioides*) and fruit trees (*Musa* sp, *Psidium guajava*, *Mangifera indica* and *Cocos nucifera*) were identified which confirmed anthropogenic incursions at different times into the pristine forest. The need for conservation therefore cannot be overemphasized.

Key words: Bonny-Nigeria, conservation, diversity, freshwater swamp, Euphorbiaceae, Phytosociological data

INTRODUCTION

Diversity provides an observer a feeling of satisfaction in the natural world (Young and Swiacki, 2006). The species diverse freshwater swamp forest is one of the five major types of vegetation in the forest zone of Nigeria (NEST, 1991). The others are the coastal vegetation, mangrove forest, riparian forest and lowland rainforest. These make up the tropical rainforest of southern Nigeria. In the Niger Delta the freshwater swamp forest covers some 12000 km^2 or about half of the delta (NDES, 1997) and one third of Rivers State. Globally, the forest is reported to constitute about 2.1% of the earth surface (Raven *et al*., 2002). The forest is either partially or wholly flooded throughout the year (Agbagwa, 2008). Mounds and ridges on the ground of this forest form numerous intricate narrow channels through which flood circulate on the forest floor. These channels also provide drainage network from the forest to surrounding rivers and streams, thus regulating coastal water flow and elimination of silt, sediment and pollutants

from moving water (Asthana and Asthana, 2003). They are variable in size, form and plant community structure (Chapman and Reiss, 1995). The freshwater swamp forest is one of the most productive ecosystems of the world. In the Niger Delta, it is a store house of biological diversity providing suitable habitats for plants (Omokhua and Koyejo, 2008), important areas for rare and endangered wildlife and enormous benefits to the people (Ubom, 2010).

With the astronomical deforestation of the other forest zones in Nigeria, the freshwater swamp forest remained the most extensive forest zone due largely to the swampy ground on which they exist which hitherto hindered exploitation. However, the continued existence of this forest in the region is seriously threatened by the ingress of sea water through canalization to facilitate oil and gas activities (Agbagwa and Akpokodje, 2010), expansion of agriculture, fuel wood collection, pole and timber harvesting and urbanization. The freshwater swamp forest of Bonny Island is currently faced with the aforementioned problems, because as a major hob of oil and gas activities in the Niger Delta where available land space is scarce, industrial expansion resulting in deforestation is *sine qua non*. For instance, the construction of the Nigerian Liquefied Natural Gas (NLNG) Plant in 1999 required the reclaiming of approximately 2.27 km^2 of this forest in Finima, Bonny Island. More than this area was also reclaimed for the resettlement of the indigenous Finima people. Thus, it is obvious that this forest ecosystem is gradually being destroyed without proper articulation of its wealth of phytodiversity. Phytodiversity studies in tropical rainforest are important to determine the processes or mechanisms that maintain high diversity, species richness, species assemblages and at the same time providing a database about the number and status of the species existing in an area and their conservation (Prasad *et al*., 2007; Reddy *et al*., 2008). It is noteworthy that detailed information on species composition and their phytosociology is lacking because the delta's swamp forests were omitted from early national forest inventories and surveys. This study therefore attempted to document the structure and floristic composition of the freshwater swamp in and around Bonny Island, Rivers State. This is a precursor to the conservation of this diverse rainforest which is inadvertently exposed to gradual erosion of structure and extinction of component species.

MATERIALS AND METHODS

Study area: Bonny is a town and a Local Government Area in Rivers State, southeastern Nigeria. It is on the Bight of Biafra within Latitude 4°26' 0" N and Longitude 7°10' 0" E (Fig. 1). It is approximately 56 km from upland Port Harcourt, the capital city of Rivers State (NDES, 1997). A small island located just offshore with predominantly freshwater swamp and mangrove forests, Bonny Island, is a major export point for crude oil and gas. The region produces a type of crude oil known as Bonny Light oil. Much of the crude oil extracted onshore in Rivers State is piped to Bonny for export. Due to its strategic position, the island hosts various multinational oil and gas companies, whose continuous expansion impact directly on the forest ecosystem. The area has average temperature and relative humidity which range from 23.00 to 42.60°C and 65.00 to 96.80% respectively. Rain falls almost throughout the year in the area. However, a defined rainy season period (April to October) and dry season (November to March) is recorded in the area (Ayoade, 1988).

Sampling: The study was conducted from July to September, 2010. The plot method was adopted for a comprehensive evaluation of 1 hectare of the freshwater swamp forest. For evaluation of the floristic composition and plant diversity the site was divided into four parts. Each part was sampled

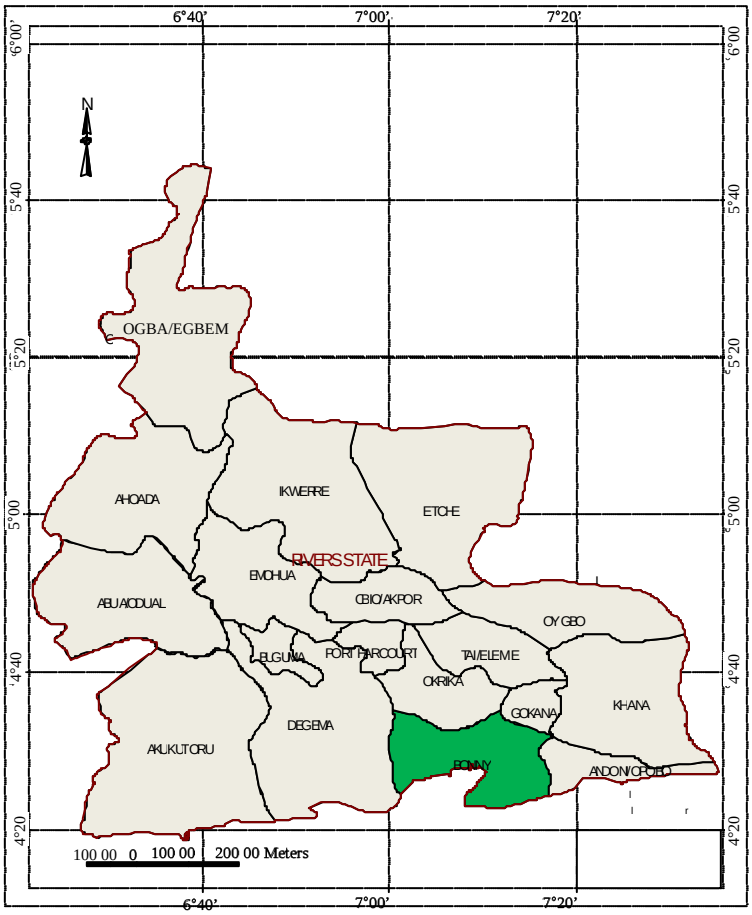

Fig. 1: Map of Rivers State, Nigerois showing the local government areas. The study area Bonny is verged green

using one 250×40 m transect containing five (10×10 m) randomly laid quadrats. From each quadrate sample species of trees, shrubs and herbs were collected and identified to species level. For vegetation analysis of the site, a total of 10 plots (10×10 m) for trees, 5×5 m for shrubs and 1 x 1m for herbs were used for the analysis following the method of Devi and Yadava (2006). In each plot, all living woody plants = 1 cm diameter at breast height (i.e., 1.3 m from the ground) were enumerated following the method of Krishnamurthy *et al.* (2010).

Data analysis: The density, abundance, frequency and basal area (as πr^2) were calculated as well as the relative density, abundance and frequency for each species and families. The sum of the relative values was calculated to give a single summary statistic or Importance Value for species (Species Importance Value- SIV) and for families (Family Importance Value- FIV) according to Ganesh *et al.* (1996). The equations used are:

SIV = Relative frequency of species + relative density of species + relative dominance of species

where:

$$\text{Relative frequency} = \frac{\text{No. of plots containing a species}}{\text{Sum of frequencies of all species}} \times 100$$

$$\text{Relative density} = \frac{\text{No. of individuals of a species}}{\text{Total No. of individuals of all species}} \times 100$$

$$\text{Relative dominance} = \frac{\text{Basal area of a species}}{\text{Total basal area of all species}} \times 100$$

The Family Importance Value (FIV) was calculated as follows:

FIV = relative density of the family + relative diversity of the family + relative dominance of the family

Where:

$$\text{Relative density} = \frac{\text{No. of individuals of the species}}{\text{Total No. of individuals in the sample}} \times 100$$

$$\text{Relative diversity} = \frac{\text{No. of species in the family}}{\text{Total No. of species in the sample}} \times 100$$

$$\text{Relative dominance} = \frac{\text{Basal area of the family}}{\text{Total basal area in the sample}} \times 100$$

RESULTS AND DISCUSSION

Floristic diversity and family-wise distribution: A total of ninety plant species (26 trees, 14 shrubs and 54 herbs) which belong to 40 families were present in the 1 hectare sampled area. These comprised of Euphorbiaceae (10 species), Poaceae (8 species), Aracaceae (7 species) and Papilionoiaceae (4 species). The families Combretaceae, Commelinaceae, Cucurbitaceae, Malvaceae, Mimosaceae and Verbenaceae recorded three (3) species each. While eleven families were represented by two (2) species each, the remaining nineteen (19) families were represented by one species each (Table 1). Herbaceous species with 57.45% occurrence constitute the most dominant group identified within the freshwater swamp forest of Bonny during the survey. This was followed by trees with 27.66% occurrence while shrubs have the least 14.89% (Fig. 2).

A recent study by Agbagwa (2008) reported 39 forest tree species from 19 families within freshwater swamp forest in a confluence area of Delta, Imo and Rivers States in the Niger Delta. The study of Agbagwa (2008) in any case did not take into account shrubby and herbaceous species due to the nature of area of the investigation (i.e., anthropogenic activities resulted in flooding and submergence of shrubby and herbaceous species). However, there is obvious similarity in floristic composition and forest structure between that described by Agbagwa (2008) and the current location at Bonny Island. Similar families have also been

Table 1: Plant diversity by families in the freshwater swamp forest

Family name	No. of species	Family name	No. of species
Acanthaceae	2	Lamiaceae	1
Amarathaceace	1	Loganiaceae	2
Anacardiaceae	1	Malvaceae	3
Annonaceae	2	Melastomataceae	2
Apocyanaceae	2	Mimosaceae	3
Araceae	7	Moraceae	2
Athyriaceae	1	Musaceae	1
Bignoniaceae	1	Myrtaceae	2
Caesalpinaceae	2	Onagraceae	1
Cleomaceae	1	Palmae (Arecaceae)	2
Caricaceae	1	Papilionaceae	4
Combretaceae	3	Poaceae	8
Commelinaceae	3	Portulaceae	1
Convolvulaceae	1	Rubiaceae	2
Cucurbitaceae	3	Rutaceae	1
Cyperaceae	2	Smilaceae	1
Dioscoreaceae	2	Solanaceae	1
Euphorbiaceae	10	Tiliaceae	1
Icacinaceae	1	Urticaceae	1
Irvingiaceae	1	Verbenaceae	2

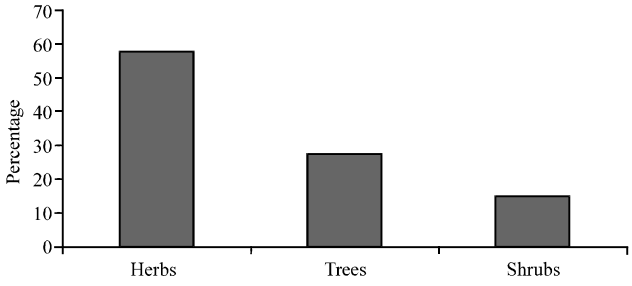

Fig. 2: Percentage composition of plant groups by habit in the fresh water swamp forest of Bonny

reported in tropical forests elsewhere in the world (Devi and Yadava, 2006; Prasad *et al*., 2007; Sahu *et al*., 2007; Addo-Fordjour *et al*., 2008; Kumar, 1997). The range of the number of species in tropical forests in some recent reports is from 38 species to 123 species and include Chowdhury *et al*. (2000) 85 species, Umar (2001) 87 species Khera *et al*. (2001) 92 species, Devi and Yadava (2006) 123 species, Reddy *et al*. (2008) 137 species, Krishnamurthy *et al*. (2010) 44 species and Kumar (1997) 38 species. Thus the 94 species recorded in this study falls within what is tenable in the tropical forest. The usefulness of phytosociological parameters in determining the status of different tropical forest ecosystems in terms of floristic composition, species diversity and forest structure has been recently highlighted (Upadhaya *et al*., 2004; Young and Swiacki, 2006; Prasad *et al*., 2007; Sahu *et al*., 2007; Agbagwa, 2008; Reddy *et al*., 2008). These different studies independently confirmed the floristic diversity and richness of tropical forest ecosystems in terms of number of species, genera and families and defined vegetation structure which are all reported for the freshwater swamp forest in Bonny.

Forest structure, stratification and species composition

Tree layer: Twenty six species of plants belonging to 17 families were identified within the tree layer. The dominant species among these trees were *Annona senegalensis*, *Anthocliesta vogelii*, *Elieas guineansis* and *Harungana madagascariensis* with species densities of 960 trees ha^{-1}, 510, 500 and 480 trees ha^{-1} respectively (Table 2). Among the trees, *Musanga cecropioides* and *Tectonia grandis* were the least with species densities of 10 trees each ha^{-1}. Characteristically, the tree layer is the uppermost layer of this forest with species like *Irvingia gabonensis, Mitragyna ledermannii, Alstonia boonei* and *Cleiostopholis patens* reaching 30 m high and towering into the sky above other members of the forest. For these tall species, tree canopy to canopy contact is never achieved.

Young and Swiacki (2006) stated that as the anthropogenic gaps into natural forests become numerous, the landscape pattern and species composition of that forest changes gradually. The presence of such secondary forest tree species like *Anthocliesta vogelii, Elaeis guineensis, Harungana madagascariensis* and *Musanga cecropioides* and fruit trees like *Musa* sp, *Psidium guajava, Mangifera indica* and *Cocos nucifera* (Table 2) in this forest point towards anthropogenic incursions at different times into the pristine forest. This situation corroborates the findings of Young and Swiacki (2006) and requires that measures be taken to preserve the freshwater swamp forest of Bonny from gradual species erosion by aliens.

Table 2: Species density and Species Importance Value (SIV) of the trees in bonny freshwater swamp forest

Species name	Family name	Species density	SIV
Lonchocarpus sericcus	Papilionaceae	120	5.4977
Macaranga barteri	Euphorbiaceae	30	5.2892
Mangifera indica	Anacardiaceae	90	4.6946
Marcaranga barteri	Euphorbiaceae	180	4.9030
Irvingia gaboneensis	Irvingiaceae	240	8.7168
Millettia griffoniana	Papilionaceae	360	3.5638
Cleiostopholis patens	Annonaceae	360	5.0408
Gmelina aborea	Verbenaceae	120	2.8229
Harungana madagascariensis	Clnsiaceae	480	3.7671
Citrus sp.	Rutaceae	210	4.1740
Elaeis guineensis	Palmae (Arecaceae)	500	8.9789
Cocos nucifera	Palmae (Arecaceae)	60	7.9037
Eucalyptus sp.	Myrtaceae	200	7.4535
Ficus vogeliana	Moraceae	30	2.6144
Alstonia beonei	Apocyanaceae	200	5.1874
Artocarpus altilis	Moraceae	90	6.2267
Annona senegalensis	Annonaceae	960	10.4038
Anthocliesta vogelii	Logamaceae	510	9.2511
Mitragyna ledermannii	Rubiaceae	360	9.7217
Musa sp	Mnsaceae	330	4.7116
Musanga cecropioides	Moraceae	10	5.3496
Newbouldia laevis	Bignoniaceae	330	5.3803
Pentaclethra macrophylla	Mimosaceae	150	7.6382
Psidium guajava	Myrtaceae	150	4.0999
Terminalia superba	Combretaceae	150	3.8208
Tectonia grandis	Verbenaceae	10	4.0122

The Species Importance Value (SIV) showed that the trees SIV of the Bonny freshwater swamp forest ranged from 2.6144 to 10.4038. *Annona senegalensis* (Annonaceae) 10.4038, *Mitragyna ledermannii* (Rubiaceae) 9.7217, *Anthocliesta vogelii* (Loganiaceae) 9.2511, *Elaeis guineensis* (Arecaceae) 8.9789, *Irvingia gaboneensis* (Irvingiaceae) 8.7168, *Cocos nucifera* (Arecaceae) 7.9037, *Pentaclethra macrophylla* (Mimosaceae) 7.6382 and *Eucalyptus* sp. (Myrtaceae) 7.4535 have the highest SIV. This is followed other tree species like *Artocarpus altilis* (Moraceae) 6.2267, *Lonchocarpus sericcus* (Papilionaceae) 5.4977, *Newbouldia laevis* (Bignoniaceae) 5.3803, *Musanga cecropioides* (Moraceae), 5.3496 *Macaranga barteri* (Euphorbiaceae) 5.2892, *Alstonia boonei* (Apocyanaceae) 5.1874, *Gmelina arborea* (Verbenaceae) 5.0408 *Marcaranga barteri* Euphorbiaceae 4.903 *Musa sp* (Musaceae) 4.7116, *Mangifera indica* (Anacardiaceae) 4.6946, *Cirtus* sp. (Rutaceae) 4.174, *Psidium guajava* (Myrtaceae) 4.0999 and *Tectonia grandis* (Verbenaceae) 4.0122 (Table 2).

Shrub layer: A total of 14 species of shrubs from 10 families were inventorized in the study area. *Anthonotha macrophylla* (Caesalpinaceae) was found to be the predominant species in freshwater swamp forest area with species density of 510 stands ha^{-1}. This was followed by *Urena lobata* (390 stands ha^{-1}), *Alchornea cordifolia* (330 stands ha^{-1}), *Icacina trichantha* (300 stands ha^{-1}), *Chromolaena ordorata* (270 stands ha^{-1}) and *Baphia nitida* (210 stands ha^{-1}). The species density ranged from 30 stands ha^{-1} to 510 stands ha^{-1} with the least species density of 30 stands ha^{-1} recorded by *Alchornea oppositifolia* (Table 3). The highest Species Importance Value (SIV) of the shrubs in the Bonny forest varied from 5.5181 recorded by *Anthonotha macrophylla* (Caesalpinaceae) to 0.7428 recorded by *Triumfetta cordifolia* (Tiliaceae) (Table 3). The family Euphorbiaceae was the most diverse being represented with 3 species while Malvaceae and Papilionaceae were represented by 2 species each. The shrub layer in this forest exhibit height range of between 10 m to 15 m with obvious canopy to canopy contact of species. Saplings of the main tree species dominated by *Elaeis guineensis* is a major feature of this layer.

Herb layer: Herbs were the most dominant plant species in the study area. They were represented by 54 species distributed among 28 famihes. Poaceae was the most diverse with 9 species, followed

Table 3: Species density and Species Importance Value (SIV) of the shrubs in bonny freshwater swamp forest

Species name	Family name	Species density	SIV
Anthonotha macrophylla	Caesalpinaceae	510	5.5181
Triumfetta cordifolia	Tiliaceae	60	0.7428
Sida acuta	Malvaceae	90	1.8250
Urena lobata	Malvaceae	390	3.1691
Melastomastrum capitatum	Melastomataceae	150	1.1460
Funtumia elastica	Apocynaceae	180	3.0917
Icacina trichantha	Icacinaceae	300	2.2920
Manihot spp.	Euphorbiaceae	120	1.4855
Alchornea cordifolia	Euphorbiaceae	330	2.7607
Alchornea oppositifolia	Euphorbiaceae	30	1.0096
Carica papaya	Caricaceace	90	2.2146
Baphia nitida	Papilionaceae	210	1.4148
Chromolaena ordorata	Asteraceae	270	2.6983
Senna sp.	Papilionaceae	180	1.2804

by Euphorbiaceae and Asteraceae with 5 species each. Commelinaceae and Cucurbitaceae have 3 species each while Acanthaceae, Cyperaceae, Mimosaceae and Zingiberaceae have 2 species each. Other families were represented by one species each (Table 4). In the study area, *Custus afer* (Zingiberaceae) had the highest species density of 1170 plants ha^{-1}. This is followed by *Cloeme* spp

Table 4: Species density and Species Importance Value (SIV) of the herbs in bonny freshwater swamp forest

Species name	Family name	Species density	SIV
Acanthus montanus	Acanthaceae	60	1.2167
Acroceras zizanioides	Poaceae	210	2.3627
Aframonum sp.	Zingiberaceae	210	2.8366
Ageratum conyzoides	Asteraceae	180	1.7543
Amaranthus sp.	Amarathaceace	120	1.4855
Abelmoschus esculenta	Malvaceae	300	2.2920
Andropogon sp.	Poaceae	30	0.6083
Laportea ovalifolia	Urticaceae	30	0.6083
I*pomea* sp.	Convolvulaceae	90	1.3511
Heterotis rotundifolia	Melastomataceae	120	1.4855
Hypoestes forkalei	Acanthaceae	150	2.0938
Hyptis lanceolata	Lamiaceae	120	1.4855
Ludwigia decurrens	Onagraceae	60	0.7428
Luffa sp.	Cucurbitaceae	60	1.2167
Vernonia sp.	Asteraceae	180	1.2804
Xanthosoma sp,	Araceae	180	1.2804
Telfairia occidentalis	Cucurbitaceae	330	3.5080
Stachytarpheta cayennensis	Verbenaceae	330	3.3742
Tridax procumbense	Asteraceae	60	0.7428
Smilax spp.	Smilaceae	90	1.9588
Spermacoce spp	Rubiaceae	360	3.0347
Spigelia authelmia	Logoniaceae	120	1.4855
Puereria phaseoloides	Papilionoiaceae	90	0.8772
Scleria naumanniana	Cyperaceae	270	2.6315
Setaria bartata	Poaceae	180	2.2283
Phyllanttus amarus	Euphorbiaceae	390	3.1691
Physalis micrantha	Solanaceae	30	0.6083
Portulaca olerecea	Portulaceae	510	3.7067
Palisota hirsuta	Commelinaceae	60	0.7428
Panicum maximum,	Poaceae	60	0.7428
Oryza sp.	Poaceae	150	1.1460
Momordica sp.	Cucurbitaceae	120	1.5524
Mimosa invosa	Mimosaceae	300	3.2398
Mimosa pudica	Mimosaceae	90	1.8250
Aspilia africana	Asteraceae	90	1.3511
Axonopus compressus	Poaceae	150	1.1460
Bruchiaria deflexa	Poaceae	120	1.4855
Bruchiaria lata	Poaceae	60	0.7428
Centrosema sp.	Caesalpinaceae	60	1.2167
Euphorbia hirta	Euphorbiaceae	330	2.4264
Euphorbia hypossifolia	Euphorbiaceae	180	1.7543
Euphorbia prostrata	Euphorbiaceae	210	1.8887

Table 4: Continued

Species name	Family name	Species density	SIV
Euphorbia thymifolia	Euphorbiaceae	150	2.0938
Commelina sp.	Commelinaceae	90	1.3511
Commelina sp.	Commelinaceae	120	1.4855
Custus afer	Zingiberaceae	1170	7.2714
Cyperus diffomis	Cyperaceae	90	0.8772
Diplazium sammatii	Athyriaceae	420	2.8296
Dioscorea bulbifera	Dioscoreaceae	180	2.2951
Cloeme sp.	Cleomaceae	540	3.3672
Elusine indica	Poaceae	300	2.2920
Emilia sp.	Asteraceae	510	2.7589

(Capparidaceae-Cleomaceae) 540, *Emilia* spp. (Asteraceae) and *Portulaca olerecea* (Portulaceae) 510 species each, *Diplazium sammatii* (Athyriaceae) 420 and *Phyllanttus amarus* (Euphorbiaceae) 390. The herb species density ranged from 30 plants ha^{-1} to 1170 plants ha^{-1} species (Table 4). The Species Importance Value (SIV) varied from 0.6083 to 7.2714. The least value of 0.6083 was recorded by *Andropogon* spp (Poaceae) *Laportea ovalifolia* (Urticaceae) and *Physalis micrantha* (Solanaceae) while the maximum SIV is recorded by *Custus afer* (Zingiberaceae).

The herbaceous and shrubby layers together form the under-canopy layer with understory species. According to Quigley and Platt (2003) and Upadhaya *et al.* (2004), there is high species richness within the under-canopy layer. This is attributed to the presence of individuals of canopy species which were either young or whose growth was arrested due to shade cast by the overhead canopy. Jamir and Pandey (2003) made similar observation which agrees with our findings in this study.

Summary of relative frequency, relative density, relative dominance and family importance value: The observation during the survey shows that the Euphorbiaceae with a total of 3010 plants recorded the highest density of species ha^{-1}. The family also had the highest relative frequency, relative density, relative dominance and Family Importance Values (FIV) of 19.319, 14.961, 19.088 and 38.581 respectively. The same species density of 1230 species ha^{-1} was recorded for both the Poaceae and Verbenaceae families. Generally, species density ranged from 30 species ha^{-1} in Icacinaceae to 3010 species ha^{-1} in Euphorbiaceae (Table 5). The relative frequency, relative density, relative dominance and Family Importance Value (FIV) in the Bonny freshwater swamp forest ranged from 0.498 to 19.319, 0.13 to 14.961, 0.0 to 19.088 and 0.016 to 38.581, respectively (Table 5). Smilaceae and Icacinaceae recorded the least relative frequency (0.498), Icacinaceae had the least relative density (0.13), while 17 families (Poaceae, Onagraceae, Malvaceae, Amaranthaceae, Araceae, Melastomataceae, Tiliaceae, Athyriaceae, Commelinaceae, Iridaceae-Araceae, Portulaceae, Myrtaceae, Cyperaceae, Nyctaginaceae, Acanthaceae, Smilaceae and Icacinaceae) had the least relative dominance of zero. The Family Importance Value (FIV) indicated that the family Dioscoreaceae had the least value of 0.016 (Table 5). It is worthy of note that the family Euphorbiaceae has been previously reported by Padalia *et al.* (2004) and Reddy *et al.* (2008) as one of the dominant families in almost all types of forests except the mangrove. This fact is supported by this study.

Table 5: Total number of species ha^{-1}, Family Importance Value (FIV), relative density, relative frequency and relative dominance in the freshwater swam forest

Family name	Total No. of species/hectare	Relative frequency	Relative density	Relative dominance	FIV
Araceae	450	2.488	1.945	0.000	4.433
Asteraceae	2820	9.952	12.192	0.212	22.355
Apocyanaceae	360	2.488	1.557	8.484	12.528
Anacardiaceae	120	0.995	0.519	8.484	9.997
Amaranthaceae	540	2.488	2.335	0.000	4.822
Acanthaceae	60	0.995	0.259	0.000	1.254
Athyriaceae	1140	1.493	4.929	0.000	6.421
Bignoniaceae	90	0.995	0.389	1.060	2.445
Caesalpiniaceae	810	3.981	3.501	1.485	8.967
Caricaceae	150	1.493	0.649	2.121	4.262
Cleomaceae	540	2.488	2.335	0.000	4.822
Combretaceae	420	2.488	1.816	2.439	6.742
Commelinaceae	180	1.493	0.778	0.000	2.271
Convolvulaceae	630	2.985	2.724	0.106	5.815
Cucurbitaceae	600	3.981	2.594	0.106	6.679
Cyperaceae	90	0.995	0.389	0.000	1.384
Dioscoreaceae	40	0.908	2.121	5.019	0.016
Euphorbiaceae	3010	19.319	14.961	12.336	38.581
Icacinaceae	30	0.498	0.130	0.000	0.627
Irvingiaceae	330	0.995	1.427	0.000	2.422
Loganiaceae	510	0.995	2.205	6.363	9.563
Malvaceae	690	2.488	2.983	0.000	5.471
Melastomataceae	240	2.488	1.038	0.000	3.525
Mimosaceae	900	7.464	3.891	19.088	30.441
Moraceae	420	2.985	1.816	13.786	18.586
Musaceae	90	0.995	0.389	2.121	3.505
Myrtaceae	120	0.995	0.519	0.000	1.514
Nyctaginaceae	90	0.995	0.389	0.000	1.384
Onagraceae	810	2.488	3.502	0.000	5.989
Palmae (Arecaceae)	690	3.483	2.983	14.846	21.312
Papilionaceae	300	4.478	1.296	2.227	8.000
Poaceae	1230	2.986	5.318	0.000	8.302
Portulaceae	270	0.995	1.167	0.000	2.162
Rutaceae	60	0.995	0.259	2.121	3.375
Sapotaceae	90	0.995	0.389	4.242	5.626
Smilaceae	60	0.498	0.259	0.000	0.757
Sterculiaceae	150	0.995	0.649	2.121	3.764
Tiliaceae	240	1.991	1.038	0.000	3.028
Zingiberaceae	240	0.996	1.037	4.242	6.275
Verbenaceae	1230	3.483	5.318	0.106	8.906

CONCLUSION

The tropical rainforest in Nigeria which is predominantly in the southern part of the country, is threatened. The threat is worsened in the Niger Delta where Bonny is located by burgeoning oil and gas exploration and production activities which is the main source of income to the Nigerian nation. This study observed that though these activities have been ongoing for long, the tropical rainforest and particularly the freshwater swamp forest of the area is still rich in floristic

composition and diversity. However, evidence of gradual depletion of this forest in Bonny is seen in the several numbers of introduced/secondary species and the gradual reduction in the overall forest height. The freshwater swamp of the area is known to harbor important and rare wildlife species. There is therefore need for further study of the area to determine measures for preservation of the biodiversity of the area as well as delineate conservation areas.

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