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Research Article
Floristic Composition and Life Forms of Plant Species in Nwamba Forest Reserve in Nigeria

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Abstract

Background and Objective: Forest habitat plays significant roles in the conservation of biodiversity, environment and the provision of essential products for the well-being of mankind. The habit of Nwamba forest reserve in Ndubia-Igbagu, Izzi Local Government Area, Ebonyi state, Nigeria was studied to ascertain the floristic composition, families, life forms, frequency distribution, diameter at breast height and basal area. **Material and Methods:** Systematic sampling design was used to lay 8 straight line transects of 400 m separated with plots of 50×50 m each to give a total of 32 sample plots for the study. **Results:** A total of (153) plant species in 128 genera and 53 families were identified. Dicotyledons were dominant with 139 species comprising 116 genera and 44 families, monocotyledon were 11 species in 9 genera and 6 families, pteridophytes were 2 species in 2 genera and 2 families while bryophytes were mono-specific. The dominant families were Fabaceae, Rubiaceae and Apocynaceae with 24, 14 and 10 species, respectively. *Napoleona vogelii* and *Colaargentia* had the highest percentage frequency distribution (84.4%) followed by *Cola hispida*, *Icacina trichantha*, *Cnestic ferruginea* and *Newbouldia laevis* (81.30%). Woody species with diameter at breast height (dbh) class ≤10 cm were dominant and the mean basal area of the woody species was 38.1 m^2/plot. The order of the life forms were phanerophytes (84.31%)>chameatophytes (7.20%)>Epiphyte (3.92)>hemicryptophytes = cryptophytes (1.96%)>therophytes (0.65%). **Conclusion:** The study revealed that the vegetation of the Nwamba forest reserve is diverse and requires forest desirable management practices by the indigenous community/government foresters in the conservation and sustainable exploitation of plant resources in the area.

Key words: Floristic composition, life forms, frequency distribution, forest elements, forest habit, medicinal herbs, forest ecosystem

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Forest is a community of flora and fauna with complex interrelationships that confer environmental protection to the earth and support a different spectrum of life forms. Forest's vegetation plays crucial roles in the well-being and development of a country, such as in soil and water conservation, production of wood and non-wood products, carbon sequestration, conservation of biodiversity, provision of medicine and medicinal products and other social benefits[1,2]. Forest biodiversity plays important roles in ecosystem services such as water re-charge and discharge, nutrient storage and flood control, habitat for wild animals, source of medicinal herbs for rural livelihood and national development[3-7]. Humans and other animals depend on plant species for food, shelter and clothing.

Historically, forest and forest resources are practically conserved by local/indigenous people who live within the forest vicinity and who in most cases own or claim ownership of the forest. Nwamba forest is one such forest where the people of Izzi conserve it for traditional and cultural purposes. Nwamba forest reserve is located in Ndubia-Igbagu in Izzi Local Government Area of Ebonyi state, Nigeria. Historically, the Nwamba forest was reserved by the ancient people of Izzi to preserve their cultural identity with the traditional belief that the protective deity of the people reside in the forest and so, its resources should not be tampered with by anybody. Thus, the people of Izzi conserved the forest with great interest and it was only visited by chief priests and the elders during selected festivals as a means of renewing the vow of the people with the forest deity until recently when western religion changed the perception of some of the people and their traditional beliefs on the forests begin to change gradually. The control of man's access to this forest ecosystem may support biodiversity conservation, and this would be impracticable without adequate knowledge of species composition therein.

The ever-increasing demand for forest goods and services has brought about intense pressure on the forest ecosystem, thereby leading to rapid degradation of forest and loss of biological species in the natural habitat. Many of the once diverse natural forests have been lost to agricultural practices, markets, companies etc. In an attempt to satisfy both local and international needs for forest and forest products and the continuous increase in rural population and the introduction of western religion that changed the traditional beliefs of the locals, forest resources exploitation has been extended to Nwamba forest reserve in uncontrolled and unsustainable manners. For example, the causes of forest loss in Nwamba forest include demand for agricultural land due to high population growth, settlements and harvesting of forest products for community and personal needs. Consequently, there are severe ecological changes recently taking place in the Nwamba forest reserve which may reduce the stabilizing functions of the forest. Assessments of forest structure are of fundamental importance to forest management, providing information on the size distribution of woody species on which harvesting plans can be developed[8]. Thus, keeping documented information on the status of the Nwamba forest reserve is necessary as this may facilitate the formulation of sustainable forest management strategies for this all-important ecosystem. Therefore, this research was designed to fill this gap by generating baseline data on the floristic composition, frequency, life forms and the structure of the Nwamba forest reserve to facilitate sustainable management practices for the local community to ensure wholesome protection of the forest for ecological and environmental sustainability.

MATERIALS AND METHODS

Description of the study site: The study was carried in the Nwamba forest reserve area measuring 400×400 m at Ndubia Igbagu community in Izzi L.G.A of Ebonyi state, Nigeria. This area lies between latitude 06° 20^{1}N and longitude 08° 19^{1}E, southwest of the derived savannah zone of Nigeria. Total mean annual rainfall is between 2,268-3,392 mm, with a mean daily temperature range of 24-34°C and relative humidity between 69.3-70.7%. Rural communities are surrounding the forest. These communities are involved in the management and protection of the forest. All the anthropogenic activities including organized farming, collection of falling twigs and branches as firewood and gathering of other non-timbers forest products were restricted to the buffer zone. These activities are carried out with adequate monitoring and effective patrol by appointed community guards.

Study design and vegetation survey: The research work commenced with a field reconnaissance survey by the team to acquaint themselves with the environment and the size of the sampling area in the Nwamba forest reserve. This was done following consent obtained from the traditional ruler of the Igbagu Izzi autonomous community. Thereafter, the Nwamba forest area was divided into different sampling plots using a systematic sampling design technique. A total of 8 transect lines of 50 m each adding up to 400 m in length (denoted as L_1, L_2, etc.) was established in the east-west direction using a

compass. Site plots of 50×50 m in size were established in an alternate direction along each transect at 50 m intervals and a total of 32 sampling plots were established in 16 ha of land and used for the study while 10×5 m were established for the determination of herbaceous species.

Plant identification was carried out in the field in collaboration with a Taxonomist, Mr. Anthony Ozioko and those that could not be identified at the site were tagged and wrapped in between newspapers and transferred to the International Centre for Ethnomedicine and Drug Development Nsukka, Enugu State for identification using flora of West Tropical Africa[9-12].

In life forms classification, all the woody plants with perennating buds or shoot apices borne more than 25 cm above the soil level was regarded as phanerophytes while the woody or semi-woody perennials at the site with a perennating bud or shoot apices near the soil that is below 25 cm were classified as chamaephytes. Plants whose above-ground parts die back during the dry season that is plants with their perennating buds on the soil surface were classified as hemicryptophytes while the therophytes are possible viable seeds that may be seen throughout the period but can grow in and out of the seasons. To obtain the spectrum occupied by each of these life forms, the number of species within each life form was counted and then divided by the total number of species and multiplied by 100 to give the percentage. The percentages make up the life-form spectrum used to plot a percentage histogram of the different life forms.

Frequency is defined as the probability of chance of finding a species in a given sample area or quadrant[13]. Thus, the presence or absence of a given species within each sample plot was used to determine the frequency of the study.

The Diameter at Breast Height (DBH) was determined by measuring the Circumference (C) of woody species from $\leq$10 cm in the 32 plots using a measuring tape at a breast height of 1.3 m. The size classes of diameter at breast height were also applied to determine the successional status of the vegetation according to the method used by others[14-16] which showed category of smaller diameter logs (DBH $\leq$20 cm), categories of medium size class distribution (20-50 cm DBH) and category of mature trees (DBH $\geq$51 cm). The basal area was computed from the Diameter at Breast Height (DBH) of each woody species from $\leq$10 cm in the sampling area.

Data analysis

Life forms: The percentage life form was calculated as shown in Eq. 1:

$$\text{Life form}(\%) = \frac{\text{Number of species in any life form}}{\text{Total number of species of all life forms}} \times 100 \quad (1)$$

Frequency: The number of occurrences of a species in a given sample area was calculated as shown in Eq. 2:

$$\text{Frequency}(\%) = \frac{\text{Number of presence}}{\text{Total number of placements}} \times 100 \quad (2)$$

Diameter at breast height (DBH): The Diameter at Breast Height (DBH) was computed using Eq. 3:

$$\text{Diameter at breast height (DBH)} = \frac{C}{\pi} \quad (3)$$

where, C is the circumference of woody species from $\leq$10 cm in the 32 plots and π is a constant numerically equals 3.142.

Basal area: The basal area was computed using Eq. 4:

$$\text{Basal area (BA)} = (\frac{1}{2}d)^2\pi = \frac{\pi d^2}{4} \quad (4)$$

where, d is Diameter at Breast Height (DBH) woody species diameter and π = 3.142.

RESULTS

Floristic composition: A checklist of families, plant species, habit, life-forms and percentage frequency were presented in Table 1. The results showed that a total of plants species (153) were distributed into (128) genera and (53) families were present in the Nwamba Forest reserve. The dicotyledonous plants were (139) plant species comprising (116) genera distributed into (44) families, the monocotyledons plants were (11) plant species distributed into (9) genera and (6) families, the pteridophytes were (2) species comprising (2) genera distributed into (2) families while the bryophyte was mono-specific.

The results also indicated that the Fabaceae family had the highest number of plant species (24) followed by *Rubiaceae* (14), *Apocynaceae* (10), *Moraceae* (9) and *Euphorbiaceae* (6) plant species. *Annonaceae* and *Combretaceae* had (5) species each, *Asclepiadaceae*, *Bignoniaceae*, *Burseraceae*, *Myristicaceae*, *Meliaceae*, *Passifloraceae*, *Sterculiaceae*, *Verbenaceae* and *Poaceae* had (3) plant species each, *Acanthaceae*, *Anacardiaceae*,

Asteraceae, *Costaceae*, *Icacinaceae*, *Irvingaceae*, *Loginaceae*, *Malvaceae*, *Menispermaceae*, *Ochnaceae*, *Convolvulaceae*, *Sapotaceae*, *Tiliaceae*, *Arecaceae*, *Dioscoreaceae* and *Dracaenaceae* had (2) plant species each while *Bombacaceae*, *Cannabaceae*, *Cecropiaceae*, *Chrysobabanceae*, *Connaraceae*, *Lecythidaceae*, *Myrtaceae*, *Rutaceae*, *Salicaceae*, *Vitaceae*, *Sapindaceae*, *Smilacaceae*, *Oxymitraceae*, *Rosaceae*, *Olacaceae*, *Polypodiaceae*, *Araceae*, *Commelinaceae*, *Nephrdepidaceae* and *Ulmaceae* were mono-specific in the study site.

The results in Table 1 also showed that the species with the highest percentage frequency of occurrence are *Napoleona vogelii* and *Cola argentina* with 84.4% of occurrence closely followed by *Cola hispida*, *Icacina trichantha*, *Cnestis ferruginea* and *Newbouldia laevis* with 81.3% of occurrence whereas the least frequent species were *Ipomea involucrata*, *Ipomea batata*, *Dioscorea dumetorum*, *Dioscorea bulbifera*, *Dracaena fragrans*, *Bambusa vulgaris*, *Oxymitra incrassata*, *Nephrolepis biserrata* and *Platycerium coronarium* with 3.1% of the frequency of occurrence.

Results of frequency class distribution of plant species in Nwamba forest reserve: The results of the percentage frequency class distribution of Nwamba forest reserve were shown in Fig. 1. The frequency class distribution of plant species showed that the percentage (%) value of the plant species in the different classes was in the order: A>B>C>D>E.

Results of life forms spectrum of plant species in Nwamba forest reserve: The results of the life forms spectrum of plant species in the Nwamba forest reserve was shown in Fig. 2. The results showed that in the distribution of plant species in the life form classes, Phanerophytes were the most abundant class making up 84.31% of the entire classes followed by Chamaephytes which had 7.20%.

The order of the percentage abundance of the various life form classes was: Phanerophytes>Chamaephytes>Epiphytes> Hemicryptophytes = Cryptophytes>Therophytes, respectively.

Results of diameter at breast height (DBH) of plant species in Nwamba forest reserve: The results of the Diameter at Breast Height (DBH) were shown in Fig. 3. A total of 10,592 individual woody species was encountered in the 32 plots studied, 3,603 were in the diameter class of $\leq$10, making up 34.0% of the total woody species encountered. This was followed by a class diameter in the order 11-20>21-30>31-40>41-50>51-60 cm with 2725>1647>1426>660 and 121

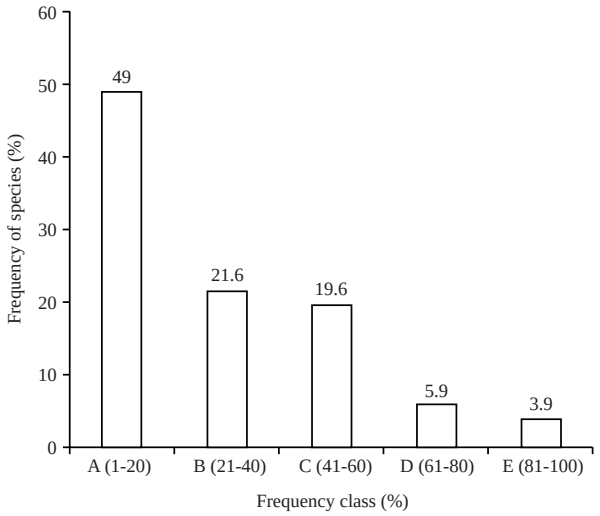

Fig. 1: Percentage frequency distribution of plant species in Nwamba forest reserve

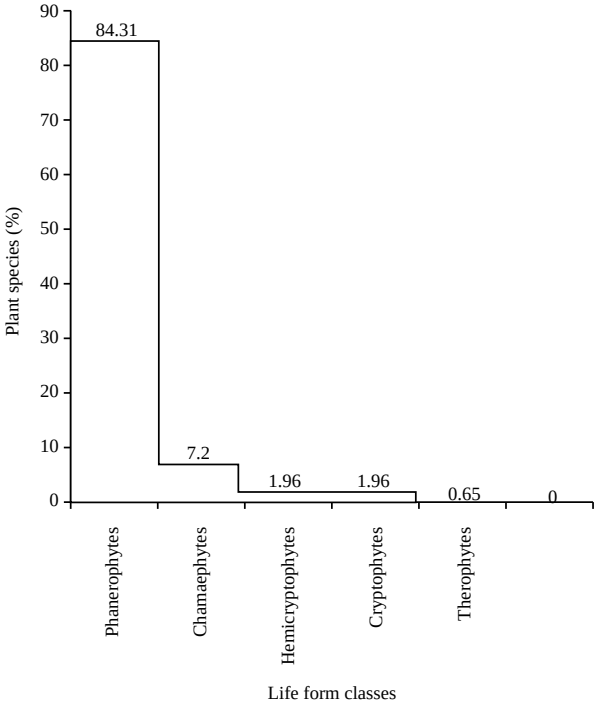

Fig. 2: Life form spectrum of plant species at Nwamba forest reserve

woody species stands representing a proportion of 25.7, 15.6, 13.5, 6.2 and 1.1%, respectively. The results showed that the number of stands decreased as the class diameter increased with a class diameter of 191-200 cm having the least stand of 12 which is 0.1% of the woody species population in the Nwamba forest reserve.

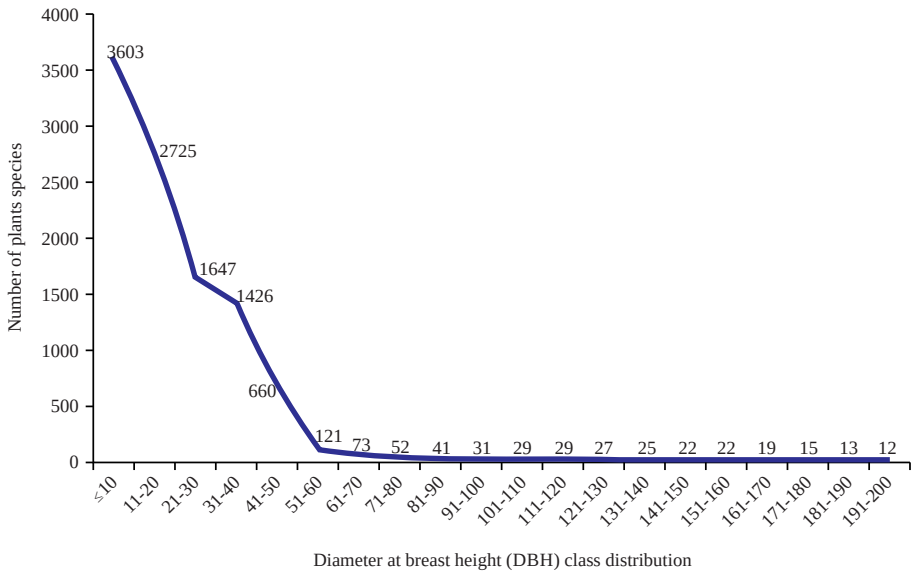

Fig. 3: Diameter at breast height (DBH) class distribution of plant species at Nwamba forest reserve

Table 1: Floristic composition, families, habits, life form and percentage frequency of Nwamba forest

Families	Plant species	Habits	Life forms	Frequency (%)
Dicotyledonous plants				
Acanthaceae	*Acanthus montanus* (Nees) T. Anderson	Shrub	Ch	9.4
	Asystasia gangetica (L.) T. Anderson	Herb	Ch	9.4
Anacardiaceae	*Spondias mombin* L.	Tree	PhE	68.8
	Mangifera indica L.	Tree	PhE	6.3
Annonaceae	*Uvaria chamae* P. Beau	Shrub	Phsc.	40.6
	Cleistopholis patens (Benth.) Engl. and Diels	Tree	PhE	53.1
	Enantia polycarpa (DC.) Engl. and Diels	Tree	PhE	35.5
	Xylopia aethiopica (Dunal) A. Rich	Tree	PhE	12.5
	Rauvolfia vomitoria Afzelius	Shrub	PhE	15.6
Apocynaceae	*Voacanga africana* Stapf	Tree	PhE	46.9
	Hedranthera barteri (Hook. f.) Pichon	Shrub	PhE	9.4
	Holarrhena floribunda (G. Don.) Dur. and Schinz	Tree	PhE	15.6
	Pleiocarpa mutica Benth.	Shrub	PhE	9.4
	Landolphia owariensis P. Beauv	Shrub	Phcl	9.4
	Landolphia lanceolata (K. Schum.) Pichon	Shrub	Phcl	53.1
	Landolphia dulcis (R. Br.) Pichon	Shrub	Phcl	21.9
	Alstonia boonei De wild.	Tree	PhE	40.6
	Lecaniodioscus cupanoides	Tree	PhE	53.1
	Funtumia elastica (Preuss) Stapf	Tree	PhE	37.5
Asclepiadaceae	*Asclepia syriaca* L.	Herb	Ch.	6.3
	Gongronema latifolia Benth.	Herb	Chcl	6.3
	Leptadenia hastata (Pers.) Decne	Herb	Chcl	6.3
Asteraceae	*Chromolaena odorata* (L.) R.M. King and H. Rob.	Herb	Phsc.	21.9
	Ageratum conyzoides Linn.	Herb	Phsc	15.6
Bignoniaceae	*Markhama tomentosa* (Benth.) K. Schum.	Shrub	PhE	21.9
	Newbouldia laevis (P. beauv.) Seem.	Tree	PhE	81.3
	Spathodea companulata P. Beauv.	Shrub	PhE	6.3
Bombacaceae	*Ceiba pentandra* (L.) Garten	Tree	PhE	31.3
Burseraceae	*Dacryodes edulis* (G. Don.) H.J. Lam	Tree	PhE	6.3
	Dacryodes klaineana (Pierre) H.J. Lam	Tree	PhE	6.3
	Canarium schweinfurthi Engl.	Tree	PhE	34.4
Cannabaceae	*Trema orientalia* (L.) Blume	Tree	PhE	21.9
Cecropiaceae	*Myrianthus arboreus* P. Beauv	Tree	PhE	37.5
Combretaceae	*Terminalia superba* Engl. and Diels	Tree	PhE	21.9
	Terminalia ivorensis	Tree	PhE	15.6
	Combretum hispidium Laws	Shrub	Phsc	56.3

Table 1: Continue

Families	Plant species	Habits	Life forms	Frequency (%)
	Combretum paniculatum vent	Shrub	Phsc	12.5
	Combretum erythrophyllum (Burch.) Sond	Tree	PhE	15.6
Chrysobalanece	*Acioa barteri* (Hook. f. ex Oliv.) Engl.	shrub	PhE	21.9
Connaraceae	*Cnestis ferruginea* DC.	Shrub/Tree	PhE	81.3
Convolvulaceae	*Ipomea involucrata* P. Beauv	Prostrate	Chcl	3.1
	Ipomea batata L.	Herb	Chcl	3.1
Costaceae	*Costus afer* ker-Gawl	Herb	Ch.	9.4
Euphorbiaceae	*Macaranga barteri* Mull. Arg.	Shrub	PhE	50.0
	Phyllanthus discoideus Mull. Arg.	Tree	PhE	15.6
	Phyllanthus amarus Schum. and Thonn.	Herb	PhE	9.4
	Uapaca heudelotii Baill.	Tree	PhE	6.3
	Alchornea cordifolia (Schum. and Thonn.) Mull. Arg.	Tree	Phsc	68.8
	Macaranga hurifolia Beille	Shrub	PhE	34.4
Fabaceae	*Baphia longipedicellata* De Wild.	Shrub	PhE	31.3
	Distemonanthus benthamianus (Bail)	Tree	PhE	53.1
	Baphia nitida Lodd.	Tree	PhE	71.9
	Afzelia african Sm. ex Pers.	Tree	PhE	21.9
	Abrus precatorius L.	Herb	Phcl	9.4
	Acacia senegal (L.) Wild.	Tree	PhE	25.0
	Berlina grandiflora (Vahl) Hutch	Tree	PhE	71.9
	Millettia thonningii (Schum. and Thonn.) Baker	Tree	PhE	68.8
	Dioclea reflexa Hook. f.	Tree	PhE	40.6
	Albizia adianthifolia (Schumach.) W.F. Wight	Tree	PhE	25.0
	Dalbergia latiofolia (Rox b.) Kuntze	Tree	PhE	18.8
	Millettia pinnata (L.) Panigrahi	Tree	PhE	40.6
	Anthonotha macrophylla P. Beauv.	Tree	PhE	28.1
	Albizia ferruginea (Guill and Perr.) Benth.	Tree	PhE	46.9
	Pterocarpus erinaceous Poir	Tree	PhE	34.4
	Lonchocarpus cyanescens (Schum. and Thonn.) Benth	Tree	Phcl	15.6
	Mucuna puriens (L.) DC.	Climber	Thcl	9.4
	Piptadeniastrum africanum (Hook. f.) Brenan	Tree	PhE	31.3
	Tetrapleura tetraptera Taub.	Tree	PhE	18.8
	Albizia zygia (DC.) J.F. Macbr.	Tree	PhE	71.9
	Brachystegia eurycoma Harms	Tree	PhE	18.8
	Dialium guineense (Wild.)	Tree	PhE	59.4
	Daniella oliveri (Rolfe) Hutch. and Dalz.	Tree	PhE	53.1
	Centrosema pubenscense	Climber	Chcl	9.4
Icacinaceae	*Icacina trichantha* Oliv	Shrub/tree	Phsc.	81.3
	Rhaphiostylis beninensis (Hook. f. ex planch.)	Shrub	Phsc	34.4
Irvingiaceae	*Irvingia wombolu* Vermoesen	Tree	PhE	21.9
	Irvingia grandifolia (Engl.) Engl.	Tree	PhE	18.8
Lauraceae	*Cassytha filiformis* Linn.	Climber	Ep	9.4
Lecythidaceae	*Napoleona vogelli* Hook and Planch	Tree	PhE	84.4
Loganiaceae	*Anthocleista djalonensis* A. Chev.	Tree	PhE	78.1
	Strychnos nux-vomica L.	Tree	PhE	6.3
Malvaceae	*Urena lobata* L.	Herb	PhE	6.3
	Bombax buonopozense P. Beaux	Tree	PhE	15.6
Meliaceae	*Entandrophragma angolense* (Welw.) C. DC.	Tree	PhE	9.4
	Carapa procera DC.	Tree	PhE	15.6
	Khaya ivorensis A. Chev.	Tree	PhE	6.3
Menispermaceae	*Chasmathera dependens* Hochst.	Shrub	Phcl	18.8
	Triclisia macrophylla Oliv	Shrub	Phcl	18.8
	Rhigiocarya racemifera Miers	Shrub	Phcl	34.4
Moraceae	*Bosqueia angolensis* Ficalho	Tree	PhE	9.4
	Ficus sur Forssk	Shrub	Ep.	28.1
	Antiaris africana Engl.	Tree	PhE	40.6
	Antiaris toxicaria Lesch	Shrub	PhE	53.1
	Ficus benghalensis Linn	Shrub	PhE	71.9
	Ficus mucuso welw. ex ficalho	Shrub	Ep.	53.1
	Musanga cecropioides R. Br	Tree	PhE	15.6
	Ficus exasperate vahl		Ep.	40.6
	Milicia excelsa (Welw.) C.C. Berg	Tree	PhE	40.6

Table 1: Continue

Families	Plant species	Habits	Life forms	Frequency (%)
Myrataceae	*Eugenia uniflora* L.	Shrub	PhE.	18.8
Myristicaceae	*Myrianthus arborea* P. Beauv	Tree	PhE	43.8
	Staudtia stipitata Warb.	Tree	PhE	12.5
	Pycanthus angolensis (Welw.) Warb.	Tree	PhE	50.0
Ochnaceae	*Ochna afzelii* R. Br. ex Oliv	Tree	PhE	28.1
	Lophira alata Banks ex Gaetnf		PhE	12.5
Olacaceae	*Olax subscorpioidea* Oliv	Shrub	PhE	53.1
Passifloraceae	*Barteria nigritana* Hook. f.	Tree	PhE	50.0
	Passiflora nitida Kunth.	Climber	PhSc	18.8
	Paropsis guineensis (olive) Barb.	Tree	PhE	59.4
Rosaceae	*Prunus africana* (Hook. f.)	Tree	PhE	40.6
Rubiaceae	*Cuviera truncata* Hutch and Dalziel	Shrub	Phsc	53.1
	Pavetta lanceolata Eckl.	Shrub	PhE	18.8
	Dictyandra arborescens Welw. ex Hook. f.	Shrub	PhE	37.5
	Psychotria calva Hiern	Shrub	PhE	12.5
	Canthium horizontale (Schumach.) Hiern	Shrub	PhE	46.9
	Canthium subcordatum DC	Tree	PhE	37.5
	Mussaenda elegan Schum. and Thonn.	Shrub	PhE	46.9
	Mitragyna stipulosa (DC.) Kuntze	Shru	PhE	37.5
	Rytigynia canthioides (Benth) Robyns	Shrub	PhE	28.1
	Rothmannia hispida (K. Schum) Fager	Shrub	PhE	34.4
	Rothmannia whitfieldii (Lindl) Dandy	Shrub	PhE	31.3
	Macrosphyra longistyla (DC.) Hook. f.	Shrub	Phsc	12.5
	Mussaenda erythrophyalla Schum. and Thonn.	Shrub	Phsc	18.8
	Rothmannia longiflora Salisb.	Shrub	PhE	9.4
Rutaceae	*Fagara macrophylla* Engl.	Shrub	PhE	6.3
Salicaceae	*Flacourtia indica* (Burm. f.) Merr.	Shrub	PhE	6.3
Sapindaceae	*Lecaniodiscus cupanioides* Planch. ex Benth.	Tree	PhE	15.6
Sapotaceae	*Synselpalum dulcificum* Daniel	Shrub	PhE	12.5
	Chrysophyllum albidium D. Don	Tree	PhE	12.5
Smilacaceae	*Smilax kraussiana* Meisn.	Climber	Chcl	37.5
Sterculiaceae	*Cola argentina* Mast.	Tree	PhE	84.4
	Sterculia tragacentha Lindl.	Tree	PhE	50.0
	Cola hispida Brenan and Keay	Tree	PhE	81.3
Tiliaceae	*Grewia venusta* Fresen.	Tree	PhE	28.1
	Glyphea brevis (Spreng) Monarch	Climber	Phcl	46.9
Ulmaceae	*Celtis zenkeri* Engl.	Tree	PhE	12.5
Verbenaceae	*Gmelina arborea* Roxb. ex. Sm.	Tree	PhE	6.3
	Vitexchrysocarpa Planch. ex. Benth.	Shrub	PhE	43.8
	Vitex doniana sweet	Tree	PhE	62.5
Vitaceae	*Cissus populnea* Guill and Perr.	Shrub	Phcl	9.4
Monocotyledonous plants				
Araceae	*Anchormones difformis* (Blume) Engl.	Herb	Cr.(G) E	25.0
	Culcasia scandens P. Beauv.	Climber	Chcl	18.8
Arecaceae	*Elaeis guineensis* jacq	Tree	PhE	9.4
Commelinaceae	*Palisota hirsuta* (Thumb.) K. Schum.	Herb	PhE	6.3
Dioscoreaceae	*Dioscorea dumentorum* (Kunth) Pax	Climber	Cr(G)CL.	3.1
	Dioscorea bulbifera Linn.	Climber	Cr(G)CL.	3.1
Dracaenaceae	*Dracaena arborea* (Wild.) link	Tree	Hc	6.3
	Dracaena fragrans (L.) Ker-Gawl	Tree	Hc	3.1
Poaceae	*Bambusa vulgaris* schrad ex J.C. Wendl.	Tree	PhE.	3.1
	Acroceras amplectens (Stapf)	Herb	PhE	9.4
	Olyra latifolia L.	Shrub	PhE	6.3
Bryophytes				
Oxymitraceae	Oxymitra incrassata (Broth.) Sergio and Sim-Sim	Liverwort	Hc	3.1
Pteridophytes				
Nephrolepidaceae	*Nephrolepis biserrata* (SW) Schott	Fern	Ep.	3.1
Polypodiaceae	*Platycerium coronarium* (J.K. ex O.F. Mull.) Desv.	Fern	Ep.	3.1

PhE.: Erect phanerophytes, Phsc.: Scandant phanerophytes, Phcl.: Climbing phanerophytes, Ch.: Erect chamaephytes, Chcl.: Climbing chamaephytes, Hc.: Hemicryptophytes, ThE.: Erect therophytes and Ep.: Epiphyte

Table 2: Basal area of woody species in plots in Nwamba forest reserve

Plot	Basal area (m^2)	Total number of woody species	Plot	Basal area (m^2)	Total number of woody species
1	42.6	281	17	39.6	364
2	38.3	280	18	40.5	375
3	34.0	318	19	43.0	360
4	28.0	280	20	35.9	313
5	36.0	320	21	38.6	349
6	39.3	362	22	43.3	389
7	44.5	325	23	35.6	343
8	36.0	349	24	28.9	324
9	34.5	302	25	43.5	307
10	36.5	299	26	38.8	320
11	42.5	352	27	44.2	299
12	31.9	380	28	28.6	325
13	37.3	377	29	37.0	313
14	35.9	382	30	42.8	322
15	44.8	314	31	46.4	376
16	30.5	262	32	40.9	331
Total				1,220.2	10,592
Mean				38.13	331

Results of life forms spectrum of plant species in Nwamba forest reserve: The results of the basal area of woody species in the different plots in the Nwamba forest reserve was shown in Table 2. The results showed that the basal area and number of species in each plot differed from one plot to another and were independent of one another. The total and mean basal areas were 1,220.2 and 38.13 m^2, respectively with a total and mean number of woody species of 10,592 and 331, respectively. Plot 31 with 376 woody species had the highest basal area of 46.4 m^2 followed by plot 15 with 314 woody species and basal area of 44.8 m^2 while plot 4 with 280 woody species had the least basal area of 28.0 m^2.

DISCUSSION

The high number of species observed in the Nwamba forest reserve may be attributed to the reduced level of disturbance from human activities which are likely to increase vegetation growth and reproduction. It could indicate that the forest has a good climate/geological location thus, offering an ideal habitat favourable for many species. They could also be a consequence of the spatial scale and coverage of these studies as they all cover large areas, involving more than one site. Reports have attributed a high number of species in forest areas to the climatic conditions (2000 mm with a known range of 1700-3200 mm) similar to that in Nwamba forest reserve[17-19]. The results showed that the Fabaceae family had the highest number of species (most dominant families) in the Nwamba forest reserve and this observation is in line with several reports of Fabaceae dominating in forests with similar climatic predispositions[20-22]. The dominance of the family, Fabaceae may be attributed to methods of their seed dispersal which is mainly by explosive mechanism and wind dispersal method. These methods have been shown to carry far away seeds of this family from the mother tree to where they germinate when conditions are suitable, thus eliminating competition for nutrients and other requirements that may lead to the death of the young seedling from their mother trees[23]. Dispersal mechanism plays a strong role in addition to climatic condition and soil type in the preponderance of species of Fabaceae[23]. This may also be a result of their germination ability and the persistence of seeds in the soil. However, a smaller number of species noticed in some families may be as a result of poor germination ability as seeds may require scarification or changes in thermal or light conditions to break dormancy for germination to occur. Other limiting factors include lean light by canopy trees, dormancy of some seeds and poor soil nutrients.

The diverse plant species composition encountered in the Nwamba forest reserve showed that the forest reserve had become established as a result of deliberate successful natural recruitments. The results of this study revealed different life-forms which varied in order: Phanerophytes>Chamaephytes> Epiphytes>Hemicryptophytes = Cryptophytes>Therophytes> Epiphyte. The existence of these life-forms is a clear demonstration that conditions prevalent in the forest are conducive for plants growth. The distribution of species in the life form classes showed that the Nwamba forest reserve supports different plant species that fall into various life form spectrums. The most dominant plant species in the Nwamba forest reserve falls in the phanerophytes (84.31%) life form class followed by chamaephytes (7.20%). This showed that the vegetation in the Nwamba forest reserve is natural as the

observation is in line with others who reported that phanerophytes as the usual dominant stands of natural vegetation[24-27]. The presence of hemicryptophyte also showed that no single life form class is associated solely with a single environmental type. This observation is supported by the reports that there is no life form exclusiveness in a particular area[28-32]. The percentage of hemicryptophyte and therophyte in the Nwamba forest reserve are 2.0 and 7.0%, respectively. This showed that when the harmony between the floristic structure and the environment is not complete, then a uniform community changes and the resultant vegetation will be a complex of the dominant and co-dominant life forms[30,32]. The climate of a region is characterized by life forms in the normal biological spectrum. However, biotic agencies such as agricultural practices, grazing and deforestation among others are the chief causes for changing the biological spectrum in a given floristic zone. The observation of a less dominant percentage of biological spectrums of hemicryptophytes and therophytes (Fig. 2) is in line with the study of Almouctar *et al*.[33], Trong *et al*.[34] and Amjad[35] that aligned these life forms with vegetative zones of plant species. Also, the observed lower percentages of life form classes other than phanerophytes and chamaephytes reflects that environmental factor such as climate, drought and human influence might have aided positively or negatively in the less distribution and development of the species in their life form spectrum[36-39].

Napoleona vogelii and *Cola argentina* with 84.4% of occurrence closely followed by *Cola hispida*, *Icacina trichantha*, *Cnestis ferruginea* and *Newbouldia laevis* with 81.3% of occurrence observed in Nwamba forest reserve indicated the high-frequency distribution of these plant species in the forest. These observations are not in tandem with the reports of Ishoro and Aja[40] with 24% highest and 6% lowest in Northern Cross River state and Nelson[41] with 11, 12, 16 and 23% in Ikot Efre-Itak community forest in Akwa Ibom State, Nigeria which indicated the low-frequency distribution of these species in the forests. The plant species in the Nwamba forest reserve were not evenly distributed throughout the forest. A higher number of species in higher frequency classes and a lower number of species in lower frequency classes is an indication of homogeneity in forest composition while the low number of species in higher frequency classes is an indication of heterogeneity of species[28]. This present study revealed a high percentage of species in lower frequency classes and a relatively low percentage number of species in high-frequency classes implying the existence of a high degree of floristic heterogeneity of plant species in the Nwamba forest reserve.

This study revealed that the highest number of plant species were at DBH between less than or equal 10 cm and that the number of stands decreased as the class DBH increased (Fig. 3). This observation agreed with the findings of Hammond *et al*.[42], Aigbe and Omokhua[43], Aigbe *et al*.[44], Adeyemi *et al*.[11], Salami and Akinyele[45], and Burju *et al*.[46] at Okomu, Onigamberi, Ondo State, Ehor Reserve Forest, Edo State, Okwangwo forest, Cross River state, Omo Biosphere Reserve, Ogun state, Nigeria and in Jibat Humid Afromontane forest, Ethiopia, respectively. The low percentage of woody species associated with larger values of DBH classes in the Nwamba forest reserve showed that the forest is affected by biotic and/or abiotic disturbance. Biotic disturbances such as deforestation among others deplete the volume of forest stands especially those with larger DBH. Nath *et al*.[47] reported that timber trees are logged at 60-90 cm DBH depending on the species. Similar results have been reported by the International Institute of Tropical Agriculture (IITA) Ibadan, Oyo state and on tree species composition in selected sacred forests in Nigeria by Christopher [48] and Daniel *et al*.[49]. Examples of trees with a small number of stands and large DHB class include *Cola argentina* with a DBH of 198.9 cm, *Piptadeniastrum africanum* with a DBH of 156.1 cm, *Antiaris toxicaria* with DBH of 165.6 cm, *Bombax buonopozense* with DBH of 199.6 cm and *Irvingia wombolo* with a DBH of 164.7cm. Also, the DBH in the class distributions of all individuals in different size classes showed a reversed J-shaped curve, that is a negative exponential pattern (Fig. 3). The results showed that Nwamba forest reserve had 59.7% of its trees in the category of smaller diameter logs (DBH$\leq$20 cm), 36.4% of its trees in the categories of medium size class distribution (20-50 cm DBH) and 3.9% portion of the trees in the category of mature trees (DBH $\geq$51 cm) using the classification of Al-Shaye *et al*.[14] and Jafari *et al*.[15]. Thus, these observations showed that the majority of the forest trees were dominated by small stemmed trees in the age distribution class. This implies a good potential for reproduction and recruitment of woody species in the Nwamba forest reserve. These observations also reinforced the hope that the forests if not destroyed can sustainably produce the various indigenous species that are threatened in the forest and other forest settlings. Generally, the results from these forests revealed that the larger the size classes, the lower the frequency of occurrence of woody plants. Fundamentally, this trend observed in the Nwamba forest reserve is an indication of a healthy or expanding population capable of self-replacement via natural recruitment. This conforms to the finding of Amonum *et al*.[50] in vegetated area of University of Agriculture Makurdi, Benue state, Nigeria, Daniel *et al*.[49] on the

woody population structure of IITA, Daniel *et al.*[49] of selected sacred forests in Nigeria which stated that in a typical rainforest the smaller size class dominate while the larger the size class the fewer the number. This is also an example of stable population structures as different types of species may emerge in the forest as a result of rain, wind or human disturbance[16]. The small size class structures of trees indicated the probability of species persistence into mature ones in the future if proper management strategies are employed to improve the stand structure. The resultant cause of decreased percentage proportion of mature trees is the death of matured trees, falling of both timber and fuel tree of the inner thick forest and the damaged down by knocking trees surrounding them. The gaps formed are in a short time filled with herbs, trees, climbers and tree lets, which can arise from exposed roots and stumps and/or a bank of seeds and seedlings. Thus, this eventually leads to small size class distribution of the forest. Generally, results from forests revealed that the larger the size classes, the lower the frequency of occurrence of woody plants.

The average basal area of plant species at Nwamba forest was 38.13 m^2 (Table 2) and is higher than 22.54, 22.68, 25.82 and 26.69 m^2 reported by Adekunle *et al.*[51], Banag-Moran *et al.*[52], Naidu and Kumar[53] and Adekunle and Olagoke[54], respectively and 1.82-28.24 m^2 ha^{-1} range reported by Aigbe *et al.*[44]. This is expected since the forest understudy is under protection by community law, with minimal human use pressure. Also, the tropical climate of the forest understudy may have contributed to the high woody growth rates and high basal area. However, the average basal area of Nwamba forest was lower than the average values of the range 1.14-73.87 m^2 ha^{-1} on vegetation types in the Tsunami impacted coastal habitats of Nicobar Islands, India[55] and 37.9 m^2 ha^{-1} in the natural forest zone[56]. However, the mean value obtained in the Nwamba forest falls within the range of those reported for the old world rainforest, Brunei (32.3 m^2)[57] and the Oban forest reserve (34.67 m^2)[44]. Generally, different management regimes had a significant influence on plant species composition and richness and forest growth and yield.

The results showed that the highest number of woody species were at DBH between less than or equal 10 cm and that the number of stands decreased as the class DBH increased, thus showing reversed J-shaped curve, which is a negative exponential pattern with a mean basal area of 38.13 m^2. The low percentage of woody species associated with larger values of DBH classes in the Nwamba forest showed that the forest is affected by biotic and/or abiotic disturbance. This implies a good potential for reproduction and recruitment of woody species in the Nwamba community forest. These observations also reinforced the hope that the forests if not destroyed can sustainably produce the various indigenous species that are threatened in the forest. In line with these findings, it is recommended that the forest requires strict protection if continuous forest regeneration is to be maintained. There is therefore a need to revise or improve the system currently being used to protect the forest. This may include involving the government, non-governmental organizations and the local people in efforts to conserve the forests without affecting the rights, wishes and traditional practices of the communal owners.

CONCLUSION

Nwamba forest reserve is a traditionally protected community forest meant to fulfil the cultural and specific functional needs of the communal owners in terms of forest resources, employment and ecological conservation. The management of Nwamba forest reserve depends entirely on the community guards which lacks adequate requisite knowledge and technicalities for forest protection and conservation. This study showed that the habits of Nwamba Forest reserve are not evenly distributed throughout the study plots and are dominated by *Napoleona vogelii*, *Cola argentina*, *Cola hispida*, *Icacina trichantha*, *Cnestis ferruginea* and *Newbouldia laevis.* The study also showed that the forest is affected by biotic and/or abiotic disturbance but has good potential for reproduction and recruitment of woody species. Overall, Nwamba forest reserve if managed efficiently has the potential to conserve and provide economic forest species.

SIGNIFICANCE STATEMENT

Nwamba forest reserve habit is not evenly distributed but is dominated by *Napoleona vogelii*, *Cola argentina*, *Cola hispida*, *Icacina trichantha*, *Cnestis ferruginea* and *Newbouldia laevis*. Woody species were more at diameter at breast height (DBH) $\leq$10 cm with decreased number of stands as the class DBH increased indicating biotic and/or abiotic disturbance. The study discovered that the Nwamba forest reserve has a good potential for reproduction and recruitment of woody species and the ability to sustain indigenous threatened species. The study revealed the need for proper protection and management of the Nwamba forest reserve for enhanced economic and research benefits.

REFERENCE

1. Jacquemyn, H., J. Butaye and M. Hermy, 2001. Forest plant species richness in small, fragmented mixed deciduous forest patches: The role of area, time and dispersal limitation. J. Biogeogr., 28: 801-812.
2. Eycott, A.E., A.R. Watkinson and P.M. Dolman, 2006. Ecological patterns of plant diversity in a plantation forest managed by clearfelling. J. Appl. Ecol., 43: 1160-1171.
3. Isbell, F., V. Calcagno, A. Hector, J. Connolly and W.S. Harpole *et al*., 2011. High plant diversity is needed to maintain ecosystem services. Nature, 477: 199-202.
4. Sala, O.E., F.S. Chapin III, J.J. Armesto, E. Berlow and J. Bloomfield *et al*., 2000. Global biodiversity scenarios for the year 2100. Science, 287: 1770-1774.
5. De Groot, R.S., M.A. Wilson and R.M.J. Boumans, 2002. A typology for the classification, description and valuation of ecosystem functions, goods and services. Ecol. Econ., 41: 393-408.
6. Diaz, S., J. Fargione, F.S. Chapin and D. Tilman, 2006. Biodiversity loss threatens human well-being. PLoS Biol., 4: 1300-1305.
7. Van Wilgen, B.W., J.L. Nel and M. Rouget, 2007. Invasive alien plants and South African rivers: A proposed approach to the prioritization of control operations. Freshwater Biol., 52: 711-723.
8. Newton, A.C., 2007. Forest Ecology and Conservation: A Handbook of Techniques. Oxford University Press, New York, ISBN: 9780198567448, Pages: 454.
9. Wright, S.J., 2005. Tropical forests in a changing environment. Trends Ecol. Evolut., 20: 553-560.
10. Fölster, H., 1994. Stability of forest ecosystems in the humid tropics. Interciencia, 19: 291-296.
11. Adeyemi, A.A., A.E. Ibe and F.C. Okedimma, 2015. Tree structural and species diversities in Okwangwo Forest, Cross River State, Nigeria. J. Res. For. Wildl. Environ., 7: 36-53.
12. Gbile, Z.O. and M.O. Soladoye, 2002. Vernacular Names of Nigerian Plants (Yoruba). 2nd Edn., Forestry Research Institute of Nigeria (FRIN), Ibadan, Nigeria, Pages: 101.
13. Khalik, K.A., M. El-Sheikh and A. El-Aidarous, 2013. Floristic diversity and vegetation analysis of Wadi Al-Noman, Mecca, Saudi Arabia. Turkish J. Botany, 37: 894-907.
14. Al-Shaye, N.A., Y.S. Masrahi and J. Thomas, 2020. Ecological significance of floristic composition and life forms of Riyadh region, Central Saudi Arabia. Saudi J. Biol. Sci., 27: 35-40.
15. Jafari, Z., M.K. Kianian, F. Aslani and M. Akbarlo, 2016. Floristic composition, life forms and geographical distribution (Case study: Lashgardar Rangelands of Malayer, Iran). J. Environ. Sci. Technol., 9: 140-148.
16. Jayakumar, R. and K.K.N. Nair, 2013. Species diversity and tree regeneration patterns in tropical forests of the Western Ghats, India. ISRN Ecol., Vol. 2013. 10.1155/2013/890862.
17. Fagua, J.C., P. Jantz, P. Burns, R. Massey and J.Y. Buitrago *et al*., 2021. Mapping tree diversity in the tropical forest region of Chocó-Colombia. Environ. Res. Lett., Vol. 16. 10.1088/1748-9326/abf58a.
18. Khalik, K.A., I. Al-Gohary and Y. Al-Sodany, 2017. Floristic composition and vegetation: Environmental relationships of Wadi Fatimah, Mecca, Saudi Arabia. Arid Land Res. Manage., 31: 316-334.
19. Wanjohi, B.K., J.T. Njunge, D.F. Otieno and E. Oyoo-Okoth, 2017. Plant species composition, structure and diversity in Nabkoi Forest Reserve (Kenya). Res. J. For., 4: 1-21.
20. Ogunleye, A.J., A.O. Adeola, L.O. Ojo and A.M. Aduradola, 2004. Impact of farming activities on vegetation of Olokemeji Forest Reserve, Nigeria. Global Nest: Int. J., 6: 131-140.
21. Ihenyen, J., E.E. Okoegwale and J.K. Mensah, 2009. Composition of tree species in Ehor Forest Reserve, Edo State, Nigeria. Nat. Sci., 7: 8-18.
22. Neelo, J., D. Teketay, K. Kashe and W. Masamba, 2015. Stand structure, diversity and regeneration status of woody species in open and exclosed dry woodland sites around *molapo* farming areas of the Okavango Delta, Northeastern Botswana. Open J. For., 5: 313-328.
23. Soladoye, M.O., M.A. Sonibare, A.O. Nadi and D.A. Alabi, 2005. Indigenous angiosperm biodiversity of Olabisi Onabanjo University permanent site. Afr. J. Biotechnol., 4: 554-562.
24. Mack, R.N., 2003. Phylogenetic constraint, absent life forms and preadapted alien plants: A prescription for biological invasions. Int. J. Plant Sci., 164: S185-S196.
25. Batalha, M.A. and F.R. Martins, 2004. Floristic, frequency and vegetation Life-form spectra of a cerrado site. Braz. J. Biol., 64: 203-209.
26. Raju, V.S., P.G. Krishna and S. Suthari, 2014. Environmental assessment of climate of a habitat through floristic life-form spectra, a case study of Warangal North Forest division, Telangana, India. J. Nat. Sci., 2: 77-93.
27. Abedi, T. and R. Abedi, 2015. Study on floristic composition, life form and chorotype of Kishkhale reserve area (Guilan province). J. Agric. Crop Sci., 8: 47-51.
28. Irl, S.D.H., A. Obermeier, C. Beierkuhnlein and M.J. Steinbauer, 2020. Climate controls plant life form patterns on a high elevation oceanic island. J. Biogeogr., 47: 2261-2273.
29. Sen, U.K. and R.K. Bhakat, 2020. Assessment of biological spectrum and phenological behaviours of coastal vegetation in East Midnapore District, Eastern India. J. Trop. Life Sci., 10: 123-140.
30. Xu, K., X. Wang, C. Jiang and O.J. Sun, 2020. Assessing the vulnerability of ecosystems to climate change based on climate exposure, vegetation stability and productivity. For. Ecosyst., Vol. 7. 10.1186/s40663-020-00239-y.
31. Sharma, A. and N. Sharma, 2020. Floristics, leaf size spectra and life-form distribution of riparian vegetation along a hill stream, Bhaderwah, Jammu and Kashmir, India. Asian J. Plant Sci., 19: 91-106.

32. Sani, H., B.L. Aliero, A.A. Aliero and H.G. Ahmed, 2014. Floristic composition and life forms study of woody plants in Magama local government area, Niger State, Nigeria. Annu. Res. Rev. Biol., 4: 527-537.
33. Almouctar, M.A.S., Y. Wu, A. Kumar, F. Zhao, K.J. Mambu and M. Sadek, 2021. Spatiotemporal analysis of vegetation cover changes around surface water based on NDVI: A case study in Korama basin, Southern Zinder, Niger. Appl. Water Sci., Vol. 11. 10.1007/s13201-020-01332-x.
34. Trong, H.N., T.D. Nguyen and M. Kappas, 2020. Land cover and forest type classification by values of vegetation indices and forest structure of tropical lowland forests in Central Vietnam. Int. J. For. Res., Vol. 2020. 10.1155/2020/8896310.
35. Amjad, M.S., 2012. Life form and leaf size spectra of vegetation in Kotli Hills, Azad Jammu and Kashmir (Pakistan). Greener J. Agric. Sci., 2: 345-350.
36. Bloch-Petersen, M., J. Brandt and M. Olsen, 2006. Integration of European habitat monitoring based on plant life form composition as an indicator of environmental change and change in biodiversity. Geogr. Tidsskr. Dan. J. Geogr., 106: 61-74.
37. Malik, Z.H., F. Hussain and N.Z. Malik, 2007. Life form and leaf size spectra of plant communities Harbouring Ganga Chotti and Bedori Hills during 1999-2000. Int. J. Agric. Biol., 9: 833-838.
38. Ajaib, M., Z. Khan, S. Muhammed and R. Mahmood, 2008. Biological spectra of Saney Bbaney Hills district Kotli Azad Jammu and Kashmir. Pak. J. Sci., 60: 53-58.
39. Asaadi, A.M., 2009. Floristic study of Firozeh watershed (North Khorasan Province). Res. J. Biol. Sci., 4: 1092-1103.
40. Ishoro, A.P. and E.E. Aja, 2017. Population frequency, density, abundance and diversity of tree species in ten communal forests of Northern Cross River State, Nigeria. Int. J. Curr. Res., 9: 59581-59596.
41. Nelson, I.U., U.I. Udoakpan and D.E. Jacob, 2015. Population density and diversity of plants species in Ikot Efre Itak community forest, Akwa Ibom state, Nigeria. Int. J. Mol. Ecol. Conserv., 5: 1-6.
42. Hammond, M.E., R. Pokorný, D. Okae-Anti, A. Gyedu and I.O. Obeng, 2021. The composition and diversity of natural regeneration of tree species in gaps under different intensities of forest disturbance. J. For. Res., 32: 1843-1853.
43. Aigbe, H.I and G.E. Omokhua, 2015. Tree composition and diversity in Oban Forest Reserve, Nigeria. J. Agric. Stud., 3: 10-24.
44. Aigbe, H.I., A.A. Nchor and F.O. Obasogie, 2017. Structure and floristic compositions of Ehor Forest Reserve, Edo State, Nigeria. Appl. Trop. Agric., 22: 197-209.
45. Salami, K.D. and A.O. Akinyele, 2018. Floristic composition, structure and diversity distribution in Omo Biosphere Reserve, Ogun State, Nigeria. Ife J. Sci., 20: 639-647.
46. Burju, T., K. Hundera and E. Kelbessa, 2013. Floristic composition and structural analysis of Jibat Humid Afromontane Forest, West Shewa Zone, Oromia National Regional State, Ethiopia. Ethiopian J. Educ. Sci., 8: 11-33.
47. Nath, T.K., M. Jashimuddin and M. Inoue, 2020. Achieving sustainable development goals through participatory forest management: Examples from South Eastern Bangladesh. Nat. Resour. Forum, 44: 353-368.
48. Christopher, A.O., 2019. Comparison of woody plants population structure in two distinct forest of international institute of tropical agriculture (IITA) Ibadan, Oyo State, Nigeria. J. For. Res. Manage., 16: 87-103.
49. Daniel, K.S., D.E. Jacob and A.U. Udeagha, 2015. Tree species composition in selected sacred forests in Nigeria. Int. J. Mol. Ecol. Conserv., 5: 1-10.
50. Amonum, J.I., B.A. Jonathan and H.D. Japheth, 2019. Structure and diversity of tree species at the College of Forestry and fisheries, University of Agriculture Makurdi, Benue State, Nigeria. Int. J. For. Hortic., 2019: 20-27.
51. Adekunle, V.A.J., A.O. Olagoke and S.O. Akindele, 2013. Tree species diversity and structure of Nigeria strict nature reserve. Trop. Ecol., 54: 275-289.
52. Banag-Moran, C.I., F.A. Bautista, K.A.M. Bonifacio, C.A.M.L. De Guzman, J.L. Lim, D.N. Tandang and N.H.A. Dagamac, 2020. Variations in floristic composition and community structure between disturbed and undisturbed lowland forest in Aklan, Philippines. Geol. Ecol. Landscapes, 10.1080/24749508.2020.1814187.
53. Naidu, M.T. and O.A. Kumar, 2016. Tree diversity, stand structure and community composition of tropical forests in Eastern Ghats of Andhra Pradesh, India. J. Asia-Pac. Biodivers., 9: 328-334.
54. Adekunle, V.A.J. and A.O. Olagoke, 2008. Diversity and biovolume of tree species in natural forest ecosystem in the bitumen-producing area of Ondo State, Nigeria: A baseline study. Biodivers. Conserv., 17: 2735-2755.
55. Prabakara, N. and B. Paramasivam, 2015. Littoral forest composition and influence of soil characteristics on vegetation succession in the Tsunami impacted coastal habitats of Nicobar Islands, India. J. Island Ecol., 1: 1-17.
56. Tenzin, J. and H. Hasenauer, 2016. Tree species composition and diversity in relation to anthropogenic disturbances in broad-leaved forests of Bhutan. Int. J. Biodivers. Sci., Ecosyst. Serv. Manage., 12: 274-290.
57. Small, A., T.G. Martin, R.L. Kitching and K.M. Wong, 2004. Contribution of tree species to the biodiversity of a 1 ha old world rainforest in Brunei, Borneo. Biodivers. Conserv., 13: 2067-2088.