PRINT ISSN 1119-8362
Electronic ISSN 1119-8362

Full-text Available Online at
https://www.ajol.info/index.php/jasem
https://www.bioline.org.br/ja

J. Appl. Sci. Environ. Manage.
Vol. 26 (4) 579-588 April 2022

A Floristic Assessment of Woody Plant Diversity in Secondary Forest, Ile-Ife Nigeria: A Proactive Step to Monitoring the Diversity Loss and Degradation

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ABSTRACT: Loss of biodiversity has been recognized as one of the main threats to the forest ecosystem. This study examined the diversity and conservation status of woody species in the secondary forest of Obafemi Awolowo University, Ile-Ife, Nigeria using six permanent plots. All woody species were completely enumerated, and identified; their girths at breast height were measured at 1.3 m above buttress. Biodiversity status was assessed using Shannon-Wiener diversity, evenness of distribution, Sorrenson index of similarity and species importance value index. There were 77 tree species distributed into 62 genera and 30 families. The most abundant species were *Celtis zenkeri* and *Lecaniodiscus cupanioides*, while the most abundant families were Moraceae, Euphorbiaceae, and Fabaceae. The tree species density ranged from 508 – 1132 plants per hectare. The Shannon-Weiner diversity index (1.83 to 3.50), evenness (0.483 – 0.741) and the basal area (6.06 – 25.73 m^2 ha^{-1}) were high in the forest. However, *Celtis mildbraedii* is critically endangered, while *Garcina kola*, *Mallotus oppositifolus* and *Ricinodendron heudelotii* are vulnerable. This study provides baseline diversity data for the conservation of woody species in the forest and concludes that this secondary forest is a potential biodiversity hub if properly managed. It will also play a key role in fashioning out realistic, appropriate, and effective conservation strategies that will enhance the restoration and management of the floristic composition of the secondary forest.

DOI: **https://dx.doi.org/10.4314/jasem.v26i4.4**

Impact factor: **http://sjifactor.com/passport.php?id=21082**

Google Analytics: https://www.ajol.info/stats/bdf07303d34706088ffffbc8a92c9c1491b12470

Dates: Received: 03 March 2022; Revised: 13 April 2022; Accepted: 27 April 2022

Keywords: biodiversity; conservation; endangered; secondary forest; woody species.

Over the years, the decline in biodiversity has been a major challenge to ecologists because of its effect on ecosystem functions and processes such as productivity and nutrient dynamics (Tilman *et al.*, 1996). Ecologists have widely used biodiversity assessment to determine ecosystem status and productivity. It is also a means of unravelling how anthropogenic activities have impacted ecological systems (Leitner and Turner, 2001). Woody species occupy a dominant position in the forest owing to the significant impact they confer on the various ecological processes in the forest ecosystem; hence, they are considered biodiversity indicators (MCPFE, 2003). Yet, trees and shrubs are mostly targeted plant species for exploitation, owing to their importance in construction, traditional medicine, shelter, and cooking (Alamu and Agbeja, 2011; Ajao *et al.*, 2022), an activity which has led to the loss of over 60 tree species in Nigeria (Emma-Okafor et al, 2010; Ihenyen, 2009). Plant species can vary in their contributions to ecosystem functioning. Therefore unravelling the species composition and conservation status is very important to prevent forest degradation. According to FAO's Global Forest Resources Assessment of 2015, significant efforts are geared globally to conserve forests over the past 25 years from degradation. As conscious efforts are being put in place towards mitigating the destruction of the tropical rainforest and securing the conservation of its rich biodiversity, adequate and appropriate quantitative and qualitative ecological data in floristic composition and its structure that produce multiple products are

imperative. However, despite that, Obafemi Awolowo University (OAU) forest is a typical secondary rain forest that has undergone different levels of disturbance such as fire and deforestation, data on the past and present woody species composition is lacking. In view of the foregoing, this study aimed at assessing the diversity and conservation status of woody species in the secondary forest of OAU. Specifically, this study investigated: (1) the structural dynamics and diversity of woody species (tree and shrub) within the secondary rain forest of OAU, and (2) the conservation status of each enumerated tree species. The findings of this study will play a key role in fashioning out realistic, appropriate, and effective conservation strategies that will enhance the restoration and management of the floristic composition of the secondary forest. In addition, this study will provide information that will enhance informed decisions on the present status of the woody species of this area.

MATERIALS AND METHODS

Study Area: The study was carried out within a 20.5-hectare secondary rain forest in the Biological Gardens of the Obafemi Awolowo University, Ile-Ife, Nigeria. Ile-Ife lies between latitudes 7° 30' to 7° 35' N and longitude 4° 30' to 4° 35' E. The elevation ranges from 213 m to 457 m above sea level (Hall, 1969). The forest is a natural regrowth under conservation within and outside the gardens, with minimal human disturbance. Six sample plots between latitudes 7° 31.38' to 7° 31.53' N and longitudes 4° 31.43' E to 4° 31.56' E, were established in the secondary forest in locations undergoing different degrees of regeneration for this study (Fig. 1). The elevation of the six sample plots ranged from 252 m to 336 m above sea level. Ile-Ife lies in the lowland rainforest zone (Keay, 1959), semi-deciduous moist forest, dry deciduous forest zone (Onochie, 1979) and Guineo-Congolian forest drier type (White, 1983). Hall (1969) also reported that the Ile-Ife area belongs to the dry forest sub-group rich in trees of the families Sterculiaceae and Moraceae. The basal area of trees in the forest was 32.2 m^2 $ha^{-1,}$ and the stem density of woody plants less than 2 m in height was 798 per 0.25 ha (Isichei *et al.*, 1986). There are two prominent seasons in the Ile-Ife area: the rainy season and the dry season. The dry season is short, usually lasting for four months from November to March of every year, and a longer rainy season prevails during the remaining months. The most recent climatic survey conducted in 2013 by the Atmospheric Physics Research Group, Department of Physics and Engineering Physics, Obafemi Awolowo University, Ile-Ife, showed that the mean annual rainfall at Ile-Ife averaged 1302 mm per year, with a relative humidity of 82.80%, average temperature of 25.5° C, solar radiation of 164.30 Wm^{-2} and average wind speed of 2.06 km/hr. The area is underlain by rocks of the Basement Complex, which are of the Precambrian age (Wilson, 1922). The Basement complex consists of a heterogeneous group of rocks (gneisses, schists, granites, and minor rock types such as pegmatites). The soil has been classified as Lixisols and Ultisols (FAO/UNESCO, 1974). The soil temperature regime is Isohyperthermic, the soil moisture is ustic and clay minerals are mostly kaolinite. The soils are usually acidic, moderately to strongly leached, have low to medium humus content, contain < 10% clay which is kaolinite and are characterized by low cation exchange capacity and low water-holding capacity (Ayodele, 1986).

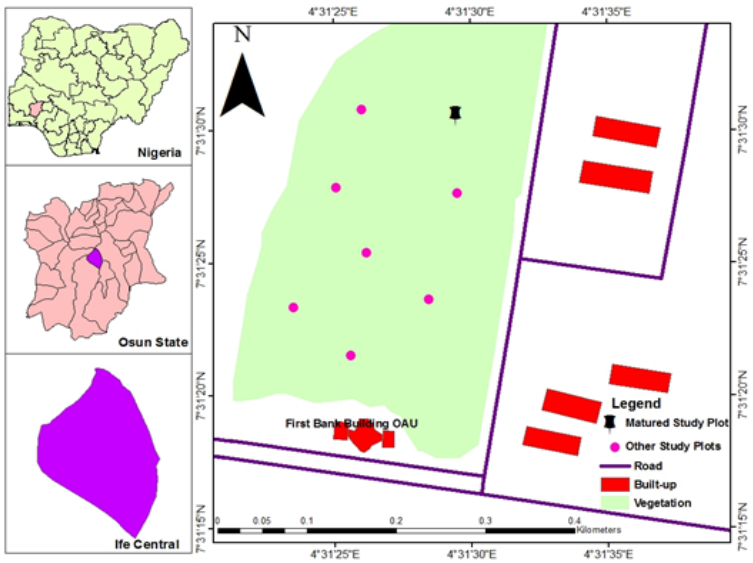

Fig. 1. Map of the study area where the study was conducted

Sampling Procedure and Vegetation Analysis: Six sample plots (I-VI) of the same size (0.25 ha) in the secondary forest in the Biological Gardens were marked out using a measuring tape. In each plot, all the woody species (shrubs and trees) were completely enumerated and identified at the species level. Specimens of plant species that could not be identified on the field were collected and identified in the IFE Herbarium.

Assessment of Conservation Status: The conservation status of the woody species encountered during this study was accessed online using the IUCN database (https://www.iucn.org/) and from the study conducted by Nodza *et al.* (2014).

Data analysis: Using the data obtained from the field, the following vegetation attributes were determined from each plot: species composition, density (ha^{-1}), basal area, Shannon-Weiner diversity index (H'), evenness of distribution of species and Sorenson's index of similarity between the plots. The composition of the species in the plots were established by listing all the species encountered in each plot and summing up to get the total number of plant species for each plot. The Sorenson index of similarity (ISS) was calculated as:

$$\text{ISS} = \frac{2C}{A+B} \times 100$$

C is the number of species common to plots A and B; A is the number of species in plot A; B is the number of species in plot B.

The diversity index was calculated as:

$$H^{l} = -\sum P_i \ln (P_i)$$

Where; H^{l} is the Shannon-Weiner diversity index; $P_i = \frac{ni}{N}$, the relative abundance of each species "i"; N is the total number of individuals of all species; n_i is the number of individuals of species.

The evenness of distribution of species was calculated by using the Pielou's evenness index, J;

$$J = \frac{H'}{ln\,(S)}$$

Where; J is the Pielou's evenness index; H^{l} is the Shannon-Weiner diversity index; S is the total number of species on each plot.

The species importance value in the forest was calculated as "the sum of the relative density, relative frequency and relative dominance of each species per plot in the forest".

$$RDs = \frac{DS}{ODS} \times 100$$

$$RF = \frac{FS}{TFS} \times 100$$

$$RD = \frac{DS}{SD} \times 100$$

The percentage contribution of tree species members of families to overall floristic composition of the forest was calculated as:

$$F\,(\%) = \frac{NSF}{TNSF} \times 100$$

Where RDs = Relative density; DS= density of species; ODS = overall density of all species; FS = frequency of species; TFS = total frequency values of all species; RF = Relative frequency; RD = Relative dominancy; DS = dominance of species; SD = sum dominance of species; F = frequency; NSF = number of species in each family; TNSF = total number of species in all families of the forest

RESULTS AND DISCUSSION

Floristic Composition: A total of 77 woody species distributed into 62 genera and 30 families were enumerated across the studied plots (Table 1). The common tree and shrub species in terms of their occurrence in at least four of the study plots are shown in Table 1. Two tree species (*Celtis zenkeri* and *Lecaniodiscus cupanioides*) were common to all the study plots. The most species-rich families in the study plots were: Apocynaceae (7.79%), Euphorbiaceae (11.69%), Fabaceae (11.69%), Moraceae (11.69%), and Sterculiaceae (9.09%) (Fig. 2).

Structural Characteristics: Density, Diversity, and Importance Value of Tree Species in the Study Plots
The species density ranged from 508–1132 plants per hectare (Table 2). Some tree species were found to be dominant in terms of their densities in the plots. For example, in plot I, *Blighia sapida* (5.7%), *Celtis zenkeri* (6.0%), *Funtumia elastica* (8.5%), *Lecaniodiscus cupanioides* (6.4%), *Mallotus oppositifolus* (4.6%), *Microdesmis puberula* (6.7%), *Milletia thonningii* (5.7%) and *Trilepsium madagascariensis* (8.8%) contributed 52.4% of the tree densities in the plot. In Plot II, *Funtumia elastica* (27.6%), *Lecaniodiscus cupanioides* (5.5%), *Myrianthus arboreus* (8.7%), *Pierreodendron africanum* (5.5%) and *Tabernaemontana pachysiphon* (6.3%) contributed 53.6% of the tree densities in the plot.

Table 1. Floristic composition, mean relative density (%), mean relative frequency (%), mean relative dominance (%) and mean importance value index of woody species in the Biological Gardens of the Obafemi Awolowo University, Ile-Ife, Nigeria.

Species	Family	Mean RD	Mean RF	Mean RDo	Mean IVI
Lecaniodiscus cupanioides Planch. Ex Benth	Sapindaceae	14.7	5.5	14.4	34.7
Funtumia elastica (Preuss) Stapf	Apocynaceae	12.5	2.4	7.9	22.8
Ricinodendron heudelotii (Baill.) Pierre ex Pax	Euphorbiaceae	1.9	3.4	16.5	21.8
Celtis zenkeri Engl.	Ulmaceae	7.0	5.5	6.8	19.3
Sterculia tragacantha Lindl.	Sterculiaceae	6.1	2.6	5.3	13.9
Manihot glazovii Mull. Arg	Euphorbiaceae	6.6	1.6	4.0	12.1
Trichilia prieuriana	Meliaceae	2.2	4.8	2.5	9.6
Microdesmis puberula Hook. f. ex planch.	Pandaceae	5.0	4.3	0.2	9.4
Pycnanthus angolensis (Welw.) Warb.	Myristicaceae	1.9	2.4	4.4	8.8
Alstonia boonei De Wild.	Apocynaceae	0.8	1.0	6.3	8.2
Celtis mildbraedii Engl.	Ulmaceae	1.7	3.9	2.5	8.2
Ficus mucuso Welwi. Ex Ficalho	Moraceae	2.5	3.0	1.9	7.4
Myrianthus arboreus P. Beauv.	Moraceae	2.9	2.4	1.9	7.3
Baphia nitida Load.	Fabaceae	2.0	4.6	0.2	6.8
Cola millenii K. Schum	Sterculiaceae	2.2	3.7	0.9	6.7
Albizia zygia (DC.) J.F. Macbr.	Fabaceae	1.5	2.4	2.2	6.1
Trilepisium madagascariensis DC	Moraceae	2.2	1.9	1.2	5.3
Bombax buonopozense P. Beauv.	Bombacaceae	1.2	2.5	1.1	4.8
Trichilia heudelotii Planch. ex Oliv.	Meliaceae	1.5	1.0	1.7	4.2
Monodora tenuifolia Benth.	Annonaceae	1.5	2.2	0.3	4.0
Cola sp	Sterculiaceae	1.2	2.6	0.1	3.9
Lannea welwitschii (Hiern) Engl.	Anarcadaceae	1.0	1.5	1.5	3.9
Tabernaemontana pachysiphon Stapf	Apocynaceae	1.4	1.2	1.4	3.9
Chassalia kolly (Schumach.) Hepper	Rubiaceae	0.8	2.6	0	3.4
Carpolobia lutea G. Don	Polygalaceae	1.4	1.9	0	3.3
Blighia sapida Konig	Sapindaceae	1.4	1.2	0.5	3.1
Pierreodendron africanum (Hook. f.) Little	Simaroubaceae	0.9	0.5	1.7	3.1
Voacanga africana Stapf	Apocynaceae	1.2	1.4	0.5	3.1
Zanthoxylum sp Linn.	Rutaceae	0.4	0.9	1.3	2.6
Elaeis guineensis Jacq.	Aracaceae	0.2	0.8	1.4	2.4
Ficus exasperata Vahl	Moraceae	0.8	0.8	0.9	2.4
Tetrapleura tetraptera (Schum. & Thonn.) Taub.	Fabaceae	0.3	0.3	1.7	2.3
Ficus sp	Moraceae	0.3	0.8	1.1	2.2
Alchornea laxiflora (Benth.) Pax & K. Hoffin.	Euphorbiaceae	0.4	1.6	0	2.0
Olax subcorpioides Oliv.	Olacaceae	0.5	1.5	0	2.0
Triplochiton scleroxylon K. Schum.	Sterculiaceae	0.6	1.2	0.2	2.0
Maesopsis eminii Engl.	Rhamnaceae	0.3	0.5	1.1	1.8
Malacantha alnifolia (Bak.) Pierre	Sapotaceae	0.4	1.3	0	1.7
Milletia thonningii (Schum. & Thonn.) Bak.	Fabaceae	0.9	0.3	0.4	1.6
Bridelia micrantha (Hochst.) Baill.	Euphorbiaceae	0.6	0.7	0.1	1.4
Chrysophyllum albidum G. Don	Sapotaceae	0.3	1.0	0	1.4
Margaritaria discoidea (Baill.) G.L. Webster	Euphorbiaceae	0.4	0.9	0	1.4
Dracaena manii Bak.	Dracaenaceae	0.4	0.8	0.1	1.3
Rauvolfia vomitoria Afzel.	Apocynaceae	0.2	0.8	0.3	1.2
Canarium schweinfurthii Engl.	Burseraceae	0.1	0.5	0.5	1.1
Canthium vulgare (K.Schum.) Bullock.	Rubiaceae	0.2	0.8	0.2	1.1
Cola hispida Brenan & Keay	Sterculiaceae	0.4	0.5	0.3	1.1
Mallotus oppositifolus (Geisel.) Mull. Arg	Euphorbiaceae	0.8	0.3	0	1.1
Pterocarpus sp	Fabaceae	0.2	0.8	0.1	1.1
Strombosia pustulata Oliv.	Olacaceae	0.3	0.7	0.1	1.1
Funtumia africana (Benth.) Stapf	Apocynaceae	0.5	0.3	0.2	1
Cola acuminata (P. Beauv.) Schott & Endl.	Sterculiaceae	0.3	0.5	0.2	0.9
Napoleona imperialis P. Beauv.	Lecythidaceae	0.6	0.3	0.1	0.9
Terminalia superba Engl. & Diels	Combretaceae	0.1	0.3	0.5	0.9
Albizia sp	Fabaceae	0.1	0.3	0.4	0.8
Spondias mombin Linn.	Anarcadaceae	0.2	0.3	0.3	0.8
Garcinia kola Heckel	Clusiaceae	0.1	0.5	0.1	0.7
Newbouldia laevis (P. Beauv.) Seemann. Ex Bureau	Bignoniaceae	0.4	0.3	0	0.7
Cleistopholis patens (Benth.) Engl. & Diels	Annonaceae	0.1	0.5	0	0.6
Blighia unijugata Bak.	Sapindaceae	0.1	0.3	0.1	0.5
Keetia vulgae Oliv.	Rubiaceae	0.1	0.3	0.1	0.5
Piptadenastrum africanum (Hook. f.) Brenan	Fabaceae	0.1	0.3	0.1	0.5
Trichilia sp	Meliaceae	0.1	0.3	0.1	0.5
Blighia sp	Sapindaceae	0.1	0.3	0	0.4
Bridelia ferruginea Benth.	Euphorbiaceae	0.1	0.3	0	0.4
Celtis sp	Ulmaceae	0.1	0.3	0	0.4
Dialium guineense Willd.	Fabaceae	0.1	0.3	0	0.4
Ficus sur Forssk.	Moraceae	0.1	0.3	0.1	0.4
Glyphaea brevis (Spreng.) Monachino	Tiliaceae	0.1	0.3	0	0.4
Hylodendron gabunense Taub.	Fabaceae	0.1	0.3	0.1	0.4
Mallotus mildbraedii Chev.	Euphorbiaceae	0.1	0.3	0	0.4
Mallotus subulata Mull. Arg	Euphorbiaceae	0.1	0.3	0	0.4
Morinda lucida Benth.	Moraceae	0.1	0.3	0	0.4
Morus mesozygia Stapf	Moraceae	0.1	0.3	0	0.4
Antiaris africana Engl.	Moraceae	0.1	0.3	0	0.3
Cola nitida (Vent.) Schott & Endl.	Sterculiaceae	0.1	0.3	0	0.3
Napoleona vogelii Hook. & Planch	Lecythidaceae	0.1	0.3	0	0.3

Key: RD = Relative Density; RF = Relative Frequency; RDo = Relative Dominance; IVI = Importance Value Index.

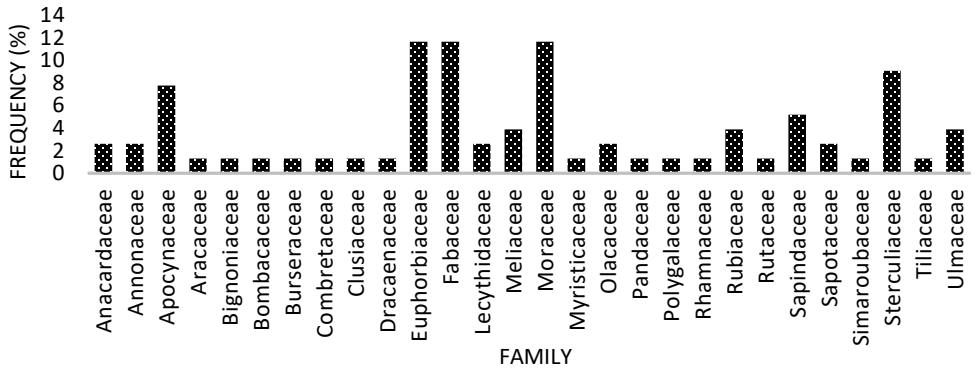

Fig 1. Percentage Family Frequency Distribution of woody Species in the Study Plots.

Table 2. Summary of floristics and structural properties of the secondary rainforest at Ile – Ife, Nigeria.

Vegetation Parameter	Plot						
	I	II	III	IV	V	VI	Forest Mean
Number of species (ha^{-1})	58	36	18	23	9	13	26
Number of genera (ha^{-1})	42	29	18	23	8	12	22
Number of family (ha^{-1})	23	22	14	17	7	10	16
Density (ha^{-1})	1132	508	642	917	512	752	744
Basal area (m^2ha^{-1})	15.89	8.37	14.27	25.73	6.06	19.9	15.04
Shannon-Weiner Species diversity index	3.5	2.93	2.75	2.66	1.83	1.86	2.59
Pielou's evenness Index	0.62	0.61	0.74	0.66	0.53	0.48	0.61

In Plot III, *Funtumia elastica* (15.3%), *Lecaniodiscus cupanioides* (12.5%), *Celtis zenkeri* (7.5%), *Cola millenii* (7.5%), *Ficus mucoso* (7.5%), *Microdesmis puberula* (7.5%) and *Pycnanthus angolensis* (7.5%) contributed 65.3% of the tree densities in the plot. In Plot IV, *Carpolobia lutea* (5.5%), *Funtumia elastica* (23.7%), *Lecaniodiscus cupanioides* (14.6%), *Microdesmis puberula* (5.5%) and *Trichilia heudelotii* (5.5%) contributed 54.8% of the tree densities in the plot. In Plot V, *Celtis zenkeri* (15.6%), *Lecaniodiscus cupanioides* (21.9%) and *Sterculia tragacantha* (34.4%) contributed 71.9% of the tree densities in the plot. In Plot VI, *Celtis zenkeri* (6.4%), *Lecaniodiscus cupanioides* (27.7%), *Manihot glaziovii* (38.3%) and *Monodora tenuifolia* (6.4%) contributed 78.8% of the tree densities in the plot (Table 1). The Shannon-Weiner diversity index of the species in the plots ranged from 1.83 to 3.5 while the evenness as measured by the Pielou's evenness index ranged from 0.483 to 0.741. The diversity of trees was highest in Plot I but lowest in Plot V (Table 3). The tree evenness index was highest in Plot III and lowest in Plot VI (Table 2). The Importance value index in plot I revealed that *Celtis zenkeri* (12.8), *Tetrapleura tetraptera* (13.8), *Trilepsium madagascariensis* (17.3), *Funtumia elastica* (17.4) and *Alstonia boonei* (21.6) had the highest values. In Plot II, *Lecaniodiscus cupanioides* (14.4), *Myrianthus arboreus* (17), *Tabernaemontana pachysiphon* (17.2), *Pierreodendron africanum* (18.5) and *Funtumia elastica* (48.2) exhibited highest important value index. Plot III showed that *Cola millenii* (15), *Albizia zygia* (15.4), *Zanthophyllum sp* (15.9), *Celtis zenkeri* (17.8), *Ficus mucoso* (19.9), *Pycnanthus angolensis* (21.9), *Lecaniodiscus cupanioides* (24.4), *Funtumia elastica* (28.9) and *Ricinodendron heudelotii* (55.2) had highest important value index. The Importance value index in Plot IV showed that *Albizia zygia* (12), *Myrianthus arboreus* (12.2), *Trichilia heudelotii* (15.3), *Pycnanthus angolensis* (15.3), *Ricinodendron heudelotii* (15.3), *Alstonia boonei* (27.5), *Funtumia elastica* (42.5) and *Lecaniodiscus cupanioides* (46). The Importance value index in Plot V showed that *Celtis mildbraedii* (22.3), *Celtis zenkeri* (47.9), *Lecaniodiscus cupanioides* (73.5) and *Sterculia tragantha* (74.9). Lastly, the Importance value index in Plot VI showed that *Monodora tenuifolia* (15.4), *Celtis mildbraedii* (17.2), *Celtis zenkeri* (18), *Trichilia prieuriana* (20.8), *Lecaniodiscus cupanioides* (40.5), *Ricinodendron heudelotii* (56.5) and *Manihot glaziovii* (68.4) *Lecaniodiscus cupanioides* (34.7) had the highest values across the forest, followed by *Funtumia elastica* (22.8), *Ricinodendron heudelotii* (21.8) and *Celtis zenkeri* (19.3) (Table 1). Also, the girth size class distribution of tree species in the study plots showed that smallest and intermediate girth size classes, 0–15 cm and 31–50 cm, had more tree species (Fig. 2).

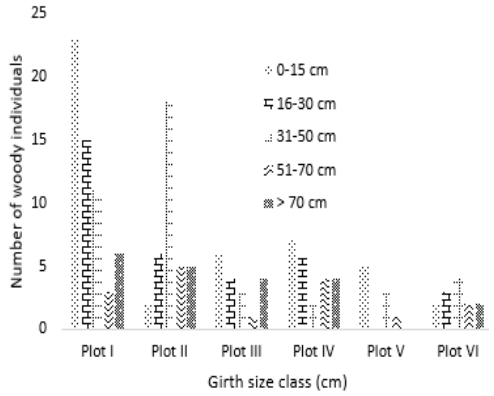

Fig 2. Girth Size Distribution of Woody Species in the Forest.

Similarity Index: From the Sorenson index of similarity, Plots III and IV (53.66%) exhibited the highest similarity in species composition under studied plots, while Plots I and V (23.88) showed the lowest similarity in species composition under the same studied plots (Table 3).

Table 3. Sorenson similarity index of the woody species in the study plots.

Plot/Plot	I	II	III	IV	V
II	46.81				
III	34.21	44.44			
IV	38.27	50.85	53.66		
V	23.88	35.56	29.63	31.25	
VI	25.35	36.73	45.16	33.33	45.45

Conservation Status: Among all of the 77 woody species encountered *Celtis mildbraedii* was the only one that is critically endangered, *Garcina kola*, *Mallotus oppositifolus* and *Ricinodendron heudelotii* were vulnerable.

The other remaining species were either of least concern or not assessed (Table 4). Understanding plant species composition, diversity patterns, and conservation status play a significant role in the management of secondary forests and their productivity (Kacholi *et a.,* 2015; Ragavan *et al.,* 2015).

In this study, a total number of 77 woody trees species encountered indicates that the forest is high in woody plant density and was consistent with the findings of Blanc *et al.* (2000), in a mature, dense lowland forest in Vietnam.

This was lower when compared with the findings of some workers in the tropical zones (e.g., Duran *et al.,* 2006; Rajkumar and Parthasarathy, 2008; Lu *et al.,* 2010; Adekunle *et al.,* 2013). However, it falls within 62–247 species reported for a mature tropical forest in Southeast Asia (Losose and Leigh, 2004).

Table 4. List of species studied and their conservation status (https://www.iucn.org/; Nodza *et al*. (2014).

Plant Species	Conservation status
Albizia zygea	LC
Alchornea laxiflora	LC
Alstonia boonei	LC
Antiaris africana	LC
Baphia nitida	LC
Blighia sapida	LC
Blighia unijugata	LC
Bombax buonopozense	LC
Bridelia ferruginea	LC
Bridelia micrantha	LC
Canthium vulgari	LC
Carpolobia lutea	NE
Celtis mildbraedii	CR
Celtis zenkeri	NE
Chassalia kolly	NE
Chrysophyllum albidum	LC
Cleistopholis patens	LC
Cola acuminata	LC
Cola hispida	LC
Cola millenii	LC
Cola nitida	LC
Dialium guineensis	LC
Dracaena manii	NE
Elaeis guineensis	LC
Ficus exasperata	LC
Ficus mucoso	LC
Ficus sur	LC
Funtumia africana	NE
Funtumia elastica	LC
Garcina kola	VU
Glyphaea Brevis	NE
Hylodendron gabunensis	LC
Keetia vulgae	NE
Lannea welwitschii	LC
Lecaniodiscus cupanioides	LC
Maesopsis eminii	NE
Malacantha alnifolia	NE
Mallotus mildbraedii	NE
Mallotus oppositifolus	VU
Mallotus subulata	NE
Manihot glazovii	NE
Margaritaria discoidea	LC
Microdesmis puberula	NE
Milletia thonningii	LC
Monodora tenuifolia	NE
Morinda lucida	LC
Morus mesozygia	NE
Myrianthus arboreus	NE
Napoleona imperialis	NE
Napoleona vogelii	NE
Newbouldia laevis	LC
Olax subcorpioides	LC
Pierreodendron africanum	NE
Piptadenastrum africanum	NE
Pycnanthus angolensis	NE
Rauvolfia vomitoria	LC
Ricinodendron heudelotii	VU
Spondias mombin	NE
Sterculia tragacantha	LC
Strombosia pustulata	NE
Tabernaemontana pachysiphon	NE
Terminalia superba	LC
Tetrapleura tetraptera	NE
Trichilia heudelotii	LC
Trichilia prieuriana	LC
Trilepsium madagascariensis	NE
Triplochiton scleroxylon	LC
Voacanga africana	NE
Zanthophyllum sp	-

KEY: LC - Least Concerned, CR- Critically Endangered NE- Not Evaluated, VU – Vulnerable, EN – Endangered.

The plant species diversity index (1.83–3.5) reported in this study shows varying species diversity in the forest, from low to high, and corresponds to the values

reported in some tropics. For example, Duran *et al.* (2006) reported a diversity index ranging from 2.69–3.33 in a Mexican tropical deciduous forest and falls within the range of 2.94–3.96 reported by Rao *et al.* (2011) for sacred groves in Southeastern Ghats, India. The girth size distribution class with the highest number of species reported in this study were 0–15 cm and 31–50 cm. This showed that the forest was still in its regeneration phase towards attaining maturity, thus underlining the need for its conservation. The number of species in the girth size classes corresponds to the 10–20 cm and 31–40 cm reported by Adekunle *et al.* (2013) in a Strict Nature Reserve in a Nigerian forest. In contrast, a study done by Sathish *et al.* (2013) in tropical rain forests of Western Ghats, India showed that the girth size classes 30–60 cm and 60–90 cm had the highest species proportion in the forest.

Albizia zygea, Baphia nitida, Celtis mildbraedii, Celtis zenkeri, Cola millenii, Ficus mucoso, Funtumia elastica, Lecaniodiscus cupanioides, Microdesmis puberula, Myrianthus arboreus, Pycnanthus angolensis, Ricinodendron heudelotii and *Trichilia prieuriana* were the commonest species in the forest. These species form part of the early successional series of the forest, as reported by Shafi (1973), which shows the importance of these species in the regeneration potential of this forest. The dominant families in the forest in descending order were Moraceae (11.69%), Euphorbiaceae (11.69%), Fabaceae (11.69%), Sterculiaceae (9.09%) and Apocynaceae (7.79%). The list of dominant families falls within that observed by Adekunle *et al.* (2013), of which Sterculiaceae and Moraceae dominated. Adekunle *et al.* (2010) had earlier suggested that these families are typical of the tropical rainforest ecosystems of the Southwestern part of Nigeria. On a much broader scale, similar reports in other parts of the tropics have shown the dominance of these families. For instance, Euphorbiaceae and Moraceae were reported as part of the dominant families in Southeast Asia (Proctor *et al.*, 1983; Kanzaki *et al.*, 2004; Small *et al.*, 2004; Kessler *et al.*, 2005; Lu *et al.*, 2010).

Species with the highest importance value index across the plots were *Alstonia boonei* (21.59) in Plot I, *Funtumia elastica* (48.23) in Plot II, *Ricinodendron heudelotii* (55.23) in Plot III, *Lecaniodiscus cupanioides* (46.00) in Plot IV, *Sterculia tragacantha* (74.85) in plot V and *Manihot glaziovii* (68.44) in plot VI. However, of all these species, *Alstonia boonei*, *Sterculia tragacantha* and *Manihot glaziovii* were not part of the 13 dominant species in the forest. This is because they were only abundant on single plots. The chief contributors to their high importance value were the density and the large basal area attributed to these three species. Some studies have shown that basal area (relative dominance) is a key parameter that defines the importance value of a species (Gebrehiwot and Hundera, 2014). The most important species in the forest in ascending order were *Celtis zenkeri* (19.3; 6.45%), *Ricinodendron heudelotii* (21.8; 7.26%), *Funtumia elastica* (22.8; 7.61%) and *Lecaniodiscus cupanioides* (34.7; 11.56%). The importance of *Celtis zenkeri, Funtumia elastica,* and *Lecaniodiscus cupanioides* was as a result of their high relative abundance, while the importance of *Ricinodendron heudelotii* was as a result of its high relative dominance. It seems *Celtis zenkeri* forms part of the important species in Nigerian forests. This is in line with the findings of Adekunle *et al.* (2013), who reported that *Celtis zenkeri* was the second most important species but had the highest relative abundance in a Strict Nature Reserve in Nigeria with an importance value of 8.23%. Furthermore, the importance value index of *Lecaniodiscus cupanioides* (34.7; 11.56%) reported in this study is greater than the importance values of species reported in Nigerian forests. For instance, it is greater than the importance value of *Mansonia altissima* (9.11%) reported by Adekunle *et al.* (2013) in a Strict Nature Reserve of Nigeria but much lower than the values reported for *Shorea robusta* (163.07) by Anshumali (2015) in a tropical deciduous forest of India and *Shorea robusta* (141.32) by Shahid and Joshi (2016) in the lower Himalayan forests. It, however, compares favourably with the 54.88 reported for *Barringtonia macrostachya* by Lu *et al.* (2009) in tropical seasonal rainforests of Southwest China.

The basal area obtained in this study ranged from 6.06 to 25.73 m^2 ha^{-1}. This range suggests that though the forest is not a mature forest, it is still an important "store" for biodiversity. Hence, there is a need for its conservation. This is similar to the value (22.54 m^2 ha^{-1}) reported by Adekunle *et al.* (2013) in a Strict Nature Reserve in Nigeria. It also falls within the range reported for two of the biodiversity hotspots in the tropical rainforest of the Ghat regions of India; 10.51 to 47.20 m^2 ha^{-1} for the Western Ghats (IIRS, 2002a) and 3.73 to 59.33 m^2 ha^{-1} for Northeast Ghats (IIRS, 2002b). The range is, however, lower than those reported in other more mature tropical forests. For instance, the 32.30 m^2 ha^{-1} reported by Small *et al.* (2004) in a Borneo rainforest; the 59.60 m^2 ha^{-1} reported by Shrestha *et al.* (2000) in natural forests of Central Nepal; and 139.70 m^2 ha^{-1} reported by Kessler *et al.* (2005) in primary forest in Indonesia.

It has been reported that the world's plants have continued to be threatened due to increased human

activities (IUCN, 2003, 2010). Interestingly, the conservation status of the tree encountered in the forest reveal no probable conservation threat for most of the trees in the future. *Celtis mildbraedii,* which has faced a high risk of extinction, should be properly conserved; the risk of extinction may be due to the usage of the tree in construction and furniture. Species such as *Garcina kola*, *Mallotus oppositifolus* and *Ricinodendron heudelotii* face a significant risk of extinction in the medium term.

Conclusion: Results showed a relevant background for ecological conservation and management of the secondary rainforest. The study generated insight into the rich biodiversity status of the secondary forest of Obafemi Awolowo University. Most importantly, the emerging pattern in tree structural diversity and dynamics suggests that the future increment in biodiversity status of the area is promising if an effective conservation strategy is imposed. These results will hopefully provide a base for further studies, possibly on ecosystem transitions that may be induced by climate change and land usage in the area.

Acknowledgements: The authors acknowledge the kind support of Late Mr. G. Ibanesebhor and B. Omomoh of Ife Herbarium for the assistance rendered in the identification and collection of the plant species and specimens.

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