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Diversity, Distribution and Abundance of Solanaceae Family Species at Ngel-Nyaki Forest Reserve, Taraba State, Nigeria

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ABSTRACT

Solanaceae or nightshades are a family of flowering plants that ranges from annual and perennial herbs to vines, lianas, epiphytes, shrubs and trees (Watson and Dallwitz, 1992). Family Solanaceae include a number of agricultural crops, medicine plants, weeds, spices and ornamentals (Heiser, 1969). Common fruits of Solanaceae family includes: tomatoes, eggplant, bell peppers and chili peppers, all of which are closely related and are use as food in the world today (Balken, 2016). Despite the economic importance of the Solanaceae family in the world today, their diversity, distribution and abundance of its species in Ngel-Nyaki Forest Reserve cannot be fully assessed. Hence the research aimed at assessing the diversity, distribution and abundance of Solanaceae species at the forest reserve. A study was carried out at Ngel-Nyaki Forest Reserve of Taraba state, Nigeria to assess the diversity, distribution and abundance of species of Solanaceae across the protected and unprotected areas of the reserve. Fourteen plots measuring 100x 50m were established after a pilot study was done to establish the positions where species of Solanaceae occurred in the reserve. In each plot, the various Solanaceae species encountered where identified and counted. 143 individuals were sampled and fourteen species were identified. Result from the study revealed that species abundance and diversity was highest in the unprotected area when compared to the protected area and this could be as a result of soil factor (such as soil mineral and soil type), grazing activities by cattle which aid seed dispersal activities and cattle dung which serves as organic manure. The study confirms that Solanaceae species are important species for conservation and regeneration, due to their economic and medicinal value they provide.

Keywords: Ngel-Nyaki, Conservation, Solanaceae and non-protected areas.

INTRODUCTION

Flowering plants contribute massively to the world's primary productivity and are the most important component of global bio-diversity; not only do they provide crops that feed us, as well as ornamentals, medicines, poisons, fibres, oils, tannins, beverages and stimulants as well as herbs and spices (Olmstead *et al*., 1999). They constitute the main structure of our terrestrial ecosystem and afford habitat for countless animals. It is not surprising that they have held a fascination for people over the centuries and that their classification has attracted a great deal of attention (Leon *et al*., 2015).

Solanaceae or nightshades are family of flowering plants that ranges from annual and perennial herbs to vines, lianas, epiphytes, shrubs and trees (Yasin, 1991). Family Solanaceae include a number of agricultural crops, medicine plants, weeds, spices and ornamentals (Jagatheeswari, 2014). Herbs are plants with aromatic properties use directly or as additives in food and medicines (Elsevier, 2020). In other words, herbs are refers to as leaves, flowers, stems, bark, seeds or roots parts of plants used for medicinal purposes or

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as additives in food. These herbs are widely distributed across the world and differ in terms of their botany, chemistry and therapeutic potency (Bot, 2003). Many members of the Solanaceae family contain potent alkaloids and some, highly poisonous (Olmestead and Bohs, 2007). Common fruits of Solanaceae family includes: tomatoes, tomatillos, eggplants, bell peppers and chili peppers, all of which are closely related and are use as food in the world today (Balken, 2016).

The family belongs to the order Solanales, in the asterid group and class Magnoliopsida (dicotyledons). It consists of 90 genera with more than 3500 species (NHM, 2008).With a great diversity of habitats, morphology and ecology (Olmestead and Bohs, 2007).

The name Solanaceae derives from the genus *Solanum*, "the nightshade plant". The etymology of the Latin word is still unclear. The name may come from a perceived resemblance of certain solanaceous flowers to the sun and its rays. At least one species of *Solanum* is known as the "sunberry". Alternatively, the name could originate from the Latin verbsolare, meaning "to soothe", presumably referring to the soothing pharmacological properties of some of the psychoactive species of the family. Despite the economic importance of the Solanaceae family in the world today, their diversity, distribution and abundance of its species in Ngel-Nyaki forest reserve cannot be assessed as such the research aimed at assessing the diversity, distribution and abundance of the species at the reserve.

MATERIALS AND METHODS

Study Area

This research project was conducted at the Nigerian Montane Forest Project Ngel- Nyaki Forest Reserve. Ngel-Nyaki Forest Reserve is located at Mambilla Plateau of Sardauna Local Government Area of Taraba state, Nigeria. The reserve is situated between longitude 07° 05'N and latitudes 011° 05'E at an altitude of 1,400m –1,600m asl. The Reserve occupies about 46km^2 area of land, with about 7.2km^2 of sub-montane to mid-altitude forest (Chapman and Chapman, 2001).

It can be reach on foot from Yelwa village past the Mayo Jigawal, from where it is less than half an hour's walk to the upper edge of the forest. The altitude ranges from 1400 (4593ft) up to 1600 meters (5249 ft). Ngel-Nyaki Forest Reserve was gazetted a Local Authority Forest Reserve under Gashaka-Mambilla Native Authority Forest Reserve Order of 24th April, 1969, but at the present it is under the management of the Taraba State Government and the Nigerian Conservation foundation (NCF), with the Nigerian Montane Forest Project (NMFP) as a project partner (Chapman and Chapman, 2001).

The forest borders directly onto overgrazed grassland. The forest edge is affected by annual grass burning, degradation by cattle grazing. Just outside the reserve, within the grassland are degraded, riparian forests varying in width from 10-50 meters from the streams. (Chapman and Chapman, 2001).

Data Collection

One week pilot survey of species of Solanaceae family was carried out across the protected and unprotected sites of the Forest Reserve. Areas where Solanaceae species were found, pink colored ribbons were used as tags for easy sighting of plots where this species are found. This was done to enable opportunistic data collection.

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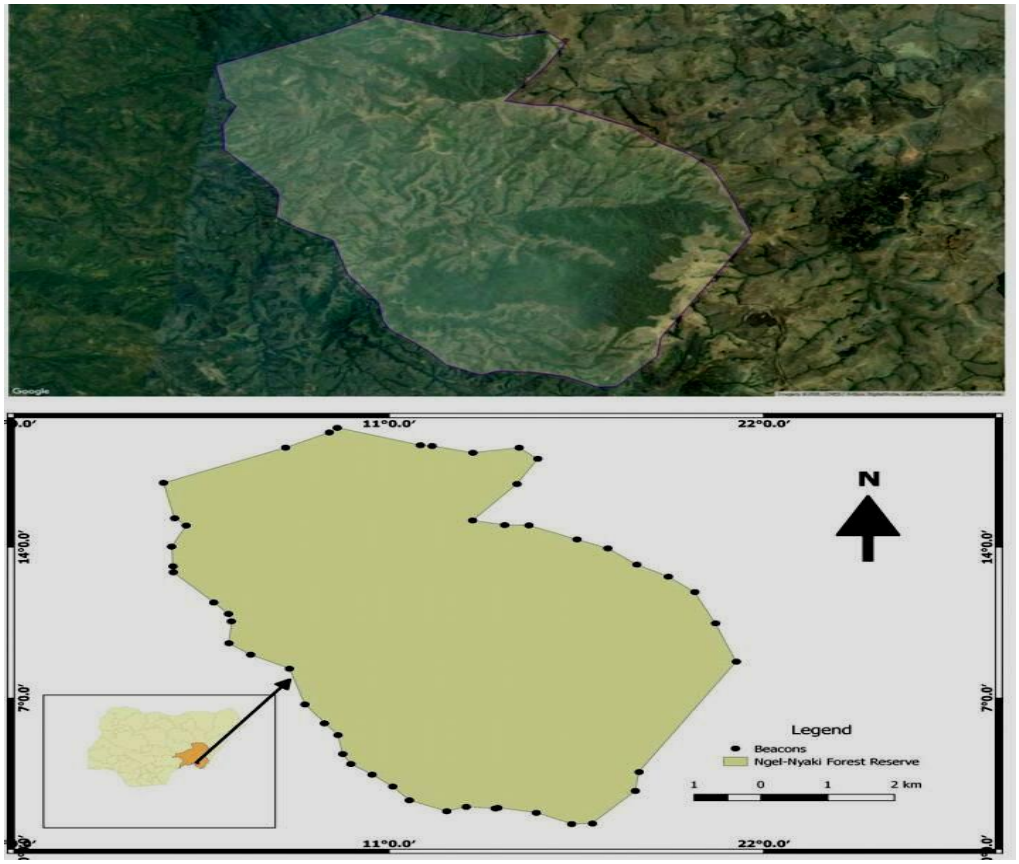

Figure 1: Map of Ngel Nyaki Forest Reserve

Systematic and Line Transect Sampling Technique

The study was conducted between the month of March and July 2021. Systematic sampling technique was used to carry out the research. Systematic sampling technique is a type of probability sampling method in which sample members from a larger population are selected according to a random starting point but with a fixed, periodic interval. This interval is called the sampling interval and is calculated by dividing the population size by the desired sample size. Line transect were established in areas where selected family species are found during the pilot survey (Merckx *et al.,* 2011). Fourteen (14) 100 x 50m plots were established using a measuring tape. Coordinates for points where plots were established were recorded using Garminetrex® global positioning system (GPS). Six (6) plots were sampled in the protected area while 8 plots were sampled in the unprotected area. In each plot, the various species encountered where identified and counted. Plant specimens of selected family species were collected and deposited at the herbarium of the Ngel- Nyaki Forest Reserve.

Data Analysis

Data was analyzed using Microsoft-excel 2007, where Plant species diversity was calculated using Shannon-Weiner index (H), which is the measure of diversity within a site according to:

$$H = -\sum Pi \, In \, Pi$$

Where Pi = S / N, S = number of individuals of one species; N = total number of all individuals in the site and In = logarithm to base e (Clarke and Warwick, 2001).

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Relative frequency was calculated by dividing the number of sample in which a species occurred by the total number of sample multiplied by one hundred (100) and Abundance of the species in the protected and unprotected areas was calculated.

RESULTS AND DISCUSSION

A total of 143 individual plants belonging to fourteen (14) species were recorded. Overall species abundance was seen to be higher in the unprotected areas with a total of eleven species and a total of 117 individual plants compared to the protected area where three species are found and a total of 26 individual plants.

Figure 2, shows the particular sampled areas where this study was carry out in the reserve. This Figure reveals areas within the reserves where GPS coordinates were taken; these includes Martin plot, Smithsonian, New Camp site, Abies Plot, Old Camp site, Protected and Unprotected Grassland, Forest Fragment, Gallery forest etc. And around the reserve, we have plot A (church side), plot B (Yelwa village), plot C (school side) etc. thus, it could be said that these species are sparsely distributed across the reserve.

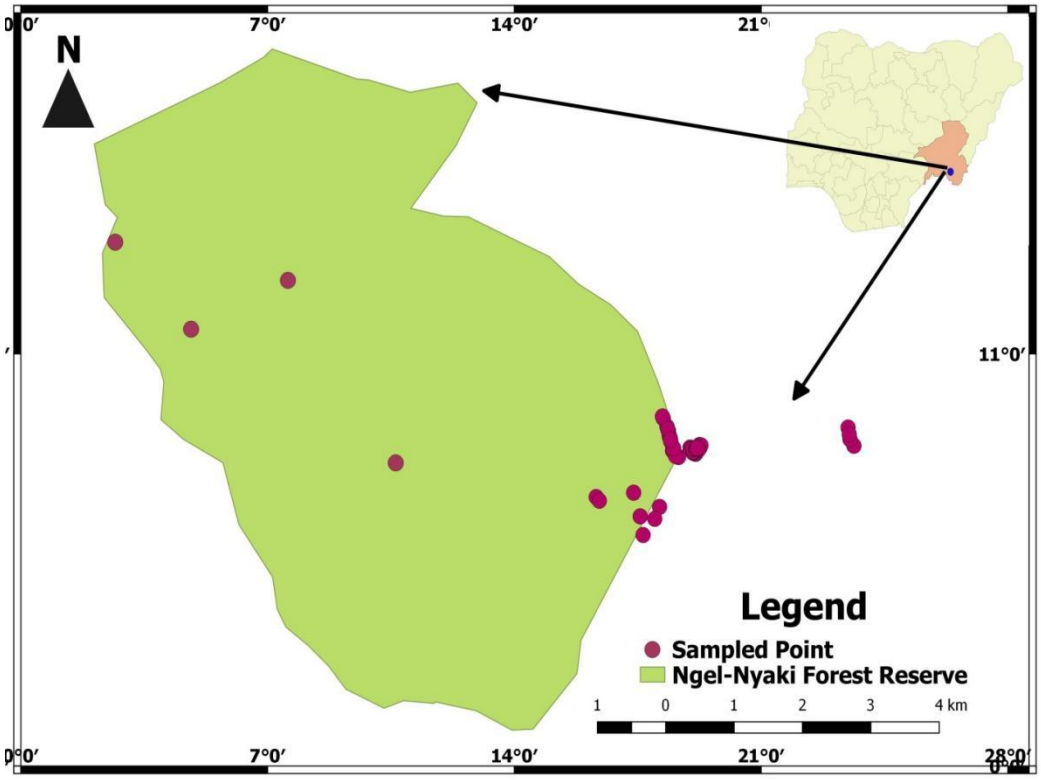

Figure 2: Sampled areas within and around the Ngel-Nyaki Forest Reserve

Table 1 shows the list of Solanaceae species identified during the course of the study both within the reserve and around the reserve. These species include: *Physalis* species (such as *Physalis peruviana*, *Physalis pubescens*),*Nicandra physalodes*,*Datura stramonium* and *Solanum* species and most of them are believed to be new species of *Solanum*. From the Table 1, *Physalis Peruviana* happens to be the most abundant species in the protected habitat and *Solanum aculeastrum* happens to be the most abundant species in the unprotected habitat.

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Table 1: List of species present in the forest reserve and their abundance

S/N	Species name	Species code	Abundance for protected area	Abundance for unprotected area
1	*Daturastramonium*	DAST	0	1
2	*Nicandraphysalodes*	NIPH	0	3
3	*Physalisperuviana*	PHPE	23	0
4	*Physalispubescens*	PHPU	1	0
5	*Solanumtorvum*	SOTO	1	0
6	*Solanumcoaglans*	SOCO	0	1
7	*Solanumaculeastrum*	SOAC	0	102
8	*Solanumincanum*	SOIN	0	3
9	*Solanumnigrum*	SONI	0	1
10	*Solanumnodiflorum*	SONO	0	1
11	*Solanumerianthum*	SOER	0	1
12	*Solanumviolaceum*	SOVI	0	1
13	*Solanumlinnaeanum*	SOLI	1	2
14	*Brugmansiaarborea*	BRAR	0	1
	Total		26	117

Key: 0 = absent

Table 2, reveals the relative frequency of the solanaceae species across the habitat type which is the protected and unprotected areas of the reserve and from the table, we could connote that species frequency is greater in the unprotected area (835.7142857) than in the protected (185.7142857).

Table 2: Relative Frequency of Species between protected and unprotected Area

S/N	Species name	Species code	Relative frequency for protected area	Relative frequency for unprotected area
1	*Daturastramonium*	DAST	0	7.14
2	*Nicandraphysalodes*	NIPH	0	21.42
3	*Physalisperuviana*	PHPE	164.28	0
4	*Physalispubescens*	PHPU	7.14	0
5	*Solanumtorvum*	SOTO	7.14	0
6	*Solanumcoaglans*	SOCO	0	7.14
7	*Solanumaculeastrum*	SOAC	0	728.57
8	*Solanumincanum*	SOIN	0	21.42
9	*Solanumnigrum*	SONI	0	7.14
10	*Solanumnodiflorum*	SONO	0	7.14
11	*Solanumerianthum*	SOER	0	7.14
12	*Solanumviolaceum*	SOVI	0	7.14
13	*Solanumlinnaeanum*	SOLI	7.14	14.28
14	*Brugmansiaarborea*	BRAR	0	7.14
	Total		185.7142857	835.7142857

Key: 0 = absent

Figure 3, shows the diversity of solanaceae species across the different habitat types (protected and unprotected areas). And from the figure we could connote that the diversity of species is richer in the unprotected areas than in the protected areas.

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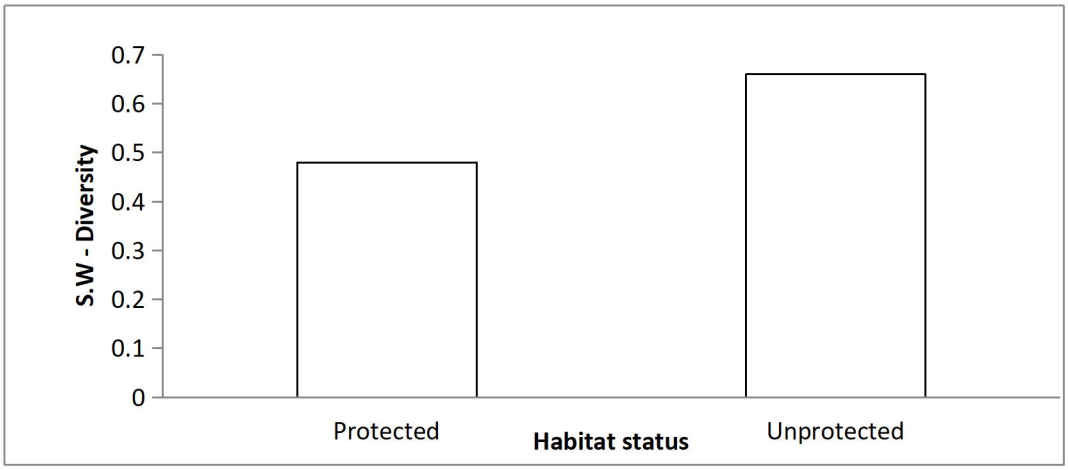

Figure 3: Diversity of species across protected and unprotected area of the forest reserve.

Figure 4, reveals the abundance of the species across the different habitat types, with unprotected areas having greater abundance of species than the protected areas.

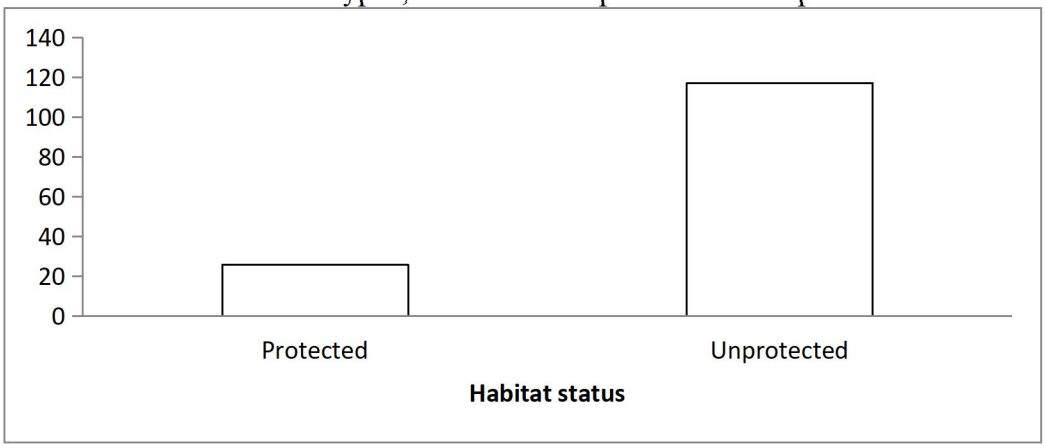

Figure 4: Abundance of Solanaceae species across protected and unprotected area of the reserve

Table 1 shows the list of Solanaceae species identified during the course of the study both within the reserve and around the reserve. These species include: *Physalis* species (such as *Physalis peruviana*,*Physalis pubescens*),*Nicandraphysalodes*,*Daturastramonium*and*Solanum*species and most of them are believed to be endemic to this reserve this could be attributed to the peculiar nature of the reserve climatic condition. From table 1, *PhysalisPeruviana*happens to be the most abundant species in the protected habitat and *Solanum aculeastrum* happens to be the most abundant species in the unprotected habitat.

Table 2 reveals, the relative frequency of the solanaceae species in the protected and unprotected areas of the forest reserve and from the table, we could connote that species frequency is greater in the unprotected area (835.7142857) than in the protected (185.7142857).

Figure 3, shows the diversity of Solanaceae species across the different habitat types (protected and unprotected areas). And from the figure we could connote that the diversity of species is richer in the unprotected areas than in the protected areas. Figure 4 reveals the abundance of the species across the different habitat types, with unprotected areas

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having greater abundance of species than the protected areas.

A total number of 14 species of Solanaceae were recorded from the study in both protected and unprotected areas of the forest reserve. From the results of this study, the unprotected areas has the highest number of species diversity compared to the protected areas and this could be as a result of restricted activities in the protected areas, which is unlike that of the unprotected areas where grazing activities by cattle is allowed, as such tend to increase dispersal rate of their fruits. Cattle dung which serves as organic manure is also considered as another factor for the high rate of diversity and abundance in the unprotected areas of the forest reserve.

Species abundance and diversity was significantly higher in the unprotected areas and this could be accredited to soil factor (such as soil mineral and soil type), grazing activities by cattle which aid seed dispersal activities and cattle dung which serves as organic manure can be considered as reasons for the species abundance and diversity in the unprotected areas.

From Table 1, *Solanum aculeastrum* appears to be the most abundance species in the unprotected area with a total of 102 individual plants and in the protected area, *Physalis peruviana* is the most abundance plant species with a total of 23 individual plants. *Solanum linnaeanum* commonly known as the Devil's apple, appears to be the only species which occur in both the protected and unprotected area of the reserve. This study agrees with the study of burrows (2003) in which he suggested that some plants have developed an adaptation to survive in other habitat types as observed in *Solanum linnaeanum* in Ngel-Nyaki Forest Reserve.

From the chart in (Fig 3 and 4), there is a significant difference in the abundance and diversity of species across the different habitat status which are protected and unprotected areas.

From the studies, it was observed that none of the species of solanaceae was found inside the forest area of the reserve but rather on the open grassland. Hence one may report that solanaceae species are rarely found inside the forest axis except for areas where thunder and lightning has destroy some tree species in the forest or canopy cover of forest trees, which tends to allow penetration of sunlight into the forest, thus, may allow the growth of some of the species of Solanaceae because most of them are light-loving plants.

CONCLUSION

There was a significant difference of species abundance and diversity across the different habitat types which are the protected and unprotected areas of the forest reserve. Therefore, this suggests that habitat status plays a functional role in the distribution of Solanaceae species. From observation, there was an interaction between Solanaceae species and fauna species. These suggest that in the wild, Solanaceae species provide food for cattle as well as insect that pollinate them. Also from the studies, it was observed that none of the species of Solanaceae was found inside the forest area of the reserve but rather on the open grassland. Hence one may report that Solanaceae species are rarely found in forest region and this could be due to the thick canopy cover of the forest which limits the penetration of light and this is peculiar to almost all forest.

Lastly, from the studies, one can suggest that soil minerals, soil type, cattle dung which serve as organic manure and fruits and seeds dispersal are factors that favors the growth and abundance of species of Solanaceae across the different habitat types of Ngel-Nyaki forest reserve.

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