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# RECRUITMENT OF WOODY PLANT SPECIES JUVENILE IN NGEL NYAKI FOREST RESERVE AND ITS POTENTIAL FOR FOREST REGENERATION

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**ABSTRACT**
The study examined the recruitment of woody plant species juveniles in both the protected portion and unprotected forest fragments of Ngel Nyaki Forest Reserve in Taraba State, Nigeria. A 1m x 1 m ($1m^2$) wooden quadrat was thrown randomly for thirty times in each of the four study sites – the protected Main Forest (MF) and unprotected adjacent forest fragments A, B and C. This was done far away from parent species in order to avoid counting juveniles that regenerated under the parent plants. Woody plants at three different stages of growth (seedlings, saplings and poles) were identified to species level for each site, and the number of individuals in each juvenile class encountered for each species recorded. The abundance of juveniles in the four sites followed the order: MF < A < B < C; a trend similar to the degree of disturbance in the sites. Although the least number of juveniles was found in MF, it was fairly distributed among the three juvenile classes examined. Juveniles in the fragments were dominated by seedlings of pioneer plant species with the saplings and poles being either scarce or missing completely. There appears to be high mortality in the fragments as juveniles progress from the seedling stage to the pole stage. A very high degree of species compositional variation was observed among juveniles found in the MF on one hand, and the fragments on the other hand; with the highest dissimilarity seen at the pole stage. *Clausena anisata* was the only plant species with its juveniles found in all the sites. The proportions of seedlings, saplings and poles found among juveniles in the fragments are not likely to sustain effective regeneration of the plant communities. Protection and control of unsustainable practices in the fragments were suggested as a corrective measure.

**KEY WORDS**: Ngel Nyaki, forest disturbance, juvenile recruitment, forest regeneration

## INTRODUCTION

Forest regeneration through seedling recruitment is the evidence that direct gene flow had occurred through the process of seed dispersal. One major means through which seeds are distributed spatially into new physical environment is seed dispersal. Dispersal is a central life-history trait (Levin *et al*. 2003), and it is important to assess seedling recruitment so that possible limitation or enhancement to forest regeneration in plant communities can be identified. Seedlings are able to grow into adult tree species through stages of saplings and poles when there is reduction of the competition among kin (Hamilton and May, 1977), avoidance of inbreeding depression (Bengtsson , 1978) and the temporal heterogeneity of the environment, such as local population extinction (Comins *et al*, 1980).

Seed dispersal by animals plays a crucial role in the tropics. Fruit-bearing plants serve not only as nutritional sources for frugivores, but also as seed sources for forest regeneration and as important foci for the re-establishment of other plant species by attracting seed-dispersing animals to their vicinity. Where forests have become fragmented they are not absolutely isolated, but interact genetically with each other through the mechanisms of seed dispersal. Natural forest succession on human-disturbed land is often slow because the resources necessary for succession are depleted. In many cases the overriding factor impeding forest recovery appears to be lack of forest seeds (Nepstad *et al*., 1991, 1996; Aide & Cavelier, 1994; Da Silva *et al*., 1996). In such landscapes, forest succession may be dependent on arrival of seeds from off-site, and many of these seeds are dispersed by fruit eating animals. In many tropical regions, frugivorous birds and mammals are the predominant dispersers of pioneer woody plants, playing an important role in their early establishment (Vierira *et al*., 1994; Da Silva *et al.*, 1996).

In a fragmented landscape like that of Ngel Nyaki Forest Reserve, it is imperative to assess seedling recruitment so that possible limitation to forest regeneration within the plant communities can be identified. The study evaluated woody plant species regeneration both in the protected portion of the reserve and three unprotected fragments with varying degrees of disturbance.

## MATERIALS AND METHODS

### *Description of the Study Area*

The study was conducted at Ngel Nyaki Forest Reserve, located towards the western escarpment of the Mambilla plateau in Taraba State, Nigeria (Figure-1). The plateau is located between longitude $11^0\ 00^1$ and $11^0\ 30^1$ East and latitude $6^0\ 30^1$ and $7^0\ 15^1$ North. It is drained by numerous water courses which unite to form the main rivers to discharge eventually into the Benue River. It comprises approximately 46km$^2$ of impressive sub-montane to mid-altitude forest, lying between 1400 - 1500m (Chapman and Chapman, 2001). Heavy rainfall is recorded from April to October while the dry season is from approximately November to March. Ngel Nyaki was formally gazetted a local authority Forest Reserve under Gashaka - Mambilla Native Authority Forest order of April 1969, but at 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.

However, Ngel Nyaki Forest Reserve is currently beset with problems of fragmentation (especially in the riverine forest strips of the buffer zone). Ihuma *et al.*, (2011) have observed a remarkable variation in tree species composition between the main forest (which is protected) and the adjacent unprotected forest fragments, with the light demanding pioneer species dominating the latter.

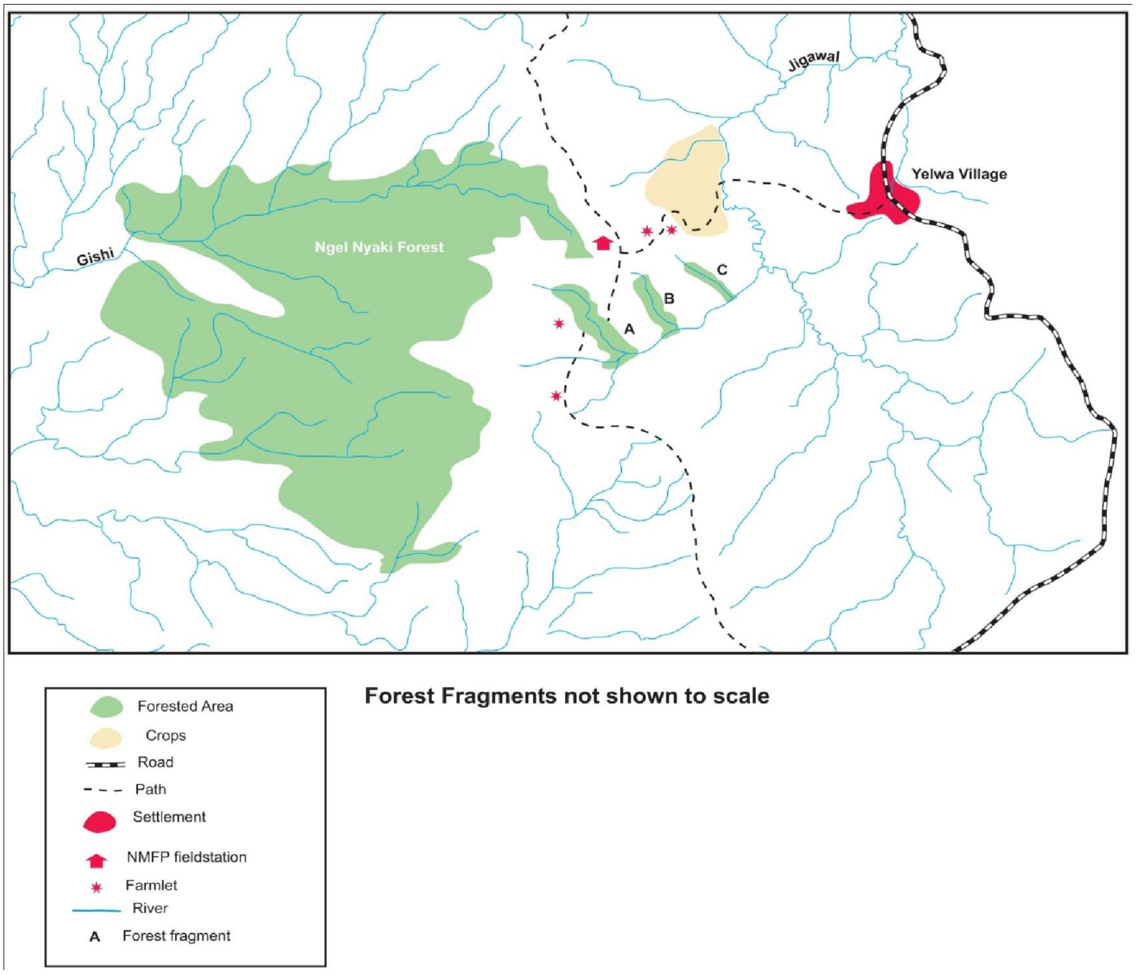


**FIGURE 1**: Map of Ngel Nyaki Forest Reserve showing the adjacent forest fragments

***Experimental Design***

The study area comprised of four sites, the main forest (MF), that is, Ngel Nyaki forest, and forest fragments A, B and C (Figure-1). The study was designed to incorporate areas of forest at different locations from large, MF (> 8km$^{2)}$, to small fragments A and B (>200 m$^2$) and very small fragment C (<200m$^2$); increasing distance from MF, 310m to 1,590m (fragment A and fragment C, respectively), and increasing habitat degradation from very little (MF) to extreme (fragment C).

***Method of Data Collection***

A 1m x 1 m (1m$^2$) wooden quadrat was thrown randomly for thirty (30) times in each of the 4 study sites – the protected MF and unprotected forest fragments A, B and C. This was done far away from parent species in order to avoid counting seedlings regenerated under the parent plants. Woody plant species at three different stages of growth: Seedlings (up 30 cm in height); Saplings (>30 cm but below 1m in height); and poles (> 1m in height), were identified to species level in each site and number of individuals encountered for each of the three height classes recorded for each species.

***Method of Data Analysis***

Sorensen's similarity index was used to ascertain the extent of similarity or dissimilarity of each pair of the studied sites with respect to the different stages of the woody species recruitments (i.e. seedlings, saplings and poles).

Sorensen's index is expressed as: RI = 100 * [a / a + b + c ]

Where:

a = number of species present in both sites under consideration

b = number of species present in Site 1 but absent in Site 2
c = number of species present in Site 2 but absent in Site 1

## RESULTS

### *Woody Plant Species Regeneration at the Various Sites*

The summary of woody plant species regeneration for the three juvenile classes is presented in Table 1. In MF, a total of 48 juveniles belonging to 10 species were encountered. Out of the 48 juveniles, 19 were seedlings, 25 saplings while 4 were poles. In Fragment A, a total of 103 juveniles belonging to 13 species were encountered. Of the 103 juveniles, 77 were seedlings, 22 saplings while 4 were poles. A total of 209 juveniles from 17 species were encountered in Fragment B. Of these, 199 were seedlings, 10 saplings, while no pole was encountered. In Fragment C, 296 juveniles belonging to 11 species were encountered. Seedlings accounted for 279 of these, saplings 15 and poles 2.

**TABLE 1:** Summary of woody species juvenile recruitment at the various sites

| | MF | | | A | | | B | | | C | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Woody plant Species | Se | Sap | Pol | Se | Sap | Pol | Se | Sap | Pol | Se | Sap | Pol |
| *Voacanga bracteates* | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Celtis gomphophylla* | 5 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Clausena anisata* | 7 | 8 | 3 | 11 | 7 | 0 | 48 | 7 | 0 | 63 | 0 | 0 |
| *Pouteria altissima* | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Deinbollia crossonephelis* | 1 | 1 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Isolona deightonii* | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Chrysophyllum albidum* | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Anthonotha noldeae* | 1 | 7 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Synsepalum sp.* | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Garcinia smeathmannii* | 0 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Albizia gummifera* | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| *Allophylus africanus* | 0 | 0 | 0 | 1 | 1 | 0 | 107 | 0 | 0 | 126 | 1 | 0 |
| *Bridelia micrantha* | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 1 |
| *Croton macrostachyus* | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 36 | 3 | 1 |
| *Ficus sp*. | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| *Psorospermum corymbiferum* | 0 | 0 | 0 | 0 | 6 | 0 | 12 | 0 | 0 | 10 | 1 | 0 |
| *Psychotria schweinfurthii* | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Syzygium guineense* | 0 | 0 | 0 | 59 | 0 | 0 | 23 | 0 | 0 | 30 | 2 | 0 |
| *Xymalos monospora* | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Canthium vulgare* | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 1 | 0 |
| *Maesa lanceolata* | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 3 | 2 | 0 |
| *Trema orientalis* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 2 | 0 |
| *Unknown sp*. 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| *Unknown sp*. 2 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 |
| *Dalbergia heudelotti* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 2 | 0 |
| Sub-Total | 19 | 25 | 4 | 77 | 22 | 4 | 199 | 10 | 0 | 279 | 15 | 2 |
| Total | | 48 | | | 103 | | | 209 | | | 296 | |

Se = seedling; Sap = sapling; Pol = pole

### Species compositional variations of juvveniles at the various sites

#### *Seedlings*

The extent of similarity or dissimilarity of plant species seedlings encountered at the four study sites is shown in Table 2. The plant species compositional variation was very high when seedlings of MF were compared with those from each of the fragments; with the highest level of dissimilarity (93.75%) observed between MF and fragment C. However, the extent of variation was less (though still high) when woody plant species seedlings were compared for each pair of the fragments; with fragments B & C having the least percentage variation (58.33%). *Clausena anisata* was the only plant species with its seedlings found in all the sites.

**TABLE 2:** Sorensen's Similarity Indices for seedlings

| | MF | A | B | C |
|---|---|---|---|---|
| MF | * | 16.67 | 7.14 | 6.25 |
| A | | * | 25.00 | 30.77 |
| B | | | * | 41.67 |
| C | | | | * |

***Saplings***

The similarity of woody plant species saplings between MF and each of the fragments was generally low (below 30%) and showed a declining trend with increasing distance from MF; with no sapling being common to MF and fragment C. The level of similarity of woody plant species saplings slightly appreciated when each pair of the fragments was compared, though, figures were lower than those obtained when seedlings were compared for same sites.

**TABLE 3:** Sorensen's Similarity Indices for saplings

| | MF | A | B | C |
|---|---|---|---|---|
| MF | * | 23.08 | 9.09 | 0.00 |
| A | | * | 20.00 | 21.43 |
| B | | | * | 18.18 |
| C | | | | * |

***Poles***

The highest level of variation in species composition of the juveniles was observed in poles (Table 4). No juvenile of woody plant species at the pole stage was common between MF and each of the fragments and between each pair of the fragments except for fragments A & C, where *Croton macrostachyus juvenile* at this stage was observed.

**TABLE 4:** Sorensen's Similarity Indices for poles

| | MF | A | B | C |
|---|---|---|---|---|
| MF | * | 0.00 | 0.00 | 0.00 |
| A | | * | 0.00 | 33.33 |
| B | | | * | 0.00 |
| C | | | | * |

**DISCUSSION**

The total number of juveniles encountered increased as one progressed from MF through Fragment A to fragment C. This shows an increasing trend with increasing level of habitat disturbance. Of all the juvenile classes, the seedlings dominated in all the sites except MF. Generally, a decrease in the number of juveniles as they grew from the seedling stage through the sapling stage to the pole stage was also observed in all the sites except MF where saplings dominated. This may be probably attributed to different forms and degrees of exploitation going on in the unprotected fragments.

The least number of juveniles found in the MF which represents the climax plant community in the area, is not out of place. In climax plant communities, seedlings on the forest floor only grow slowly, and in most species seldom reach taller than 1m because they eventually die unless released (Whitmore, 1998). This probably explains why the majority of the juveniles encountered in the MF were at the sapling stage. Although, fewer juveniles were found in the MF than in each of the fragments, their mix with respect to the three classes (seedlings, saplings and poles) indicates higher potential for regeneration and sustainability of the plant communities, than what was observed in the fragments. The juveniles in the fragments were dominated with seedlings while the other two classes (especially poles) were either few or totally missing. With some good level of protection, this unsustainable trend and even the much variation in juvenile plant species composition between the MF and the fragments could be corrected at the later stage of succession. *Clausena anisata* was the only plant species with its seedlings found in all the sites.

Most of the juvenile plant species encountered in the study either showed more affinity for the MF on one hand or the fragments on the other hand. This probably accounted for the very low similarity indices between the MF and each of the fragments in all the Juvenile classes.

The evidence of seed dispersal from the MF to fragments would have been the presence of seedling in the fragments of adult species only found in the MF. These were looked for, but none was found. Instead, most of the regeneration in the fragments was of the pioneer species, many of which were not found in the MF. In large gaps (similar to what now obtains in the fragments), pioneers which appear after gap creation, form the next forest growth cycle. Ihuma *et al* (2011) equally observed a remarkable difference between the tree species composition of the MF on one and the forest fragments on the other. While the MF was dominated by shade-tolerant (climax) tree species, the light demanding (pioneer) tree species have colonized the forest fragments following varying degrees of disturbance and exploitation. Thus, the absence or paucity of juveniles of the shade-tolerant adult tree species (found in the MF) in the fragments may not likely be due to failure in seed dispersal by the frugivores. Ihuma, *et al* (2011) have observed an appreciably high level of similarity in frugivorous species between the MF and each of the fragments, and attributed it to the migratory nature of the avian fauna which accounted for over 70% of all the frugivores recorded for the 5 taxonomic classes ( birds, primates, ungulates, rodents and bats). However, the absence or paucity of juveniles of adult climax tree species found in MF, in the fragments may be as a result of failure in germination and establishment of seeds of such species due to unfavourable microclimatic conditions orchestrated by habitat disturbance and exploitation in the fragments. Such disturbances which encourage the penetration of full sunlight, favour the germination and growth of seeds of pioneers in the soil seed bank. This explains why the population of juveniles increased with increase in habitat disturbances, and why there were great species compositional variations between the fragments and the MF.

## CONCLUSION

Although, less number of juveniles was recorded in the main forest than each of the fragments, the proportion of the three classes of juveniles in the main forest is such that can sustain the regeneration of the plant community unlike in the fragments. Juveniles in the fragments were dominated by seedlings, with poles being the scarcest. In the fragments, there seems to be juvenile mortality as seedlings move through the sapling stage to the pole stage. Some appreciable level of protection and control of unsustainable practices in the fragments may help in correcting this trend.

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