Understory Tree Diversity and Regeneration pattern in Four Land-Use Systems in Tropical Rainforests, Nigeria

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Abstract

The diversity of understory tree species and regeneration pattern were examined in *Gmelina arborea* plantation (GP), primary (PF), degraded (DF) and enrichment (EF) forests in Akure and Oluwa forest reserves, Nigeria. The order of species richness in the sapling layer was: GP (13) < PF (15) < DF (16) < EF (21) while it is EF (18) = PF (18) < GP (24) < DF (25) in the seedling layer. When understory (seedlings and sapling layers) species richness was pooled together, species richness in the understories of the different forest types compared favourably with those of the overstories, except in Gmelina plantation. This indicates the bright restoration prospects of the ecosystems if degradation activities are halted.

Introduction

The overstories of tropical forests have received more attention than their understories in biodiversity assessments. This is probably because the overstories contain many matured economic, highly valuable and commercial tree species. Thus, the understory remains the least understood and investigated

The understory is an integral component of the forest ecosystems, thus it demands as much attention as the overstory. Understory tree species play fundamental roles in the diversity, structure, functioning and dynamics of the forest ecosystems; provide habitats and food for wild animals, etc (Chastain *et al.,* 2006). The understory could be as species-rich or richer than the forest overstory (Tchouto *et al.,* 2006; Onyekwelu *et al*., 2008).

Research Objective

To investigate understory species diversity and regeneration pattern in primary forest, degraded forest, enriched forest and Gmelina arborea plantation.

Methodology

***The study sites*:**

The study was conducted in Akure and Oluwa forest reserves in Ondo State in the tropical rainforest zone of southwestern Nigeria (Figure 1). The details of the climatic variables have been given by Onyekwelu et al. (2008).

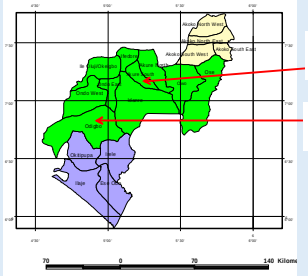

Figure 1: Location of the study sites (Akure and Oluwa forest reserves) in Ondo State, south-west Nigeria.

Data collection

Systematic sampling design was used in selecting sample plots as shown in Figure 1.

- ❖ One transect of 1000m long was delineated
- ❖ Four 20m x 20m sample plots were laid at every 250m along the transect.
- ❖ This was repeated on another transect separated by at least 1000m from the first.
- ❖ A 5m x 5m quadrant was laid at the middle of the 20m x 20 plot.
- ❖ A 2m x 2m sub-quadrant was laid at the middle of the quadrant

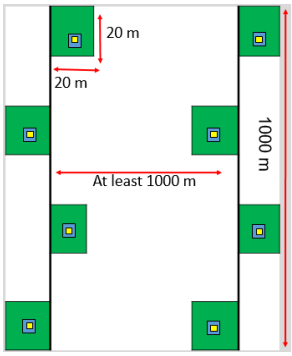

Figure 1: Layout of sample plots in the field

There was a total of 8 sample plots per forest type and 40 sample plots for this study

Overstory trees (dbh ≥ 10 cm), saplings (dbh >1 cm but <10 cm) and seedlings (dbh <1 cm) were assessed within the main plots, quadrants and sub-quadrants, respectively. The biodiversity indices computed were:

1. Shannon–Wiener diversity index $H' = -\sum_{i=1} pi \ln(pi)$

H' = Shannon-Wiener diversity index; S = nounber of species in the community; pi = proportion of S made up of the ith species; ln = natural logarithm.

2. Spp. relative dominance $RDo = \frac{(\sum Ba_i \times 100)}{\sum Ba_n}$

Bai = basal area of individual trees belonging to species iBan = stand basal area

3. Spp. relative density $RD = (n_i/N) \times 100$

RD = species relative density; ni = number of individuals of species iN = total number of all tree species in the entire community.

4. Importance Value index $RD + RDo/2$

5. Spp. evenness $E_H = \frac{H'}{H_{max}} = \frac{\sum_{i=1} P_i \ln}{\ln(S)}(pi)$

Results

Plates 2: Overstorey species compositions in: *(a)* Primary forest; *(b) Enrichment planting; (c)* Degraded forest and *(d) Gmelina arborea* plantation in Nigeria

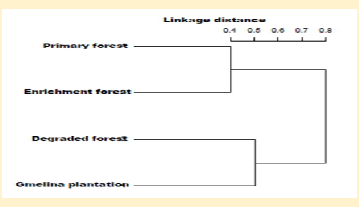

Figure 2: Dendrogram of cluster analysis of understory species assemblages based on Bray-Curtis (Sorensen) dissimilarity index among the four forest types

Table 1: Growth and biodiversity indices of the overstory

Tree Growth/ Biodiversity indices	Primary forest	Degraded forest	Enrichment forest	Gmelina plantation
Mean Dbh	50.1^a	24.3^b	23.91^b	24.5^b
Basal Area	65.0^a	31.3^b	26.36^b	26.19^b
H′	3.30^a	3.41^a	3.09^a	0.26^b
E	0.59^a	0.65^a	0.88^a	0.13^b
Hmax	3.47^a	3.55^a	3.50^a	2.08^b
No. of families	23.0^a	21.0^a	17^a	7.0^b
No. of species	51.0^a	45.0^a	33^a	8.0^b
No. of endangered spp	14 (28%)	13 (29%)	10 (24%)	2 (25%)*

** Values in parentheses are percentages of total species in respective forest type*

Plate 3: Understory vegetation of *(a)* Primary; *(b) Enrichment Planting (c)* Degraded & *(d) Gmelina arborea* Plantation forests in Nigeria

Table 2: Biodiversity indices of the understorey (seedling & sapling)

Tree Growth/ Biodiversity indices	Primary forest	Degrad. forest	Enrichment forest	Gmelina plantation
Saplings				
Mean Dbh	4.9^b	6.2^a	4.4^b	6.2^a
H′	2.26^a	2.44^a	2.68^a	2.07^b
E	0.83^a	0.88^a	0.88^a	0.81^a
Hmax	2.71^a	2.77^a	3.05^a	2.57^a
No. of families	9^a	9^a	13^a	10^a
No. of species	15^b	16^b	21^a	13^b
Seedlings				
No. of families	15^b	19^a	13^b	17^{ab}
No. of species	18^b	25^a	18^b	24^a

Discussion

- Biodiversity indices were significantly higher in natural forest (i.e. primary, degraded and enrichment forests) overstories than in Gmelina plantation (Table 1). They were also higher in the overstories than in both sapling and seedling layers of the forest understories.
- However, when understory (i.e. seedlings and sapling layers) species richness was pooled together, species richness in the understories of the different forests compared favourably with those of the overstories, except in Gmelina plantation
- This similarity of species richness of the understory and overstory of natural forest ecosystems in this study agrees with the findings of Tchouto *et al.* (2006). Some authors (e.g. Lü *et al.,* 2011) reported higher species richness in forest understory than in the overstory.
- Based on the pooled number of understory species, order of regeneration was: degraded forest (33) > Gmelina plantation (27) > enriched forest (26) > primary forest (24). The species with high rate of regeneration in all the four forest land-use types are *Aframomom melegueta* and *Strombosia pustulata.*

Conclusion

The species richness of the understories of the forest ecosystems is similar to those of the overstories, except in Gmelina plantation. Thus the understory could contribute significantly to total species richness of tropical rainforests. More attention should be given to understory species assessment in biodiversity assessments.

References

Lü, X., Yin, J. and Tang. J., 2011. Diversity and composition of understory vegetation in the tropical seasonal rain forest of Xishuangbanna, SW China. Rev. Biol. Trop. (Int. J. Trop. Biol.), 59 (1): 455-463.

Onyekwelu, J.C. Mosandl, R. and Stimm, B., 2008. Tree species diversity and soil status of primary and degraded tropical rainforest ecosystems in south-western Nigeria. J. Trop. For. Sci. 20(3): 193–204.

Tchouto, M.G.P., De Boer,W.F., De Wilde, J., Vander Maesen,L.J.G., 2006. Diversity patterns in the flora of the Campo-Ma'an rain forest, Cameroon: do tree species tell it all? Biodiversity and Conservation 15: 1353-1374.

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