

**Forest Regeneration in Moca, Bioko
Island, Equatorial Guinea:
A Comparative Study of Tree Plots
Focusing on the Population and Basal
Area Variance at Differing Post-
Clearance Intervals**

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Abstract

This project established research plots and a baseline for the long-term monitoring of tree species succession and growth at regenerating plots from which montane forest was removed for agricultural use in Moca, Bioko Island, Equatorial Guinea. The major findings of this report suggest that those trees which are common, both in terms of numbers of stems and basal area in recently (3 years) abandoned plots, vary greatly from those which are common in intermediate (8-24 years) and old (27-∞ years) plots. This study found that the method by which a plot is cleared greatly influences how quickly the basal area of the trees on the plot is restored to pre-degradation levels. Clearing by machines, such as, bulldozers and chainsaws, severely retard the rate of increase of basal area. Traditional methods of forest clearance such as using draft animals and manual labor leave the larger trees intact allowing for the development of basal area.

Introduction

This project focuses on how tropical montane forest reclaims areas that were once used for agriculture. This is a unique opportunity to accumulate data on a subject that is poorly researched on Bioko Island. There appear to be no published data on forest regeneration on Bioko Island. Logging companies from Rio Muni have done some internal surveys on how fast forests regenerate after being logged, but these are by no means comprehensive (J. Weinberg, pers. comm.). Knowledge of forest regeneration may contain important insights for biodiversity conservation initiatives. After all, it is the flora that establishes the environment in which the fauna will or will not survive (White & Edwards, 2000). By determining which trees return after an area is cleared, biologists will be able to better understand the dynamics of secondary forest ecology and of those species that favor such forests.

Research on this topic is widespread throughout Latin America documenting aspects like basal area, tree density, growth rates, and tree mortality rates (Lewis, 2004). Other studies in Latin America illustrate gap-phase regeneration, that is, how fast and which types of species grow when a gap is created in the forest canopy. These studies have focused on densities of colonizing species and their increased mortality rates after 3-6 years of competition (Brokaw 1985).

These various studies are conducted as long-term projects, monitoring changes in forest dynamics. In direct opposition to that, this study collected a large amount of data in a very short amount of time in order to establish a baseline from which further research can be done.

Objective

Establish research plots and a baseline for the long-term monitoring of tree species succession and growth at regenerating plots from which montane forest has been removed for agriculture.

Hypothesis

There will be different tree species found in the degraded plots than in the parts of the forest that have been undisturbed.

Methods

Through talking with local guides, multiple plots were identified that had been used for agriculture, mostly by the Spanish, and had since been abandoned. The goal was to find at least two plots for every 5-year-period (e.g., 1-5, 6-10, 11-15...) and at least two plots in forest that had never been cleared. Unfortunately, a plot that had been abandoned for 11-15 years was not located. Steep slopes and streams were avoided, as these conditions may bias the data.

Once a plot was identified, the characteristics of the land were discussed with the guide, including when the plot was abandoned, how the land was used, and how the plot was cleared. Later on these timetables were confirmed with Claudio Posa, the Universidad Nacional Guinea Ecuatoral Forestry professor who grew up in Moca.

In order to establish plots within these abandoned fields, groupings of trees were identified and the 10m x 10m plots were marked around them. In the denser plots, like plots 5, 6, 11 and 12, 10m were measured from the nearest path and then the 10mx 10m squares were marked out (White & Edwards, 2000). Two plots were established per abandoned field at least 10 m from one another. We put the corners of the plots at NE, SE, SW and NW, creating a North side, East side, South side and West side. Where possible, GPS readings were taken at one corner of each plot. In lieu of GPS coordinates, trail markers were used which provide general latitude, longitude and altitude.

The circumference of each tree was measured at breast height. Only trees with a circumference greater than 5cm were considered. Counting and measuring were done systematically from North to South, ensuring the inclusion of every tree.

When we were unable to identify a tree species, we referred to our guide who usually provided the Bubi name and, on occasion, the Fang name as well. On the rare occasion when the guide was unable to identify the tree, the tree was assigned a name using phenotypic characteristics such as "Alternate Simple Leaves with Major Venation". Sample specimens from all of these trees, including the ones with only Bubi names, were collected and catalogued for future identification. These specimens are currently housed at the herbarium at the Moca Research Station. For the complete plant press listings, see Appendix 2.

Results and Discussion

As was expected, in recently abandoned plots, there was a large percentage of colonizing species like *Macaranga* and *Trema* present though their presence was much greater at the plots cleared by machines (21 times greater for *Trema* and twice as great for *Macaranga*). This is especially true of the plots at the cell phone tower where the topsoil was completely removed to create a more level and stable area for the tower (T. Butynski, pers. comm.). This suggests that *Trema* is much more effective at colonizing open areas than areas where larger trees are left intact, such as those that have been cleared by hand. Twenty-seven of the 49 trees (55%) counted at plots abandoned 3 years ago were these two species of tree. In contrast, these two species account for only 548 cm² (6%) of the 9017 cm² total basal area for plots abandoned 3 years ago. The bulk of this basal area (8722 cm²) comes from the two plots that were cleared by hand, where larger trees still stand. This discrepancy admittedly skews the data to downplay the basal significance of *Trema*.

The frequency of *Trema* and *Macaranga* falls off dramatically as the number of years a plot has been abandoned increases. *Trema* is not present and *Macaranga* represents only 6% of trees in plots abandoned for more than 3 years. This suggests that *Trema* and *Macaranga* only survive for a few years before dying.

Other trees that are present at these recently abandoned (3 years) plots, which were also present at intermediate (8-24 years) and old (27-∞ years) plots, include Kaala, Tree Fern, Vosocola and *Strombosia*. Though these plants represent a progressively larger percentage of the tree population as time passes, it should be noted that they are also present in some of the initial stages of abandonment.

Trees that are common in intermediate plots include Epoopo, Xymalos, Riloba, Polysius, *Strombosia* and Tree Fern. While more varied in species diversity than the recently abandoned plots, these species represent 29 of the 51 trees or roughly 57% of the stems. This is surprisingly close to the percentage represented by just the two species in the recently abandoned plots. In terms of basal area, these six tree species represent 3820 cm² (26%) of 14548 cm², much more than in the *Trema* and *Macaranga* of the recently abandoned plots. As far as basal area is concerned Polysius and Tree Fern were the most important species. Polysius accounts for 36% of the total basal area and 8% of the stems. Tree Fern is responsible for 18% of the basal area and 24% of the stems, suggesting a large quantity of medium diameter stems.

In the old plots, the predominant species were *Strombosia*, Kaala, Bush Coffee, and *Macaranga*. These tree species represent 52 (46%) of the 114 trees counted. In terms of basal area these trees represent only 11800 cm² (31%) of 37909 cm². The trees that account for the most basal area are Vosocola (13%) and Unknown Tree/ Pinnately Compound (11%). Vosocola represents only 5% of the stems in the old plots. Similarly, Unknown Tree/ Pinnately Compound is only 4% of the stems. (Figure 1)

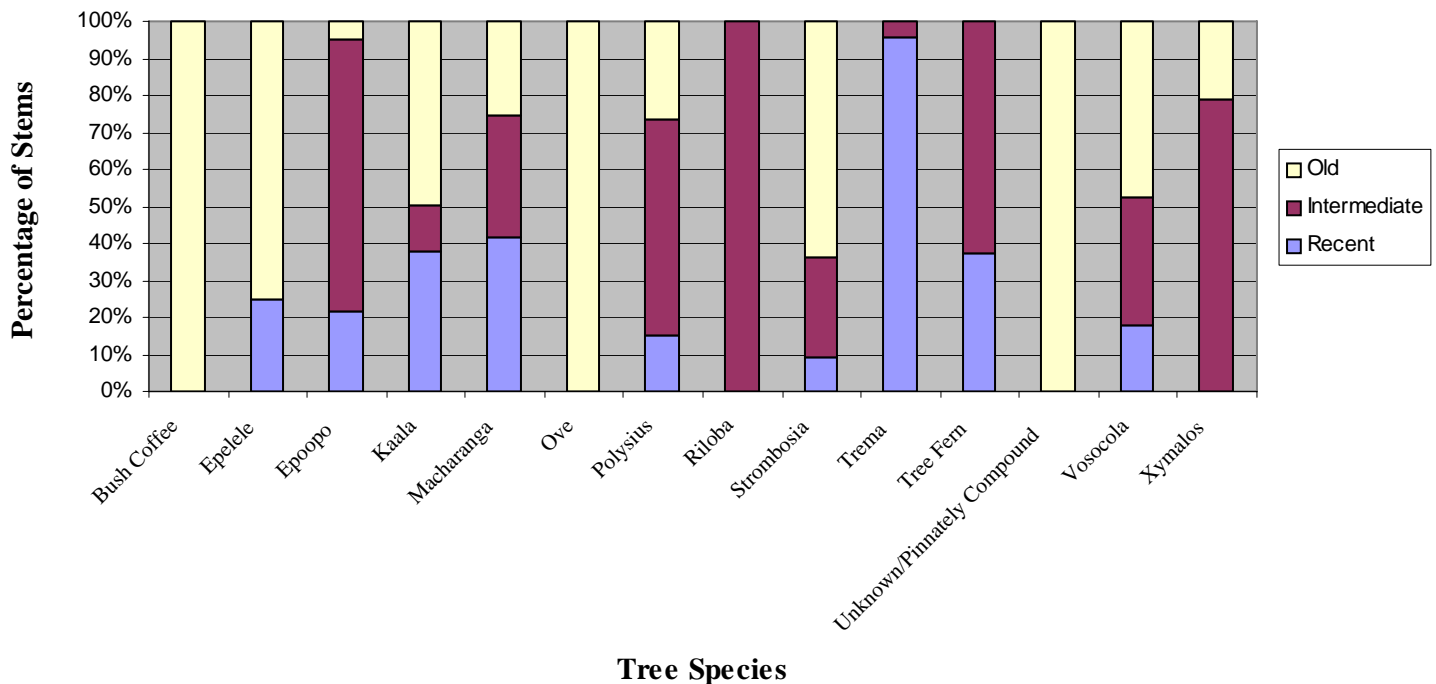


Figure 1. This graph depicts the percentage of stems for tree species in Moca, Bioko Island, Equatorial Guinea in 2006. n = 215

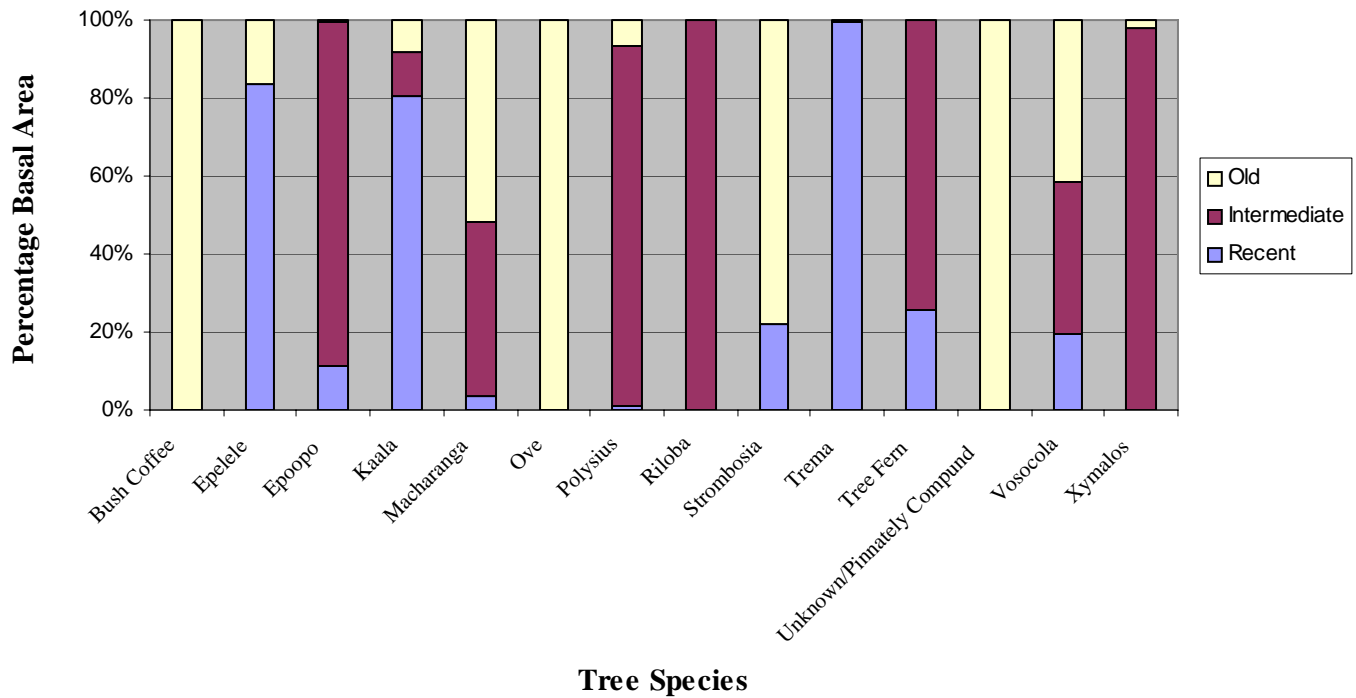


Figure 2. This graph shows the percentage of total basal area for tree species in Moca, Bioko Island, Equatorial Guinea in 2006. n = 215.

The other aspect of ecological succession that was studied was how the method of clearing the land for agriculture, by hand or with machines, seems to have affected the total basal area and/or the types of species that re-colonize the area. When an area was cleared by hand, larger trees (e.g. figs) were left intact because it would take too much effort to cut them down and clear them away using a handsaw and man/animal power. In areas cleared by chainsaws and bulldozers, by and large, all the vegetation is cleared (C. Posa, pers. comm.).

Under direct comparison, Plots 1 and 2 (machine) and Plots 13 and 14 (hand) have very different species composition even though all four plots have been abandoned for 3 years. In the plots cleared with machines *Trema* was very common (21 of 25 stems) though rare in the plots cleared by hand (1 of 24 stems). In Plots 13 and 14, the most common species of tree was the tree fern, a species not present in plots 1 and 2.

As far as total basal area is concerned, the differences are equally as striking. For Plots 1 and 2, total combined basal area is 295 cm², while the total basal area for Plots 13 and 14 is 8722 cm², nearly 3 fold more basal area (Figure 3).

Other plots that are easily compared are Plots 11 and 12 that were abandoned 24 years ago and cleared with machines. These two plots have a combined total basal area of 4804 cm². In contrast, Plots 17 and 18 were abandoned 27 years ago and cleared by hand. These two plots have a combined total basal area of 9227 cm², nearly twice as much as Plots 11 and 12 (Figure 3).

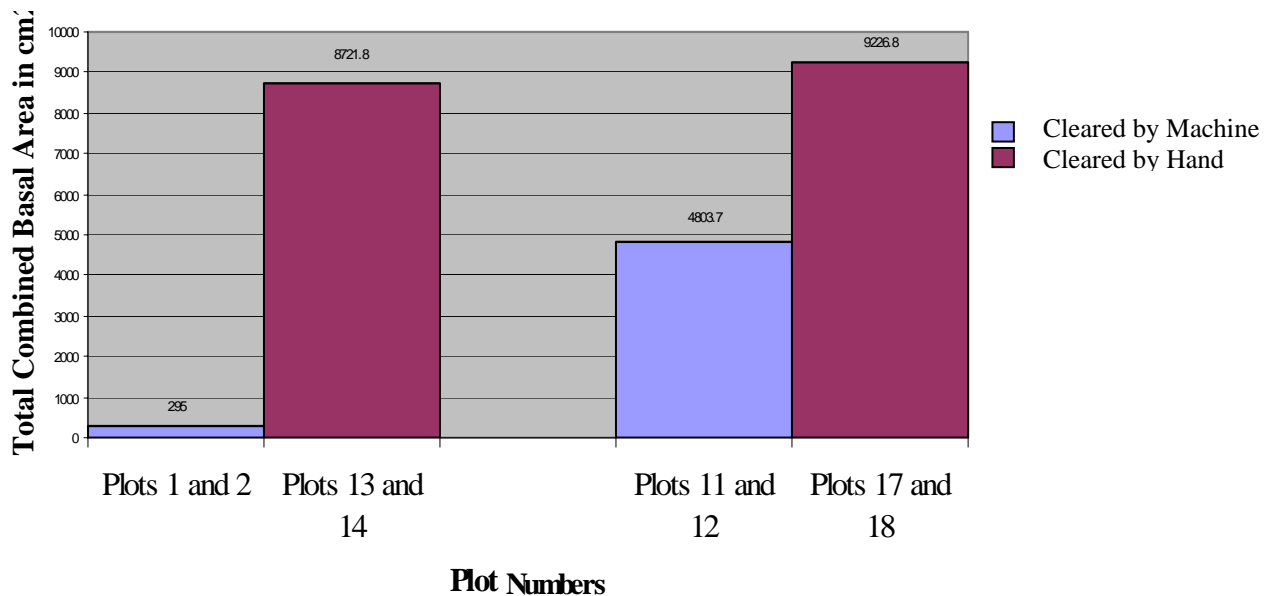


Figure 3. This graph shows the combined total basal area for selected tree plots in Moca, Bioko Island, Equatorial Guinea in 2006. The figure above the column is the combined total basal area for those Plots. n = 65

Another variable that this study obtained data on was tree density within the tree plots. It is unclear what the effects of the method of clearing have, if any, on tree densities.

As related to conservation actions, the results of this study indicate that more information needs to be gathered about tree succession in the Moca area.

Recommendations

The major obstacle faced by this project was the fact that the people present could not identify many of the trees on the various plots and therefore, the trees have yet to be given a scientific name. Guides occasionally mistook one species of tree for another, and we would not become aware of this until we were discussing our sample specimens with another guide or with Professor Claudio Posa. This major issue calls into question the legitimacy of all of the data. While it is exceedingly unlikely that the bulk of our data are incorrect, the fact remains that individual trees may be misnamed, possibly leading to inaccurate trends and conclusions.

To correct this problem, I suggest that the Moca Herbarium be expanded and used as a reference for future identification of tree species. It cannot be stressed enough that the herbarium needs to be scrutinized and memorized by the local guides in addition to those running the Moca Research Station. After all, it is the guides who are the ones out with students and other researchers identifying trees.

The other step that needs to be taken to ensure more accuracy in identification is to make it clear to the guides that if they do not know the name of a tree, it is perfectly acceptable to say just that. During my time in the field, I felt that when my guide was unsure of the name of the tree, he would give the name of the previous tree we measured, instead of just telling us that he did not know.

The other major problem we ran into while in Moca was finding the scientific names of our specimens. There are exceedingly limited resources for identifying our specimens, only three books, one of which is in French and another in Spanish. We did the best we could and compiled a short list of Bubi names and their Scientific or English equivalents. (For full list see Appendix 3). As with the herbarium, this list needs to be expanded in order to better understand the ecology of the Moca area. Ashley Bone and Jenny Parham's project should help considerably to further this end.

With the amount of data collected from this project alone, many other findings could be made. These studies include, but are not limited to, specific species by species diversity charts by plot, comparing and contrasting all of the species at each plot. A species richness analysis could be conducted on the present database to see how many of each species exist at each plot. Finally, diversity indices could be applied to these data.

If I had another few weeks at Moca to continue my research, the first thing I would do is find two plots that had been abandoned 11-15 years ago. Beyond this I would expand the scope of my paper to specifically compare plots that were cleared in the same way and abandoned at the same time. I feel that these comparisons would be more direct, more informative and more accurate than the comparisons I have made thus far.

Acknowledgements

I would like to take this chance to thank some people who made both this project and report possible. First off, thank you to our professor, Dr. Tom Butynski, who was able to provide important information, necessary guidance and a consistent air of humor. Next I'd like to thank my research partner, Teofilo Sima Nzang Obono, who trudged through the rain with me day in and day out, from plot to plot, to compile all of these data. I'd also like to extend thanks to all of the guides and other staff members at the Moca Research Station, and Jessica Weinberg in particular. It is their hard work that makes all of this information possible. Finally, I'd like to thank Amy Lehman and Amber Gellar for not only helping me visually represent my data and edit my paper, but also for their commitment to the CEA/BBPP program that allows us to be here in the first place. Without their dedication, diplomacy and tolerance we would not have been able to participate in this remarkable opportunity. I'd also like to thank them for creating a new breakfast and dinner menu for the CEA/UNGE students during the second week in Moca. Repollo is a beautiful thing.

References

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Appendices

Appendix 1

This appendix contains all of the raw data collected for this project, including years abandoned, plot number, species name, circumference of tree, diameter of trees, altitude, longitude, latitude, method for clearing the plot, plot density, individual basal area for each tree, and total basal area for each plot.

Appendix 2

This appendix is the herbarium voucher specimen list. This list contains all of the names of the plants we were unable to identify or match with the scientific name. The rest of the information about the voucher specimen/herbarium can be found with the sample species. This information includes our names, the date the specimen was filed, and the Bubi name or descriptive name we assigned the specimen. The specimen also includes the plot number the specimen was collected from, which can be matched with Appendix 1 to obtain more specifics. Ideally, Appendix 2 would have contained all of the aforementioned data, but I failed to copy it into my notebook.

Appendix 3

This Appendix contains the list of plants for which we identified the Bubi name and either the common name and/or scientific name. This list is not as specific as it could be, sometimes only giving the family name of the plant, but it is at least a start.

Appendix 4

This appendix contains the information used to make Figures 1 and 2. This includes the 14 most common tree species at recent, intermediate and old plots, in terms of number of stems or basal area.