Seedling Dynamics Under Maesopsis tree canopy in Different Forest Conditions at Amani Nature Reserve (ANR)

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Abstract

There is much discussion on the threat of *Maesopsis* in Amani on native floral diversity. A study was conducted to examine the seedling kinds and seedling diversity and distribution under *Maesopsis* trees in three forest conditions. Adhoc and systematic sampling, including transecting were adopted in collecting data. A total of 59 Forest tree species were existing under the *Maesopsis* trees. Populations of seedlings under *Maesopsis* and native trees were not significantly different. About 63% of the seedlings under *Maesopsis* were climax species. Diversity was highest under *Maesopsis* trees in the secondary forest. Significantly higher numbers of seedlings existed within the inner 2m-radius of the crown than the outer part.

INTRODUCTION

Maesopsis eminii is a large tree reaching up to 43m high. Its diameter at breast height can reach 100cm. The trunk is cylindrical and straight with no buttresses and is free from branches for 10 to 20m. An average tree will start fruiting after 10 years of growth when both wind and animals will spread its seeds. Dispersal is very efficient and occurs evenly through the natural forest. Germination of the seeds occurs over a period of 200 days, and seedlings can survive until a suitable opportunity to grow such as the appearance of a light gap presents itself, no matter at what point in the season this occurs.

Although several native pioneer species exist in the Amani Nature Reserve, *Maesopsis eminii* an alien species introduced to the East Usambara forest nearly a century ago has become a challenge to conservationist and management of the Reserve. It currently dominates the most disturbed forest in the area and can be found in any gaps created by nature or by unnatural means. It has become a species of particular interest on the East Usambara because of its invasive properties and probable ability to increase greatly the rate of soil erosion (Hamilton, 1989).

There has been much research effort over the years into *Maesopsis* in an attempt to understand its role at Amani. Although the conclusions are varied and seem conflicting, they point to one direction. Ruffo 1989, observed that human influences especially fuelwood extraction encourages the spread of *Maesopsis*, which cannot normally establish itself under the crown area of a tree, but can do so if wood is gathered from this area while Amasor and Williamson 1999 noted that *Maesopsis eminii* is a poor competitor with native species in forest gaps. Yet, it is feared that *Maesopsis* may occupy 50% of the Amani forest area in 200 years time (Binggeli, 1989).

These findings coupled with the rapidity with which *Maesopsis* is currently colonising the forest put a lot of doubt on the future biodiversity value of the forest. A fundamental question to ask is does *Maesopsis* really affect the populations of indigenous tree species in East Usambara? And if *Maesopsis* has successfully and progressively displaced other pioneer species in gaps then what is the fate of native climax species in the forest? Forest succession is strongly dependent on there being climax species nearby but rapidity of succession is enhanced when there is a good seedling bank. Hence knowledge of the seedling/sapling bank diversity and distribution underneath *Maesopsis* tree canopies could help predict possible future succession in the Amani Nature Reserve. Thus, this study is an attempt to understand the relationship between *Maesopsis* tree canopy and forest tree seedling diversity and distribution pattern in the forest.

The Objectives

The objectives of this study were:

- To identify the tree seedlings, constituting the seedling bank under *Maesopsis eminii* trees in different forest conditions at Amani Nature Reserve (ANR).
- To characterise the composition, diversity and distribution of tree seedlings under *Maesopsis* and their nearest native trees.

METHODOLOGY

Study site

The study was conducted in Amani, East Usambara Mountains, North Eastern Tanzania, (4°-5°13 S and 38°32’-38° E) at an altitude of about 900m above sea level 40 km inland from the coast. Three different forest types were selected in the Amani Nature Reserve area; a Secondary Forest at the Amani Community area, Pure

Maesopsis stand at Kwamkoro and a Primary Forest at Monga. The data was collected between 15th and 18th of September 2005.

Sampling Approach

At each of the three sites at least ten pairs of trees were selected for study. With the exception of the pure *Maesopsis* stand, Half of each pair of sampled trees was *Maesopsis* and the other half a tree native to Usambara.

Two sampling techniques were adopted: Adhoc sampling in the primary and secondary forests and systematic sampling in the pure *Maesopsis* stand.

Two opposite transects were established under the crown of each selected tree within the width of the crown diameter. Transects were 1m wide but the length depended on the radius of the crown. Seedlings were counted on each $1m^2$ from the base of the tree bole towards the edge of the crown.

Data Analysis

Data analysis was done using a number of statistical packages. Excel was used for drawing graphs. The Kruskal-Wallis test under STATVIEW was used to test for significance.

RESULTS

Table .1 Summaries of Seedling Population Figures

Forest Condition Type	Climax	Pioneer	Secondary	Total
Maesopsis in Secondary	248	198	15	461
Maesopsis in Pure Stand	164	90	56	310
Maesopsis in Primary	307	30	4	341
Native in Secondary	359	162	15	536
Native in Primary	215	17	5	237
Total	1293	497	95	1885

See appendix 1 for list of species in all forest types surveyed**.**

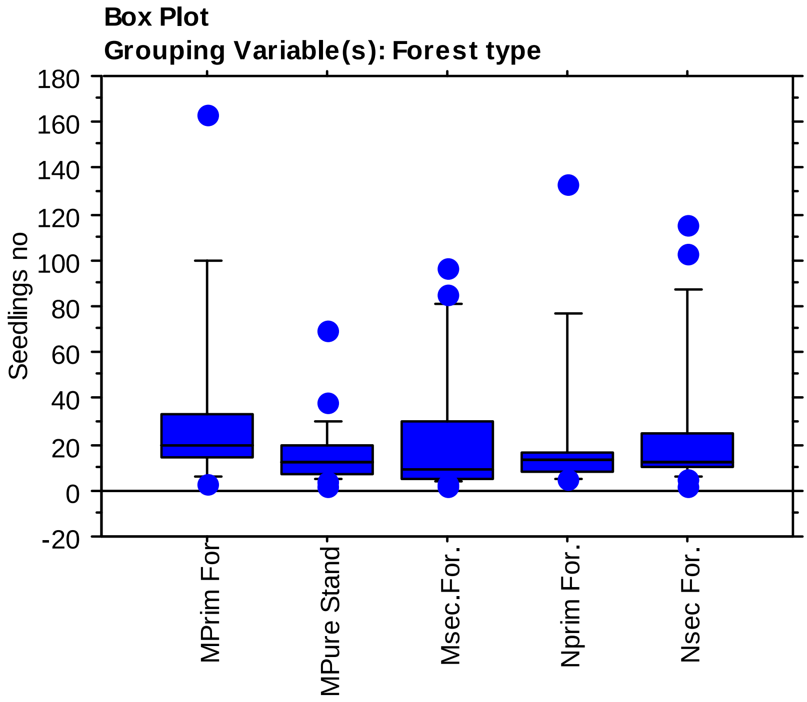

Fig 1. Distribution of seedling populations in Different Forest Types.

Numbers of Seedlings in different forest conditions did not show any significant differences in their populations ($H = 3.775$. $P = 0.4373$).

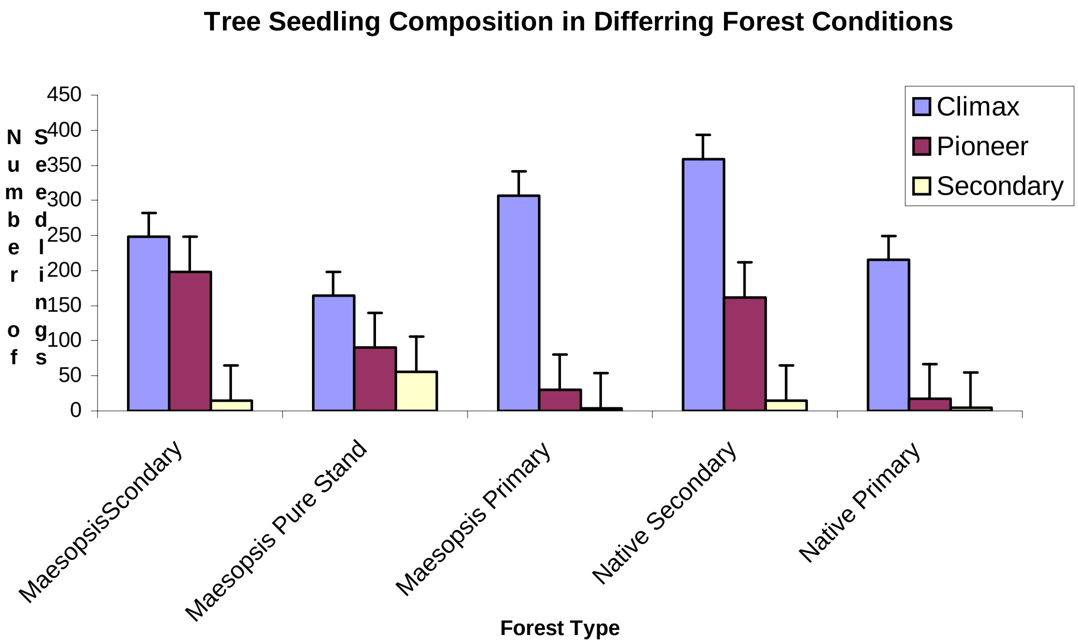

Fig 2. Seedling Classification in different Forest according to Succession habit.

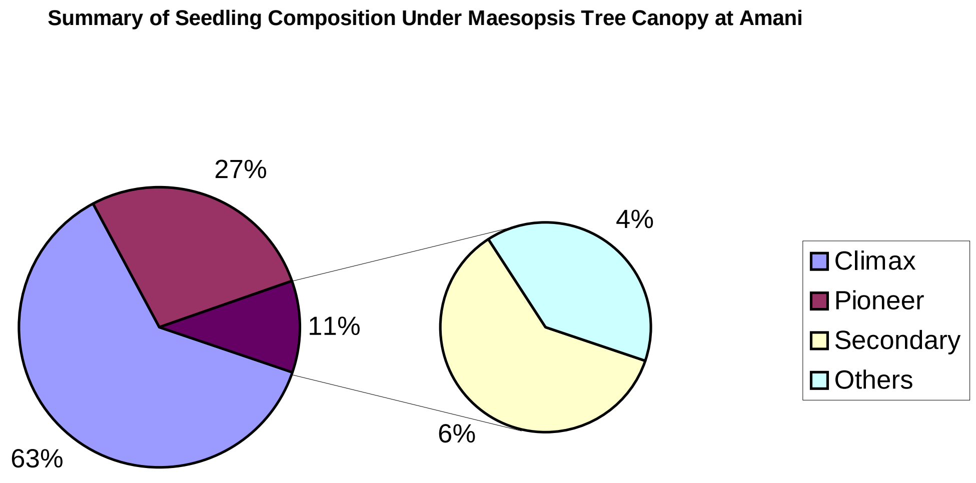

Fig 3. Summary of succession habits of tree seedlings surviving under *Maesopsis* trees

Climax species were significantly higher than the other seedling components (H corrected for ties = 6.054, P = 0.0484)

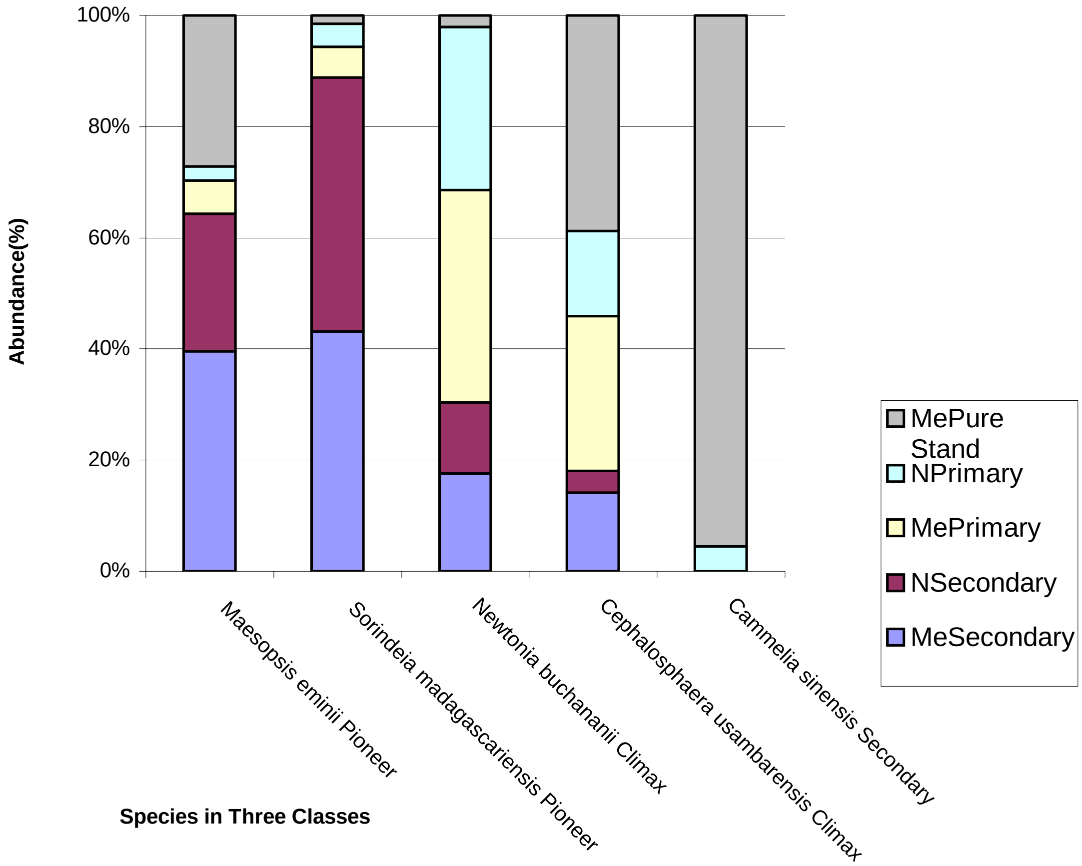

Fig 4. Comparison of five most abundant seedlings in three species classes under the *Maesopsis* and Native forest trees in different forest types.

Distribution of Seedlings under Tree Crown

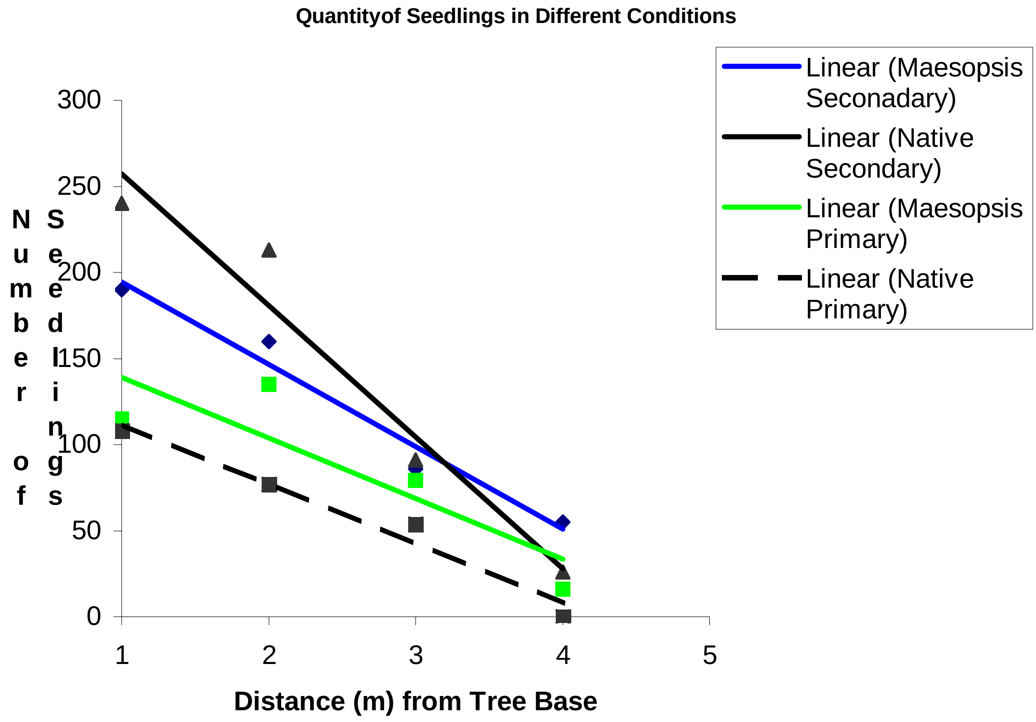

Fig 5. Pattern of Distribution of Seedlings under Trees in Different Conditions

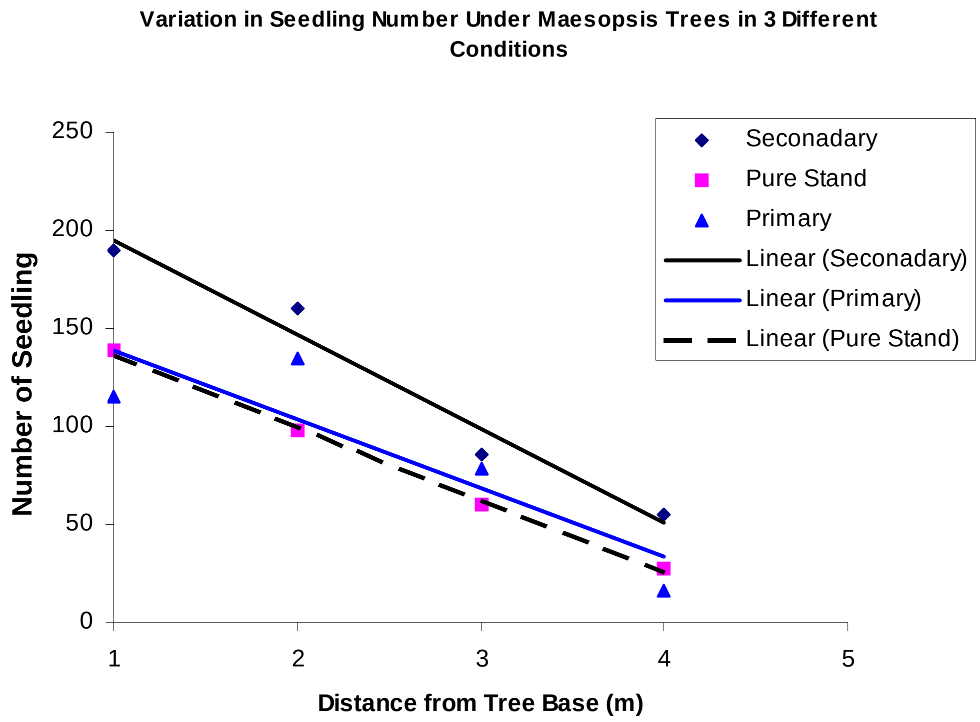

Fig 6. Pattern of Distribution of Seedlings under *Maesopsis* Trees in Different Forest Types.

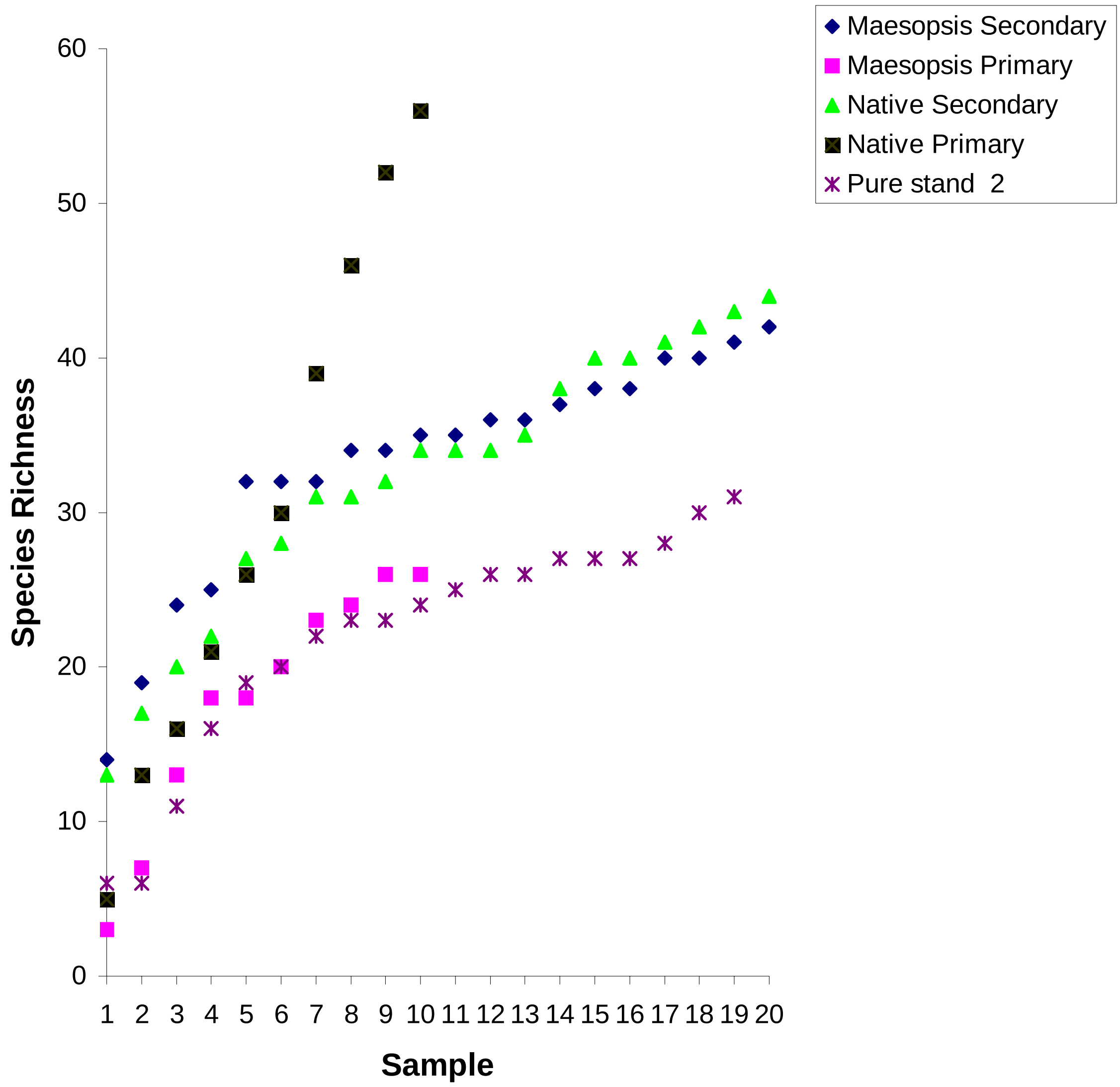

Fig 7. Seedling Diversity Accumulation Curve under *Maesopsis* and Native Trees in Different Forest Types

DISCUSSION

The study showed that a number of forest tree seedlings exist under *Maesopsis* trees in all forest types. There were more seedlings in the secondary forest in general, (table 1, Appendix 1). However no significant differences were found in the species richness of seedlings in all forest types regardless of whether they occurred under *Maesopsis* or Native trees. This trend in species relative importance may be attributed to the preference of seedlings for different ecological requirements. Hence, low numbers of a particular species in a given microsite were compensated for by higher numbers in its preferred forest type.

The high proportion of seedlings of climax species in all forest types may be attributed to high shading and perhaps efficient dispersal of seeds of matured climax trees. Climax species require shade when young and persist as saplings with little net growth, (Obsorne, 2000). It can be inferred that *Maesopsis* and their native tree pairs provide sufficient canopy cover in all the forest types. However, the higher values in primary forest are probably the result of the higher density of climax species in the primary forest than in the secondary forest.

Seedlings of pioneers occurred in all forest types, but were particularly low in the primary forest. Pioneers generally require light to germinate and survive under the forest canopy. Hence, the observed trend is probably due to limited light reaching the forest floor in all the forest types. Disturbance in the secondary forest may have led to breaks in the canopy hence resulting larger light holes and the consequent high abundance of pioneer seedlings than in the primary forest.

Climax species under *Maesopsis* in all the forest types combined were more than twice the number of pioneers. This is contrary to Binggeli's, 1989 suggestion that climax species will not regenerate in *Maesopsis* plantations. The difference in results between his study and this may be because at the time of his study the forest was not old enough to create the necessary conditions for the establishment of the seedlings of these native climax trees. The findings however confirm recent suggestions that increasing number of seedlings and saplings are now found under stands of Maesopsis (Newmark, 2002).

In Binggeli's, (1989) survey, only one *Newtonia buchananii* sapling was found as a climax species. There were no climax seedlings found under *Maesopsis*. In contrast our study showed a number of climax species including *Cephalosphaera usambaransis,* as the most dominant were found under the *Maesopsis eminii,* trees in all forest types. The higher abundance of *C.usambarensis* than all other climax species in pure *Maesopsis* stands is because it was planted under the *Maesopsis* canopy in an effort to restore native vegetation in the East Usambara. *Cammelia sinensis* (tea) also occurred in large numbers

The persistence of *C.usambarensis* in the pure *Maesopsis* stand indicates the potential of *Maesopsis* tree to be a best-bet nurse tree for native climax species in the East Usambara Mountains. The presence of *Cammelia sinensis* (tea) in the primary forest may be an accident since it is relatively uncommon. In the pure *Maesopsis* stand it may be due to its proximity to the tea plantation. This however, needs further research.

The abundance of climax and pioneer species in the primary forest and secondary forest respectively, confirm the significance of shade and light in the stimulation of seedling establishment and survival. High light intensity reaching the forest floor in secondary forest favour high populations of pioneers while the closed canopy in the primary forest provides sufficient shade for climax seedlings. The presence of pioneers and climax species in the pure *Maesopsis* stand may be that the latter was planted and the former took advantage of open holes in the canopy.

There was an inverse relationship between the numbers of seedlings and distance from the tree base (Figures 5 and 6). It is likely that density of crown will decrease along the crown radius towards the crown margin. Light holes are also likely to be stronger and increase in size at the interlocking ends of tree crowns. According to Linda, (1989) light holes occasionally develop in the forest canopy allowing light to reach the forest floor and this supports establishment of light demanding communities in the forest floors. The mode of seed dispersal of climax species could be instrumental in patterning of seedlings under the trees. In the primary forest however, the trend may be determined more by the parent plant.

Species accumulation curves shown for all the forest conditions are progressively increasing. The richness in the secondary and primary forest is higher than that in the Pure Maesopsis stand. The low diversity in pure stand may be due to two factors; 1) that only limited indigenous tree seedlings were planted under the canopy and 2) dispersal of other tree species in this forest is relatively low due to its separation from other indigenous forest. The rather high species richness in the primary forest with ten samples suggests that the diversity could be much higher with more sampling.

CONCLUSION

Maesopsis trees are capable of supporting seedling banks of all categories of species, just as well as native trees. There are more climax species under *Maesopsis* trees than pioneers and secondary species in all forest types.

Thus, with limited disturbance *Maesopsis* populations will decline and be replaced by native climax species. Though it may be a good nurse tree, pure stands should not be encouraged, since diversity is relatively low in such conditions.

The pattern of seedling distribution under the *Maesopsis* and native trees within the crown width is not well understood. Seedlings are sparsely populated towards the tip of the crown but the specific species are not known.

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Appendix 1. List of forest Tree Species under Maesopsis and Native Trees in 3 Forest Types

			Maesopsis Canopy			Native Tree Canopy	
Name of species	**Code**	**Habit**	**Secondary**	**Pure Stand**	**Primary**	**Secondary**	**Primary**
Albizia adianthifolia	Aa	Secondary	2		2	1	
Anthocleista grandiflora	Ag	Secondary		1			
Annikia kummeriae	Ak	Climax	2	1		1	
Allophylus meliodorus	Am	Secondary	1				
Anisophyllea obtusifolia	Ao	Climax	46	9	15	88	3
Allanblackia stuhlmanii	As	Climax	5	5	2	2	5
Ailsodoepsis schummanii	Asc	Secondary			1		
Antiaris toxicaria	At	Secondary				1	
Bersama abyssinica	Ba	Climax	3			7	2
Beilschmieda kweo	Bk	Climax		1	4		
Blighia unijugata	Bu	Climax	7			10	3
Cynometra brachyrrachis	Cb	Climax			5		
Cola greenayi	Cg	Climax	2	1	3	1	
Chrysophyllum perpulchrum	Cp	Climax	2		22	6	8
Coffea robusta	Cr	Pioneer	3				
Cammelia sinensis	Csi	Secondary		42			2
Cephalosphaera usambaransis	Cu	Climax	26	71	51	7	28
Cola usambarensis	Cus	Climax	1			2	
Celtis zenkeri	Cz	Secondary	1				
Drypetes gerardii	Dg	Climax	2	24	5	6	5
Deiribolia kilimandcharica	Dk	Secondary	1				
Diospyros occult	Do	Climax				1	
Drypetes usambarenrica	Du	Climax				1	
Englerodendorn usambarense	Eu	Climax	2	3	2	2	1
Funtumia africana	Fat	Secondary	1			1	
Ficus sur	Fs	Secondary		1			
Grewia calymmatosepale	Gc	Pioneer	1				
Greenwayodendron suaveolens	Gs	Climax	9	23	9	97	14
Hovenia dulcis	Hd	Pioneer	1			1	
Isoberlinia schefferi	Is	Climax	1	1	1	1	5
Leptonychia usambarensis	Lu	Pioneer		5	1	1	2

Name of species	Code	Habit	Secondary	Pure Stand	Primary	Secondary	Primary
Macaranga capensis	Mc	Pioneer		2			
Milletia dura	Md	Pioneer			1	1	
Maesopsis eminii	Me	Pioneer	112	77	17	70	7
Maranthes goetziena	Mg	Climax	3	2		1	
Myrianthus holstii	Mh	Pioneer		5	1		
Mesogyne insignis	Mi	Secondary	2	9		3	1
Newtonia buchananii	Nb	Climax	83	10	180	60	138
Ochna holstii	Oh	Climax	1				
Pouteria adolf-friedericii	Pa	Climax	1	1	3	6	
Peterocarpus chrysthrix	Pc	Climax	13			3	
Parinaria excelsa	Pe	Climax	4	5	1	3	1
Pterocarpus tinctorius	Pt	Climax	6			7	
Quassia undulata	Qu	Climax		2	1	2	2
Rawsoma lneida	Rl	Secondary		4			1
Synsepalum ceraciferum	Sc	Climax	4	3	2	2	
Sorindeia madagascariensis	Sm	Pioneer	85	3	11	90	8
Srombusia scheffleni	Ss	Climax		4	1	1	
Trichilia dregeana	Td	Climax	7		1	6	
Tarrna gravedens	Tg	Secondary				1	
Trilepisium madagascarensis	Tm	Secondary				1	
Tricalysia pallens	Tp	Secondary	4	2		8	
Tabernamontana stapfiana	Ts	Secondary	2	2	2		
Uvanodendron Usambarensis	Us	Climax				1	
Verpis nobilis	Vn	Secondary	1	3			
Xylopia aethiopica	Xa	Climax	15			19	
Xymalos monospora	Xm	Secondary	4		1	3	2
Zanthoxylum deremense	Zd	Climax				1	
Zanthoxylum gullets	Zg	Climax	1				
Total			**491**	**325**	**345**	**562**	**239**