

Small mammals as potential seed predators of *Maesopsis eminii*.

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Abstract

Rodent preference for *Maesopsis eminii* was investigated. Propogules in different stages of development (ripe, unripe, seed, nut and nutcase) were offered in paired plots under *M. eminii* trees and under a native forest tree species. Small mammal activity in each of the plots was monitored using track plots. The information was supplemented by setting up two rodent trapping grids. Small mammals were active in the experimental area, although they were not all frugivores. Small mammals selected for bare seeds and ripe fruits and the preference did not differ between the paired plots. Total propagule utilisation decreased with increased % of woody debris cover only under *M. eminii* plots. Rodents were not shown to be important sources of *M. eminii* seed predation and dispersal on a local scale.

INTRODUCTION

Seed predation and dispersal have been recognised as important processes that affect the dynamics of tree populations and communities (Hubbell 1980). In adult tree populations seed predation is highest beneath the parent plants, potentially due to high densities of seeds beneath them. A result is that seeds that get dispersed some distance from the parent plant have a higher chance to escape from predation (Hubbell 1980). This process may limit seed success and prevent any one species from becoming a single species dominant (Hubbell 1980).

Maesopsis eminii is an invasive tree that is fast becoming dominant in areas of the Eastern Usambara Mountains, Tanzania. Its native range extends from West-Tanzania to West Africa. It was introduced to the East Usambara Mountains in 1913 (Viisteensaart et al. 2000) and it now poses a serious threat to biodiversity in an area where levels of endemism are very high. Binggeli (1981) suggested that in 200 years *M. eminii* could make up 50% of the total canopy cover with the current invasion/dispersal rate.

A suggested reason for the high dispersal rate is the very high production of propagules (Binggeli 1981). The fruits are ovoid and measure about 2 to 3 cm in length. They consist of a soft fleshy exocarp, surrounding a hard mesocarp that contains the endocarp. Observations show that hornbills are important dispersers of the seeds as they swallow the fruits and scatter them. Blue monkeys also consume large quantities of mainly the unripe yellow fruits from the trees, but after removing the exocarp, they spit out the mesocarp, leading to very localised distribution of seeds around parent plants (Binggeli 1981). Monkey movement through the canopy also causes a large amount of seed

scatter around the parent plant. Thus a large number of propagules land on the forest floor, mostly under the parent trees, where their fate is largely unknown.

Damage to stored seeds by the coleopteran *Araecerus fasciculata* DeGeer (Anthribiidae) has been reported by Mugasha ((1981) in Binggeli 1981) but was relatively low for the invasive range compared to the native range (Binggeli 1981). Predation and damage caused by other agents, however, has been under investigated, particularly for one potentially important group of seed predators, small mammals. In the East Usambara Mountains 21 species of small rodents have been recorded (Kingdon 2003, Stanley et al. *in prep*), a number of which are partly frugivores or generalist feeders (Kingdon 2003). Considering the wide and relatively abundant distribution of many small mammal species (Stanley et al. *in prep*) in the area we investigated the impacts of small mammals on *M. eminii* fruits under *M. eminii* trees and under other native forest trees.

Objectives:

1. Investigate the interaction of small mammals with *M. eminii* fruits.
 - Do small mammals exhibit a preference for a particular developmental stage of *M. eminii* fruit?
 - Do small mammals act as a potential source of seed predation/dispersal?
2. Investigate interactions with small mammals and *M. eminii* fruit in *M. eminii* plots and control plots.
 - Do variables that influence rodents, differ between treatment plots?
 - Environmental variables

METHODS

Study site

The study was performed in the Amani Nature Reserve in the East Usambara mountains (5. 06°S, 38.37°E). Data was collected over an 8-day period from the 16th September 2005 – 24 September 2005. The experiment was set up in section of sub-montane forest with a high proportion of the invasive tree *Maesopsis eminii*.

Fruit choice and removal

To test if rodents choose a specific developmental stage of *Maesopsis eminii* propagules and whether the choice differs under *M. eminii* or native trees we established 9 pairs of 1 m² plots. Paired plots were placed with one plot beneath the canopy of *M. eminii* and another paired plot

approximately 10 - 20m away under the canopy of native forest tree species. Each pair of plots was placed approximately 20m away from the neighbouring plots. This resolution was selected as it was considered a reasonable scale for rodent movement and home ranges. Each plot contained 10 piles of seeds. The seed piles consisted of 1 undamaged ripe *Maesopsis* fruit (black), 1 undamaged unripe *Maesopsis* fruit (bright yellow), 1 fruitless nut, 1 naked seed and 1 empty seed case. All propagules were collected from the field and naked seeds were removed from intact nuts. Every seed pile was marked by the presence of a small flag on top of a toothpick to allow monitoring of seed removal and predation over the days (Figure 1). Everyday seed/fruit removal and consumption was noted. If the fruit had not been removed but had been nibbled, a fresh one replaced the nibbled propagule. On the 21st of September naked seeds were added to the choice piles. If the seeds were eaten they were not replaced.

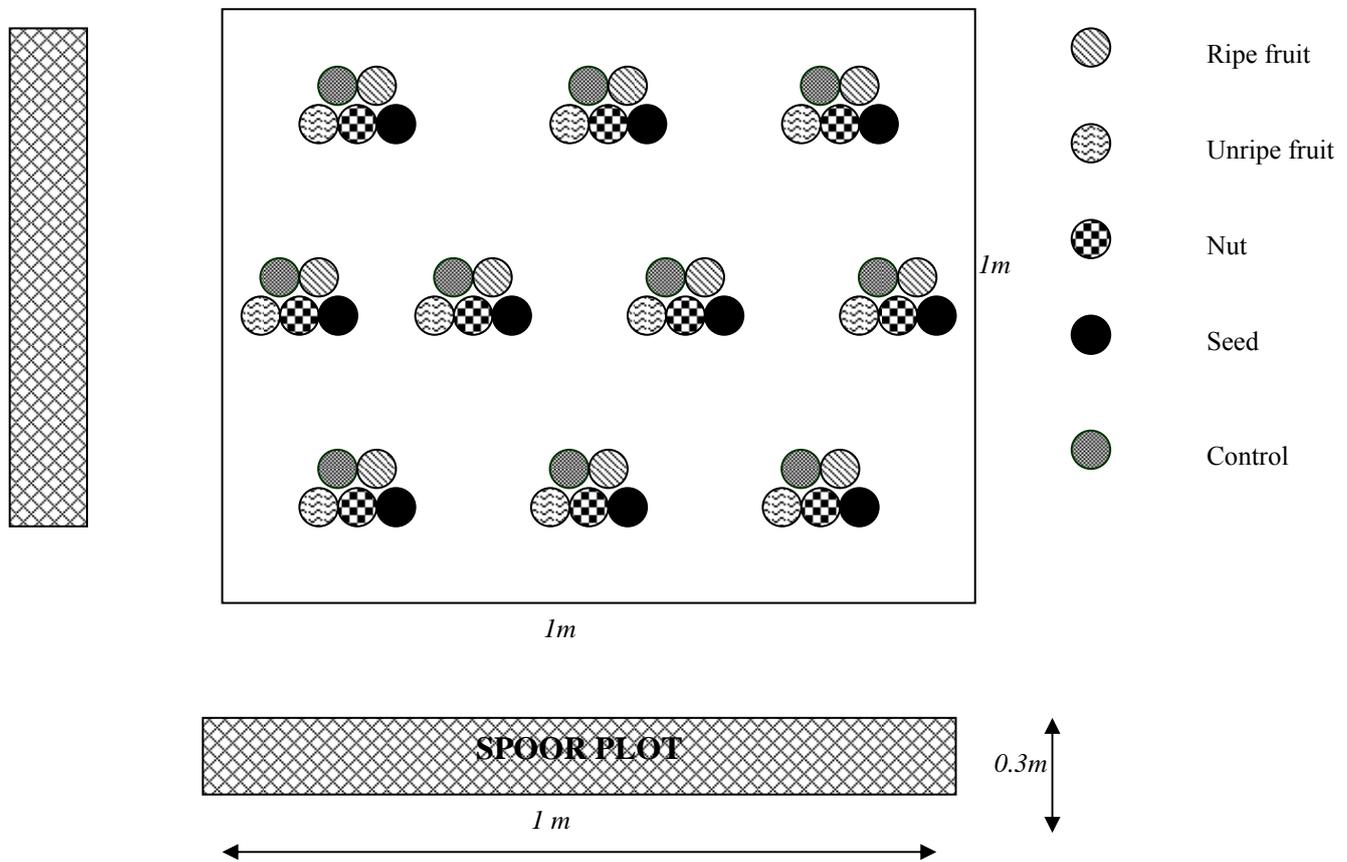


Figure 1: Seed choice experiment set-up, surrounded by spoor plots.

Before the seed preference experiment was set up, the plots were cleared of any existing propagules. The seeds were collected and their state was recorded. Old seeds were recorded as either viable or non-viable. Fresh fruits were characterised according to the ripeness and damage. Damage was divided into monkey damage, rodent damage and other. After seed removal biotic and physical environmental factors were recorded. The percent of woody debris cover and leaf litter

cover were estimated for every plot. Canopy cover for each plot was determined with a densiometer. Four measurements were taken in each cardinal direction and were averaged.

Rodent activity

Spoor plots

At every seed plot, two spoor plots were established along two sides of the plots. The plots were set up to observe animal activity in and around the plots. The 1m x 0.3m spoor plots were created by removing bulky parts of the vegetation and covering the ground with finely sieved sand. All tracks were measured and characterised according to size. Small rodent tracks were less noticeable but could be identified by the nail marks of the claws. Both spoor plots were monitored on a daily basis.

Live trapping

To investigate which rodent species may be involved in the seed predation/utilisation events we live-trapped animals using 2 sizes of Sherman traps. 25 traps were set out at each end of the choice experiment area. Traps were placed in a grid at 5-m intervals and were baited with a mixture of peanut butter, banana and salt. The traps were checked twice daily, in the early morning and the late afternoon. Trapped rodents were identified to genus level and any characteristic markings on their ears were noted so that the individual rodent could be recognised if it was recaptured. The traps were in the field for a period of 4 trapping nights.

RESULTS

Rodent activity

Small mammals occur in trapping areas and around seed choice plots. No small mammal track (track size 4mm – 40mm) activity differences were noted between *M. eminii* plots and control plots (Paired t-test $DF_8 = 1.53$, $p = 0.165$). Rodent activity (tracks <5mm) showed no differences between plot treatments (Paired t-test $df_8 = 0.618$, $p = 0.554$). The number of tracks did not show a relationship with the total propagule utilisation overall nor with propagule utilisation in *M. eminii* plots and control plots.

Over 5 days of trapping 17 small mammals were captured in the two 25m² trapping grids. Sixteen *Praomys delectorum* (soft furred rat) were captured, all of which, during the evening. One *Lophuromys flavopunctatus* (brush furred mouse) was captured during the day.

Fruit choice and removal

Fruit choice

Given a choice of *M. eminii* ripe fruit, unripe fruit, nuts, nutshells and bare seeds, small mammals preferentially chose ripe fruit and seeds, with seeds being the most favoured (Figure 2). Of all propagule utilisation we recorded, 10.3% seed predation events and 17.1% of potential dispersal events. Significantly more ripe fruits were partly eaten where they lay, than ripe fruits that were removed from the plot (T test $df_{34} = 4.095$, $P < 0.005$).

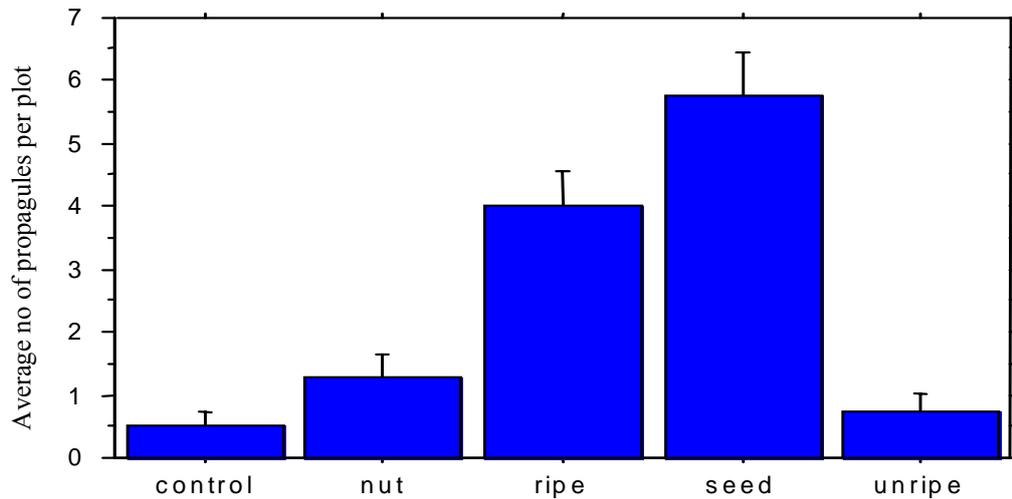


Figure 2: Graph illustrating rodent preference for *Maesopsis eminii* propagules, determined by average number of each propagule type utilised per plot. ($\chi^2 = 5.88$, $p < 0.05$, $d.f = 4$)

Treatment plots

Seed fall of ripe fruit was significantly higher in *M. eminii* plots. The amount of unripe fruit and propagules damaged by monkeys and rodents did not significantly differ between *M. eminii* and control plots (Figure 3). Environmental variables: % leaf litter, % woody debris cover and % canopy cover, did not differ significantly between *M. eminii* plots and control plots (Table 1). In *M. eminii* plots % woody debris cover significantly decreased total propagule utilisation by small mammals ($F_{1,16} = 4.178$, $P < 0.05$) (Figure 4). The propagule selection and utilisation, by small mammals, did not significantly differ for any class of propagules between *M. eminii* plots and control plots (Table 2).

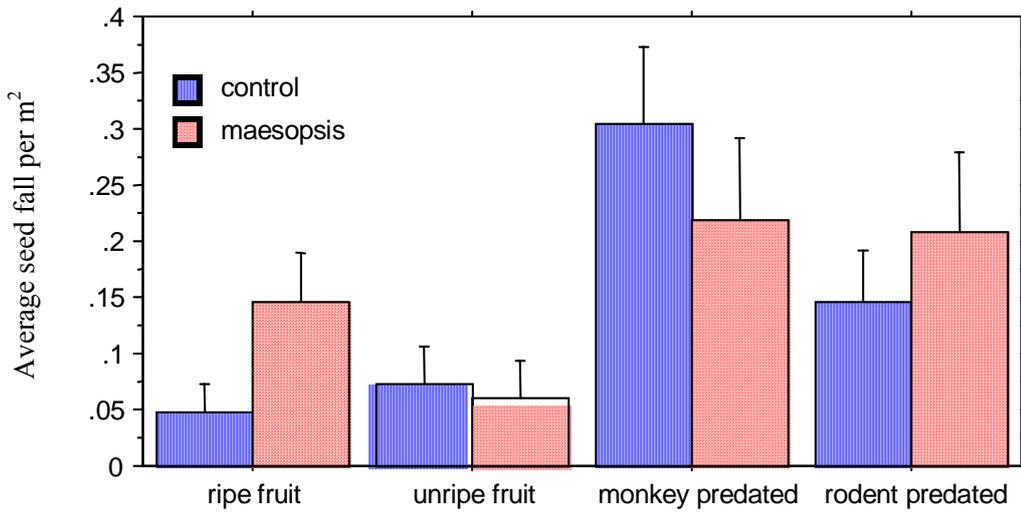


Figure 3: Average seed fall into plots across sampling period. Ripe fruit seed fall is greater under *M. eminii* trees ($F_{1,162} = 3.939$, $P < 0.05$).

Table 1: ANOVA tables of environmental variables under *M. eminii* and native trees.

	Df	MS	F	P
% light	16	4.215	1.686	0.213
% litter	16	234.722	0.351	0.562
% woody cover	16	22.222	0.210	0.653

Table 2: Paired t-tests of propagule utilisation between paired *M. eminii* plots and control plots

	T value	P
Unripe	-0.500	0.631
Ripe	0.195	0.850
Nut	1.492	0.174
Control	-0.244	0.813
Seed	0.187	0.856

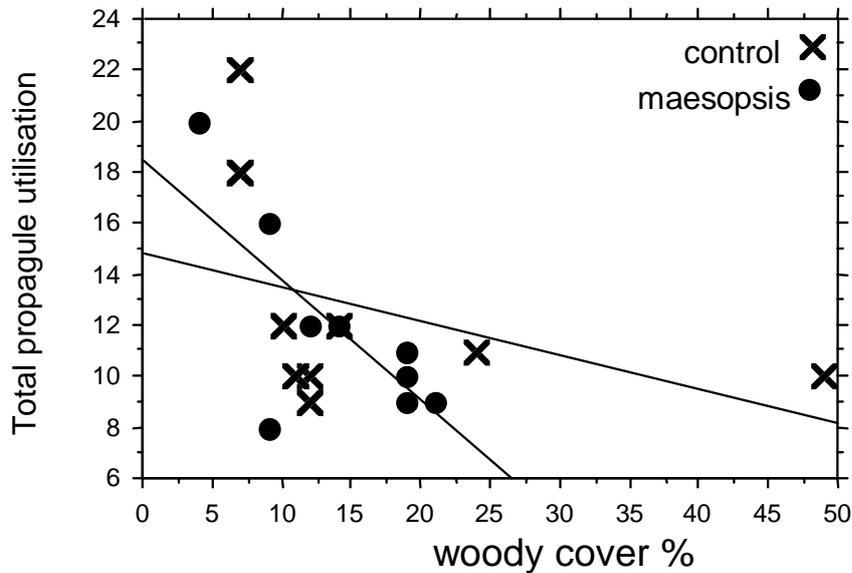


Figure 4: Total propagule utilisation in *M. eminii* significantly decreases with increasing % woody debris ($F_{1,16} = 4.178$, $P < 0.05$, $R^2 = 0.52$) but shows no significant relationship in the control plots ($F_{1,16} = 1.382$, $P = 0.272$, $R^2 = 0.17$)

DISCUSSION

Trapping and track data confirm small mammal activity in the study area. Tracks that were observed in the plots were mongoose, squirrels, small rodents, frogs and birds. The tracks observed in the plots could not always be accurately detected and were easily obscured by raindrops etc. It is likely that overall we underestimated the number of tracks, particularly the small mammal tracks as they are light and the tracks are more likely to be missed. However the presence of rodents in the area was confirmed by our trapping attempts. *Praomys delectorum* was the most commonly captured animal. Stanley *et al.* (in prep) show that that *Praomys delectorum* and *Hylomyscus denniae* are the most abundant rodents in the East Usambaras, both of which are seed and fruit consumers (Kingdon 2003). Of the small mammals noted in both the track and trapping data squirrels and rodents are the most likely to act as seed predators.

The results show small mammals on occasion do crack open nut cases to retrieve the seeds however these events were few. Yet the data shows that when given the opportunity small mammals will choose bare seeds and therefore act as potential seed predators. The naked seeds are however usually protected by the hard nut shell. We did observe soft degraded nuts on the forest floor that still contained viable seeds. Binggeli (1981) shows that seeds remain viable up to 200 days on the

forest floor. During this period the nut can lie in the moist litter and the seed coat can soften, making the seed more susceptible to rodent predation. This idea was supported by observations of freshly cracked open degraded nutcases.

The removal of fruits and nuts indicate potential dispersal events, although seed fate remains unknown after the removal from the plot. Several controls were removed, probably due to the fact that bare seeds were offered on the empty nutshells. While going for the bare seeds rodents may perceive the seed and shell as a single unit and inadvertently remove the control.

Rodent preference, seed utilisation and environmental variables did not differ between *M. eminii* plots and control plots. However a strong inverse relationship between % woody litter cover and total propagule utilisation was found for *M. eminii* plots. The control plots showed a similar, although non-significant trend. We propose that an increase in woody litter acts as an obstruction to rodents and makes propagule utilisation more difficult. We suggest that the relationship is strongest in the *M. eminii* plots as the woody litter structure may differ between the two treatments. *M. eminii* trees are self-pruning and drop large amounts woody litter. The largely homogeneous woody litter may make it more difficult for rodent movement in the area. In the control areas, there may be a different quality of woody litter, perhaps larger sticks and branches that could act as a less of a hindrance to rodent activity. An alternative hypothesis is that a large amount of variance in the control plots weakens the relationship. Our control plots were not placed consistently under the same species of tree, therefore a larger amount of variation in woody litter structure may occur in those plots.

The small-scale comparisons between *M. eminii* and control trees did not give results in terms of rodent activity. We propose as a future avenue of research, to extend the period of observation of the current experiment and to conduct a similar experiment on a broader scale. We expect that rodent activity changes over a larger scale when comparing areas with high *M. eminii* density and pristine forest. It has been shown that rodent diversity and abundance is greater in disturbed forest patches (Isabirye-Basuta and Kasenene 1987). It is also known that *M. eminii* invades disturbed areas. Together with the high availability of seeds and fruits in *M. eminii* dominated forests that may attract rodents, more rodents can be expected in these areas. Therefore *M. eminii* areas may have unnaturally high numbers of rodents that can then acts as a more significant source of seed predators, for both *M. eminii* and native tree species.

ACKNOWLEDGEMENTS

We would like to thank Rosie, Mark, Bridgid, Rowan, Pauline and Robert for organising, teaching and facilitating the 2005 Amani TBA course. We also would like to thank the staff of Amani Nature Reserve for guiding us around and sharing their knowledge with us. Our special thanks go out to the staff of Amani resthouse for providing us with excellent food during the course period. Finally we would like to acknowledge the British Ecological Society, Groninger Universiteitsfonds and TBA for making the attendance on this course possible.

REFERENCES

- Bingelli, P. 1981. The ecology of *Maesopsis* invasion and dynamics of the evergreen forest of the East Usambaras and their implications for forest conservation and forestry practices. Pages 269 - 300 in A. C. Hamilton and R. Bensted - Smith, editors. Forest Conservation in the East Usambara Mountains, Tanzania. IUCN, Gland, Switzerland, Cambridge.
- Hubbell, S. P. 1980. Seed predation and coexistence of tree species in tropical forests. *Oikos* **35**:214 - 219.
- Isabirye-Basuta, G., and J. M. Kasenene. 1987. Small rodent populations in selectively felled and mature tracts of Kibale Forest, Uganda. *Biotropica* **19**:260 - 266.
- Kingdon, J. 2003. The Kingdon Field Guide to African Mammals. Christopher Helm, London.
- Stanley, W. T., P. M. Kihale, K. M. Howell, and R. Hutterer. *in prep*. Small mammals of the Eastern Arc Mountains, Tanzania.
- Viisteensaart, J., S. Johansson, V. Kaarakka, and O. Luukkanen. 2000. Is the alien tree species *Maesopsis eminii* Engl. (Rhamnaceae) a threat to tropical forest conservation in the East Usambaras, Tanzania? *Environmental conservation* **27**:76 - 81.