

Abundance and Species Richness of *Macaranga* spp. in Forest Gaps with Respect to Canopy Openness, Soil Type, and Altitude in the CTFS-AA Forest Dynamic Plot and Surrounding Lambir Hill NP

Ling Chea Yiing¹, Wulan Pusparini², and Katherine O'Leary³

¹ SARAWAK FORESTRY Corporation Sdn. Bhd./Forest Research Centre, Jln Datuk Amar Kalong Ningkan, 93250 Kuching, Sarawak.

² Yayasan Badak Indonesia (Rhino Foundation of Indonesia), Jl. Ir. H. Juanda No. 15 Bogor, Indonesia

³ Harvard University/Cambridge, MA, 02138, U.S.A.

ABSTRACT

Forest gaps in the CTFS-AA Forest Dynamic Plot and surrounding Lambir Hill NP were studied to understand the relationship between *Macaranga* spp. species composition and canopy openness, soil type, and altitude. This short study recorded environmental variables within 20 gaps and among 9 species of *Macaranga* found within a given plot inside the gaps. Results generated using the Spearman Rank Correlation Test revealed that canopy openness exhibits a weak, positive correlation with the species diversity of *Macaranga* stems inside the gaps (p -value = 0.11). However, no correlation was found between either soil type ($p=0.96$) or altitude ($p=0.76$) and species diversity.

Key words: gap, Lambir, Macaranga, species composition

INTRODUCTION

"We argue that an understanding of life-history variation and its role in the maintenance of high diversity in tropical rain forests, must involve detailed analyses of species' responses to the full spectrum of resource heterogeneity throughout their life cycles."

-Stuart James Davies et al., 'Comparative ecology of 11 sympatric species of Macaranga in Borneo

Canopy gaps form by either major or minor natural and anthropogenic disturbances within the forest, such as landslides, lightning strikes, human interactions with forests (tree felling, path clearing, etc.), or fallen aged trees (Whitmore 1988). Due to these disturbances, openings in the canopy allow sunlight to reach the usually dim undergrowth. Pioneer plant species that would normally not grow in the undergrowth due to the lack of light take advantage of the light provided by the canopy openings to catalyze their growth. We are interested in how different gap conditions give one pioneer an advantage over the other. We have chosen to focus on one particular genus of pioneers, *Macaranga* spp. Multiple gaps of varying canopy openness, soil types, and altitudes were visited. We surveyed the *Macaranga* species present using circular sample plots to determine what conditions have the greatest influence in *Macaranga* species composition.

METHODS

Gaps were sampled from the Lambir CTFS plot and the area surrounding the Lambir Hills National Park by choosing gaps which met pre-determined criteria based on gap age and size. Age appropriateness was determined based on the requirement that at least 50% of the *Macaranga* stems within the gap had a diameter that fell within a range of 1-10 cm. If no *Macaranga* stems were present, the gap was removed from analysis. Size was determined using a densiometer to gauge an average of canopy openness within the total gap based off of four readings taken along perpendicular transects rooted at the estimated center point of the gap. If the densiometer reading indicated that the canopy openness was 16% or less, we considered that the openness of the canopy was not great enough to establish the area as a gap. Any gap with a densiometer reading of 16% or greater was accepted as valid.

Upon acceptance of a gap, the central point would be marked with a small flag. From that point, a circular area of radius equal to 4 meters was established. Every *Macaranga* stem that fell within this area was measured for stem diameter with a diameter tape, as well as for height based off of the calculation of a clinometer. Species type was also recorded after being determined using leaf observations. For samples within the CTFS plot, we were able to access a database using tag numbers of each stem to check that our prediction of species type was correct, and we were also able to access the soil type and altitude of the surveyed gap. However, for the gaps found within the Lambir Hills

National Park, no database which included tree species, soil, or altitude exists. Therefore leaf samples of species were collected and brought back to the base camp to be identified with the help of the CTFS crew. A soil sample was collected, and altitude calculated using a GPS device. Unfortunately the GPS stopped functioning for the last three gaps sampled at the Lambir Hills National Park sites, and we were unable to include those three gaps in our analysis of correlation between altitude and species richness.

RESULTS

A total of 72 *Macaranga* stems was recorded and included a variety of nine species (Table 1). Of the 9 recorded species *M. beccariana* prevailed as the most abundant, comprising 22 of the total 72 sampled stems, followed by *M. trachyphylla* at 15 stands and then *M. winkleri* with a total of 13 stands. *Macaranga hulletii*, *M. hypoleuca* and *M. triloba* shows the lowest number of stands, with only one tree recorded per species from the sampled gaps.

TABLE 1: Nine species of *Macaranga* spp. recorded from the sample plots and the number of stands for each species

Species	Number of stands
<i>Macaranga beccariana</i>	22
<i>Macaranga trachyphylla</i>	15
<i>Macaranga winkleri</i>	13
<i>Macaranga hosei</i>	9
<i>Macaranga gigantea</i>	6
<i>Macaranga conifera</i>	2
<i>Macaranga havilandii</i>	2
<i>Macaranga hulletii</i>	1
<i>Macaranga hypoleuca</i>	1
<i>Macaranga triloba</i>	1
Total	72

The Spearman Rank Correlation Test between species abundance and soil type yielded a p-value of 0.96. For altitude, a slightly lower p-value of 0.76 was recorded. The lowest p-value calculated by the Spearman Rank Correlation Test occurred between species abundance and canopy openness, with a p-value equal to 0.11. However, in most of the gaps, only one or two species of *Macaranga* spp. recorded and only one gaps where six species of *Macaranga* recorded (Figure 1).

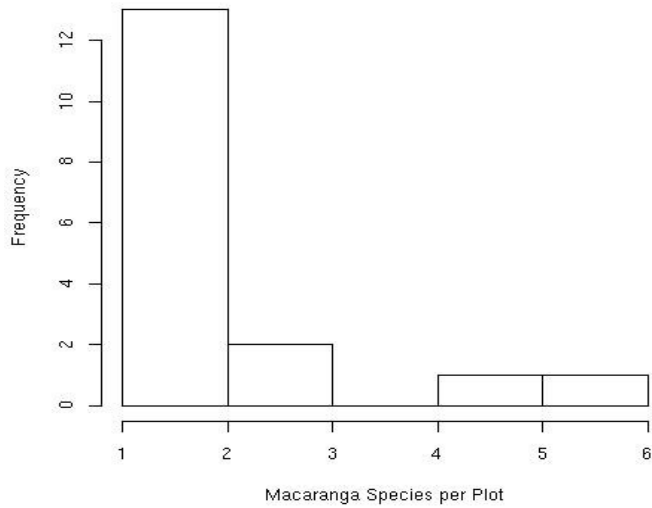


FIGURE 1: Most gaps, regardless of *Macaranga* abundance, showed little *Macaranga* species diversity. The histogram above illustrates how more than twelve of the seventeen gaps only included 1-2 different species of *Macaranga*, while only one sample had as diverse a sample as six species of *Macaranga*.

We then used linear model regression to analyze the relationships between tree height and diameter and canopy openness for each of the *Macaranga* species. Both height ($p = 0.037$, R-squared = 0.061) and diameter ($p = 0.057$, R-squared = 0.051) were significant. These results show that tree height and tree diameter are both significantly negative correlated with canopy openness; however, the correlation with tree height is stronger than that of tree diameter (Figure 2), though both p values were not strongly correlated. Linear regression between altitude and soil type and the size (both height and diameter) of *Macaranga* spp. yielded no significant relationship.

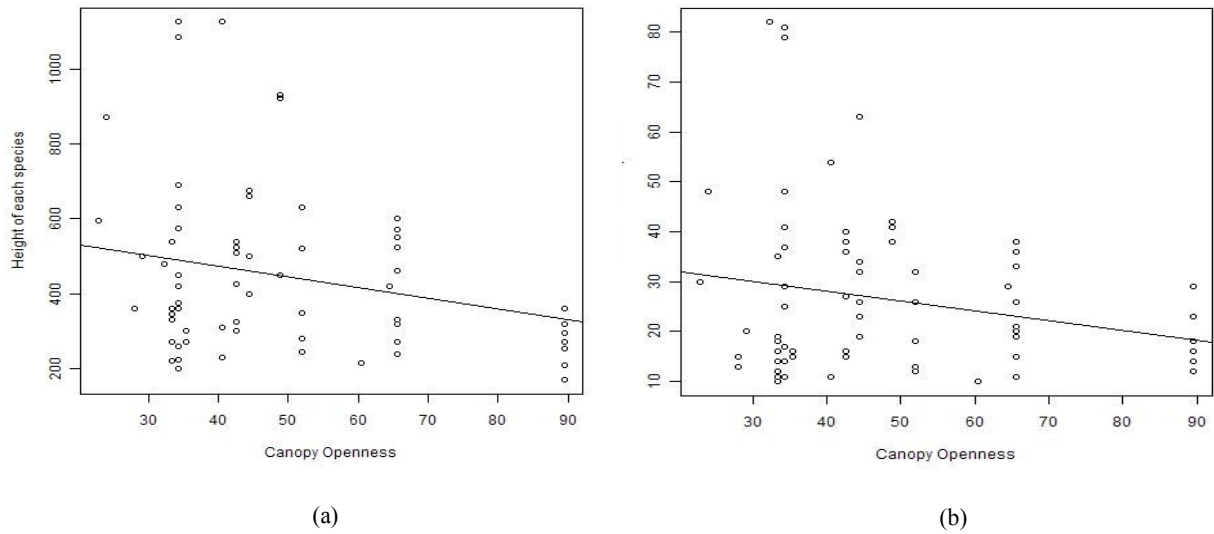


FIGURE 2: (a) Regression between canopy openness and height. (b) Regression between canopy openness and diameter.

From the figure 3, the tree height will reached the constant stage earlier than the tree diameter based on the slope of the linear regression line. This make sense as when the gaps aged, the diameter and height growth of the *Macaranga* species will slow down too, until it reaches a certain stage where trees will grow horizontally but not vertically.

Nevertheless, amongst the three environmental variables, the strongest correlation was between the *Macaranga* species composition and the canopy openness from the ordination test (Figure 3), indicating that canopy openness contributes more to richness of *Macaranga* within gaps rather than soil type or elevation. This result corresponds to the role of canopy openness in provide light for *Macaranga* growth. As we all know, most of the pioneer species will dominate an area as soon as there was a gap, which indicates that pioneer species need lights to grow. But not all *Macaranga* spp. are light-demanfing species, there are few species such as *M. havilandii*, *M. hulletii*, *M. lamellata* and *M. kingii* are shade-tolerant species and can grow on undisturbed area (Davies et al, 1998).

CONCLUSION

The study conducted only included 17 gaps, and with such a small sample number we were able to generate a significant p-value. Because our p-value was so close to being considered significant based on such a relatively minimal number of sample plots, we suggest that a future study be conducted which would include a greater number of gaps and of different forest types. We believe based on our own field observations that it is probable that such a study would be able to conclusively prove that canopy openness is a deciding factor in the *Macaranga* species abundance and species richness of a gap, and would unveil previously unknown growth mechanisms of a dominating pioneer species within the Sarawak region.

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