ISB Journal of Physics Volume 8, 2014
http://www.isb.ac.th/HS/JoS

The Effect of Height, Wing Length, and Wing Symmetry on *Tabebuia rosea* Seed Dispersal

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Abstract

The relationship between the vertical drop height and the horizontal distance travelled (dispersal ratio) was investigated for a sample of fifty *Tabebuia rosea* seeds by dropping the seeds from five heights ranging from 1.00 to 2.00 meters. The dispersal ratio was found to be a constant 0.16 m/m for these heights. The effects of total seed length and asymmetry of seed wings on dispersal ratio were also measured using separate samples of fifty *Tabebuia rosea* seeds. It was found that neither seed length nor asymmetry had a significant effect on the dispersal ratio.

Introduction

Seed dispersal is the movement of seeds away from the parental plant. Dispersal is important because seeds that travel a greater distance have the possibility of reaching hospitable areas not populated by other plants of the same species, while those that remain close to the parent plant must compete with it for resources. The area around the parental plant in which the seeds are dispersed is known as the "seed shadow"[1]. Statistical models of varying complexity have been used to study wind dispersal in seeds either by attempting to simulate observed seed shadows or by modeling environmental factors[2]. These models do not include the potential effect of variations between seeds. Variations in seeds may be influenced genetically, and therefore subject to selective forces. Alleles that code for seed traits that allow greater dispersal from the parental plant are expected to have increased reproductive success in the next generation.

This investigation explores the relationship between dispersal and variations within *Tabebuia rosea* seeds under windless conditions. Some studies have looked at variations in mass and wing areas of seeds, either artificial seeds[3] or natural seeds[4]. No research was found on dispersal in *Tabebuia* species or on the seed variations used in this investigation. Other studies have concluded that taller trees have a greater distance of dispersal than shorter trees[5]. However, there is little information on dispersal from controlled drop heights, which allows a calculation of dispersal ratio. Dispersal ratio is defined as ratio of the horizontal distance and the vertical distance travelled by the seed as it falls.

The seeds used in this study were collected in Nonthaburi, Thailand during mid-December 2012. Examples of the *Tabebuia rosea* seeds can be seen in Figures 1 and 2. The seed falls in a twirling motion. Under natural conditions, *Tabebuia rosea* seeds are dropped in both windy and still (windless) environments and the average mature tree, shown in figure 3, is 25 to 30 meters tall.

Figure 1 Examples of symmetrical (top) and asymmetrical (bottom) seeds.

Figure 2 Examples of long-wing (top) and short-wing (bottom) seeds.

Figure 3 *Tabebuia rosea* trees

Method

A sample of fifty *Tabebuia rosea* seeds were dropped 0.030 ± 0.005 meters away from the wall at five heights ranging from 1.000 to 2.000 ± 0.005 meters, as seen in Figures 3 and 4. The horizontal distance that the seed travelled was recorded.

Figure 3 How the seed was released.

A second sample of fifty seeds had total length measured from tip to tip as shown in Figure 6 and dropped as shown in Figures 3 and 4 from two heights (1.000 and 2.400 ± 0.005 meters). A third sample of fifty seeds had each wing length measured individually to determine asymmetry, defined as the ratio between the lengths of the longer and shorter wing of a seed, as shown in Figure 6. These seeds were dropped as shown in Figure 3 and held as shown in Figure 5. A summary of the data for seed length and wing asymmetry is shown in Table 1.

Figure 4 Seed release method (vertical height and seed length).

For all three investigations, the *Tabebuia rosea* seeds were of a similar age, and were collected from the same group of trees at the same time. Precautions were taken to eliminate any draft. Seeds with damaged wings were not used. It was noticed that the seeds were increasingly fragile and broke more easily as they were used; those that were broken were not used.

Figure 5 Seed release method (asymmetry).

	Asymmetry	Total Length
Mean	1.1	3.8 cm
Standard Deviation	0.12	0.53 cm
Range	1.0-1.5	2.7-5.1 cm

Table 1 Variation in the population of *Tabebuia rosea* seeds tested. The sample size was 50 seeds for both sets of seeds.

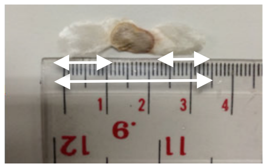

Figure 6 Measurement method for asymmetry (top) and total length (bottom).

Results and Discussion

The results showed that for *Tabebuia rosea* seeds, there is a constant dispersal ratio of 0.16 m/m for all heights tested, as can be seen in figure 7. A seed will travel on average a horizontal distance of 0.16 m for each vertical meter of height. Data from t-tests showed no significant differences between dispersal ratios for consecutive heights.

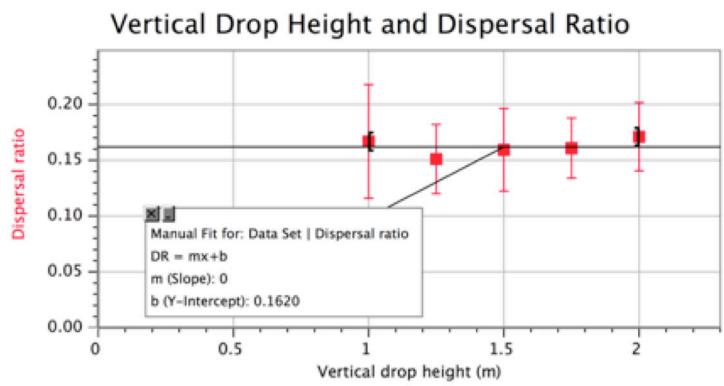

Figure 7 Effect of Height on Dispersal Ratio

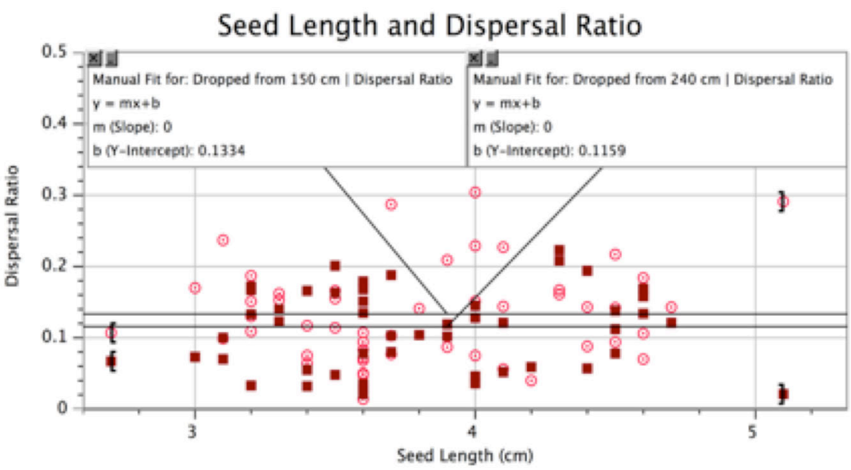

Figure 8 Effect of Wing Length on Dispersal Ratio.

It was also found that seed length had no effect on dispersal ratio, shown in figure 8. Seeds dropped from 2.4 m and from 1.5 m showed no significant difference in dispersal ratio (p=0.190) as a function of seed length. This supports the results of the first investigation. It must be noted that the dispersal ratios are slightly lower here, perhaps due to procedural differences. Long seeds (above the mean length) and short seeds (below or equal to the mean length) showed no significant difference in dispersal ratio at either height (p=0.065 at 1.5 m; p=0.386 at 2.5 m). The data suggest a possible weak positive correlation between wing length and dispersal ratio, however this difference is not shown to be significant.

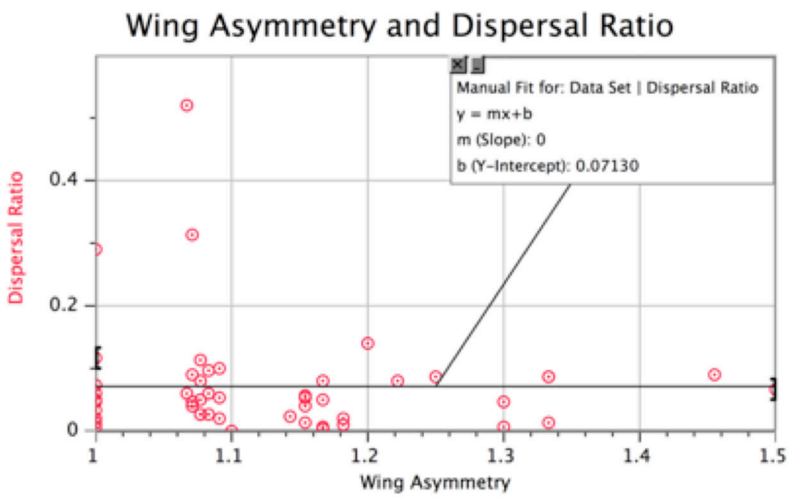

Figure 9 Effect of Asymmetry on Dispersal Ratio.

Looking at the effect of wing asymmetry, figure 9 shows a constant dispersal ratio. This dispersal ratio is significantly lower than the other two investigations, possibly due to the method of holding the seed or other procedural differences. A t-test between seeds with high wing asymmetry (above the mean) and low wing asymmetry (below or equal to the mean) showed no significant difference (p= 0.158).

The results presented here are based on a sample population of *Tabebuia rosea* seeds in Thailand. These results are expected to apply to other populations of *Tabebuia rosea* and other similar species with wind dispersed, two-winged seeds.

A major concern with this investigation is that the data from the three variables was not originally intended for direct comparison. Although procedures were consistent within an investigation, some differences, for example the specific sample of seeds and how they were released, existed between investigations. This reduces the ability to compare results directly. Another issue with this investigation was the age of the seeds used in the trial. The first few trials were done with *Tabebuia rosea* seeds that had recently been removed from refrigeration after several months of storage. It was noticed that the seeds were more fragile and broke more easily on the second day of data collection. Although undamaged seeds were used, it is possible that fragility of the seeds affected dispersal. No significant difference was found between data collected on the first and second days except for 1.25 m ($p=0.0201$) and 2.00 m ($p=0.0011$). This suggests the possibility that the age of the seeds could have had an impact on the dispersal distance in certain cases. It should be noted that the degree of confidence in these p-values is low due to small sample size.

Further research is needed to determine the dispersal ratios of *Tabebuia rosea* seeds dropped from heights that more closely represent the natural range of heights for seeds on *Tabebuia rosea* trees. Further, the effect of wind on the dispersal of these seeds should be investigated.

Conclusion

Tabebuia rosea seeds showed a constant dispersal ratio of 0.16 m/m when dropped from heights ranging between 1.00 and 2.00 meters when there is no wind. This suggests that as the tree increases in height, it increases the distance over which its seeds are dispersed in a linear fashion. Greater height could increase its odds of successfully passing on its genes to a new generation of *Tabebuia rosea* trees. Overall, the total seed length and the asymmetry of the wings of the *Tabebuia rosea* seeds was shown to have no effect on the dispersal ratio. Within the range of variation found in the seed samples, variation in wing symmetry and total seed length does not affect the distance seeds would disperse, and would therefore not be influenced by selective pressures. It is currently not known whether these variations play an important role in dispersal under windy conditions.

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