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The Number of Segments on a *Culsia rosea* Seed Capsule

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Math 472 (Statistical Inference)

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Culsia rosea (*C. rosea*) is a tree native to the Caribbean. It produces apple-sized fruits which, after ripening, become eye-catching seed capsules with multiple segments. By examining the seed capsules, we see a direct correlation between the number of seed capsule segments and the amount of seeds that each seed capsule contains.

C. rosea is invasive to Hawai'i and work on its management is unknown. Intuitively, a possible way to combat the spread of *C. rosea* is to reduce the number of seeds that each tree produces. This process will require knowing the mean number of segments per seed capsule, however this has not yet been determined.

In this paper, we counted the number of segments from a random sample of fallen seed capsules collected from three locations. We assumed that for each location the number of segments per seed capsule follows a normal distribution. Hence, we used an Analysis of Variance (ANOVA) and Tukey's range test to assess the null hypothesis that the mean is the same for each location. After performing these tests, we rejected the null hypothesis and we recommend further research into what may have caused the means to be different.

C. rosea

In Hawai'i, *C. rosea* is a popular ornamental tree and is commonly planted in parking lots and residential areas [3]. It is an epiphyte like the strangler fig, and *C. rosea* can quickly spread from initial plantings to surrounding areas [3]. The tree can grow up to 65 feet tall and is commonly found in lowland forests and along roads [1].



Figure 1. Map of Oahu. The three locations are the pins.

Table 1. Approximate coordinates of each location.

Location	North	West	Elevation (ft.)
UHM	21°17'39.14"	157°49'4.20"	20
Pali Hwy	21°19'25.01"	157°50'46.71"	185
KCC	21°16'18.29"	157°47'54.88"	176

Methodology

In March and April of 2016, we collected samples from *C. rosea* trees in three locations: on the campus of the University of Hawai'i at Mānoa (UHM), a lookout along Pali Highway near Kapena Falls (Pali Hwy), and a parking lot at Kapi'olani Community College (KCC). These locations were chosen because of their differences in elevation, surrounding vegetation and general environments.

Using Google Earth, we determined the coordinates for each location. They are displayed on Table 1.

At each location, we gathered *C. rosea* seed capsules from the ground. Figure 2 is one such capsule.

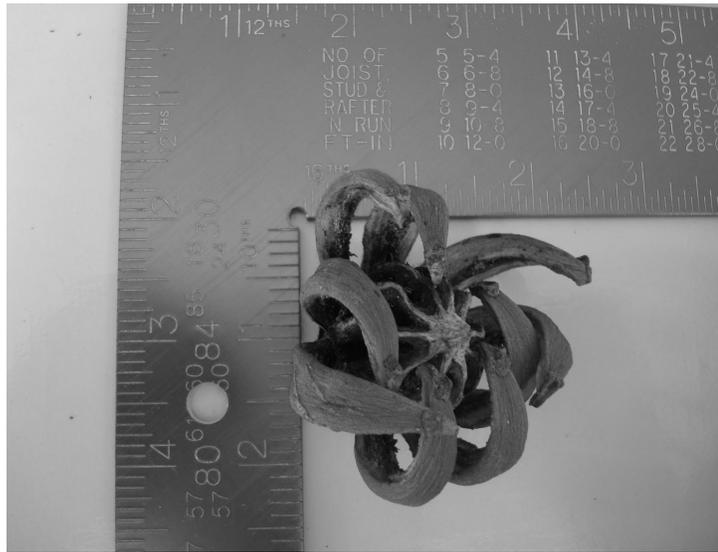


Figure 2. Fallen *C. rosea* capsule collected from Pali Hwy

Next, we counted the number of segments on each seed capsule and logged it onto a Microsoft Excel spreadsheet. We then exported the Excel spreadsheet as a CSV file and used R version 3.2.4 to perform the statistical analysis. We decided to use ANOVA and Tukey’s range test.

In order to use ANOVA, one needs to have more than two normal distributions with the same true variance [2]. ANOVA checks the hypothesis that the true means of the normal distributions are equal [2].

Afterwards, the Tukey's range test was used in conjunction with ANOVA to compare two locations to each other. It is similar to the t-test and will show us which two locations have similar true means.

For these tests, we assumed a 95% confidence level. Statistically, this means that we will incorrectly conclude that the true means of the normal distributions are not equal 5% of the time.

Finally, this document was created using Microsoft Word from Microsoft Office 365 version 16.0.7070.2033.

Results

First, Table 2 summarizes the collected data. The observations ranged from six to ten and Figure 3 shows the density of each observation.

Table 2. Summary of collected data

Location	Number of Samples	Sample Mean
UHM	12	8
Pali Hwy	117	8.19
KCC	70	7.47
Total	199	7.92

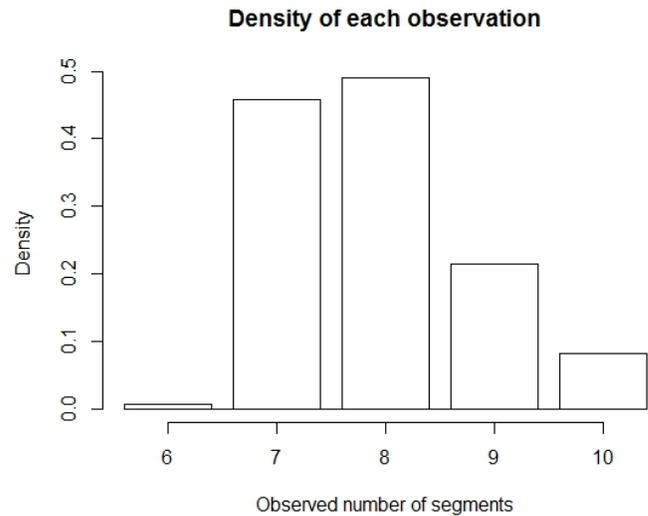


Figure 3. Histogram showing the density of each observation.

After running the ANOVA test, we get a large F value of 15.873. The large F value tells us that one location has a true mean that is statistically different from the other locations. We then run Tukey’s range test to find which location is different. The results of the Tukey test are summarized in Figure 4.

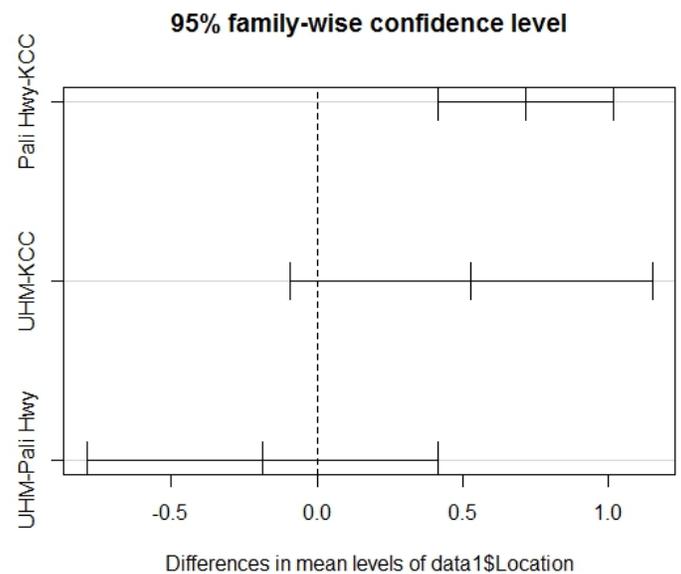


Figure 4. Plot of Tukey test.

Conclusion

Since we assumed a 95% confidence level, the F value of the ANOVA test will be 3.04 if the true means of each location are equal. The F value from our ANOVA test is 15.87. Since 15.87 is greater than 3.04, we reject the hypothesis that the true means are equal. That is, we conclude that the mean of at least one location is different from the others.

Each of the three horizontal lines in Figure 4 is a confidence interval representing the difference in the true means between two locations. The top line represents the comparison between Pali Hwy and KCC. Since this interval does not contain zero, we conclude that these two sites are significantly different. On the other hand, zero is close to the middle of the bottom line. This shows that UHM and Pali Hwy locations are similar.

Future Work

The rejection of the hypothesis that the true means are equal leads us to wonder why the means are different. Perhaps there are differences in the water availability, soil composition and other biological factors. A comprehensive ecological experiment is recommended to explore the similarities and differences between each habitat and tree. The results of such an ecological experiment

could become a basis for ways to combat the spread of *C. rosea*.

This experiment looked at three sites in the Honolulu area. In order to get a better idea of the mean number of segments of *C. rosea* seed capsules, we would like to see this experiment expanded to other parts of O‘ahu and possibly the whole state of Hawai‘i.

Finally, a key assumption in our experiment is that the number of segments of *C. rosea* seed capsules follows a normal distribution. A future experiment could instead seek to find the mean number of segments assuming that it follows a different distribution, the Poisson distribution.

References

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