Oophaga pumilio:

Population Estimates in Two Different Forest Habitats on Ísla Cólon, Bocas del Toro, Panama

Abstract

We studied frog populations of O. pumilio at two different rain forest sites near the Institute of Tropical Ecology and Conservation research station on Boca del Drago on Ísla Colón, Panama. A mark/recapture study was carried out in two different forest sites varying in surrounding plant maturity. Frogs were found to populate the older forest site more than the younger, despite the numerical difference in populations being found insignificantly different.

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Introduction:

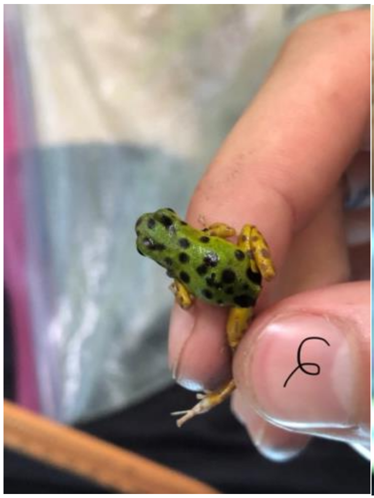
Janzen (1983) provides the following background information on *Oophaga pumilio* a poison dart frog species native to Costa Rica and Western Panama. It is a commonly occurring species in rainforests, brightly colored green and yellow, and only slightly poisonous. Its poison is used to poison the tips of certain peoples' blow darts hence the common name 'poison dart frogs'. Male frogs are very territorial and defend their individual plots from intruders. They are identifiable via their green vocal sac located used for mating calls to attract female frogs. *O. pumilio* are dependent on tree epiphytes called bromeliads to reproduce and nurture their offspring. After a female frog's eggs are fertilized, the resulting tadpoles will be carried up to the water filled bromeliads high in the trees. The tadpole stays in the bromeliad and eats unfertilized eggs provided by the mother frog. Populations of O. pumilio will vary in size depending on the resources available to them within in a given area. These resources include leaf litter, specific vegetation, and bromeliads.

Based on the greater abundance of these resources in the mature forest plot, we hypothesized a higher number of frogs there. Despite the displacement of resources, we did not know how many frogs would be recaptured our second day and wanted to see if our hypothesis would be supported. Through this experiment, we wanted to see if frogs prefer a more mature habitat than a less mature and if the overall plant growth would dramatically increase or decrease the frog population.

Materials:

- Calculator
- Compass
- 8 Flags (4 for each plot)
- Ruler
- Stick
- Ziploc bags
- Caliber

Methods:



a. Setting up plots:

To get a sample population of the frogs in each forest, we created two random plots in the forests in which to run our experiment. We used a calculator to generate a random number that dictated the angle stemming from the forest path to fall in line with a boundary line of the plot. We then randomized another number to determine how many steps to take off the path to the first corner of the plot. From the first corner, we walked ten meters forward following the same angle trajectory and marked the last two in parallel with the previously set up boundary line. The first plot set up in the immature forest was dry, green, and let in a lot of sunlight. The second had less sun, more developed plant life, and was generally damper. Both sites contained trees with buttresses which housed a large portion of the frogs we collected.

b. Catching:

Our first day of actively experimenting consisted of searching for and catching as many frogs as possible in 45 minutes at each site. Each of us carried a Ziploc bag to hold our collected frogs until the 45 minutes elapsed. After catching, we tagged each frog by photographing the spot pattern on the backs of each frog and numbering them. Body length and sex of each frog was also recorded. After processing the frogs, we released them all together in the center of the plot.

c. Recapturing:

To recapture, the same procedure was followed at each frog site. Once captured, we visually matched each frog with the pictures of those that we caught the previous day or recorded it as a "new frog". Again, all frogs were released in the center of both plots concluding our active experiment.

d. Comparing plots:

After completing our experiment, we compared the resources included in both plots that allow a higher abundance of *O. pumilio* population. The three resources measured were leaf litter, number of bromeliads, and number of dieffenbachia plants. We counted visible bromeliads on trees located within the plot boundaries. We had to settle for an estimate of number of bromeliads as many were not visible due to tree growth. To count the number of dieffenbachias, we stood in a four-person, horizontal line along one boundary line of the plot. We then walked forward, counting the number of plants we saw. In order to measure average leaf litter in each plot we used a straight stick and a ruler to determine the thickness of the litter above the surface. The stick was randomly placed slightly outside the plot boundaries to account for our compacting of the surface leaves within the boundaries in 10 different locations. At each location, the ruler was pressed as far down to the ground as possible. The number where the stick touched the ruler was the determined leaf litter at that spot. Each of those 10 numbers were averaged to acquire an average leaf litter of the plot.

Table 1: Frogs collected at immature forest site (first day of collecting):

Frog #	Sex	Body Length (Cm)
1	M	17.5
2	M	18.5
3	F	18.5
4	F	18
5	F	19
6	F	18
7	M	19
8	F	17.5
9	M	18
10	M	17
11	F	16.5
12	M	17.5

Table 2: Frogs collected at immature forest site (second day of collecting):

Frog #	Sex	Body Length (Cm)
N1	F	17
10	M	17
9	M	18.
5	F	19
N2	M	17.5
4	F	18
N3	F	18.5
N4	F	17.5
N5	M	17.5

N6	M	17
N7	M	18.5
8	F	17.5

New frogs are notated as N1, N2 etc.

Table 3: Frogs collected at mature forest site (first day of collecting):

Frog #	Sex	Body Length (Cm)
1	F	17.5
2	F	17
3	M	17.5
4	M	16.5
5	M	17
6	M	17
7	M	17
8	M	17.5
9	M	17
10	M	17
11	M	18
12	M	17.5
13	F	17.5
14	M	17

Table 4: Frogs collected at mature forest site (second day of collecting):

Frog #	Sex	Body Length (Cm)
N1	M	17.5
N2	F	14.5
N3	F	17
13	F	17.5
N4	M	19
N5	M	18
10	M	17
N6	F	18.5
N7	F	18.5
N8	M	18.5
2	F	17
4	M	16.5
9	M	17
N9	M	17.5

Results:

Table 5: Overall Data

	Plot 1 (Immature)	Plot 2 (Mature)
Day 1	12	14
Day 2	12	14
Recaptures	5	5

Using Bailey's Method, we were able to calculate an estimation for the population size of frogs at each site.

Bailey's Method:

Population Estimate $= \frac{r(n+1)}{m+1}$ where…

r = number of frogs marked on day 1

n = total number of frogs caught on day 2

m = number of recaptures on day 2

An estimate of 26 frogs were determined to be inhabiting the 10x10 plot in the younger (immature) forest site and 35 were estimated to be inhabiting the 10x10 plot in the older (mature) forest site. On average, female frogs collected in the immature forest site measured 17.833 cm while males measured 17.8 cm. At the mature site, the females averaged 17.21 cm in body length while the males were 17.47 cm. The immature forest site averaged 4.1 cm in leaf litter while the mature forest averaged at 2.95. To end our calculations, we also completed a Chi Squared test which gave us a p-value of .24, which is greater than the baseline of .05 that determines if the difference in populations is significant or not.

Discussion:

Statistically, the two forest sites demonstrated an insignificant difference in population size through our experiment. Despite this, more frogs are estimated to populate one plot than the other. It can be speculated that this difference in population may be due to the number of bromeliads present in the trees within the plot boundaries.

O. pumilio are dependent on bromeliads to reproduce and nurture their offspring. After a female frog's eggs are fertilized, the resulting tadpoles will be carried up to the water filled bromeliads high in the trees. The tadpole stays in the bromeliad and eats unfertilized eggs provided by the mother frog (Janzen, 1983). Because bromeliads are so integral to the continuation of any given *O. pumilio* population, it makes sense that more frogs inhabit the plot with more bromeliads. Positive correlations have been found between tree surface area to number of bromeliads (Merwin et al, 2003). This reinforces our findings in that the mature forest with larger, more developed trees was the same forest plot with more bromeliads and therefore the one that we determined has a larger *O. pumilio* population.

In addition to bromeliads, leaf litter was another plot attribute we compared between the two sites. This refers to the average elevation of leaves from the surface floor inside the plot. This typically is a significant factor to the frog populations as leaves serve as deposition sites for mating frogs. We found a greater average at the younger site despite the lower frog population. Initially, we presumed this meant the litter was disguising the frogs from us and we were unable to catch them. However, frogs do not typically react to intruders by hiding so this was discredited. Leaf litter most likely did not contribute to the mature site housing more than the immature.

Dieffenbachia plants are another factor in frog population that we observed and compared between the two sites. Frogs use the stems of the plants as deposition sites to protect their eggs as the stem has a hollowed-out portion that the frogs keep their offspring inside of 21 *Dieffenbachia* plants were found in the mature forest site and 22 were found in the immature. This correlation did not separate the two forests or provide an additional reason for why more frogs were estimated to be inhabiting the older forest.

Our calculations suggest that there is no significant difference in the population between the two sites despite a difference in the two numbers representing the two populations. However, we can argue that if we had more sample sites, we might have been able to come up with a larger p-value, which would indicate a more significant difference between the two sites' populations of frogs.

Conclusion:

While not being significantly different, we estimated a larger number of frogs inhabit the older forest than the less mature forest. If this estimate were borne out by further studies, we believe this might be credited to a greater number of bromeliads in the trees at the particular site where more frogs were collected. This observed difference also could correlate to the age of the forest and the corresponding tree growth of the mature forest. As stated, an older, more developed forest will yield larger trees and more developed plants. Greater surface area on tropical trees has been proven to correlate with more bromeliads (Merwin et al, 2003). This might increase the sustainability of a large population of frogs and could be a reason for the larger sample size found at the older forest site. Because we looked into the populations at only two sites, we were unable to determine if the difference in bromeliads is a significant contributor to the difference in number of frogs and cannot definitively state that would be the reason between the population estimates for the two sites.

Works Cited

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