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Effect of Color and Territoriality on Hummingbird Visitation to Feeders in Monteverde, Costa Rica.

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ABSTRACT

Many plants evolve to specialize in attracting hummingbirds by using color, timing, and flower shape. Depending on the quality and quantity of flowers some species of hummingbirds become very territorial and protective of the area. Using three different colors, I studied which color was preferred by the hummingbirds and if there was a preference in the position of the feeder. A common belief is that red is the most favored color of hummingbirds. Another factor observed was territoriality. Its affect on other hummers' visitations and color preference was noted. The movement of feeders and territoriality was also studied. Only one species significantly preferred red, while the others did not have a significant preference between red and white. Blue was disfavored, possibly due to its visibility in contrast with green. A dislike of the center feeder over the left and right feeders was also discovered, most likely due to the vulnerability of the location. The territorial bird pushed the other birds to the inside of the forest, and all of the feeders on the forest edge were still protected after an alteration in location.

INTRODUCTION

Over time plants evolve to attain characteristics that attract the most reliable pollinators. Such pollinators are hummingbirds (Miller, 1971). These small birds play a major role in the pollination of numerous plants such as the *Heliconia* (Grant, 1966). Braving the rain and the cold makes them preferable over insects, such as bees and butterflies (Fogden *et al.* 2005). The reliability of their pollinating capability leads plants to specialize in attracting hummingbirds (Stiles, 1976).

Bird pollinated flowers do not necessarily need to produce a scent, since birds have a poor sense of smell. Flowers that are tubular, odorless, diurnal, produce a significant amount of nectar, and reflect colors on the long-wavelength end of the visual spectrum are specialized to attract hummingbirds (Stiles, 1976). These birds are said to prefer red flowers and bracts over all other colors (Miller, 1971). There are investigations, though, that do not uphold this belief (Grant, 1966).

Some species of hummingbirds are very territorial over a specific area of flowers (Long 1997). They will perch in their territory and chase off trespassers of any species, even insects. Their beak is used as a weapon to peck or stab their competition (Long, 1997). In gaining healthy territory males have a better chance of reproducing (Long, 1997). How a hummingbird chooses a flower determines what visual cues flowers will evolve to possess. The preferred color will get more visits, and therefore a higher chance of reproduction. If plants did not evolve to maximize their reproduction and fitness they would eventually become extinct.

The main objective of this study is to observe which color hummingbirds prefer. Although it is commonly believed that red is the favorite color of these birds this experiment is designed to prove if this is true for hummingbirds in Monteverde and to show how other colors compare to red. This will help us to possibly understand why red, or the preferred color, is the favored color. Another part of this study involves the territorialism and its effects on other hummingbirds in the area.

METHODS

STUDY AREA AND SAMPLING METHOD—The biological station in the cloud forest of Monteverde is located in the premontane wet forest life zone. It has two main seasons; a wet season/winter (May-November) and a dry season/summer (December-April). This study takes place during the wet months of July and August.

The bases of six feeders were painted using spray paint and Wite-Out®. Two were painted blue, another two red, and the last two white (Fig. 1). Filled with a four to one mixture of water and sucrose (18oz:4.5oz), one of each color was hung on a string on the forest edge as well as inside the forest. Therefore there were three different colored feeders at each site. Over six days the number of hummingbird visits to each feeder was observed and noted. The colors were rotated each day to avoid the data from being affected by favoritism towards a certain location. Feeders were observed at the same time for three hours every day in both sites. The time slots for the locations were alternated each day. One day the feeders inside the forest would be observed first and the following day they would be observed second.

For the last two days of the study, the blue and white feeders on the forest edge were moved to a location between the next set of trees to the right of the initial location (Fig. 1). This allowed for the observation of the territoriality of an individual hummingbird. The visitations to each color as well as each position were noted. To test differences between colors and sites the significance of the data the Freidman tests and Paired T-tests were performed, respectively.



FIGURE 1. Comparison of the original setup of inside the forest (same as original forest edge) to the second setup at the forest edge. **RESULTS**

A total of four species of hummingbirds visited the colored feeders over the six day period. The Violet Sabrewing (77 visits), Green-crowned Brilliant (94), Stripe-tailed (84) and Green Hermit (143). It was found that only the Green-crowned Brilliant had a significant preference for red (Figure 2) (Friedman test, GCB: $df = 2, P = 0.0095, \chi^2=9.307$; VS: $df = 2, P = 0.3849, \chi^2=1.909$ $df = 2$; ST: $P = 0.3823, \chi^2=1.923$; GH: $df = 2, P = 0.3114, \chi^2=2.333$).

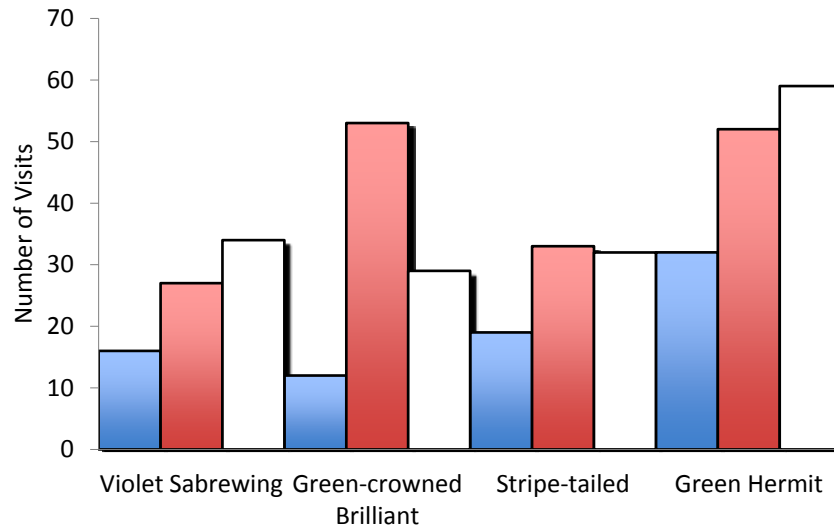


FIGURE 2. Number of visitations of each species to the different colored feeders both inside the forest and on the forest edge.

The feeders began with 264mL of the sucrose water mixture. After the data for Day 3 was taken it was noted that the red feeders had lost the most amount of sucrose solution (in forest: 222mL; edge:208mL), the white lost the second most (in forest: 134mL; edge: 192mL) and the blue had lost the least (in forest:113mL; edge:74mL).

POSITION OF FEEDER – There was an apparent preference for the position of the feeder; counting only the first 4 days. It was evident that the hummingbirds, as a whole, disfavored the center. No apparent trend was visible relating color and position except that there were no visits to the feeder on the left when it was blue (Figure 3).

Table 2. Number of visits of the Green-crowned Brilliant to the feeders on the forest edge.

Feeder Color	Blue	Red	White
Total Visits	5	32	17

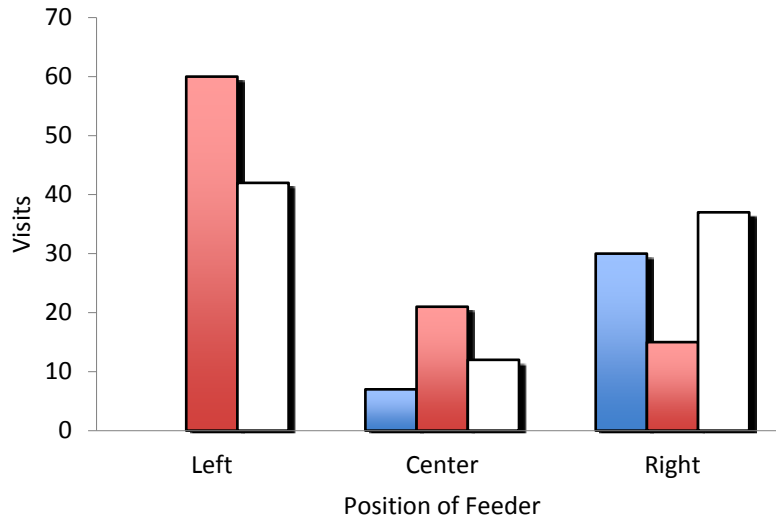


FIGURE 3. Distribution of visitations to each color in the three different positions by 4 species of hummingbirds (Violet Sabrewing, Green-crowned Brilliant, Stripe-tailed, Green Hermit) .

EDGE VERSUS INSIDE THE FOREST AND TERRITORIALITY— On Day 5, the positions of the feeders on the forest edge were altered to test the territorial reaction of a single Green-crowned Brilliant that dominated the three feeders. The red feeder was placed in the left position while the blue and white feeders were moved between two different trees farther to the right.

A significant change in visitations inside and at the forest edge was noted (Paired t-test $df=5$, $t=3.92$, $P=0.011$) for the GH, he preferred the inside. This was not found for the rest of the hummingbirds, but an interesting trend was found. By Day 3 the number of hummingbirds in the forest, began increasing, while the number at the forest edge decreased.

Using the Green Hermit as an example (Figure 6), it was observed that there were initially more visits at the forest edge by the Violet Sabrewing, Green-crowned Brilliant, and Stripe-tailed than inside the forest.

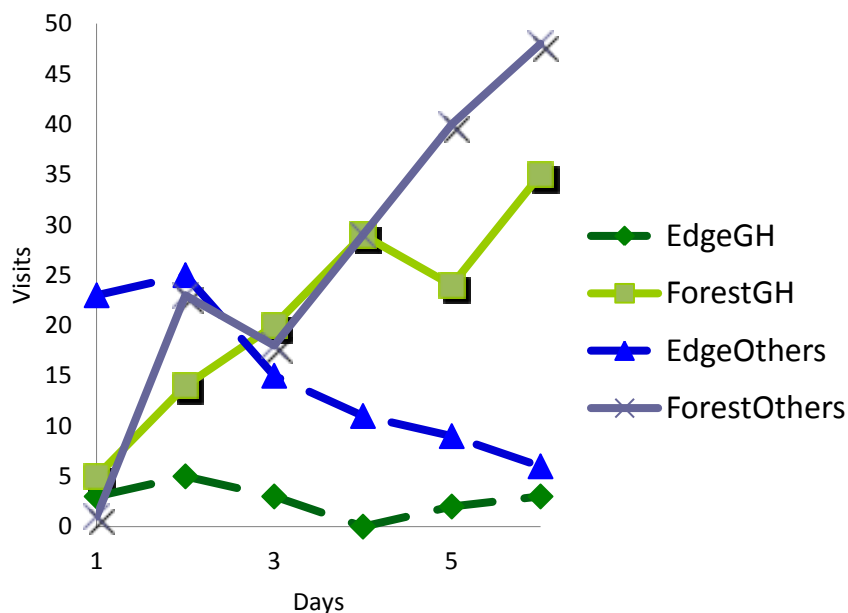


FIGURE 4. Comparison of the number of visitations of the Green Hermit and the total amount of visits by the other species both inside the forest and along the forest edge. The others include the Violet Sabrewing, Green-crowned Brilliant, and Stripe-tailed hummingbirds.

DISCUSSION

COLOR PREFERENCE—According to Stiles hummingbirds prefer brightly colored, un-patterned flowers (Stiles 1976). It was visible that red and white were preferred over blue, though it was only statistically significant for the GCB (Fig. 2). Additional observations could have given enough data to make the color preference of the hummingbirds noteworthy. The red contrasts the green of the surrounding environment (grass, trees, etc.) more so than blue. On the color wheel green is directly across from red, and next to blue. Therefore the colors of the feeder could be preferred by how easily they are seen in contrast to their background, which in nature is usually green (Grant 1966). It is also suggested that hummingbirds are colorblind to the blue end of the color spectrum or they could be more sensitive to red and yellow than humans (Grant 1966). Another suggestion is that red is the least favored color least liked by insect pollinators, the competitors of hummingbirds (Grant 1966). Some studies also suggest that color is not their first determinant. It is possible that the flow of nectar is the most important determinant, followed by the concentration of sugar, then the color (Stiles 1976).

POSITION PREFERENCE—The preference that hummingbirds had for the position of the feeder was most likely related to how safe the feeder was. The left and right feeders were both close to a tree while the center feeder was more vulnerable due to lack of tree coverage. The

territorial GCB also could have affected the feeder visitations by guarding a particular position more so than the others. This did not affect the data for color preference though because of the even rotation of the colors each day.

EFFECTS OF Territoriality— Though small, these birds are aggressive when it comes to defending their territory. They will guard their flowers and chase off trespassers, even insects (Long 1997). On the forest edge a single (most likely) Green-crowned Brilliant began chasing off other hummingbirds on Day 2. By Day 3 the GCB had significantly shifted the majority of birds from the forest edge to inside the forest (Figure 4). On Day 5 the white and blue feeders were moved to a new location (Figure 1) to see if the Green-crowned Brilliant would still protect them. This hummingbird continued to guard all of the feeders, but more so the red than the others. In nature territoriality can be bad for the plants because it leads to self-pollination. The hummingbirds guard the flowers in order to attract females (Long 1997). For most cases the most brightly hummingbirds are the most territorial (Long 1997).

The color preference of the birds could have been presented more strongly with additional data, possibly an additional week of observations. Marking the hummingbirds would have also been helpful in retrieving more accurate data and deciphering repeat visitations. Red, as expected, was the favored color for only one species of hummingbird, though it was closely followed by white. Blue proved to be the least favored color. The center was the least favored position, most likely due to its lack of cover and protection from predators. It was observed that hummingbirds' territories can expand and/or be altered and the bird will still protect the area. This may not have occurred inside the forest because it was easier for the hummingbirds to hide in the trees.

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