FACTORS AFFECTING NECTAR ROBBERY IN TWO SPECIES OF HUMMINGBIRD POLLINATED FLOWERS OF SIMILAR COROLLA LENGTH

Jennifer L. Burnaford, Catherine N. O'Neill, and Jon A. Rettmann

Abstract. A study in Monteverde, Costa Rica of two flower species with similar corolla lengths showed that nectar robbery was significantly more frequent in a red flower, *Razisea spicata*, than in an unknown species of orange flower. Three possible explanations for the difference were examined: corolla length, species density, and nectar concentration. Judging by the length of the fused corolla, a short-billed hummingbird would not have the ability to drink the nectar from either flower without using a robbery technique. This implies that some other factor must be affecting the differential selection of flowers for robbery. No correlation was found between the overall density of the two flower types and robbery frequency, but the nectar of the orange flowers had a greater sucrose concentration than did the red flowers. Perhaps the long-billed hummingbirds out-compete the short-billed robbers for the sucrose-rich orange flowers, making it worthwhile for the flowers to invest in high-sucrose nectar to ensure their pollination. (CNO)

INTRODUCTION (JAR)

Hummingbird bill shapes often correspond to particular flower morphology (Stiles and Skutch 1989). Flowers with long corollas are typically used by long-billed hummingbirds, as short-billed hummingbirds are unable to access the nectar in the deep floral tube. Some short-billed species, however, have overcome this obstacle by piercing the base of the corollas and robbing the nectar. By using this method, the hummingbird does not contact the anthers or stigma and fails to pollinate the flower. This is an obvious cost to the flower, as it loses nectar without being pollinated.

Previous studies at the Monteverde Cloud Forest Reserve have shown that the frequency of nectar robbery is positively correlated with corolla length (Mattoon, et al. 1991). In the present study, we examined two different species of flowers with similar corolla length to determine if the frequency of robbery varied between flower species. The two study species, *Razisea spicata* and an unidentified species with orange flowers (Species B) were both members of the family Acanthaceae. Both species had corollas longer than the 25mm maximum limit for feeding by short-billed hummingbirds (Feinsinger 1986). We hypothesized that if differences existed in the frequency of nectar robbery between the two flower species, it would be due to differing sucrose concentrations in the nectar and/or varying density between the two types of flowers. We predicted that a flower with a higher concentration of sucrose in the nectar would be robbed more frequently and that patches with high densities of flowers would have a higher frequency of nectar robbery due to the increased attraction of short-billed hummingbirds to the patch.

METHODS (JLB)

This study was conducted along a 234m path leading to the Bull Pen on the Campbell Farm, Monteverde, Costa Rica. This is the only location in Monteverde where Species B was found. Data were taken on two species of flowers (*Razisea spicata* and Species B). Flowers found within three meters of either side of the path were studied.

All flowers of the two species within the limits were counted and scored for presence or absence of a small slit at the base of the corolla, used to indicate robbery. Density data were taken for 36 square-meter plots at 12m intervals along the path. Local density measurements, using each flower as a focal point, are more accurate indicators of neighborhood density (Feinsinger 1986) but time constraints prevented using this technique. In each transect, total number of flowers and number of flowers robbed were recorded.

Inflorescences outside the study plot were chosen for nectar analysis to minimize damage due to handling. Inflorescences were enclosed in clear plastic bags (tied around the stem). After 24 hours nectar was collected with a capillary tube and sugar content analyzed in the field with a refractometer. Nectar was summed for each inflorescence to obtain adequate quantities for analysis.

Because the corolla of species B was partially split, two measurements of corolla length were taken: total length from base of petals to end of lip and fused corolla length from base of petals to bottom of lips. As the *R. spicata* corolla is entirely fused, only one measurement for corolla length was taken, from the base of the petals to the top of the petals. Thirty flowers of each species were measured.

RESULTS (JAR)

We found that 55% of the *R. spicata* flowers examined were robbed, compared to 10% of species B flowers (Table 1). These differences were significant (χ^2=33.1, p<0.005). The mean sucrose concentration of *R. spicata* nectar was 16.8±1.9% (n=18, range=10.5-19.0%) sucrose, while species B averaged 20.5±2.5 (n=5, range=18.0-24.75%) sucrose (Table 1). The sucrose concentration of *R. spicata* nectar was significantly lower than that of species B (t= -3.58, p<0.01).

Table 1. Comparison of study parameters between *R spicata* and Species B.

		R. spicata	Species B
Total corolla length	mean	47.8 mm	52.5 mm
	s.d.	5.1	3.8
	#flowers	n=30	n=30
Effective corolla length	mean	-----	29.4 mm
	s.d.	-----	3.1
	#flowers	-----	n=30
%Sucrose in nectar	mean	16.8%	20.5%
	s.d.	1.9	2.5
	# flowers	n=18	n=5
%of Total Flowers Robbed	% robbed	55%	10%
	#flowers	251	69

The mean corolla length of *R. spicata* was 47.8mm, while the mean length of the lower portion of species B's corolla was 29.4 mm and the mean total corolla length was 52.5mm (Table 1). The corolla length of *R. spicata* was significantly shorter than the total corolla length of species B (t=-4.05, p<0.001) and significantly longer than the lower portion of species B's corolla (t=16.89, p<0.001).

Total flower densities (*R. spicata* and species B combined) ranged from 0.03 flowers/m^2 to 1.92 flowers/m^2. A Spearman rank correlation comparing density and frequency of robbery (both species combined) showed no significant correlation (r=0.050, p>0.05). It should be noted that Spearman rank correlation coefficients are typically used when the sample size is ≥10—our

sample size was 9. Small sample sizes prevented analyses comparing total flower density to frequency of conspecific robbery.

Discussion (CNO)

We studied three variables (flower patch densities, nectar sucrose concentrations and corolla lengths) that could affect the different frequencies of nectar robbery in two flower species. We found that the density of total flowers in a plot and the frequency of robbery of these flowers were not significantly correlated. Although previous studies have shown that the number of flowers foraged on by birds increases with the density of flowers in a patch (Bertin 1989) this does not seem to apply to hummingbird nectar robbery of the two flower species that we studied. If more of the orange flowers could be found, the single species density effects on nectar robbery frequencies could perhaps be determined more accurately.

Contrary to our expectation that the species with higher sucrose concentrations would have a higher frequency of nectar robbery, the orange flowers had a sucrose concentration higher than that of the red flowers. Perhaps the long-billed hummingbirds prefer the orange flowers and deplete the nectar in them, making it less energetically profitable for the small-billed birds to rob the orange flowers.

Finally, the corolla lengths of the two flower species differed in an important way, namely that the corolla of the orange flower was not completely fused. Perhaps a short-billed hummingbird could push the petal lips apart, reaching the nectar without resorting to robbery. Feinsinger, et al. (1986), however, classified flowers as accessible to short-billed hummingbirds if they had a maximum corolla length of >25mm. Since the orange flowers had corollas fused to a mean length of 29mm, it seems unlikely that the shortened fused corolla length in the present case explains the differential nectar robbery.

Several other factors, untested in this study due to time constraints, may also affect the number of robberies on each of the flower species. Abiotic factors, such as time, temperature, soil and sun, were controlled for in this experiment by using flowers from the same area. Age, color and fragrance may attract hummingbirds differentially. Other aspects of the flowers' morphologies should be tested to explain the difference in the frequency of nectar robbery of the red and orange flowers.

Literature Cited

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