comes harsher, better adapted species will replace more poorly adapted ones.

Both of these aspects of plant community change in response to a harsh environment were probably prevalent in this study. However, because we did not identify the species at each site, we were unable to quantify the species compositional changes. Qualitative observation showed that, in our quadrats, species in all size classes differed between the two sites. Two species seemed the most prevalent on the ridge: a tree species that at the lower site was above our sampling size, and an herb that covered the ground almost 100% in many cases. No single species seemed to be prevalent at the lower site.

Another observation we made was that Melastomes seemed to dominate the ridge top community, whereas they were much less dense in the lower area. This implies that either the family is well adapted to stressful environments, or that the species in this family are very common everywhere, with a few able to thrive in high wind and sun. It would be useful to look at the percentage of species that are Melastomes and the species diversity in the two areas, to gain further insight into the response of Melastomaceous to increased environmental stress.

DIURNAL FEEDING PATTERNS OF TWO HUMMINGBIRD SPECIES: *CALLIPHLOX BRYANTE* AND *CAMPYLOPTERUS HEMILEUCURUS*

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Abstract. This study examined the effect of temperature on the time spent foraging at an artificial feeder by two species of hummingbird in Monteverde, Costa Rica. Although foraging time did not decrease as temperature increased, as predicted, it did decrease significantly over the course of the day. A comparison of the two species indicates that the smaller Magenta-Throated Woodstar (*Calliphlox bryante*) dipped into the nectar source significantly more times on each visit than did the Violet Sabrewing (*Campylopterus hemileucurus*). However, the Sabrewing made more visits per unit time. Because we did not know the size of each population, no conclusions could be made about the number of times each species utilized the nectar source. (KAI)

INTRODUCTION (KAI)

The hummingbirds which live in the cloud forests of Monteverde experience lower temperatures than those which exist at lower altitudes. Due to their high metabolic rate, they must spend a large portion of their time foraging in order to obtain sufficient energy (Kircher 1989). We questioned whether, as temperature changed over the course of the day, hummingbirds would exhibit a detectable change in time spent feeding. In a related manner, we examined the effects of body size and foraging techniques on the relative time spent feeding during the day. We examined two species of hummingbirds which differ in their method of foraging: the Violet Sabrewing (*Campylopterus hemileucurus*) a large (11.5g) bird which perches while feeding, and the Magenta-Throated Woodstar (*Calliphlox bryante*), a small (3.5g) hovering feeder. Based on body size, would we expect the Sabrewing to feed more total, or perhaps per unit body weight? However, according to Feinsinger (1987) "the mode of locomotion employed during foraging (hover flight, flapping flight, or landing) affects the total energy expended and therefore required." We therefore wondered if the smaller Magenta-Throated Woodstar wood require more energy and thus consume more nectar than the larger, perching Violet Sabrewing.

METHODS (SAW)

This study was conducted on the grounds of the Hummingbird Gallery, near the Monteverde Cloud Forest Reserve, Costa Rica. For half an hour of every hour, from 0730-1800 on 16 January 1992 and from 1230-1700 on 17 January 1992, we observed the feeding behavior of two species of hummingbirds at two of the pre-existing feeders at the Gallery. For the two species, we recorded the number of visits of individuals of each species, the number of dips into the feeder during each visit, and the total number of seconds spent dipping during each visit. A visit was defined as the period during which a bird would leave its perch in a nearby tree, hover around or land on one of the two feeders, and then return to the vegetation. At the beginning of each half

hour session the air temperature was recorded.

With this data, we calculated the total time spent feeding at the two feeders by all the individuals of each species per half hour session. We made the assumption that the number of individuals of each species visiting the feeders remained constant over the course of the day. However, we could not assume that the population size of birds visiting the feeders was the same for both species. We also assumed that the length of each dip into the feeder was an indication of the amount of nectar consumed and that all individuals of each species consumed nectar at the same rate. Finally, we assumed that the feeding behavior of the birds at these two feeders was an indication of their behavior at any other artificial feeder.

Table 1. Comparison of feeding behavior between the Violet Sabrewing and Magenta Throated Woodstar.

	Sabrewing	Woodstar
# of dips per visit	n=10, mean = 2.3±0.5	n=10, mean = 6.7±1.9
Total visits per session	n=10, mean = 37.4±7.4	n=10, mean = 14.9±6.0

Results (JVK)

The total time spent feeding per half hour period was negatively correlated with time for both the Violet Sabrewing (Figure 1; r=-0.81, p<0.01) and the Magenta-Throated Woodstar (r=-0.64, p<0.02) on the first day of observation. Combining the data from both days, we found no significant correlation between total time spent feeding and temperature for either species (Sabrewing, r =-0.08, p>0.05;

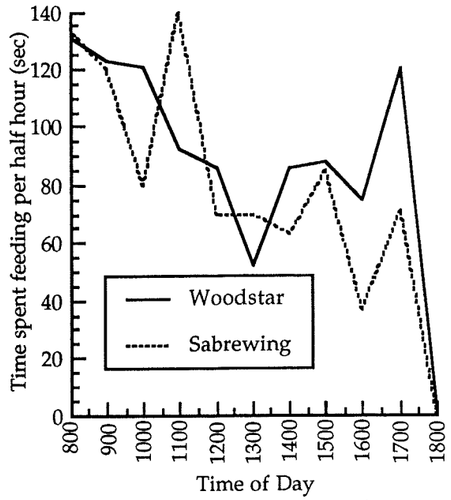

Figure 1. Changes over one day in hummingbird feeding time.

Woodstar, r=-0.07, p>0.05). Woodstars made significantly more dips per visit (Table 1; t= 7.22, p<0.001) while Sabrewings made more overall visits per half hour session (t=3.47, p<0.01).

Discussion (JJS)

Although we found no correlation between feeding time and temperature, the range of temperatures observed (3.5°C) was probably insufficient to discern any relation. However, feeding time did significantly decrease throughout the course of the day for both species. Although we are unable to compare the slopes of these lines because we could not calculate a model II regression, the implications of the correlation are nonetheless interesting. In most hummingbird pollinated flowers, nectar production decreases after daybreak (Gill 1987) and ceases altogether by midmorning

(Feinsinger 1976, ? 1978). This would lead to a reduction in hummingbird feeding time in natural circumstances. However, since the food supply at the feeders was superabundant, the observed decline in feeding cannot be related to a decrease in food availability. Yet for some reason, these birds maybe "programmed" to reduce feeding time as the day progresses or perhaps energy needs decreases during the day.

A possible explanation for this is that the birds leave their territories to feed at the feeders more in the earlier parts of the day. Many hummingbirds are highly territorial, and any time spent away from the territory may result in the loss of that territory– a huge cost to an individual. However, this can be offset (at least partially) by a supply of abundant nectar. Perhaps early in the day food supply is a more overriding concern to the individual, but as metabolic requirements are met, territory defense becomes more important. Marking of individuals to track population fluctuations would help distinguish between the two "concerns" mentioned.

We showed that Woodstars took more sips per visit, and the Sabrewings made more visits, suggesting that total energy requirements for the two species may be similar. The high cost of hovering for the Woodstar may be balanced by its small body size, and the large body size of the Sabrewing may be balanced by its tendency to perch. However, total number of visits is dependent on population size, which we were unable to determine.

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