THE RELATIONSHIP OF FLOWER DENSITY TO TERRITORY SIZE AND CALL RATE IN *COLIBRI THALASSINUS*

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Abstract. We examined the effect of flower density on territory size and call rate of male green violet-ear hummingbirds, *Colibri thalassinus*. We predicted that territory size would decrease and that call rate would increase with increased flower abundance. We tested our hypotheses by mapping nine territories and recording flower density and call rate for the resident males. Territory size (102 - 1620 m^2) was inversely related to flower density (0.03 - 27 flowers/m^2), though large territories tended to have more flowers than small territories (~ 28 - 17612 flowers/territory). All males called continuously so there were no differences in male call rate among territories of different size. We believe that territory quality is a joint function of territory size and flower density; optimal territory is predicted to be smaller in habitats with high flower density than those with low flower density. However, our understanding of territory quality in *Colibri thalassinus* is limited by our knowledge of how females use male territories.

Key words: Green violet-ear hummingbird

INTRODUCTION

Many birds establish and defend territories to ensure access to resources and attract mates. Territory size in some birds may be related to resource quality or resource quantity within an individual's territory. In theory, birds should defend the smallest territories that will provide them with sufficient forage and mating opportunities. Thus, resource-rich territories should be smaller than resource-poor territories. One might also expect resource-rich territories to attract more potential invaders and require the resident male to call at a faster rate to advertise his presence to other birds.

The green violet-ear hummingbird *(Colibri thalassinus)* is an altitudinal migrant that frequents the highlands of la Cordillera de Talamanca from December to March (Skutch 1967). This migration coincides with the peak flowering period of *Centropogon valerii*, its primary food source (Colwell 1974). However, the green violet-ear also feeds on, and defends territories containing, other types of tubular flowered plants. The male violet-ear often sets up a territory around patches of these plants and defends the territory against conspecifics as well as hummingbirds of other species (Colwell 1973). In general, male violet-ears divide their time between feeding, perching and calling, and chasing intruders. We hypothesized that territory size and call rate are positively related to flower density. We tested the hypothesis by quantifying patterns in territory size, flower density, and call rate of male violet-ears in the subalpine paramo of Cerro de la Muerto.

METHODS

On 29 January 1998, we observed male green violet-ear hummingbirds at Estación Biológica Cuericí, Costa Rica. We located 9 territories in an early successional forest containing a variety of flowering shrubs and small trees that were 1-10 m in height . A variety of hummingbird-pollinated herbaceous plants were found in the patch: a red flower in the Scrophulariaceae dominated and a yellow flower in the Scrophulariaceae family was nearly as abundant. *Centropogon talamancensis, C. valerii, Bomeria acutifolia,* an orange flower in the Lobeliaceae, and an unidentified orange and red flower were all present but extremely rare. We spent 15 - 30 minutes mapping the primary perches used by each male green violet-ear. We measured the distance between peripheral perches to determine the territory perimeter, from which we calculated territory area. Within each territory, we counted the number of inflorescences within a 1 x 10 m east-west transect to obtain flower density. We recorded the number of calls over three minutes to determine call rate. Later observations confirmed that our study territories had not changed.

We regressed territory size and call rate on inflorescence density, and call rate on territory size. We used the regression equation of territory size vs. flower density to estimate the number of flowers in the largest and smallest territories that we measured.

RESULTS

Territory size was inversely related to flower density ($r^2 = 0.43$, $P = 0.055$; Fig. 1). Large territories tended to have more flowers than small territories (~ 29,500 vs. ~ 3,000). Call rate was not related to flower density ($r^2 = 0.08$, $P = 0.49$) or territory size ($r^2 = 0.01$, $P = 0.79$).

DISCUSSION

Compared to small territories, large territories had more total flowers at a lower density. Our hypothesis that territory size was related to flower density was supported. It appears that territory size (positively correlated with flower numbers) and flower density combine to determine overall territory quality (defined as the number of flowers per unit of energy expended). This suggests that optimum territory sizes will be smaller in habitats with high flower density than in habitats with low flower density (Fig. 2).

The relationships between territory quality and territory size would likely change depending on the purpose of the territory. If the territory only serves to attract females for mating then the impression of flower abundance (density) may be most important. If the territory further serves as a nesting location and provides food resources for the female and young then territory size and total number of flowers may become more important. In terms of the graphical model in Fig. 2, this is likely to change the operational definition of territory quality. One could clarify these issues by measuring visitation by females (this is difficult because there is no sexual dimorphism in green violet-ears). In a different species, the fiery-throated hummingbird *(Panterpe insignis)*, Taliaferro and Little (1996) found that male territories with a higher density of flowers attracted more females, but they did not look at total flower number.

Future research should examine female visitation in green violet-ears to characterize the relative contributions of flower density and number of flowers towards overall territory quality.

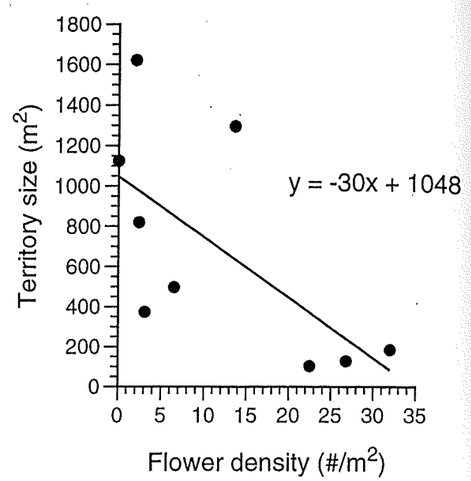

FIG. 1. Territory size as a function of flower density.

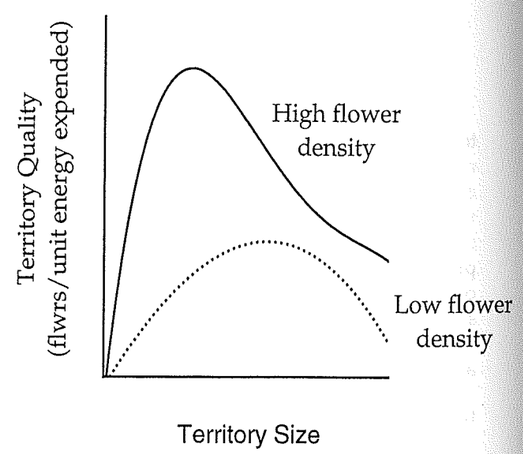

FIG. 2. Hypothesized relationships between territory quality and territory size in habitats with high flower density vs. those with low flower density.

Male green violet-ears called continuously throughout the study, an observation consistent with previous studies (Wolf et al. 1976). The energetic costs of this behavior must be very high. We found no evidence to suggest that high-quality territory owners suffer increased pressure from adjacent males. Over the course of two days, we only observed one male/male intraspecific interaction. Perhaps

constant calling by male violet-ears is a tactic employed to reduce the number of potential interactions. This is supported by our observations of volcano hummingbirds in our sites that rarely called, but were observed chasing other males almost continuously. Presumably, the cost of calling incessantly is offset by the decreased number of male-male chases and represents a viable territorial alternative to overt aggression.

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