BAT SPECIES DISTRIBUTION IN PRIMARY AND SECONDARY FORESTS AT CORCOVADO NATIONAL PARK

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Abstract: As frugivores, nectarivores, and insectivores, bats will respond to differences in plant communities. Using an ultrasound detector and computer software to analyze bat calls as sonotypes (a proxy for bat species), we tested whether differences in the plant community between primary and secondary forests were associated with different bat communities. We calculated species-area curves and found greater alpha diversity of bats in secondary forest and greater beta diversity of bats in primary forest, with little species overlap between them.

Key Words: Chiroptera, *bats, species richness, species-area relationship, primary forest, secondary forest*

INTRODUCTION

Differences in plant composition can produce differences in higher trophic levels. Primary forest tends to have greater plant species richness, while secondary forest tends to have lower chemical defenses. The community structure in each type of forest may reflect these differences: herbivores in primary forests may be more scarce and specialized, while herbivores in secondary forests may be more abundant and omnivorous. Differences in the herbivore community could then influence the structure of the predator community.

As frugivores, nectarivores, and insectivores, bats are close to plants in the food chain. The species composition of bats in or near deforested areas could differ significantly from nearby, undisturbed areas.

We tested the predictions of three hypotheses regarding bat species distributions: (H_1) primary forest has higher bat species richness because greater vegetative diversity produces more diverse insect feeding clades spanning the prey preference of a greater number of bat species (Wainwright 2002); (H_2) secondary forest has higher bat species richness because lower levels of plant chemical defense result in more insects for bats to prey upon; this speculation rests on the assumption that insect abundance in primary forest is low enough to severely limit the number of bats in a given microhabitat; (H_3) primary and secondary forests have equal bat species richness, but bat species composition differs between the two forests, indicating that both habitats are suitable for bats but that different bat species prefer different habitats.

METHODS

We sampled bat calls at 16 sites (8 in primary forest, 8 in secondary) along the trail system surrounding Sirena Biological Station at Corcovado National Park, Costa Rica. We chose sites using a combination of scouting walks during the day and observations of high bat activity at night, and attempted to match pairs of microhabitats between the primary and

secondary forests. We recorded bat calls over a 15-minute interval at each site using a Petterson Ultrasonic Detector. We visited 4 sites (half in primary, half in secondary) from 21:00 – 24:00 on 2 February 2006, 4 more sites from 03:00 – 05:30 on 3 February, and 8 more sites from 01:00 – 05:30 on 4 February. We analyzed each bat call visually and audibly with Sonobat 2.0, and divided the bat calls into sonotypes (a putative proxy for species, see Krivak-Tetley et al. 2002).

For each forest, we calculated alpha diversity (mean number of species at one site) and then generated species-area curves by calculating the mean number of species found in permutations of 1, 2, 3, 4, 5, 6, 7, and 8 sites and then fitting a Michaelis-Menten saturation function to the data from our species-area curves:

$$y = \frac{K * x}{d + x}$$

[Eq. 1]

where K is the saturation value and d is the number of sites necessary to reach the half-saturation value. We then calculated beta diversity by linearizing the species-area curves using Gleason's (1922) logarithmic model:

$$\log(E[S_n]) = h\log(n) + k$$

[Eq. 2]

where k is the y-intercept and h is slope, where greater slope equals increased beta diversity.

RESULTS

We recorded 68 bat calls across all of the sites (47 in secondary forest, 21 in primary), and distinguished 19 sonotypes. Eight of these sonotypes occurred exclusively at sites in primary forest, 9 of the sonotypes occurred exclusively at sites in secondary forest, and 2 sonotypes were recorded at sites in both primary and secondary forest.

Alpha diversity in primary forest was lower than in secondary forest (mean species per site ± 1 SE; primary = 1.62 ± 0.42, secondary = 2.75 ± 0.36; $t_{1,13}$=2.02, p= 0.06). Beta diversity was higher in the primary forest than the secondary forest (primary: $\log(E[S_n]) = \mathbf{0.878}\log(n) + 0.521$, $r^2 = 0.998$; secondary: $\log(E[S_n]) = \mathbf{0.660}\log(n) + 1.067$, $r^2 = 0.994$; $t_{1,12}$= 7.97, p<0.001, Fig. 1). Based on the function's fit to the species-area curves, total species richness (K) was 35.9 ± 1.1 species in the primary forest and 19.5 ± 0.4 in the secondary forest($t_{1,12}$=1384.19, P<0.001).

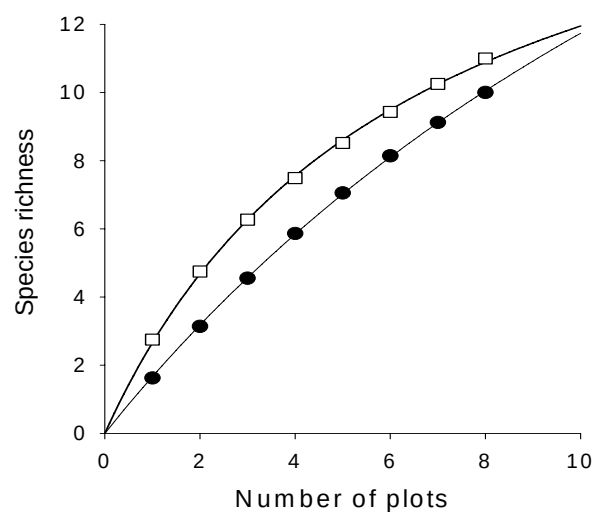

Figure 1. Species-area curves for bats in primary (●) and secondary (□) forests at Corcovado National Park, Costa Rica. Lines show Michaelis-Menten function fit to data; $y_{primary}$= (35.90 * x) / (20.58 + x), $y_{secondary}$=(19.53 * x) / (6.35 + x),

Discussion

We modeled higher total species richness in primary forest; this is consistent with greater vegetative species diversity driving greater bat species richness (H_1) on a forest-wide scale. However, we also found lower bat species richness at each site in primary forest; higher plant chemical defenses in these forests may result in less edible resources, leading to decreased insect prey abundance and thus reduced bat species richness (H_2) on a microhabitat scale. The small overlap in bat species composition between primary and secondary forests suggests that different bat species prefer, or are better able to utilize, different habitats (H_3).

Literature Cited

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