

SELECTION OF ROOST SITES IN THE TENT BUILDING BAT,
ARTIBEUS WATSONI (PHYLLOSTOMIDAE)

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ABSTRACT (BME, PLK, LCB & MPA)

We examined Artibeus watsoni roost sites in Heliconia spp. and Cardulovica palmata at the Estacion Sirena in Corcovado National Park, Costa Rica. We proposed that A. watsoni select potential roost sites based on the cost of building the tent and the crypticity of the tent. We discovered nine times as many C. palmata tents as expected given the abundance of C. palmata leaves. The number of severed veins per leaf was five times larger for Heliconia than for C. palmata. Three naive human subjects took 31-300% longer to find Heliconia tents than C. palmata tents. Apparently, construction costs favor the use of C. palmata for tents while predator avoidance favors the use of Heliconia for tents.

Key Words: Artibeus watsoni, tent-making bats, roost selection

INTRODUCTION (PLK)

Neotropical tent-making bats (Phyllostomidae, Stenoderminae) alter the shape of different leaf species by biting lateral veins along the midrib and tissue between them (Barbour 1932; Timm 1984, Timm and Clauson 1990). The altered leaves function as cryptic diurnal roost sites and provide the bats with protection from sun, wind, and predators (Timm 1984). Thomas' fruit eating bat (Artibeus watsoni) is commonly found in Corcovado National Park (Choe and Timm 1985) where our study was conducted. A. watsoni have been reported to construct tents in Anthurium raveonii (Araceae), Cardulovica palmata (Cylanthaceae), Heliconia spp. (Musaceae) and Calanthea insignis (Marantaceae) (Timm and Clauson 1990, Timm 1984). We used Heliconia and C. palmata as focal plants because they are commonly found in secondary growth habitats used by A. watsoni (Choe and Timm 1985).

Boinski and Timm (1985) proposed that predation by squirrel monkeys (Saimiri oer-

stedii) may be a significant source of mortality for tent-making bats. Squirrel monkeys develop search images for these tents and approach them laterally for visual and manual inspection.

We hypothesized that A. watsoni select potential tent sites based on the time and energy required for construction and crypticity from predators. We predicted that more tents should be constructed in the species that has fewer veins to cut and therefore requires less investment by the bat, and that bats will preferentially roost in the species that provides more cryptic tents.

METHODS (MPA)

Research was conducted in the tropical wet forest surrounding Estacion Sirena, Corcovado National Park, Costa Rica. On 2-3 February, 1994, we searched for tents of A. watsoni in the following areas: all trails leading from the field station to a distance of ≈ 750 m from the station (22 observer hours); outer reaches of

Guanacaste and Sirena trails (5 observer hours); outer reaches of Naranjo trail (5 observer hours); Rio Pavo trail to the Rio Pavo (8 observer hours); and the Rio Claro trail (6 observer hours). In all cases, we walked the trails and forest edges looking for light gaps and secondary growth that contained Heliconia and C. palmata, then carefully examined the foliage by eye for evidence of A. watsoni tents. Incidental observations of tents on other plant species were also recorded.

We estimated the relative abundance of Heliconia and C. palmata by censusing leaves within 2.5 x 2.5m sample plots. Sampling was conducted in secondary growth near the field station where we had previously searched for tents. In patches where we had located at least one tent, we established a sample plot every 20m, immediately to the right or left of the trail. However, if suitable habitat only occurred on one side, we sampled only that side. Within each plot, we counted all Heliconia or C. palmata leaves that appeared to be suitable for tent construction by A. watsoni. We measured a total of 42 plots, distributed across 880m of trail in 4 habitat patches. Both Heliconia and C. palmata were rare along intervening, unsampled stretches of trail.

In a sample of 23 tents (13 Heliconia and 10 C. palmata), we counted the number of lateral veins that had been severed by the bat to construct the nest.

We evaluated tent crypticity using human subjects as an ecological analog to primate predators. For each of 26 tents (7 Heliconia and

19 C. palmata), we haphazardly placed flagging within 3-5m of the tent. We selected 3 subjects who had little or no experience searching for bat tents. Each subject was shown one Heliconia tent and one C. palmata tent to develop a search image. Then they were individually led to each flagged location and challenged to find the nearby tent. We measured the time to discovery in seconds. A route was established that interspersed the two plant species throughout the trial (to control for spurious effects due to learning).

We used a G-test to compare tent abundance on Heliconia and C. palmata to that expected based on relative leaf availability. T-tests were used to compare the number of severed veins in Heliconia versus C. palmata tents. Crypticity data (seconds until discovery) were log transformed.

RESULTS (LCB)

We found 79 C. palmata, 21 Heliconia, 27 Araceae, five Marantaceae, and 12 ground palm (probably Askrozyne martiani) tents (total tents = 144). One Heliconia was occupied by three A. watsoni on two consecutive days. We discovered two C. palmata with bats, one with one bat and one with two bats.

Sample plots contained ten times more Heliconia leaves than C. palmata leaves (mean \pm SE = 8.5 ± 1.6 vs. 0.8 ± 0.4), yet there were three times more tents in C. palmata leaves. Thus, bats constructed tents in C. palmata leaves far in excess of that expected based on their abundance in the environment ($G_{adj} = 25.85$,

df = 1, $p < 0.001$; Figure 1).

Bats severed an average of 201 veins to construct *Heliconia* tents compared with only 39 veins to construct *C. palmata* tents ($t = 18.67$, $df = 21$, $p < 0.001$; Figure 2).

All three naive human subjects took long-

er to find *Heliconia* tents than *C. palmata* tents (Table 1). Subjects one and three required more than twice as long to find *Heliconia* tents as *C. palmata* tents ($p < 0.01$; Table 1). Subject two required 31% longer to find *Heliconia* tents as *C. palmata* tents ($p > 0.05$; Table 1).

Table 1: Mean discovery times of *Heliconia* and *C. palmata* tents for three naive human subjects ($n = 7$ *Heliconia* tents and 19 *C. palmata* tents.)

Naive Primate	Mean Discovery Time (s)		n_{Hel}	$n_{C. pal.}$	t	p
	<i>Heliconia</i>	<i>C. palmata</i>				
1	91	28	7	19	2.85	<0.01
2	51	39	6	19	0.73	<0.5
3	46	22	7	19	3.64	<0.01

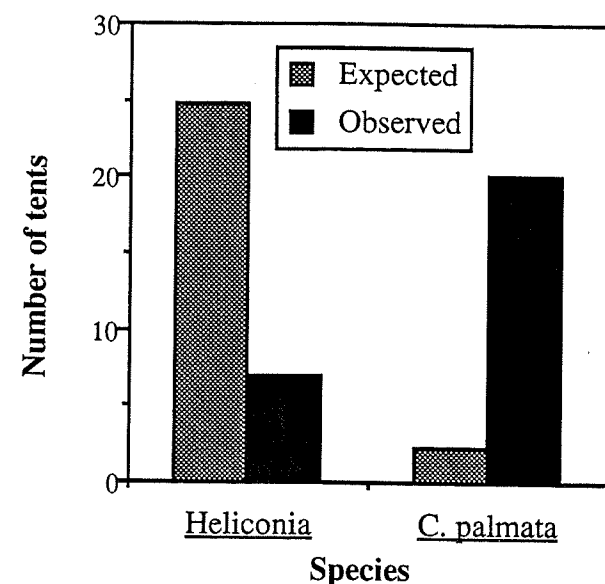


Figure 1. Comparison of observed tent abundance and expected tent abundance based on natural leaf abundance of *Heliconia* and *C. palmata* ($n = 7$ *Heliconia*, 20 *C. palmata*).

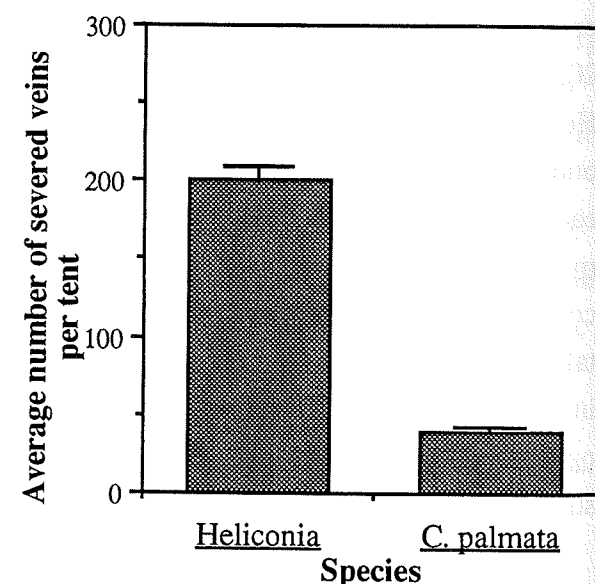


Figure 2. Mean number of severed veins per tent in *Heliconia* and *C. palmata* ($n = 13$ *Heliconia*, 10 *C. palmata*).

DISCUSSION (BME)

The tent making bat *A. watsoni* showed strong preference for building roosts in the leaves of *C. palmata*. Presumably, *C. palmata* tents require less time and energy to construct than *Heliconia* tents because far fewer veins must be severed (Figure 2). Our measure of crypticity suggests that tents made in *Heliconia* are far harder for primate predators to find than tents in *C. palmata*.

According to Barnsler and Timm (1985) and our own observations, squirrel monkeys descent to the forest floor and search for tents from the side and below, as did our naive primate analyses (humans). *A. watsoni* appears to balance two factors when selecting tent sites: the crypticity of the tent, and the relative work involved in making that tent.

The energy costs of making a tent do not appear trivial. One of us (MPA) observed an incomplete *Heliconia* leaf tent with only 63 veins cut, implying that tents made in *Heliconia* cannot be made in one construction bout.

We found one bat colony for every 48 tents, indicating that bats commit a significant amount of energy to roost construction. The large number of empty tents must reduce squirrel monkey foraging success, perhaps deterring

the monkeys from investing foraging time searching for bats.

We predicted that a higher proportion of cryptic *Heliconia* tents should contain roosting *A. watsoni*, but we did not find enough colonies in this study to test this prediction. Bats should selectively roost in *Heliconia* because they would be less likely to be located by predators there.

Alternatively, bats may construct new tents and move between them in order to reduce parasite load (Timm, 1984), to reduce the amount of wear and tear on any one tent, or to facilitate roosting near a variety of foraging sites.

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