



## Tent-roost Dynamics and Occupancy by Bats in the Palm *Sabal mauritiiformis* in a Montane Dry Forest

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**Tent-roost Dynamics and Occupancy by Bats in the Palm *Sabal mauritiiformis* in a Montane Dry Forest**

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## ABSTRACT

Tent-making bats modify leaves to build refuges. Leaf modification involves energetic and defense costs that should be balanced by the benefits of tent-roosting. The alteration of the leaf's vascular system could reduce the tent's life expectancy, so to obtain a benefit bats are expected to use tents regularly as long as they are functional and not modify more leaves than necessary. Over two years we documented the dynamics of tent construction and occupancy in the palm *Sabal mauritiiformis* in a Colombian dry forest. We also assessed tent condition and compared it to nonmodified leaves of approximately the same age in focal palms. The daily rate of roost occupancy was low (<6% of 292 tents) and most tents were never used. There were no differences in abiotic factors between tents that were never used and those that were used at least once. Bats cut the main vein of folioles, partially affecting water transport in the leaf. However, there were no differences between tents and nonmodified leaves in deterioration scores or deterioration rates over one year. During two years, 48 tents were lost for different causes and this loss was offset by the construction of 51 new tents. Thus, bats maintained a surplus of usable tents even though most were never used. Palm leaves are long-lived and seem preadapted to sustain damage and remain viable, particularly in species growing in dry environments. We present several hypotheses to explain the advantage of maintaining a surplus of usable tents.

*Key words.* Arecaceae; Colombia; Phyllostomidae; Refuge construction; Roosting ecology; *Uroderma convexum*.

REFUGES ARE ESSENTIAL RESOURCES FOR MANY SPECIES OF MAMMALS BECAUSE THEY PROVIDE PROTECTION AGAINST PREDATORS AND ADVERSE ENVIRONMENTAL CONDITIONS, AND MAY BE IMPORTANT SCENARIOS FOR SOCIAL INTERACTIONS. Thus, refuge availability may be a limiting factor for mammal populations (Berryman & Hawkins 2006). Most bat species use both natural and man-made pre-existing structures as diurnal shelters, but a small proportion of species build their own daytime refuges by modifying the leaves of a variety of plant species (Kunz & Lumsden 2003, Chaverri & Kunz 2010).

Tent-making bats build refuges by biting into the midrib and other veins of leaves, in such a way that the leaf folds and forms a tent-like structure with a variety of architectural types (Kunz & Lumsden 2003, Rodríguez-Herrera *et al.* 2007). These bats use almost 100 species of plants in 24 families, but Arecaceae is one of the most important in terms of both the number of palm species, and the species of bats that use them. Some species of bats do not build tents, but use them opportunistically as daytime roosts. Currently, 22 species of bats are known to roost in tents, most of them in the Neotropics; all Neotropical tent-roosting species are in the family Phyllostomidae (Kunz & Lumsden 2003, Rodríguez-Herrera *et al.* 2007, Chaverri & Kunz 2010).

Tents may provide multiple benefits to bats, such as protection against predators and the weather, proximity to food sources, maintenance of social interactions, and a positive energetic balance related to thermoregulation (Kunz & Lumsden 2003, Chaverri & Kunz 2010, Parker-Shames & Rodríguez-Herrera 2013). On the other hand, tent-building involves energetic costs, which vary with the physical characteristics of the leaves such as toughness and size, and costs related to social interactions such as tent defense (Kunz & McCracken 1996, Chaverri & Kunz 2010, Parker-Shames & Rodríguez-Herrera 2013). For tent-building to result in a positive

benefit-cost balance, we expect that (1) the alteration should not cause leaves to deteriorate too fast, or leaves should last for a time sufficient to justify the investment (Timm & Lewis 1991), (2) bats should use tents on a regular basis for as long as they are functional, and (3) bats should not modify more leaves than strictly necessary for roosting purposes, unless there is an advantage in maintaining an ample supply of usable tents, even if they are not in use.

The alteration made by bats damages the leaf lamina and vascular system, and changes the leaf's shape and orientation (Kunz & McCracken 1996), which could accelerate leaf deterioration and affect its viability, both as a roost and as a functional leaf. Thus, tents are a relatively ephemeral resource that requires continuous renovation (Timm & Lewis 1991). Some studies report that tents in Heliconiaceae, Marantaceae and Musaceae last for only a few weeks; other studies, however, report that tents may last for months and up to several years, particularly in palms (Chaverri & Kunz 2010). In three species of plants (one species of Heliconiaceae and two of Arecaceae), the alteration of the vascular system does not seem to interrupt water transport completely, as alternative routes for water flow form along secondary and transverse veins that supply most of the leaf tissues (Cholewa *et al.* 2004). However, to our knowledge no study has evaluated the deterioration rates of modified and nonmodified leaves in a comparative way.

A few studies have documented tent use and roost fidelity in tent-roosting bats (Chaverri & Kunz 2010). Patterns of tent use are very variable among species and sites, depending on factors such as tent availability and the bat species' social system. Individual bats may switch to different tents within a restricted area on a daily basis. For example, in Costa Rica individuals of *Artibeus watsoni* maintain a roosting range of 0.1 ha, but frequently switch roosts (Chaverri *et al.* 2007). In general it is rare for a bat to occupy the same tent for several days, although there are

cases, particularly in the Paleotropics, of bats occupying the same tent for several weeks (Campbell *et al.* 2006). Roost and food availability are important determinants of use patterns and switching behavior (Chaverri & Kunz 2010). However, no study has documented patterns of tent availability and occupancy for periods longer than a couple of months. Villalobos-Chaves *et al.* (2016) monitored 221 tent-roosts in ten plant species for periods of one or two months between 2009 and 2011 in Costa Rica, and found that 4 percent were occupied at any time.

In this study we report on tent availability, viability and patterns of occupancy by bats roosting in the palm *Sabal mauritiiformis*, in a dry forest remnant in the Cauca Valley, Colombia. At this site, *Uroderma convexum* is the most common bat in tent roosts, and is likely the species that modifies leaves; three other species, *Dermanura glauca*, *Artibeus lituratus* and *A. jamaicensis*, also use tents (Herrera-Victoria *et al.* unpublished data). Our overall objective was to document tent dynamics (loss and construction) in relation to tent availability and use patterns. Our study is the first to report tent-making and roosting in a montane dry forest.

We had four specific objectives. First, we monitored tents regularly over a total of 16 mo (a 5-mo period in 2015 and 11 mo in 2016), to document spatial and temporal patterns of occupancy. Microclimate may be a selective factor determining roost use, as roosts may offer insulation against adverse external conditions (Kunz & Lumsden 2003, Willis & Brigham 2005). Tent microclimate may be influenced by canopy cover, by limiting solar radiation and damage by heavy rain and wind (Rodríguez-Herrera *et al.* 2008). Therefore, we tested whether occupancy was related to abiotic factors affecting the refuge environment: temperature, relative humidity, light and canopy cover. For the second objective, we individually marked modified and nonmodified leaves to assess the leave's condition and roosts' integrity, and evaluate deterioration rates (change in condition over time). We expected tents to be more deteriorated

and to deteriorate faster than nonmodified leaves of approximately the same age. We also tested whether tent occupancy was related to its physical condition. Third, we used a dye to observe how the modification affected water flow in the vascular system of the leaves. Finally, over a period of two yr we monitored tent loss and construction to determine how tent availability changed over time.

## STUDY AREA AND METHODS

The study was conducted at El Vínculo Natural Regional Park (3°50'23" N, 76°18'07" W), located on the eastern edge of the Cauca Valley floor, on the western foothills of the central range of the Andes in the Municipality of Guadalajara de Buga. The park extends over 83 ha that span elevations of 977 to 1150 m. El Vínculo is a partially deciduous, dry forest remnant with a relictual area of mature forest and areas of second growth of different ages, and is surrounded by a small area of degraded secondary forest in a landscape of pastures and sugar cane (Torres *et al.* 2012). Precipitation is bimodal, with an annual mean of 1379 mm and two peaks of rainfall in April and October (Candelo & Parra 2007).

For this study we focused on an area of approximately 18 ha along trails on the western part of the park, where juvenile palms are abundant, but only five adults remain. Descriptive aspects of the palms and tents and their spatial distribution are reported on a separate publication (*in preparation*). Ninety-four percent of tents were in juvenile palms that lacked aerial stems, and the other 6 percent were in adult palms. Most tents (288 of 308) had a height of less than 4 m, whereas 20 tents were 4-6 m high.

The study was conducted between January-June 2015 and January-December 2016. In 2015 we marked 58 focal palms with 202 tents, and 42 palms without tents. Palms had a mean of 8 expanded leaves (plus 2 or 3 developing leaves), and palms with modified leaves had 3 tents on average (Herrera-Victoria *et al.* unpublished data). To document tent occupancy, in 2015 we made complete rounds to check all tents in 15 nonconsecutive days spread throughout 5 months, noting the presence and number of bats. We captured some bats with hand nets at the tents to document the species, but did not mark bats individually. In 2016 we marked additional tents and plants for a total of 308 tents in 84 palms, making complete rounds to record occupancy on 28 days spread throughout the year (i. e., approximately one census day every two weeks).

To test the hypothesis that tent occupancy may be related to abiotic characteristics, we compared tents that were never occupied during this study with tents that were occupied at least once, with Mann-Whitney *U*-tests. We hypothesized that bats may build tents but then use only those that presented a favorable environment, which would not be possible to determine before building the tent. We measured internal (under the tent close to the tent top) and external (adjacent to the tent) ambient temperature and relative humidity. We took paired internal and external measurements for each tent of relative humidity (%) and temperature (°C) with a thermometer-hygrometer (Votcraft HT-200 with a precision of 0.5°C and 2% RH). We then calculated the difference between internal and external measurements. We also measured incident light under the tents, because some tents show tear in the lamina at the top and light may filter through. For light measurements we used a quantum meter (Quantum flux MQ100) placed vertically with the sensor aimed at the tent's crown. Additionally, we measured canopy cover from photographs taken with a hemispheric lens (NOOT Products) on a Samsung cell phone digital camera. Photographs were taken at the central part of the palm, between 0600-0800 h or



1700-1800 h. Images were analyzed with Gap Light Analyzer 2.0 software. The program calculates the area occupied by gaps in a hemispheric photograph. The canopy cover measurement applies to the whole palm, so we compared palms that had at least one tent used during the study, to palms with tents that were never used. Additionally, we measured external incident light, by placing the light sensor in a vertical position next to the tents, to determine whether there was a correlation between canopy cover and light. We also made the comparison between unoccupied and occupied tents for tent condition (see below).

To document leaf condition, we used a categorical scale of five levels where 1 represented a highly deteriorated leaf and 5 represented a new leaf: (1) chlorotic leaf with abundant necrotic areas, usually with holes and a dry appearance (2) leaf with more than 50 percent of the lamina with chlorotic and necrotic areas, (3) opaque green leaf with lichens and less than 50 percent of leaf area showing damage (lichen presence represents relative leaf age), (4) opaque green leaf with no lichens or discernible damage, and (5) bright green (new) leaf. This condition score reflects leaf age, but also possible deterioration related to tent construction. We assessed the condition of tents and unmodified leaves on two occasions 10 months apart, in February 2016 (initial) and November 2016 (final). To evaluate deterioration rate as the change in condition, we subtracted the final from the initial measure. If there was no change in condition, the difference was zero, and if there was a change the difference was a positive number between 1 and 4. All condition assessments were made by the same person to maintain consistency. We also assessed the physical integrity of the tent with two criteria: structure (i. e., damage to the folioles or missing pieces of lamina) and accessibility (i. e., whether the entrance was blocked by fallen branches or the tent was inclined and close to the ground). We used three

categories, good, intermediate and poor, to qualify integrity. We used a G-test to evaluate whether leaf condition and tent integrity were independent.

To evaluate the hypothesis that the modification made by bats accelerates deterioration rate, we compared the condition of tents with that of non-modified leaves of approximately the same age within 77 focal palms. *Sabal mauritiiformis* has alternate leaves that grow in a spiral pattern (Pérez & Rebollar 2003), so we used one of the two leaves bracketing the tent for comparison (depending on which were non-modified). These leaves were a little younger or older than the tent (it was difficult to discern exactly which leaf was younger or older, because 97.7 percent of palm leaves sprouted underground). The interval between two consecutive leaves unfolding is up to six months, so this is the maximum age difference between neighboring leaves. However, we believe we have no bias in consistently using an older or younger leaf for comparison. To test for differences in the state of deterioration between tents and nonmodified leaves, we used a Wilcoxon signed-rank test.

To evaluate how the modification affects the vascular system of leaves, we examined the gross anatomy of the modified section under a dissecting scope. We also cut six tents and immediately immersed the petiole in a safranin solution to dye the vascular system and observe how the modification may affect water flow (Cholewa *et al.* 2004). We measured the maximum distance the dye ascended in the lamina, and counted the number of dyed veins proximally (towards the petiole) and distally of the modified area. As a control, we compared these measurements with data from paired unmodified leaves from the same plants, by counting the number of dyed veins at the same distance where the modification occurred in tents.

## RESULTS

In 15 days of monitoring during February-June 2015, only 39 of the 202 tents that we monitored were occupied at least once. The rate of tent occupancy was low both spatially (tents occupied per observation day) and temporally (number of days each tent was occupied; Table 1). Fifteen tents were occupied only once during the 15 monitoring days. In 2016 we added 106 tents and 26 focal plants to our sample. Occupancy rates were lower than the previous year (Table 1). Only 47 out of 292 tents that we monitored were occupied at least once, and 22 were occupied only once during the 28 monitoring days.

Tents were occupied by four species of bats: *Artibeus lituratus*, *A. jamaicensis*, *Uroderma convexum*, and *Dermanura glauca*. During the study we obtained 493 records of bats roosting in tents (242 in 2015 and 251 in 2016). The frequency of tent occupation by the four species varied between years. In 2015, 82.6 percent of records were of *U. convexum*, with *A. jamaicensis* representing the other 17.4 percent. The abundance of *U. convexum* decreased in 2016 to 20.3 percent of records, whereas *A. jamaicensis* maintained a similar rate of occupancy (25.1%) and three new species appeared in tents: *A. lituratus* (13.1%), *D. glauca* (10%) and undetermined species (31.5%) (Fig. 1). In 2015 we recorded eight reproductive events (tents with juveniles) of *U. convexum* in late March and early April, and in 2016 there was only one reproductive event of *A. lituratus* in late June.

There was no correlation between light intensity measured externally and adjacent to tents, and canopy cover ( $r=0.07$ ,  $P=0.6$ ,  $N=65$ ). Canopy cover above focal palms varied between 70 and 85 percent and the light intensity reaching the understory was very low for all tents ( $<100$   $\mu\text{moles}/\text{m}^2/\text{s}$  compared to  $>1000$   $\mu\text{moles}/\text{m}^2/\text{s}$  in full sun exposure). We found no differences

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3 between tents that were never occupied and tents that were occupied at least once, in any of the  
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5 three abiotic variables: internal light ( $U=2089$ ,  $P=0.31$ ,  $df=79$ ), and the temperature ( $U=2217$ ,  
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7  $P=0.39$ ,  $df=79$ ) and relative humidity ( $U=2456$ ,  $P=0.99$ ,  $df=79$ ) differentials. Likewise, there  
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9 were no differences in the condition score of occupied vs. unoccupied tents ( $U=809$ ,  $P=0.35$ ,  
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11  $df=254$ ).  
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15 We assessed the condition of 128 tents and compared it with the condition of paired  
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17 nonmodified leaves of approximately the same age. There were no differences in deterioration  
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19 scores between tents and nonmodified leaves, for both the initial (Wilcoxon signed-rank test,  
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21  $P=0.6$ ) and the final assessments ( $P=0.6$ ; Fig. 2). Most tents and nonmodified leaves were in  
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23 good condition (levels 3 and 4), but bats used tents with condition scores 2 to 5. Tent condition  
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25 and structural integrity were not independent ( $G=108.5$ ,  $P<0.001$ ,  $df=8$ ); bats tended to use tents  
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27 that were in good condition and had high structural integrity (Fig. 3). More than one-half of tents  
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29 and nonmodified leaves showed no change in condition between initial and final assessments  
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31 (Difference=0; Table 2).  
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37 To build the tent, bats bite and tear the main lignified vein of folioles of new leaves (leaf  
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39 condition score =5; Fig. 4a). The safranin dye showed that a water pathway was maintained  
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41 through secondary and transversal veins (Fig. 4b). There was no difference in the sizes of paired  
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43 tents and nonmodified leaves used for the water transport test, measured as the length of the leaf  
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45 ( $t=1.41$ ,  $P=0.23$ ,  $df=4$ ). The distance that the dye ascended in the lamina after 8 days of dye  
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47 immersion was lower in tents (Mean=17.2 cm, SD=11.3) than in nonmodified leaves (Mean=  
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49 36.2 cm, SD=15.8;  $t=2.57$ ,  $P=0.012$ ,  $df=6$ ). In addition, the number of dyed veins decreased  
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51 distally to the modification in tents, and the number of veins that took the dye distally of the  
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53 modified section was lower in tents than in nonmodified leaves (Table 3).  
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During the 2 yr of the study, 48 tents were lost for different causes. In 31 cases the tent deteriorated and wilted, or was destroyed by falling branches. In 17 cases tents were lost to human disturbance (including the 10 tents that we cut for different purposes). In the same time period, 51 new tents were built, 34 in 2015 and 17 in 2016. Forty-four tents were built in palms already having modified leaves, and seven in palms with no modified leaves. All tents were built in new, recently expanded leaves. In nine of the 51 new tents, construction was initiated (one or more folioles modified) but was apparently abandoned and tents had not been finished by the end of the study (December 2016).

## DISCUSSION

We found that to build tent-roosts in the palm *Sabal mauritiiformis*, bats cut through the folioles' midribs, causing the distal portion of the leaf to fold and hang down (Kunz & McCracken 1996). The flow of dyed water suggests that this alteration decreases water transport to the distal portion of the leaf's tissues, but does not interrupt it completely, as alternate pathways are maintained through secondary veins. In the three plant species studied by Cholewa *et al.* (2004), water transport is maintained by short, transverse veins that have high conductance.

The alteration does not seem to have an impact on the leaf's viability neither (at least with our assessment of leaf condition), which results in tents with a long lifespan. The rate of deterioration of tents was not faster than that of nonmodified leaves, and 64 of 121 tents that we marked right at the beginning of the study were still functional two yr later. In Trinidad, tents in *S. mauritiiformis* last in good condition for as much as 9 mo (Kunz & McCracken 1996). Palm leaves in general grow slowly and have long lifespans, with reports of 20-30 mo in

*Chamaedorea bartlingiana* (Ataroff & Schwarzkopf 1992) and 12-24 mo in *C. radicalis* (Endress *et al.* 2006). In palm species adapted to dry environments leaf lifespan is even longer, in response to stressful conditions such as low light and nutrient availability. For example, leaves of *Sabal etonia* and *Serenoa repens* in the Florida peninsula may last for up to 3.5 yr (Abrahamson 2007).

The persistence of *S. mauritiiformis* leaves in spite of the damage, may be related to a slow metabolism in the low ambient light of the understory. In the palm *Attalea funifera* in Brazil, photosynthetic rates are consistently lower in the understory than under full sun exposure (Pamponet *et al.* 2013). Leaf production in *Geonoma schottiana* is more limited by light availability than by soil humidity, and it has been experimentally shown that *Euterpe edulis* leaves increase their lifespan by 100 d in response to low light levels (Gatti *et al.* 2011). Thus, it is conceivable that understory plants of *S. mauritiiformis* are pre-adapted to resist the damage made by tent-making bats. However, it remains to be determined how this damage affects growth, survival and reproduction of the whole plant in the long run, particularly when several leaves are modified. On the other hand, it has been proposed that feces and fruit residues deposited by bats provide limiting nutrients to the host plant, which may compensate for the damage (Foster & Timm 1976, Voigt *et al.* 2015).

We found that tent occupancy rates were low during the two years of our study. There were no differences in the abiotic environment or in physical condition between used and unused tents. Therefore, although bats tended to use tents in good condition and with good structural integrity, they maintained an excess of apparently usable tents, and built a few more tents than would be required to offset the loss to falling branches and other causes. The rate of tent loss was relatively low (16% in the two years) compared to availability, even including human

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3 disturbance. Bats may need to maintain several refuges, in case the one in use is unexpectedly  
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5 lost. However, the surplus of tents seems much larger than what would be required by this  
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7 alternate-home hypothesis. The frequency of tent-switching is related to tent availability, but the  
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9 observation that tent-switching on a short-term basis is common, suggests that there is a cost to  
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11 remaining in the same roost or a benefit to moving among roosts (Chaverri & Kunz 2010).  
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15 Is there any advantage in maintaining an excess of tents? A similar phenomenon occurs  
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17 in several species of birds that build a surplus of nests during the breeding period (Gill *et al.*  
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19 2005, Berg *et al.* 2006). Two main hypotheses have been proposed to explain the construction of  
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21 dummy nests in these species. First, these extra nests may serve as decoys to confuse predators.  
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23 Although predator protection is a possible benefit of roosting in tents (Kunz 1982, Kunz &  
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25 McCracken 1996, Stoner 2000), tent-roosting bats may be vulnerable to diurnal predators  
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27 searching among plant foliage and predation risk may be an important factor causing bats to  
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29 frequently switch tents (Boinski & Timm 1985, Lima & O’Keffe 2013). Surplus tents may  
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31 function as decoys for predators that may develop a search image, but are discouraged by finding  
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33 most tents empty.  
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39 The second hypothesis proposes that multiple-nest building functions to attract mates by  
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41 signaling male or territory quality. Most tent construction is done by male bats, and as a  
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43 defensible resource, tents may function to attract females, which is known as resource-defense  
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45 polygyny (Hodgkison *et al.* 2003, Kunz & Lumsden 2003, Chaverri & Kunz 2010). Although  
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47 group structure is very variable in tent-roosting bats, associations of one male and several  
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49 females (harems) are common, so tents may serve as extended-phenotype signals (Mainwaring *et*  
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51 *al.* 2014). The potential for polygyny is related to the fidelity of females to roosting sites and  
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53 whether they move among roosts with males, at least within a limited area dominated by a male  
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(Kunz & Lumsden 2003, Campbell *et al.* 2006), because these sites become crucial resources for breeding females (Hodgkison *et al.* 2003). Males of *Balionycteris maculata* in the Old World (Hodgkison *et al.* 2003) and *A. lituratus* in the New World (Muñoz-Romo *et al.* 2008) return to their roosts between foraging trips, and have smaller feeding ranges than females, which may be a roost defense mechanism. This hypothesis requires that females identify the tent-building male and keep track of how many tents he has built or is defending, and their quality.

Other hypotheses have been proposed to explain tent-switching in bats, such as reducing parasite loads and promoting social relationships in the local population (Chaverri & Kunz 2010). Reducing flea infestations has been proposed as an explanation for constant roost-nest relocation in a species of bird (*Cinnycerthia olivascens*; Kattan *et al.* 2013). Another intriguing explanation documented for a species of bird (*Accipiter melanoleucus*) is that multiple nest-building is a passive strategy to deal with nest usurpation by other aggressive species (Sumasgutner *et al.* 2016). Tent-making bats may have to deal with roost usurpation by other species of bats that roost in tents but do not build them. There is currently no evidence to sort out all these possibilities and there is probably no single explanation for all cases. Interestingly, despite observational and experimental tests, the causes for the construction of dummy nests in birds remain unclear (Berg *et al.* 2006).

The tent-tent-making bat system is potentially highly dynamic in space and time dimensions. In plant families such as Araceae and Heliconiaceae, tents are relatively short-lived and spatial leaf turnover is high. In addition, bats frequently move around and shift roosts. Therefore, the system is spatially dynamic on a short-term basis. In this context, the tolerance to damage exhibited by palm leaves, and their large size and long lifespans, coupled with palm abundance, make palms a suitable choice for tent-building because roosts are more permanent.



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3 However, in spite of the tents' relative permanence and high availability, tent occupancy in our  
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5 study was low and variable. This suggests that other factors such as intraspecific or interspecific  
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7 interactions may be driving tent-building behavior and the spatial dynamics of bats in this dry  
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9 forest remnant.  
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**TABLE 1.** Tent occupancy patterns in the palm *Sabal mauritiiformis*, by four bat species in a dry forest remnant in the Cauca Valley, Colombia.

Variable	Year	
	2015	2016
Number of tents monitored	202	292
Number of occupied tents <sup>1</sup>	39 (19.3%)	47 (16.1%)
Tents occupied/day, mean	7.4 (3.7%)	5.2 (1.8%)
Tents occupied/day, range	1-12 (0.5-5.9%)	1-10 (0.3-3.4%)
Days occupied/tent, mean	3.2 (21.3%)	4.2 (15%)
Days occupied/tent, range	1-11 (6.7-73.3%)	1-10 (3.6-35.7%)
Number of tents occupied 1 day	15	22

<sup>1</sup> Occupied at least once during 15 days of monitoring in 2015 and 28 days in 2016.

**TABLE 2.** Condition of tents and paired nonmodified leaves of approximately the same age, in the palm *Sabal mauritiiformis* in a dry forest remnant in the Cauca Valley, Colombia. Condition evaluated with a score from 1 (highly deteriorated leaf) to 5 (new leaf). Initial assessment in February 2016 and final assessment in November 2016. The table shows the number of tents and leaves, with percent in parenthesis.

Condition	Tents	Nonmodified leaves
Number evaluated	128	128
Difference=0	62 (48)	54 (42)
Difference=1	51 (40)	50 (39)
Difference=2	13 (10)	19 (15)
Mean initial score (SD)	3.10 (0.74)	3.14 (0.94)
Mean final score (SD)	2.51 (0.72)	2.37 (0.75)
Mean change (SD)	0.60 (0.66)	0.77 (0.78)



**TABLE 3.** Number of water-conducting vessels that took a safranine dye in palm leaves modified as tents and in control, nonmodified leaves.

Plant	Number of dyed vessels		
	Pre-modification	Post-modification	Control leaf
1	112	82	177
2	49	43	143
3	42	19	103
4	5	0	74
5	151	116	86
6	11	8	36

**Figure captions**

**FIGURE 1.** Comparative abundance of bat species roosting in *Sabal mauritiiformis* tents during 2 yr at El Vínculo Regional Park, Cauca Valley of Colombia.

**FIGURE 2.** Comparisons of condition scores measured on a scale of 1(deteriorated) to 5 (new), of tents and nonmodified leaves, between an initial (February 2016) and final assessment (November 2016), in the palm *Sabal mauritiiformis* in the Cauca Valley, Colombia.

**FIGURE 3.** Number of tents occupied by bats as a function of tent condition scores measured in a scale of 1(deteriorated) to 5 (new) and structural integrity qualified in three categories (good, intermediate and poor).

**FIGURE 4.** Aspect of a leaf of the palm *Sabal mauritiiformis*, showing the modification made by bats to construct tents, and the alteration to the central vein of a foliole. (a) The arrow shows veins dyed with safranin, also visible in other parts of the leaf; (b) Alternate routes of water transport through lateral and transversal veins are shown by the red dye.







