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Leaf modifying behavior in *Artibeus lituratus*

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INTRODUCTION

Fourteen species of Neotropical and four species of Paleotropical bats are thought to construct tents, by modifying large leaves and other plant parts in order to use them as diurnal roosts (Kunz and McCracken, 1996). These authors argue that the kinds of cuts on palm leaves and the architecture of the resulting tent are determined more by the general shape of the leaf than by the behavior of the bat species thought to be responsible for the construction of the tent. There is increasing evidence that some tent-making bats tend to have polygynous mating systems (Brooke, 1990; Kunz and McCracken 1996; Tan *et al*., 1997; Storz *et al*., 2000; reviewed in Kunz and Lumsden, 2003).

Kunz and McCracken (1996) have suggested that tent making may be the result of nocturnal activity by a single male. Once a tent is completed, other females join the male and a harem is established (Kunz, 1994; Kunz and McCracken, 1996; Tan *et al*., 1997). The male defends the tent he has built, and, as females join him, he also defends them (Balasingh *et al*., 1995). A significant number of cases of apparent resource defense polygyny occur in frugivorous, tent-making species from Central and South America, all in the phyllostomid subfamily Stenodermatinae (Timm and Mortimer, 1976; Timm 1987; Brooke, 1990; Kunz, 1994; Kunz and McCracken, 1996; Stoner, 2000). Females seem to depend on the male to find a roost and this may have conditioned the establishment of harems, because the result is always an association between a group of females with a male who displays defensive behavior (Kunz and McCracken, 1996). In this report, we describe a new example of leaf modification, rather than tent making, in the big fruit-eating bat, *Artibeus lituratus*.

MATERIALS AND METHODS

During a study of social behavior (Muñoz-Romo, 2003), two groups of *Artibeus lituratus* were found roosting beneath leaves of the palm *Washingtonia* sp. in a residential area in Mérida (08°36'N, 71°11'W, 1400 m a.s.l.), Venezuela, in 2001. The trees were planted in a row along the sidewalk, at approximately 2 m intervals. The trees were 12 m tall and the leaves were about 130 cm wide and 90 cm long. One colony was located in a tree at 8 m and the other at 6 m above the ground.

On 27 July 2001, using a mechanical ladder, six animals from one group (1 ♂ and 5 ♀♀) were captured and three from the other (1 ♂ and 2 ♀♀). An estimated five more bats were present in the groups on that day but were not captured; others joined later during the observation period so the total number of males confirmed to be regular attendants at the locality was three, while the number of females varied between one and 13. All captured bats were measured, weighed, and a colored, individually numbered tag (Gey Band & Tag Co, Norristown, PA; style 374, size 4) was placed on the left (♂♂) or right (♀♀) forearms. During the months of November-2001 to January-2002, roosting bats were observed for 11 nights from 19:30 to 00:30 h using a video camera (Sony DCR-TRV 110P) and an infrared light source (Sony HVL-IRC). Fifty-five hours of video were recorded. These were later observed and analyzed

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using scan sampling and focal animal sampling methods (Martin and Bateson, 1993), noting all behavior patterns observed. On sixty-four occasions the groups were also observed during the day, using 10 × 25 binoculars.

Results

During the three months of observation, leaf modifying behavior was recorded six times, and on each occasion it was a male. During the recording period (19:30–00:30), tent modification behavior was observed between 20:00 and 22:00 h four times by male A and twice by male B. On one occasion male A was observed perforating the leaf from which he was hanging at three different times. The general pattern observed in both males was as follows. Several times each night, a male would return to the palm tree to feed on the fruits that were brought back from a foraging bout. As the male hung from the leaf, he was observed perforating the leaf from which he was hanging. To accomplish this, the male appeared to firmly fix his thumbs to the veins of the leaf before proceeding to bite at it. As he shut his mouth to apply the bite, he moved his head from side to side, apparently to make sure the leaf was perforated. On five of six occasions, the behavior lasted a short time (18 ± 14 s), but once, male A spent 220 seconds biting at the leaf. The perforated leaf did not appear different from an intact leaf, except for the roughly circular or ellipsoidal array of holes (about 2 mm diameter) around the center of the leaf near the rachis, and apparently avoiding the veins (Fig. 1). The pattern of perforations can be described as pleurocostal-elliposidal on the medial region of the lamina. We propose the term 'aggregate ellipsoidal' for the perforation pattern observed (Fig. 1). We did not observe perforations near the edges of the leaves: always close to the medial section.

Discussion

This is the first report of leaf modification by *A. lituratus*. We prefer the term 'leaf modification' in this case, as opposed to 'tent making' because the leaf did not change shape as a result of the bats' behavior. However, we believe this is a deliberate action on the part of a male *A. lituratus* and he appears to modify the leaf for a 'purpose'. The purpose seems to be to produce a number of points from which females can attach themselves more securely to the leaf. During the day, strong winds can badly shake the leaf, and if the animals are not securely attached to it, they could fall off. Perhaps the perforations, which do not conform to any of the patterns described by Kunz *et al*. (1994) for tent making bats (conical, palmate umbrella, pinnate, apical, bifid, boat, paradox, stem), also allow for a certain amount of air circulation on hot days.

It is noteworthy that the leaves do not appear withered around the edges of perforations and the male clearly makes the holes on the flat portion of the leaf rather than on the veins, which presumably keeps the leaf healthy, and therefore the roost can last longer, as Kunz and McCracken (1996) and Cholewa *et al*. (2001) have pointed out. Since palms are extremely slow growing trees and leaves are not often renewed (Stoner, 2000), it becomes even more important to maintain a roost in good shape.

This is also the first report of a direct observation of a bat modifying a leaf, and it allows us to confirm that it is the male who performs the behavior. Although we cannot rule out the possibility that females also participate (Kunz and McCracken, 1996) in the modification of leaves (especially between 00:30–06:30), the fact that we only observed this behavior at night (the only behaviors observed in daytime were grooming, sleeping, change of position, shaking,

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stretch the wings, etc.) and that the males were the only ones ever to be observed returning to the roost at night, suggests very strongly that it is only males who perform this activity. This is consistent with observations reported for the Old World megachiropteran, *Cynopterus sphinx* (Balasingh *et al*., 1995).

The fact that only males were observed modifying the leaf also suggests that the kind of polygyny observed in this species could be associated with resource defense

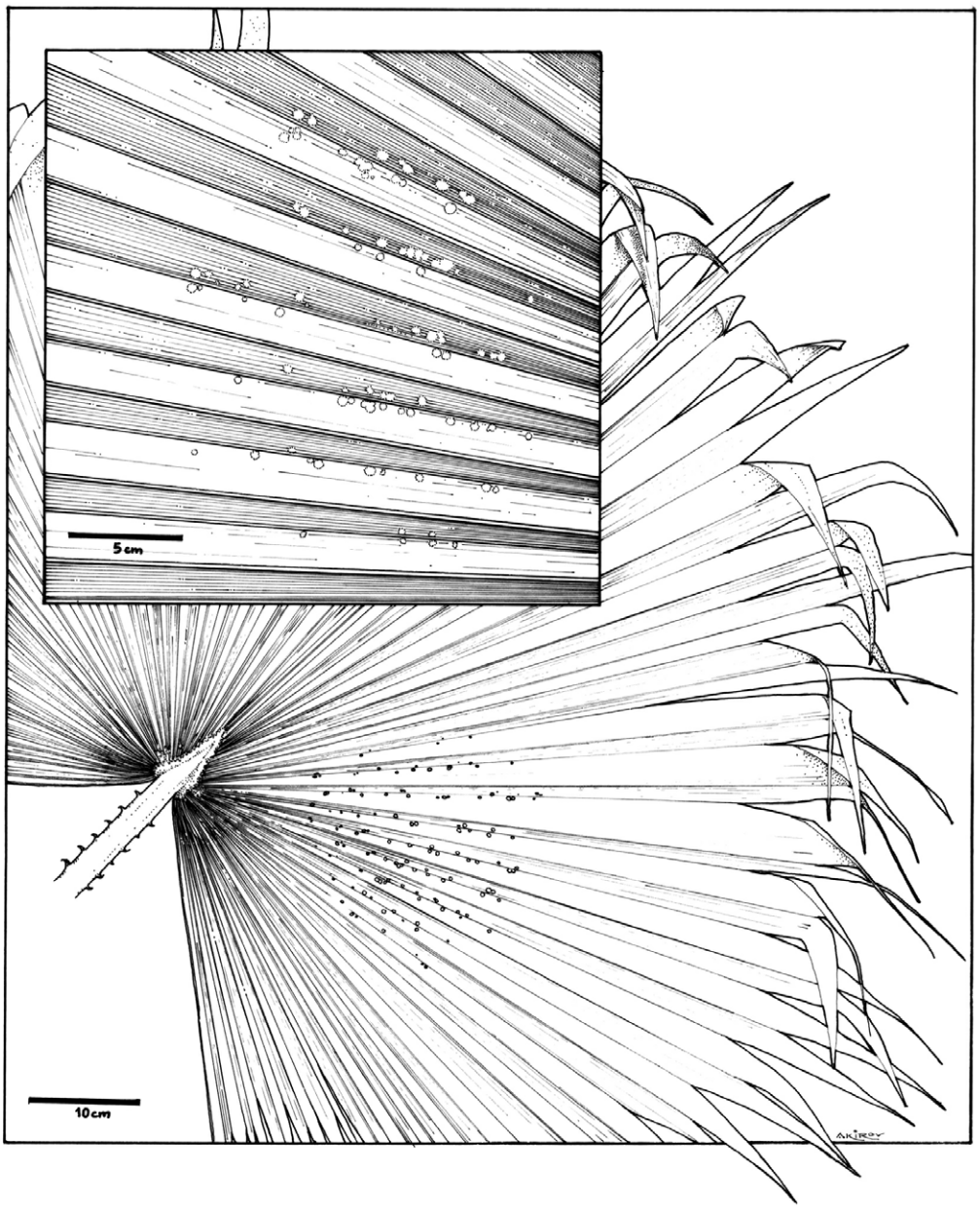

FIG. 1. Illustration of the perforation produced by a male of *Artibeus lituratus* on a palm leaf (*Washingtonia* sp.). (Drawing by Iván Akirov R.)

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(Kunz and McCracken, 1996). This is further corroborated by the observation of male A shaking his wings from side to side when an unmarked male flew close to his roost, apparently to drive the intruder away, on one night when he was unaccompanied.

Tent making, or more generally, leaf modifying behavior seems to be limited to small bat species, because heavy bats cannot be supported by leaves (Kunz *et al*., 1994). The latter authors point out that the Neotropical tent-making bats weigh between 5 and 50 g, and the heaviest species belongs to the megachiropteran genus *Cynopterus*, weighing in at 60 g. With an adult body mass averaging 70 g (♂♂: 63 g and ♀♀: 76 g; Davis, 1984), *A. lituratus* is the heaviest leaf-modifying bat thus far described.

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