Tent-Making by Artibeus jamaicensis (Chiroptera: Phyllostomatidae) with Comments on Plants Used by Bats for Tents

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ABSTRACT

Four species of bats have been reported to modify leaves of various plants to produce tents for daytime roosts. Herein we report tent-making by a fifth species, *Artibeus jamaicensis* (Chiroptera: Phyllostomatidae). In addition we report bat tents from *Scheelea rostrata, Geonoma congesta, Bactris wendlandiana,* and *Asterogyne martiana,* four species of palms not previously known to harbor them. A review of the plants used by bats for tents reveals a preference for species with a broad leaf surface, though pinnate leaf forms may also be used. Tents may provide effective protection from predators through total concealment or through the disruptive pattern presented. Tents in species with broad leaves probably require less effort for construction and provide better protection from the weather.

FOUR SPECIES OF BATS *(Artibeus cinereus, A. watsoni, Ectophylla alba,* and *Uroderma bilobatum)* have been reported to modify leaves of various plants to produce tents for daytime roosts (Barbour 1932, Chapman 1932, Ingles 1953, Goodwin and Greenhall 1961, Timm and Mortimer 1976). Herein, we report tent-making by a fifth species, *Artibeus jamaicensis,* which, like the other four species, is a tropical member of the phyllostomatid subfamily Stenoderminae. In addition, we report bat tents from four species of palms not previously known to harbor them and consider the form of leaves preferred for tent-making. Taxonomic designations of palms follow Glassman (1972).

TENT-MAKING BY *ARTIBEUS JAMAICENSIS*

On 16 July 1974, several *Artibeus jamaicensis* were flushed from a daytime roost in a modified frond of the palm *Scheelea rostrata* (Oersted) Burret. The tree was located in a riparian strip of Tropical Dry Forest (described in Janzen 1973) adjacent to the Rio Higuerón, approximately 2.4 km SE Estación Experimental Enrique Jiménez Nuñez, Guanacaste Province, Costa Rica. Several bats were flushed from the same roost on 20 July 1974. On 21 July the roost contained three bats hanging close together. During one hour of observation, they were relatively quiet although one bat stretched and refolded a wing on two occasions. Two adult male *A. jamaicensis* were removed from the roost and are deposited in the Natural History Museum of Los Angeles County (LACM). The larger (LACM 47107, forearm 57.9 mm) had enlarged testes; the testes of the smaller one (LACM 47108, forearm 55.9) were not prominent. Goodwin and Greenhall (1961) reported communal roosts of this species in Trinidad but did not record tent-making.

The *Scheelea* palm in which the bats roosted was quite small. The fronds, which arose from the central base nearly at ground level, were approximately 3.6 m long with leaflets ranging from 55 to 70 cm in length. Although actual construction was not observed, we assume that the bats occupying the roost were responsible for it. Only a single frond was modified to form the roost (fig. 1). Leaflets along the proximal 1.7 m and distal 0.6 m were unmodified. Those on both sides of the middle 1.3 m region were cut at varying distances from the rachis as follows: area 1) leaflets over the lowest 0.25 m cut at gradually increasing distances from 5 to 10 cm; area 2) all leaflets in the subsequent 0.45 m section cut at about 10 cm; area 3) leaflets over the next 0.35 m cut at gradually decreasing distances from 10 to 1 cm; area 4) leaflets of the distal 0.25 m cut 1 cm from the rachis. Cuts appeared to have been made by the bats' teeth. Each leaflet was chewed on the midrib and at each opposing edge (fig. 2). Pieces of tissue were removed leaving small holes. It appeared that the bats cut each side of the midrib independently to make the center hole. As a result of

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FIGURE 1. *Artibeus jamaicensis* roosting tent in a modified frond of *Scheelea rostrata*, Estación Jiménez, Guanacaste Province, Costa Rica.

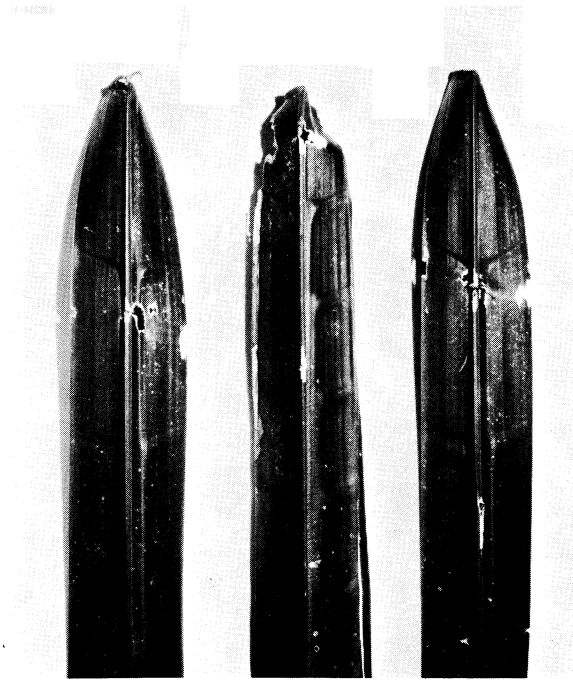

FIGURE 2. Modified leaflets of *Scheelea rostrata* from a roosting tent of *Artibeus jamaicensis*. Note cuts on the midrib and each opposing edge.

these bites, the distal parts of the leaflets folded perpendicularly, hung vertically below the frond, and formed a broadly lanceolate tent (fig. 1).

The bats were situated in the upper half of area 3, and roosting probably was confined to this area as evidenced by the distribution of perforations apparently made by claws of the bats. The proximal six pairs and distal four pairs of leaflets were not perforated. Claw holes were confined to seven of the middle 10 leaflets, five on one side and two on the other. The remaining leaflets forming the tent bore no claw perforations, suggesting that the bats hover while constructing the tent.

PLANTS USED FOR TENTS

Tents made by bats have been discovered previously in five species of palms and five species of *Heliconia* (Musaceae). Tents of *Uroderma bilobatum* were found in the palms *Pritchardia pacifica* Seemann & Wendland, *Cocos nucifera* Linnaeus, and *Sabal mauritiiformis* (Karsten) Grisebach & Wendland ex Grisebach (= *S. glaucescens*) (Barbour 1932, Goodwin and Greenhall 1961). *Artibeus watsoni* was reported by Chapman (1932) and Ingles (1953) to make tents in *Geonoma cuneata* Wendland ex Spruce (= *G. decurrens*) and *G. oxycarpa* Martius (= *G. binervia*). Goodwin and Greenhall (1961: 262) reported roosts of *Artibeus cinereus* under the cut leaves of palm trees although they did not specify the species of palm involved. Tents of *Ectophylla alba* have been reported (Timm and Mortimer 1976) in five species of the genus *Heliconia*.

The present report constitutes the first record of a bat tent in *Scheelea rostrata*. In addition, data were gathered on the use by bats of four species of native palms at the Organization for Tropical Studies Field Station, Finca La Selva, Herédia Province, Costa Rica (described in Timm and Mortimer 1976) from 11 to 19 July 1974. Several hundred palms along approximately 10 km of trail and in patches within sight of the trail were examined. Only one of the species, *Geonoma cuneata*, previously had been reported to harbor bat tents. Of the 29 palm tents discovered, two were found on *Geonoma congesta* Wendland ex Spruce, seven on *G. cuneata*, one on *Bactris wendlandiana* Burret, and 19 on *Asterogyne martiana* (Wendland) Wendland ex Hemsley. Most

were formed in the manner described by Barbour (1932) and Chapman (1932) with "J" shaped cuts beginning near the distal end of the blade along the rachis and curving back toward the base of the blade and out to each side (fig. 3). In a few, however, the cuts ran in the reverse direction, extending along the rachis from the base of the frond to about mid-leaf and then curving out toward each side. *Uroderma bilobatum, Artibeus watsoni,* and *A. jamaicensis* were netted in the area, but it was not possible to associate any bats with the tents.

SELECTION OF PLANT SPECIES

LEAF FORM: A comparison of the leaf forms of the various plants used by bats is particularly revealing. *Heliconia* has simple leaves with a broad flat blade. The leaves of *Asterogyne martiana, Geonoma congesta,* and *G. cuneata* are simple, deeply lobed at the apex, and generally not divided into leaflets. The broad leaves of *Bactris wendlandiana* are undivided, whereas the palmate leaves of *Pritchardia pacifica* are divided only at the tips of the segments. *Sabal mauritiiformis* has large leaves multifid only to the middle and with loose fibers between the bifid lobes. Thus, most species used for bat tents have broad, flat leaves. The three exceptions are *Cocos nucifera, Scheelea rostrata,* and *Geonoma oxycarpa.* The two former species have long, ascending pinnate leaves with discrete leaflets set at intervals along the rachis. Leaves of the latter species are irregularly divided, with the pinnae along the length of the rachis ranging from 1 to 8 cm in width. The terminal pair of pinnae may reach 12 cm in width.

AVAILABILITY: The use of *Scheelea* by *Artibeus jamaicensis* at Estación Jiménez may be due to the absence of more suitable plants. Although several broad-leaved marantaceous and musaceous species occur in the area, most are less than 2 m tall. The plants and their leaves appear too small and too weak to support several *A. jamaicensis,* which weigh 40-50 g each. As most of these plants die back to the ground during the dry season, leaves are unavailable for tents for 5 to 6 months each year. In addition to *S. rostrata,* only two other species of palms, *Acrocomia vinifera* Oersted and *Bactris guineenis* (Linnaeus) H. E. Moore, are reported (Hartshorn 1971; D. Wilson, pers. comm.) from Estación Jiménez. All have leaves with completely separate pinnae, but unlike *S. rostrata,* which is quite common, *A. vinifera* and *B. guineenis* are rather sparsely distributed. Fronds of *A. vinefera* appear suitable for tents except for the presence of long, sharp spines along the rachis. However, Jimbo and Schwassman (1967) recorded a roost of *Artibeus jamaicensis* in the spiny *Acrocomia wallaceana* (Drude) Beccari in Brazil. The form of the roost, located high in the crown of the palm, was not reported. Leaflets of *B. guineenis* are also quite spiny and appear too weak to support roosting *A. jamaicensis.*

FIGURE 3. *Artibeus watsoni*-type tent in *Asterogyne martiana,* Finca La Selva, Herédia Province, Costa Rica. Undersurface of the modified frond showing veins cut by the bats and the white rachis.

Ingles' (1953) report of tents in *G. oxycarpa* implied that the bats prefer this species over *G. cuneata* which was also present in the area. He did not specify, however, whether the tents were formed from several narrow pinnae, the large terminal pinnae, or both. Unfortunately, Barbour's (1932) mention of the use of the coconut palm *(Cocos nucifera)* by bats included no comments on the flora of the area, nor did it indicate whether trees of other species were examined for bat tents.

The situation is quite different at La Selva. Here, many species of palms with a broad leaf surface occur together with pinnate leaf species in which the

leaflets are discrete. Although all species were not examined equally, no tents were found in any of the pinnate leaf forms. Thus the bats seem to prefer the palms with a broad leaf surface when a choice is available. Barbour (1932) also suggested such a preference even though the palm *(Pritchardia pacifica)* utilized by the bats he studied was an introduced one. He noted that his examination of many coconut palms in the Panama Canal Zone yielded no records of bat tents in this species.

DISCUSSION

It has been suggested that tents conceal bats from predators and shelter them from the weather (Barbour 1932; Timm and Mortimer 1976). Intuitively, one would then assume that tents presenting a solid surface would afford more protection than those with periodic gaps as in *Scheelea* and *Cocos.* However, individual leaflets are not widely separated, and in *S. rostrata* at least, spaces between leaflets decrease in width from the base to the tip of the frond (fig. 1). The *A. jamaicensis* were located distally where the leaflets were quite close together.

Obviously, protection from the elements, particularly rain, will be less in forms with divided, pinnate leaves than in forms with a broad leaf surface. However, the disruptive pattern presented by the individually separated leaflets may provide more effective camouflage. In conjunction with this interpretation, it is interesting to note that many phyllostomatids, including the tent-making *Artibeus* and *Uroderma* as well as members of the genera *Chiroderma, Enchisthenes, Vampyressa, Vampyrodes,* and *Vampyrops,* are generally dark with two to four white facial stripes. Several have a dorsal stripe running down the head and back to the base of the tail. These markings may complement the disruptive pattern of the individual leaflets. The color pattern also may be cryptic for bats roosting under various species of plants, particularly palms such as *A. martiana,* in which the light rachis of the undersurface contrasts with the dark undersurface of the blade (fig. 3).

Possibly the effort required for the construction of tents in species with undivided leaves is less than that required for tent-making in pinnate leaf palms. After close examination of Barbour's figure 2 (1932: 308), we estimated that the cut leaf illustrated included approximately 80 veins; we estimated only 52 veins in the leaf pictured by Chapman (1932: 555) and only 44 in a tent-forming leaf of *Asterogyne* (fig. 3). Seventy-seven leaflets were cut to make the *A. jamaicensis* tent in the *S. rostrata* frond. Therefore, fewer bites may be required for tent-making in palmate and bilobed leaves. Barbour (1932) stated that ". . . by nipping the ridges of the plications on the underside the leaf is . . . sufficiently weakened so that the distal portion droops sharply downward." Each leaflet of *S. rostrata* was chewed not only at the rachis, but also on each opposing distal edge. If we assume that at least two bites are required to weaken sufficiently a midrib, then considering these two factors together, we estimate that a tent in a pinnate palm leaf may require up to three times as many bites. If the bats hover to make the bites, as suggested by Barbour (1932) and by our data, then tent-making in pinnate leaves would require the expenditure of considerably more energy.

This plant-bat, tent-mediated association may be a form of protocooperation provided that the bats are more likely to defecate or urinate over the root system of the tent-containing plant. A damaged leaf seems a small sacrifice compared to the benefit of an increased supply of nitrogen-rich nutrients. This may be especially true in tropical forests where nutrients are tied up in the standing crop of plants to such a great extent.

From data now available, it is evident that tent construction is a fairly common practice among certain species of bats and probably will be discovered among other species as well. Obviously, much additional information will be required to determine how widespread this interesting behavior pattern is, to discover other factors affecting plant selection and tent construction, and to define the adaptive value of tent utilization.

ACKNOWLEDGEMENTS

We wish to thank Ing. Eladio Carmona B. of the Costa Rican Ministry of Agriculture who generously arranged for Foster's use of facilities at Estación Jiménez and the Organization for Tropical Studies for providing field facilities and partial support for Timm. In addition we thank E. Birney, L. Klotz, R. McDiarmid, D. Wilson, and R. Wunderlin who read the manuscript and provided helpful suggestions. D. Patten identified the bats. J. Findley, G. Hartshorn, J. Mortimer, D. Wilson, and R. Wunderlin kindly contributed to the study in various ways. Field work was supported in part by a Grant-in-Aid of research from the Society of Sigma Xi to Foster. Expenses for Timm were provided in part by a grant to Elmer C. Birney from the College of Biological Sciences and the Office of International Programs of the University of Minnesota. To all of these individuals and institutions we extend our sincere gratitude.

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Announcement

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Any person engaged in scientific primatology or interested in supporting the goals of the Society may apply for membership in the Society. Annual dues are $12.00 except for students and those that are retired, for whom the dues are $6.00. Membership may be obtained by sending a check or postal money order, made out to AMERICAN SOCIETY OF PRIMATOLOGISTS, to W. Richard Dukelow (Acting Treasurer), Endocrine Research Unit, Michigan State University, East Lansing, Michigan 48824.

The founding meeting of the Society will be held in Seattle, Washington, April 16-19 in the Washington Plaza Hotel and the Seattle Center, immediately after the annual meeting of the American Association of Physical Anthropologists and before the Western Psychological Association meeting. Further details of the meeting will be sent to all members.