

VARIANCE OF SAC-WINGED BAT DISPLAY BEHAVIOR ACCORDING TO DAILY CYCLES

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Abstract (A.B.)

We studied *Saccopteryx bilineata* at different times during the day, hypothesizing that these bats would exhibit more display behavior at dawn than at dusk, the two times during each day when the bats form their harems. We found no significant difference in display rate at dawn versus at dusk. Perhaps the difference was not large because the bats are not breeding at this time of year; therefore, harem establishment before foraging and harem establishment before resting take on more equivalent levels of importance. This distribution of energy costs may be more beneficial for the bats during the non-breeding season.

Introduction (L.T.)

The sac-wing bat (*Saccopteryx bilineata*) has a specific breeding season at the end of the rainy season. However, the males of this species maintain harems of females throughout the year (Bradbury in Janzen, 1983). Perhaps to ensure that he has a group of females to bear his young, a male must maintain control of them throughout the year. To do this males maintain a daytime roosting territory within the larger colony. The male encourage females to roost within this territory with a series of displays, which include chirps, hovers, and salts (opening and fanning the wing to release an order from scent glands located beneath the wing). These daytime territories are also important for organizing the bats into groups when they leave the roost to feed at night. Each bat has its own "foraging beat" and females of the same harem forage in adjacent beats. The feeding territory of the male overlaps that of all of his current females (Bradbury in Janzen, 1983). Therefore, the harems maintained by the males affect all aspects of the colony's day to day activity. Their territories are all very close to one another at the roosting site and females often move between harems. It seems that these movements would occur most often at those times when the harems are closest; i.e., when the bats come together at the roosting site in early morning.

Therefore, in examining the behavior of these bats, we hypothesized that we would see the greatest number of displays in the morning hours. At this time the colony has just come back together and the females are still active enough to stray into another male's territory, so the male must display to keep them or to attract new females.

Methods (A.B.)

We observed *Saccopteryx bilineata* at Rafael's House, approximately 20 meters off the Sendero Oriental, La Selva, Costa Rica on 6-7 February 1991. We ran trials three times a day, at (1) dusk, before the bats left to forage, (2) dawn, as the bats returned from foraging, and (3) midday, as the bats were resting.

Each person sat in one of four rooms of the house and observed the bats. We ran 15-minute trials, each of us shining flashlights on the walls to help count and keep track of the bats in our quadrant of the house. When a display occurred, we recorded the type of display and time of occurrence. We observed 3 types of displays which had previously been described by Alberts (1983). We labeled vocalizations by the bats 'chirps'. We defined a 'salt' as a bat raising and shaking its wing toward a nearby bat to release an odor from its scent gland beneath the wing. We defined a 'hover' as a bat suspended in mid-air and flapping its wings while facing another bat. We also recorded number and time of departures, defined as when a bat left the wall to move within the house or to leave the house. At each session we paused for at least one minute between each trial. During dusk and dawn sessions, we ran trials until the bats either left the building or ceased displaying. During midday sessions we ran 4 trials.

We calculated the hover and flight rates for each 15-minute trial and compared morning, midday, and evening activity using Mann-Whitney U Tests. We used non-parametric tests because our data did not meet the assumptions required for parametric tests.

Results (C.L.G.)

During two days of observations, anywhere from zero to thirty-five bats total were observed at one time, depending on time of day.

The bats followed a consistent pattern: the first arrivals were between 6:40 and 6:43am, and nearly all the observed bats arrived by 7:20. In general, they circled the room several times before landing. As they established their roosting positions, they made several short flights and hover displays, followed by occasional salt displays (Figure 1, 2). Daytime activity occurred primarily when the bats were disturbed by intruders. Hovering behaviors and numbers of short flights increased as the bats prepared for the evenings foraging. Chirping was nearly constant throughout both the morning and evenings' burst of activity.

We calculated the average number of hovers per bat, and the average number of "takeoffs" (flights from a wall) per bat for two 15 minute periods for each morning (6:43 - 7:16), midday (1430-1500 on 2/6 and 1145-1215 on 2/7), and evening (1830-1900). The

numbers of hovers per bat were significantly greater during both the morning and evening than during midday ($U = 256, p < 0.001$; $U = 176, p < 0.001$), but the morning hover rate was not significantly different from the evening's. Similarly, the number of flights per bat were significantly greater during both morning and evening than during midday ($U = 230, p < 0.001$; $U = 224, p < 0.001$). The number of takeoffs per bat were significantly greater during the evening than during the morning ($U = 187, p < 0.001$).

Discussion (T.G.)

By recording hovers, salts, chirps and flights of the sac-winged bat we assessed two different aspects of its behavior displays and general activity level. Both hovers and salts are considered to be display behaviors (Alberts, 1983). We observed that salts are similar to hovers except that the bats salted less than they hovered. The observations of salts were too few to analyze statistically, but we did note that salts tended to occur later in the session than hovers did.

It has been suggested that males display more often than females, and that they use these physical scent-releasing actions. (1) to attract females to a harem, (2) to retain females in a harem, and (3) to establish and maintain territory boundaries (Alberts, 1983). Some individuals displayed more frequently than the rest; we assumed these were males. However, many other individuals, which we might have been females, displayed as well. It has been documented that females' roosting territories determine their feeding territories (Janzen, 1983) that is, females transpose their relative roosting positions into feeding territories outside the roosting territory. Perhaps there is a dominance hierarchy among the females that determines these roosting and feeding territories. This boundary establishment could require some form of display. Although the females have no scent glands (Janzen, 1983), perhaps the physical display is enough to establish territories.

It also has been suggested that chirps are a third form of display (Alberts, 1983). Our observations did not support this theory. Chirps rarely occurred on their own; rather they seemed to be either a part of a display or a response to a display. We also observed that bats chirp most in times of high activity, specifically, at night when they go out to feed, and in the morning when they return from feeding.

We found no significant difference between hover rates in the morning and at nights. This demonstrates that display rates are not greater in the morning as we had hypothesized. We had originally thought that display rates would be greater in the morning because the male bats establish their harems at that time. It would make sense that the bats would expend the greatest amount of energy in display when there is the most to gain, namely, a larger harem, more copulations, and thus more offspring. However, we found that bats display equally in the morning and evening. This can be explained in

one of two ways. Perhaps there is no difference; that is, establishing breeding territories and establishing feeding territories are equally important. It is also possible that establishing breeding territories is more important, but only during the breeding season, which runs from June to August (Alberts, 1983). Perhaps when the bats are not breeding, the morning displays (to establish breeding territories) become less important, and the evening displays (to establish feeding territories) take on more importance.

We did find that dawn and dusk display rates are significantly greater than midday display rates. The bats are nocturnal; they conserve energy during the day so that they, can expend it for the important activities of establishing feeding territories, foraging, and establishing roosting territories.

Thus, to assess display behavior we looked at hovers, salts, and chirps, comparing hover rates between times of day. We also measured activity levels throughout the day by calculating the rates of departure.

We found that there was a significantly greater number of departures at night than in the morning. This seems logical because at dusk the bats are preparing for their most active time periods, whereas at dawn they are preparing for their least active time period. Although we did find this significance, we are not certain that is an accurate representation of our data: calculating activity level as number of departures from the wall may have skewed the results because the bats all leave the building at night anyway, thus increasing the total number of departures for the evening. Activity levels could affect display rates because males are most at risk of losing their harems when the bats are most active. If activity level does affect display rate, it would make more sense for activity levels to be represented in the same proportions as display rates. If our analysis is not appropriate, as discussed above, then perhaps it is possible that our data might support this idea.

It seems that the displays we studied in this experiment are important to the fitness of *S. bilineata* individuals. They affect male fitness by controlling territory size and location and harem size and continuity; they affect female fitness by establishing her breeding and feeding territories. Though we were unable to find that one time of day has significantly more displays than another, we suggest that a significant difference might occur during the breeding season. Further study is needed to determine whether this is the case. It also might be interesting to mark males and females to more accurately assess the display behavior of each gender. It is also important to note that *S. bilineata* is highly sensitive to disturbances. We observed that flight rate and chirping of the bats increased vastly when they were disturbed; these occurrences may have affected our data. It is also possible that different light intensities of our flashlights may have affected display rates.

Figure 1 Hover rates (number of hovers / bat / 15 minute interval) of *Saccopteryx bilineata* observed February 6 and 7, 1991 at "Rafael's House," La Selva, Costa Rica. Each line represents the bat activity in different rooms.

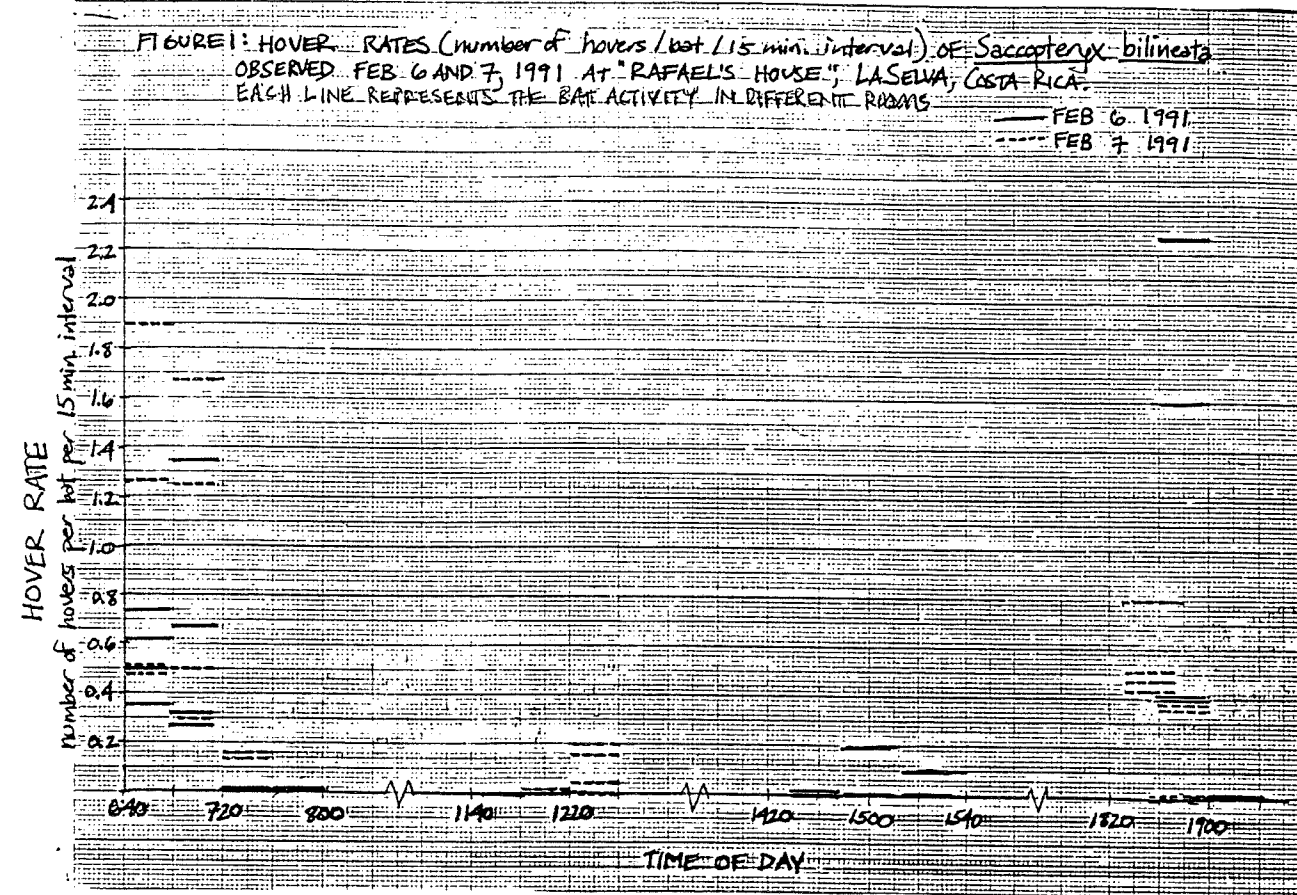
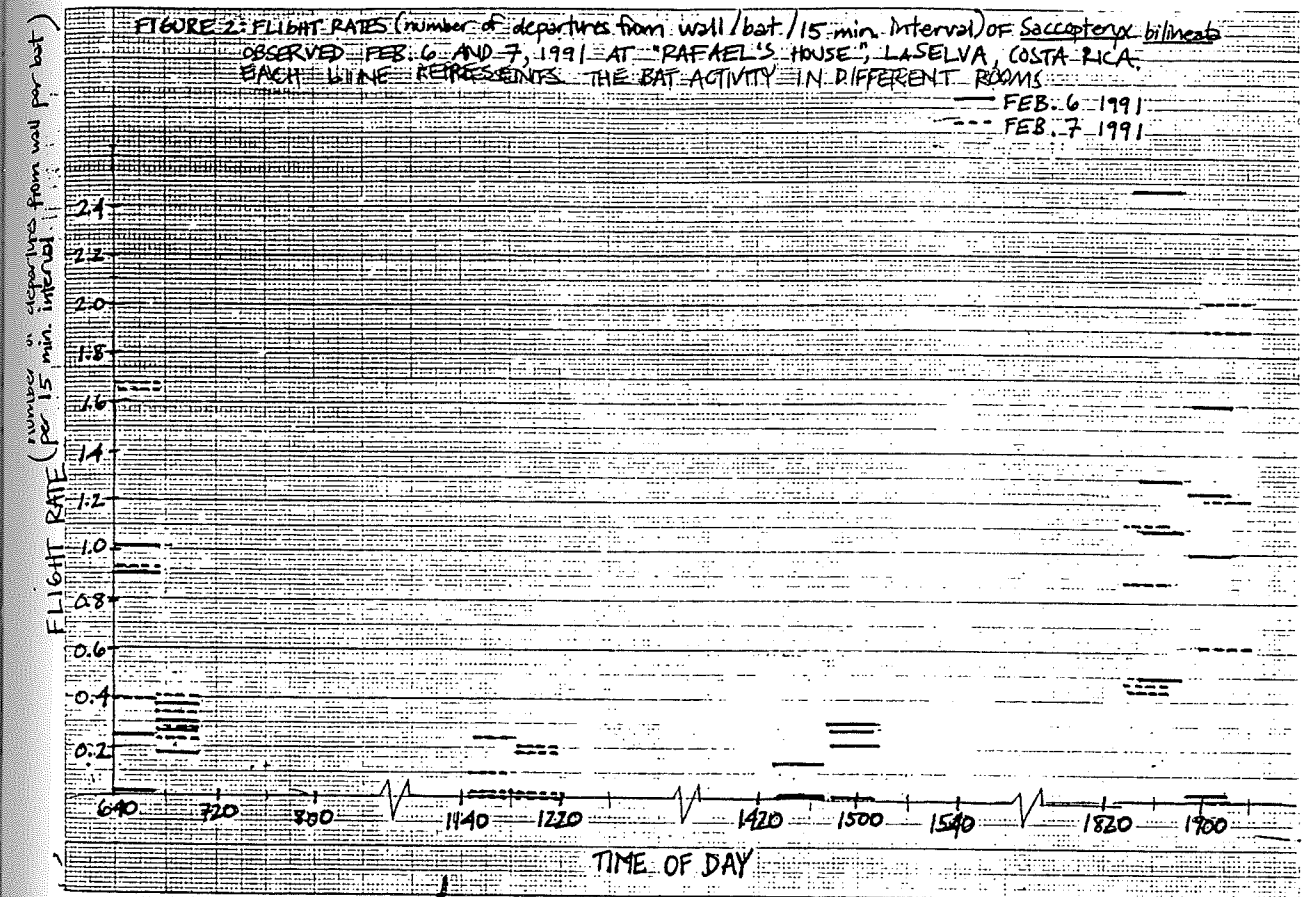


Figure 2 Flight rates (number of departures from wall / bat / 15 minute interval) of *Saccopteryx bilineata* observed February 6 and 7, 1991, at "Rafael's House," La Selva, Costa Rica. Each line represents the bat activity in different rooms.



Literature Cited

Alberts, Allison, "Behavior of *Saccopteryx bilineata*", OTS, 83-4: 27-31.

Janzen, Daniel, *Costa Rican Natural History*, (Chicago University Press: Chicago, 1983).