Social Interactions in the Short-tailed Fruit Bat (Carollia perspicillata):

Wing-boxing Behavior and Screech Vocalizations

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Short-tailed fruit bats (Carollia perspicillata), a species of neotropical frugivorous bats native to the humid jungles of Central and South America, is an excellent model for the study of social communication (Cloutier & Thomas, 1992). Being that these animals roost in both communal and dark environments (Cloutier & Thomas, 1992), they depend largely on vocalizations for social communication (Porter, 1979).

Past research on Carollia perspicillata (C.p) has yielded valuable information regarding the social behavior (Porter, 1979), postnatal development (Williams, 1986), hearing (Sterbing, 2002), reproduction (Rasweiler et al, 1996), and the role of the nose-leaf in the echolocation calls (Hartley & Suthers, 1987). However, very limited research has been done to date on the social vocalizations that accompany the social behaviors of C.p.

Porter (1978) examined the roosting patterns and social behavior of C.p. and determined that the stereotyped “wing-boxing” behavior, where two roosting males strike each other with their wings, was an aggressive social behavior. In a subsequent study, Porter (1979) described several different vocal signals used by this species of bat in social communication, and determined that these vocalizations were critical in the preservation of social structure among conspecifics. Of the vocalizations identified in the aforementioned study, the “screech” vocalization was suggested to be agonistic and emitted during boxing behavior. These non-echolocating vocalizations are broad frequency range calls which last 140-400 ms and which are often emitted multiple times in a row (Porter 1979).
However, as informative as this literature is regarding the nature and characteristics of the wing boxing behavior and the screech vocalization, the association between the two remains unconfirmed. In addition, it is unclear whether screech vocalizations play a role in social communication at all. Based on these unknowns about the social communication methods of C.p., this experiment proposes the hypothesis that screech vocalizations are aggressive social communication signals. Therefore, it is predicted that when bats are engaged in the aggressive wing boxing behavior they will be emitting screech vocalizations.

I will test my hypothesis by recording the social behaviors and vocalizations of a single harem in this colony of short tailed fruit bats. I will then code the recordings, looking for specific “wing-boxing” behavior and classifying the social vocalizations that occur during this behavior. Using statistical methods, the social vocalization that corresponds with the wing-boxing behavior will be determined. This will be done by comparing the frequency of each classification of social vocalizations that occurred during wing boxing behavior.

Methods

Participants

A colony of short-tailed fruit bats, Carollia perspicillata, housed on the Washington State University Vancouver campus, Classroom Building room #323 will be the model for this study. This colony of captive-bred bats consists of about 30 male and female adult, sub-adult, and juvenile bats.

Materials and Equipment

Two main pieces of equipment will be used for recording behaviors and vocalizations. For audio vocalization recordings I will use Avisoft SASLab Pro Recorder and Pro Analysis
software by Avisoft Bioacoustics. Audio recording hardware includes the accompanying Avisoft UltraSound Gate (high-speed data acquisition unit) and four Avisoft Bioacoustics UltraSound Gate NCM6 microphones. Visual behavior will be recorded using a Sony DCR-DVD610/DVD710/DVD810 Handycam with Nightshot capabilities. All equipment and subjects will be used by permission from Dr. Christine Portfors.

Data Collection

Housing conditions include a large flight room maintained at a constant 24 C temperature and 65% Hg humidity. Dim light is cycled at 12 hours on/12 hours off using automatic timers. Food is placed on two shelves located on opposite walls once daily immediately following the onset of the dark cycle. Diet amount and composition are closely monitored and recorded, and include pureed peaches, apricot nectar, dicalcium phosphate, TestDiet© Monkey Tablets, High Protein Monkey Diet 5045 (produced by PMI Feeds, Inc. 1401 S. Hanley Rd. St. Louis, MO 63144) and Tween 80 (the emulsifier Polyoxymethylenesorbitan monooleate). Fresh non-citrus fruit are also provided at the same time as the liquid diet. The colony's enclosure is cleaned every second day to maintain optimal living conditions.

Visual and audio data will be recorded during specific times of the bat’s greatest activity, possibly during feeding. There might be greater competition over food and therefore there may be more instances of wing-boxing behavior, which has been suggested as an antagonistic behavior. Whether this behavior occurs in the presence of food would be another informative test to determine.

I would, however, prefer to record under conditions that past studies have employed in order to maintain consistency. It appears that that boxing behavior occurs immediately after
the onset of the dark cycle (Porter 1978, 1979) also recorded during the dark cycle. Other studies (Bohn, Ma, & Pollak, 2008) have recorded in the late evening (2200-0100h), but these studies were on different species of bats (Mexican Free-tailed) and so their methodology will not be strictly followed. I would record at the same time after the onset of the dark cycle with and without the presence of food. After several recordings with and without food, it would be informative to see whether there is a difference in the frequency of the wing boxing behavior. If such a difference can be observed, then I will continue recording with that condition to optimize recording efficiency.

My criterion for ending data collection will be based on how often the wing boxing behavior occurs. Once I determine how often per hour they perform his behavior, then I can better estimate how long I need to record.

Data Analysis

Data analysis will include two main phases: vocalization and behavior coding and statistical analysis. In the first phase of analysis, I will be coding for specific hallmarks of the wing boxing behavior that have been identified by other studies. In the article written by Porter (1978), nosing behavior occurred prior to boxing behavior. This nosing behavior is recognized when two males who are facing each other slowly approach with their wings and mouths partially open. Their heads will be pulled up towards each other and they will be flicking their tongues out while emitting loud, harsh vocalizations (Porter, 1978). The specific boxing behavior that I will be looking for has been described in Porter (1978) as a situation in which two males strike each other with alternating wings while their mouths remain partially open and they frequently emit vocalizations.
Screech calls will be coded based upon specific acoustical patterns, such as frequency range, duration, repetition rate, and rate of frequency modulation (Porter, 1979). Also, these calls are said to be very loud, wide frequency band, 100-400 ms long, and are, “usually preceded by a brief FM pulse” in addition to occurring in phrases of 2-3 screeches (Porter 1979).

Secondly, statistical analysis will include correlation tests, such as Pearson r. Additional tests may include t-tests and ANOVA’s. Additional tests may be conducted as I learn about them (my current statistical knowledge is rather limited).

Expected Results

I am expecting a correlation between the screech vocalization and the wing-boxing behavior. If there is a significant correlation, then I could conclude tentatively that the screech vocalization has a purpose in social communication. And if there is no significant correlation, then I would not be able to suggest that the screech vocalization has a purpose in social communication.

Significance

The results from this study will be used in further social and vocal communication research. Bats present a unique perspective on social communication because they roost in complete darkness and therefore must rely on vocalizations almost entirely for social communication between conspecifics. Furthermore, this species of bats has been studied relatively little and much remains unknown about their behavioral and vocalization patterns. Specifically, it is not yet known whether the screech vocalization has a particular purpose in social communication between members of the same species. If the results of this study
indicate that the screech vocalization is correlated with wing-boxing behavior, then it could be suggested that the screech vocalizations are an aggressive vocalization used in social communication in *Carollia perspicillata*.

References


Figure Caption

Figure 1: Classification of most commonly seen frequency modulated calls of *Carollia perspicillata*. The classification scheme in this figure was based largely on page 1249 by Kanwal et al, 1994 and the descriptions by Porter, 1979.
Preliminary Data:

Frequency Modulated (FM) Calls for *Carollia perspicillata*

**Guidelines**
- FM >10% of the call is frequency modulated
- Write descriptive notes for Miscellaneous calls
- CF < 10% of the call is frequency modulated

**DFM** - Downward Frequency Modulated

**AFM** - Arched Frequency Modulated

**SFM** - Sinusoidal Frequency Modulated

**Misc** - Miscellaneous