INDIVIDUAL AND ROOST IDENTIFICATION USING THE ECHOLOCATION CALLS OF WILD BIG BROWN BATS, *EPTESICUS FUSCUS*

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1. INTRODUCTION

The majority of bats use echoes of sound pulses to acquire three dimensional acoustic images of their environment, which allows them to navigate in darkness during flight (Griffin; 1958). This process is termed echolocation (Griffin;1958) and can aid bats in avoiding objects, gaining access to roost sites and, locating, identifying and capturing prey.

Previous studies on microchiropteran bats have indicated that their echolocation calls contain variation and information unique to the individual and/or roost location that makes them identifiable to conspecifics (Burnett et al. 2001; Fenton et al. 2004; Kazial and Masters 2004; Masters et al. 1995 and Obrist et al. 1995). Studies on adult Big brown bats (*Eptesicus fuscus*), provided evidence of the vocal distinctiveness of individuals, sex, families, and age classes (Kazial et al., 2001; Kazial and Masters 2004; and Masters et al. 1995).

Despite the abundance of evidence and conjecture for distinctive individual call signals most supportive data has been collected in laboratory settings. However bats flying in natural conditions show more call variation as call features are altered depending on external factors such as proximity to obstacles or the ground and whether other not other bats are present (Burnett et al. 2001; and Surlykke, 2000). My research provides a unique opportunity to study the communication function of echolocation calls of wild Big brown bats under natural conditions

2. METHOD

The echolocation calls from emerging Big brown bats were recorded at 4 different maternity colonies outfitted with passive integrated transponder (PIT) tag readers throughout Fort Collins, Colorado. As a tagged bat enters or exits an equipped roost site a unique time stamp is created, recording the individual's identity, and the time and date that they passed through. The recordings were done with multi-array condenser microphones (UltraSoundgate 416) and Avisoft Recorder USG. This system allows the recording of a wide range of acoustic frequencies and can provide images of inaudible sounds in waveform, spectrogram and energy displays instantaneously. Using the resulting visual displays the following 7 relevant call features were quantified: duration, frequency (kHz) with most energy (FME), lowest frequency (kHz) at both 5 and 10 dB below the FME, highest frequency (kHz) at both 5 and 10 dB below the FME, and Interpulse/Interval. Using only statistically significant call characteristics I attempted to identify the presence of individual voice signatures and asses call variation by running a Discriminant Function Analysis (DFA) using; individuals by roost location, sequence by roost location, and roost location as my grouping variables.

3. RESULTS

One hundred and twenty-eight useable call sequences from all roost locations, representing 99 individuals (29 repeated individuals) were identified.The number of individuals and sequences varied for each site.

A multivariate analysis of variance (MANOVA) determined that all seven call characteristics were statistically significant ($P < 0.01$). Low levels of classification accuracy (both original and cross-validated) were determined using the DFA for both the grouping variables of sequence and individual. However, a DFA classifying roost location, using the same echolocation, calls yielded a reasonably high level of overall accuracy for both original (61.9%) and cross-validated (60.7%) classifications.

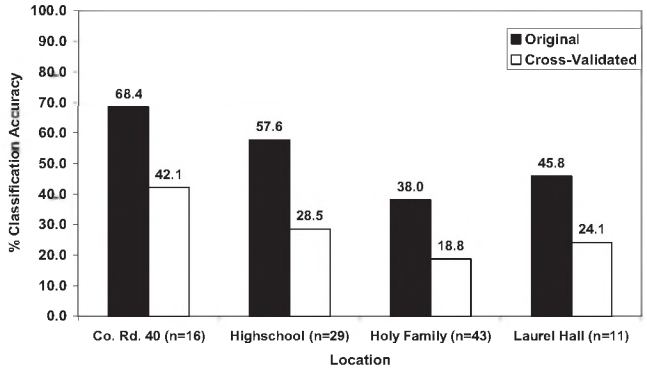

Fig. 1 Classification accuracy results using individual as grouping variable, varied between roost locations. .

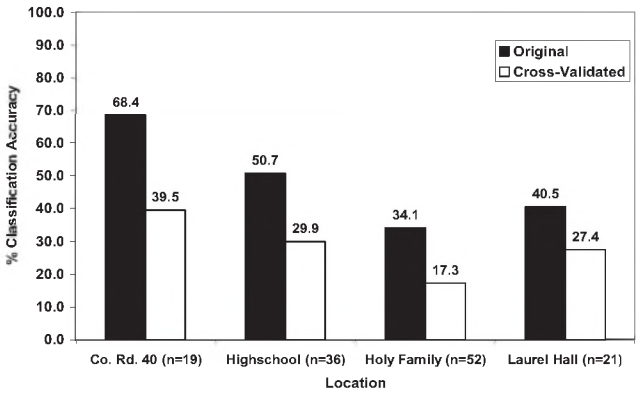

Fig. 2 Classification accuracy results using sequence as grouping variable, varied between roost locations.

In general, it can be seen that the smaller the roost sizes the higher the classification accuracy when running the DFA.

4. DISCUSSION

There is currently is no given threshold to denote an overall acceptable correct classification level in identifying echolocation calls using DFA. Previous literature has confidently stated classification accuracy with percentages ranging from 64-96% (Biscardi et al., 2004). My results although close fall below this range (Figures 1 and 2), indicating that it is likely that more than the echolocation calls of wild Big brown bats is needed to identify individuals during emergence. These classifications results are likely result of a large the sample size, when using DFA to classify echolocation calls the correct classification accuracy decreases as the sample size increases (Biscardi et al, 2004). This tendency can clearly be seen in both Figures 1 and 2 when comparing the DFA for Co. Rd. 40 (the smallest colony) and Holy Family (the largest colony). In addition, identification of specific individuals is made even more difficult, as it appears there is higher classification accuracy when using sequence as the grouping variable in a DFA (Fig. 2). This data indicates that there is call variation of echolocation calls within the individual level and that a bat can actually sound slightly different each time it echolocates. Geographic, environmental, behavioural and body size variation have been listed as likely explanations for this (Barclay, 1999; and Obrist, 1995).

Bat calls are relatively simple high frequency sweeps that some believe are best suited for target detection and identification alone and that the physics of sound places constraints that would not allow the consistent and accurate identification between bat species (Barclay, 1999). Despite evidence opposing this claim (Kazial and Masters, 2004; Masters et al. 1995; Obrist, 1995), it may be reasonable to assume that there is not enough call variation within an individual bat's echolocation calls to identify every bat in colonies that potentially contain hundreds of individuals. And it is the difference in sample size that explains the differences in conclusion. However, this does not preclude the idea that echolocation calls could contain enough variation for an individual to identify a fellow roost mate (Boughman, 1997; Fenton et al., 2004; Kazial et al., 2001; and Masters et al., 1995).

Big brown maternity colonies, such as the ones where I recorded, can be quite large containing hundreds of bats in which high degree of relatedness has been suggested. The ability to recognize ones roost mate or family members while outside the roost in flight situations where visual, olfactory, and even low frequency audible calls may be ineffective, may mean that useful information can be transferred that would be beneficial to both individuals. The capacity to recognize roost mates could play a significant role during foraging and hibernation; additionally it could help Big brown bats maintain group or pair cohesion as they alternate between roosts.

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