A Study of Echolocation Calls of the Bats of Dominica.

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Abstract

Echolocation calls were recorded from three species of bats over a two week period on the Island of Dominica. After catching the bats in mist nets, they were flown through a 40 foot flight tunnel on Mt. Joy and recorded using Petterson D240X ultrasound detector and the Handy Recorder H2 Zoom. The three species recorded were *Molossus molossus, Tadarida brasiliensis,* and *Artibeus jamaicensis.* The purpose of this project was to analyze the calls recorded in order to expand on the study that was done by Heather Medina over the echolocation of bats on Dominica. We found slight differences between Medina's result and ours in one species of bat and similarities in another. Comparisons were based off of high and low frequencies, duration, and slope of echolocation parameters.

Introduction

Dominica is the youngest nation in the Lesser Antilles islands. It is filled with lush, tropical rainforest of several different types, and the density of trees and underbrush vary between these types. Dominica is home to six different families of bats and 12 unique species, but has surprisingly few mammals overall. In fact, bats make up the majority of the island's mammalian population. Depending on where the bats are located, they may or may not emit different echolocation frequencies to help them navigate (Russ, 1999). Whether they are frugivorous, insectivorous, or carnivorous also plays a role in this; some bats emit higher echolocation frequencies, while others emit lower ones. The purpose of this experiment was to expand on Heather Medina's work on investigating the characteristics of echolocation calls between different species. Because of the new technology available to us, recording and graphing these calls became possible. The calls of four species were recorded: *Molossus*

molossus, Tadarida brasiliensis, Artibeus jamaicensis, and *Sturina lilium*. The calls were then compared and contrasted to one another.

Materials and Methods

Bats of Dominica were captured over several nights using mist nets. Four were set up around the Bee House of the Archbold Tropical Research and Education Center, where bats have been known to drink from a small pond. A net was also placed across a stream near the field station for the same reason. The nets were roughly nine meters in length, propped up on cut bamboo poles and stabilized with small ropes, stakes, and large rocks.

The nets were checked every ten minutes; once a bat was caught in one of the nets it was carefully untangled, put in a tube sock, and secured with a clothespin for transport to the flight tunnel. Once we arrived at the flight tunnel, we weighed each socks containing a bat with a Pesola scale. Then we removed the bat from the sock with working gloves that were strong enough to withstand bites but flexible enough to maintain hold on small bats. The empty sock weight was recorded after the bat was removed and subtracted from the first weight to get the bat's true weight. We recorded the species, the sex, and used a ruler to measure right forearm length.

A 40-foot flight tunnel was constructed in the burned down remains of Mount Joy. Tarps were used to cover the corridor, ropes were used to secure the tarps, and heavy rocks were used to keep the tarp in place. An object was constructed out of bamboo and placed at the end of the tunnel so that the bats would be forced to use echolocation to avoid the object. We used the Petterson D240X ultrasound detector and the Handy Recorder H2 Zoom to record the echolocation calls of three different bat species. We hand released the bats at the beginning of the flight tunnel and had an individual sit on the ground after the obstacle with the detector and recorder devices. We used the settings for the detector and recorder specified in Heather Medina's research paper from the 2011 Dominica study abroad. For the detector we used "a manual trigger, 3.4 seconds memory size, low-level trigger, high frequency source trigger, "normal" setting, and time exp" (Medina, 2011). We used low gain for all bats except for frugivores, which required high gain setting (Medina, 2011). For the recorder we used, "a low cut off filter off, 44.1 kHz.16 bit recording format, automatic gain control off, mono mix off, and 15-second light period. We set the recorder to default for the left/right position, metronome, tuner, play mode, AB repeat, contrast, and USB" (Medina, 2011).

Before the bat was released we pressed the manual button on the detector in order to reduce static and put the recorder on standby mode by pressing the record button once. We had two people at the end of the tunnel, one person to say now at the instant when the bat reached the obstacle to indicate to the other person, working the detector device, to turn off the detector so that the last three seconds of echolocation would be recorded. After the bat flew out of the tunnel we transferred the three-second recording from the detector to the recorder. When back at the station we used SonoBat 2 to analyze the digitized recordings on a computer.

Results

We caught 36 bats in total and managed to record echolocation calls from seven of them.

In total three different species were recorded (*Artibeus jamaicensis, Molossus molossus, Tadarida brasiliensis*) using the flight tunnel.

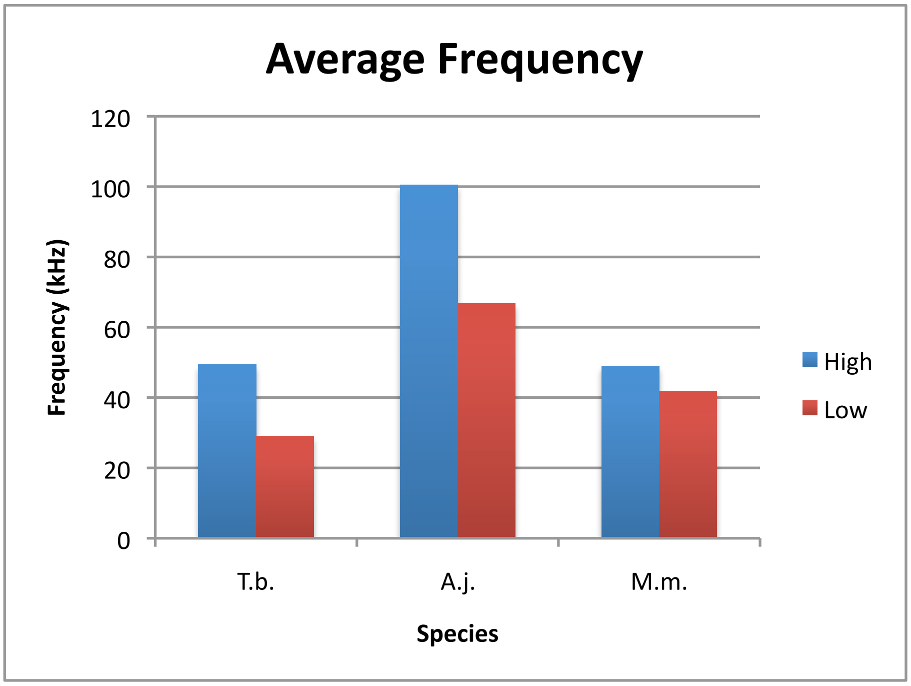
Bat #	Sex	Species	Location	Weight(g)	Hi Fequency	Low Frequency KHz	Duration(ms)	Slope
6	Male	A.j.	Springfield Stream	49	100.5	66.8	1.13	29.82
9	Female	T.b.	Springfield Stream	9	50.4	30.9	2.98	6.54
10	Male	T.b.	Springfield Stream	8	53.2	30.5	2.8	8.11
11	Male	M.m.	Springfield Stream	15	50.7	49.2	2.7	0.56
17	Male	M.m.	Springfield Stream	11	47	30.8	3.78	4.29
22	Male	M.m.	Springfield Stream	12	49.2	45.5	3.02	1.23
26	Male	T.b.	Springfield Stream	8	44.5	25.9	3.53	5.27

Table 1: Measurements from three species of bats in Dominica and their echolocation parameters.

	High	Low	Avg Duration
T.b.	49.367	29.1	3.1033333
A.j.	100.5	66.8	1.13
M.m.	48.967	41.833	3.1666667

Table 2: Average high and low frequencies of three different bat species.

Chart 1: Average high and low frequencies of *Tadarida brasiliensis, Molossus molossus,* and *Artibeus jamaicensis*.



Below are the structures of the calls for each species. The X-axis represents time in millisecond and the Y-axis represents frequency of the calls in kHz.

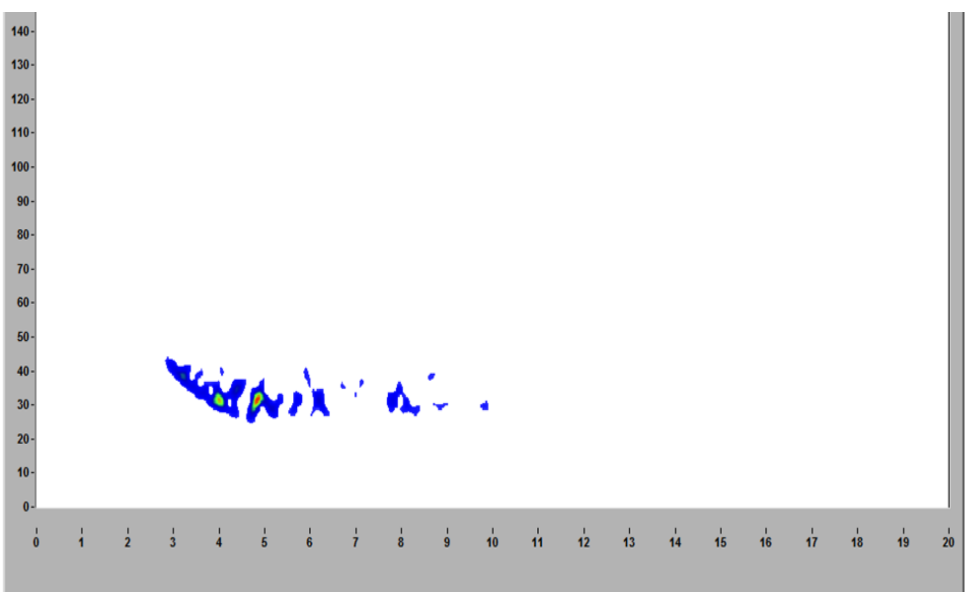


Figure 1: Call from *Tadarida brasiliensis*

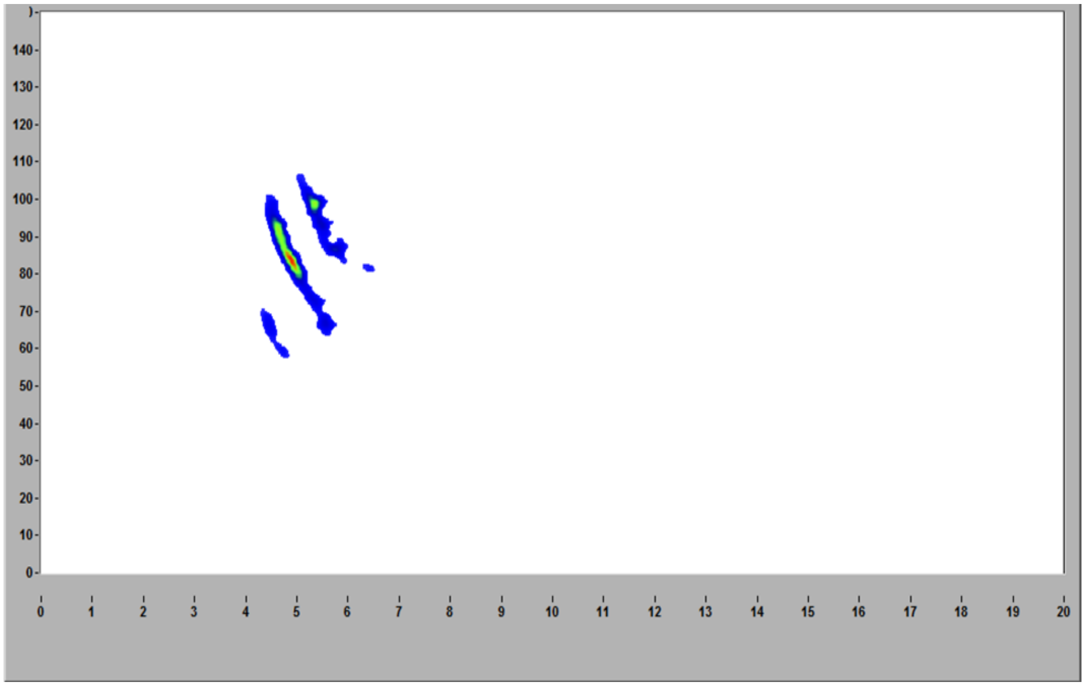


Figure 2: Call from *Artibeus jamaicensis*

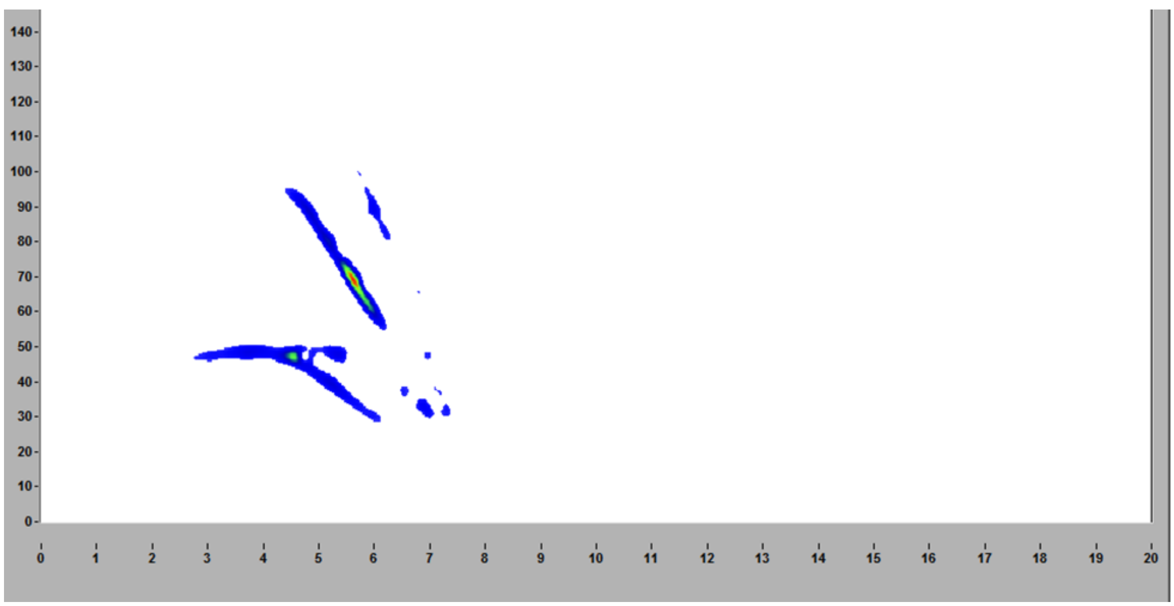


Figure 3: Call from *Molossus molossus*

Discussion

The echolocation calls we recorded for *Tadarida brasiliensis* were higher than most of the Tadarida that Heather Medina recorded. Two of the three calls we had recorded had high frequency points above 50 kHz. However *T. brasiliensis* have been known to make hard tocks around 50 kHz which matches our recordings (Medina, 2011). With Medina's and our recordings the range for the high and low frequency points for *T. brasiliensis* is 43.1-53.2 kHz and 21.7-30.9 kHz respectively (Medina, 2011). We also found that the average duration of these calls was 3.1 ms with a range of 2.8-3.53 ms (Table 1, Table 2). In addition, the calls had a very small slope in the range of 5.27-8.11 kHz/ms (Table 1).

The only recording for *Artibeus jamaicensis* partially fell within the range that Medina had found. The high frequency point was 5.7 kHz lower than her range at 100.5 kHz. The low frequency point fell well in the middle of her low point range at 66.8 kHz. The new range for the high frequency point is now 100.5-111.6 kHz (Medina, 2011). The low frequency point range is still 59.8-77.5 kHz (Medina, 2011). The call we recorded had a duration of 1.13 ms with a relative steep slope of 29.82 kHz/ms (Table 1, Table 2).

We recorded three different calls for *Molossus molossus*. The average high frequency point was 48.967 kHz (Chart 1), while the average low frequency point was 41.833 kHz (Chart 1). These frequencies are a little higher than what was recorded in Kössi et al.'s study. They found that the peak frequency was around 39.68 ±1.47 kHz (Kössi, 1999). However the structure of their calls remained consistent with their finding. In all three recordings the bat emitted a pair of echolocation calls. This can be seen in Figure 3. Kössi et al.'s study proposes that this pairing is beneficial during echolocation by allowing the bat to better recognize the echoes of their own calls (Kössi, 1999). They also suggest that the echoes from insects can better interrupt the "simple melody of paired calls instead of a pattern of uniform calls" (Kössi, 1999). The average duration for these calls was 3.16 ms with a range of 2.7-3.78 ms (Table 1, Table 2). They had a small slope in the range of .56-4.29 kHz/ms.

When comparing the calls of each species, we can see that the insectivorous bats, *Tadarida brasiliensis* and *Molossus molossus*, have lower frequency calls with a longer duration, while the frugivorous bat, *Artibeus jamaicensis*, has a higher frequency call with shorter duration. This can be explained by their differing foraging habits. Insectivorous bats are looking for open spaces where the insects will be. So they use a lower frequency call that goes farther with a longer duration. This gives them a more general picture of the area they are flying in. The frugivorous bats use multiple short choppy calls of a higher frequency that do not travel as far. However because it is a higher frequency, they can get a sharper image from their echoes. They need a good picture so they can better find the fruits that they eat.

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