Beetle Diversity at three locations on Dominica estimated by traps in Canopy and Ground Malaise traps

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Introduction

In 2000, Lucille Benavides, E. C. Chavez, Jeremiah Dye, and Edith Kretch performed an experiment based on Terry Erwin's beetle diversity experiment. We followed the example from the beetle experiment from 2000. Our goal was to further their work in different environments using the same equipment. The 2000 study concluded that the beetle species richness of aerial and ground malaise traps was the same.

Our null hypothesis therefore states that the richness in both ground and aerial is the same. We intend to test our hypothesis by collecting more samples in a variety of habitats.

Methods

Our test methods include the use of seven ground Malaise and four aerial Malaise traps. We placed these traps at optimum locations on site at Springfield Station, Morne Trois Pitons National Park (Middleham Falls Trail), and Cabrits National Park.

At Springfield Station, we placed one aerial trap and one ground trap at Fig Tree #1 (Ficus Citrifolia). This tree was located to the west of the station along the southwest property line at N 15 20.760 W 61 22.390. The aerial trap was approximately 14.02 meters above the ground. The ground trap was at 251.15 meters above sea level. Also at Springfield, we placed an aerial trap and ground trap at Fig Tree #2 (Ficus Citrifolia). This tree is located to the southwest of the station along the north side of the Checkhall River, where the trail from the station meets the river. This tree is located at N 15 20.740

W 61 22.147. The elevation of the ground trap was 294.13 meters above sea level and the aerial was 10.36 meters above it. The traps at these locations collected samples from May 31 to June 4. These fig trees are located in secondary rain forest. There is very little understory vegetation and a very high canopy that was very dense. The area around fig tree one was relatively flat, possibly used as farmland previously. Fig tree two sat in similar conditions but along a mountain stream on one side and a steep hill on the other. The area had very dense understory vegetation and moderately dense canopy.

Our third location was at Morne Trois Pitons National Park where we put four traps, two aerial and two ground. The first location of the traps was at N 15 20.953 W 61.20.556 along the trail to Middleham Falls. The elevation of the ground trap was 689.15 meters while the aerial hung about 12.19 meters. The second set of traps we set were about five minutes down the trail from the first set. The location of the traps was N 15 20.960 by W 61 20.627. The elevation of the ground trap was at 678.48 meters and the aerial trap hung about 10.66 meters above the ground. These traps at this location collected samples from June 1 to June 5. The area around Middleham was primary rain forest. The first sets of traps were in a wooded area with very little understory vegetation and a dense canopy. The second set of traps were along a river with very little understory vegetation on one side and a high embankment on the other side.

We also set out three traps at Cabrits National Park. There were no more aerial traps left for us to use so we set out three ground traps. Ground trap one was located along the West Cabrits trail at N 15 35.153 by W 61 28.464. The elevation of this trap was 96.31 meters above sea level. Ground trap two was located along the same trail at N 15 35.106 by W 61 28.576 which was 181.66 meters above sea level. The third trap we set out at Cabrits was also along the West Cabrits trail. It was located at N 15 35.177 by W 61 28.565 which was located at 181.96 meters above sea level. The traps at this location collected samples from June 3 to June 7. The Cabrits area was primary a dry forest and scrubland. All three traps were placed along the trail on steep inclines.

All traps were filled with 95% alcohol while collecting. After samples were retrieved, the group sorted through the beetles (Coleoptera) to separate the beetles from the rest of the sample. The beetles were the separated and identified using *Peterson Field Guides: Beetles* by Richard E. White and *An Introduction to the Study of Insects 6th edition* by Donald J. Borror, Charles A. Triplehorn, and Norman F. Johnson.

Our method for setting up the aerial traps was adapted from Jeremiah Dye's project in 2000. We basically used the same techniques with slight changes determined by our group's climbing ability. We used a hand over hand ascension method, which included the use of two hand ascenders. For maximum safety we attached one ascender straight into the belt of the climbing harness while the other was used to support the feet. We climbed on a 1500-pound load rope, which was looped over a branch and tied off to another tree using a secure bowline knot with three half hitches as back-up knots. The rope was thrown over the branch by using smaller nylon cord with a weighted bag on the end. We used the ascenders to climb up and a figure eight descender to come down. The descender was used like a simple belay method modified from a repel method. While the ascenders were attached, we switched the load to the descender and came down. While we were up in the tree we would attach the traps to the rope and lift them up to the worker in the tree. The group members monitored all procedures and techniques while the worker was in the tree.

We will be using the Shannon Weiner diversification index to show similarities in our data as well as prove our hypothesis. To achieve the H' needed, we used the formula H'= Pi*ln (Pi). The functions in the equation deal with the percentage of specimens at each site. When H' is closer to one, the samples are less diverse and vice versa. This formula aided us in our interpretation of the data at each site.

Materials

Four Aerial Malaise Traps

Seven Ground Malaise Traps

95% Alcohol

Nalgene Bottles

Two Handsaws

Microscopes

1500-pound load rope

Nylon lead rope

Weighted Bags

Two Climbing Harnesses

Two Sets of Ascenders

Two Safety Helmets

Two Figure-eight Descenders

Aluminum Carabineers

Steel Carabineers

Pigma Pens

Notebook Paper

Computer

Results and Data

(See next few pages)

Discussion

From our data and field observations, we have enough evidence to support our hypothesis, which was that the diversification in both ground and aerial would be the same. Through careful experimentation and collection methods, we successfully retrieved consistent data from all locations.

Our results and conclusions were achieved by using the Shannon Weiner diversification index. We divided up the sites by ground and aerial data and determine its H' and H' max. (See Table 6) We compiled Table 6 to show the differences accordingly. For complete data results of each site, see Appendix 1. This appendix has all data collected and separated by site. (Woolley)

Looking through our data, we have found several trends to support our hypothesis. At first glance, one might conclude that the ground traps are more diverse due to the couple of samples that had an extraordinary high H'. Actually, only half of our samples that are from locations that have both aerial and ground traps, were more diverse (larger H') in ground traps. To further support our hypothesis, we note that the average H' of aerial and ground traps are very similar, 1.74 and 1.90, respectively. Considering the short time that our traps were out and the very close averages, it could be predicted that over enough time these numbers would be much closer.

There were also some unusual trends that appeared in our data. There were several insect families that were found only in the ground traps, including Lampyridae, Cleridae, Eucnemidae, Malachiidae, Anthicidae, Anobiidae, Bostichidae, Staphylinidae, Melandryidae, Calliriphidae, Nitidulidae, Platypodidae, and Cerambycidae. The aerial traps only contained one family that was not found in the ground traps, Coccinelliidae. We have always previously thought that Lampyrids were highflying insects, but after collecting them in ground traps, the whole mating process of these insects has taken on a new light. Another related interesting fact is that 46% of the time, per location, beetles are found in both air and ground locations. This information supports the existence of substantially different (diverse) communities of insects in these habitats. Even though there are thousands upon millions of insects, there were still none that were dominant enough to be found in all of the traps. It is certainly possible that the differences in the aerial and ground insect fauna represented in our samples reflects specialized adaptations of these insects for different habitats.

Conclusion

Through experimentation, we proved our hypothesis to be accurate. According to our data, the differences found in beetle families follow the theory that each site will have similar family numbers. We concluded that diversification in the canopy as well as on the ground are similar.

Appendix

Appendix 1: Calculations of H' for each sample								
					Fig Tree #1			
	Ground				Aerial			
Families	**Specimens/Family**	**Pi**	**ln (Pi)**	**Pi*ln(Pi)**	**Specimens/Families**	**Pi**	**ln(Pi)**	**Pi*ln(Pi)**
Scarabaeidae	6	0.24	-1.43	-0.34	0			
Curculionidae	3	0.12	-2.12	-0.25	0			
Elateridae	8	0.32	-1.14	-0.36	2	0.2	-1.61	-0.32
Mordellidae	1	0.04	-3.22	-0.13	1	0.1	-2.30	-0.23
Cucujidae	0				1	0.1	-2.30	-0.23
Nitidulidae	0				0			
Cerambicidae	0				1	0.1	-2.30	-0.23
Bostrichoidae	0				0			
Coccinellidae	0				1	0.1	-2.30	-0.23
Tenebrionidae	0				1	0.1	-2.30	-0.23
Meloidae	0				0			
Platypodidae	0				0			
Chrysomelidae	0				0			
Malachiidae	0				0			
Callliriphidae	0				0			
Cantharidae	0				0			
Lampyridae	0				0			
Scolytidae	4	0.16	-1.83	-0.29	0			
Eucnemidae	0				0			
Ptilodactylidae	1	0.04	-3.22	-0.13	3	0.3	-1.20	-0.36
Histeridae	0				0			
Anthicidae	0				0			
Staphylinidae	0				0			
Cleridae	1	0.04	-3.22	-0.13	0			
Anobiidae	1	0.04	-3.22	-0.13	0			
Melandryidae	0				0			
# Specimens	25	1			10	1		
# Families	8				7			
H'				1.77				1.83
H' Max				3.13				1.43
H'Max-H'				1.36				-0.4
					Fig Tree #2			
	Ground				Aerial			
Families	**Specimens/Family**	**Pi**	**ln (Pi)**	**Pi*ln(Pi)**	**Specimens/Families**	**Pi**	**ln(Pi)**	**Pi*ln(Pi)**
Scarabaeidae	4	0.11	-2.21	-0.24	0			
Curculionidae	2	0.05	-3.00	-0.15	3	0.12	-2.12	-0.25
Elateridae	4	0.11	-2.21	-0.24	0			

Mordellidae	2	0.05	-3.00	-0.15	3	0.12	-2.12	-0.25
Cucujidae	1	0.03	-3.51	-0.11	2	0.08	-2.53	-0.20
Nitidulidae	2	0.05	-3.00	-0.15	0			
Cerambicidae	3	0.08	-2.53	-0.20	2	0.08	-2.53	-0.20
Bostrichoidae	1	0.03	-3.51	-0.11	0			
Coccinellidae	0				3	0.12	-2.12	-0.25
Tenebrionidae	0				0			
Meloidae	0				0			
Platypodidae	6	0.14	-1.97	-0.28	0			
Chrysomelidae	0				5	0.17	-1.77	-0.30
Malachiidae	1	0.03	-3.51	-0.11	0			
Callliriphidae	3	0.08	-2.53	-0.20	0			
Cantharidae	7	0.18	-1.71	-0.31	8	0.31	-1.17	-0.36
Lampyridae	1	0.03	-3.51	-0.11	0			
Scolytidae	1	0.03	-3.51	-0.11	0			
Eucnemidae	0				0			
Ptilodactylidae	0				0			
Histeridae	0				0			
Anthicidae	0				0			
Staphylinidae	0				0			
Cleridae	0				0			
Anobiidae	0				0			
Melandryidae	0				0			
# Specimens	38	1			26	1		
# Families	14				7			
H'				2.46				1.82
H' Max				2.71				3.71
H'Max-H'				0.25				1.89
					Middleham Falls Site 1			
	Ground				Aerial			
Families	**Specimens/Family**	**Pi**	**ln (Pi)**	**Pi*ln(Pi)**	**Specimens/Families**	**Pi**	**ln(Pi)**	**Pi*ln(Pi)**
Scarabaeidae	0				0			
Curculionidae	0				0			
Elateridae	1	0.02	-3.91	-0.08	2	0.07	-2.66	-0.19
Mordellidae	0				0			
Cucujidae	0				1	0.03	-3.51	-0.11
Nitidulidae	2	0.04	-3.22	-0.13	0			
Cerambicidae	6	0.12	-2.12	-0.25	0			
Bostrichoidae	0				0			
Coccinellidae	0				2	0.07	-2.66	-0.19
Tenebrionidae	0				1	0.03	-3.51	-0.11
Meloidae	0				0			
Platypodidae	0				0			
Chrysomelidae	3	0.06	-2.81	-0.17	3	0.10	-2.30	-0.23
Malachiidae	0				0			

Callliriphidae	4	0.08	-2.53	-0.20	0			
Cantharidae	22	0.44	-0.82	-0.36	18	0.60	-0.51	-0.31
Lampyridae	2	0.04	-3.22	-0.13	0			
Scolytidae	0				0			
Eucnemidae	3	0.06	-2.81	-0.17	0			
Ptilodactylidae	7	0.14	-1.97	-0.83	3	0.10	-2.30	-0.23
Histeridae	0				0			
Anthicidae	0				0			
Staphylinidae	0				0			
Cleridae	0				0			
Anobiidae	0				0			
Melandryidae	0				0			
# Specimens	50	1			30	1.00		
# Families	9				7			
H'				2.32				1.35
H' Max				5.56				4.29
H'Max-H'				3.24				2.94
					Middleham Falls Site 2			
	Ground				Aerial			
Families	**Specimens/Family**	**Pi**	**ln (Pi)**	**Pi*ln(Pi)**	**Specimens/Families**	**Pi**	**ln(Pi)**	**Pi*ln(Pi)**
Scarabaeidae	1	0.05	-3.00	-0.15	1	0.07	-2.66	-0.19
Curculionidae	1	0.05	-3.00	-0.15	4	0.27	-1.31	-0.35
Elateridae	0				1	0.07	-2.66	-0.19
Mordellidae	0				1	0.07	-2.66	-0.19
Cucujidae	0				3	0.20	-1.61	-0.32
Nitidulidae	3	0.14	-1.97	-0.28	0			
Cerambicidae	0				0			
Bostrichoidae	0				0			
Coccinellidae	0				0			
Tenebrionidae	0				0			
Meloidae	0				0			
Platypodidae	0				0			
Chrysomelidae	2	0.1	-2.30	-0.23	1	0.07	-2.66	-0.19
Malachiidae	0				0			
Callliriphidae	2	0.1	-2.30	-0.23	0			
Cantharidae	9	0.41	-0.89	-0.36	2	0.13	-2.04	-0.27
Lampyridae	2	0.1	-2.30	-0.23	0			
Scolytidae	0				2	0.13	-2.04	-0.27
Eucnemidae	0				0			
Ptilodactylidae	1	0.05	-3.00	-0.15	0			
Histeridae	0				0			
Anthicidae	0				0			
Staphylinidae	0				0			
Cleridae	0				0			

Anobiidae	0				0			
Melandryidae	0				0			
# Specimens	21	1			15	1.00		
# Families	8				8			
H'				1.78				1.96
H' Max				2.63				1.88
H'Max-H'				0.85				-0.08
					Cabrits Sites			
	Ground 1				Ground 2			
Families	**Specimens/Family**	**Pi**	**ln (Pi)**	**Pi*ln(Pi)**	**Specimens/Families**	**Pi**	**ln(Pi)**	**Pi*ln(Pi)**
Scarabaeidae	3	0.07	-2.66	-0.19	3	0.04	-3.22	-0.13
Curculionidae	0				41	0.55	-0.60	-0.33
Elateridae	3	0.07	-2.66	-0.19	17	0.23	-1.47	-0.34
Mordellidae	25	0.63	-0.46	-0.29	7	0.10	-2.30	-0.23
Cucujidae	0				0			
Nitidulidae	0				1	0.01	-4.61	-0.05
Cerambicidae	1	0.02	-3.91	-0.08	0			
Bostrichoidae	0				0			
Coccinellidae	0				0			
Tenebrionidae	1	0.02	-3.91	-0.08	0			
Meloidae	0				2	0.03	-3.51	-0.11
Platypodidae	0				0			
Chrysomelidae	1	0.02	-3.91	-0.08	0			
Malachiidae	0				0			
Callliriphidae	0				0			
Cantharidae	0				0			
Lampyridae	0				0			
Scolytidae	1	0.02	-3.91	-0.08	0			
Eucnemidae	0				0			
Ptilodactylidae	2	0.05	-3.00	-0.15	1	0.01	-4.61	-0.05
Histeridae	0				1	0.01	-4.61	-0.05
Anthicidae	2	0.05	-3.00	-0.15	0			
Staphylinidae	0				0			
Cleridae	2	0.05	-3.00	-0.15	1	0.01	-4.61	-0.05
Anobiidae	0				0			
Melandryidae	0				0			
# Specimens	41	1			74	1.00		
# Families	10				9			
H'				1.43				1.33
H' Max				4.1				8.22
H'Max-H'				2.67				6.89

	Ground 3			
Families	**Specimens/Family**	**Pi**	**ln (Pi)**	**Pi*ln(Pi)**
Scarabaeidae	3	0.03	-3.51	-0.11
Curculionidae	14	0.12	-2.12	-0.25
Elateridae	37	0.31	-1.17	-0.36
Mordellidae	4	0.03	-3.51	-0.11
Cucujidae	1	0.01	-4.61	-0.05
Nitidulidae	13	0.12	-2.12	-0.25
Cerambicidae	5	0.04	-3.22	-0.13
Bostrichoidae	0			
Coccinellidae	0			
Tenebrionidae	2	0.02	-3.91	-0.08
Meloidae	6	0.05	-3.00	-0.15
Platypodidae	25	0.19	-1.66	-0.32
Chrysomelidae	2	0.02	-3.91	-0.08
Malachiidae	2	0.02	-3.91	-0.08
Callliriphidae	0			
Cantharidae	0			
Lampyridae	0			
Scolytidae	0			
Eucnemidae	1	0.01	-4.61	-0.05
Ptilodactylidae	0			
Histeridae	0			
Anthicidae	0			
Staphylinidae	1	0.01	-4.61	-0.05
Cleridae	1	0.01	-4.61	-0.05
Anobiidae	1	0.01	-4.61	-0.05
Melandryidae	1	0.01	-4.61	-0.05
# Specimens	119	1.00		
# Families	12			
H'				2.21
H' Max				9.92
H'Max-H'				7.71

Table 1: Number of Specimens, Families, and Shannon Weiner diversity statistics for all samples

	# of Specimens	# of Families	H'	H'Max
Fig Tree #1				
Ground	25	8	1.77	3.13
Aerial	10	7	1.83	1.43
Fig Tree #2				
Ground	38	14	2.46	2.71
Aerial	26	7	1.82	3.71
Middleham Falls				
Site 1: Ground	50	9	2.32	5.56
Site 1: Aerial	30	7	1.35	4.29
Site 2: Ground	21	8	1.78	2.63
Site 2: Aerial	15	8	1.96	1.88
Cabrits				
Ground 1	41	10	1.43	4.1
Ground 2	74	9	1.33	8.22
Ground 3	119	12	2.21	9.92

Table 2: Number of Beetles of each family in each trap

Families	FT1 Gr	FT1 Air	FT2 Gr	FT2 Air	MF Gr 1	MF Air 1	MF Gr 2	MF Air 2	Cab Gr 1	Cab Gr 2	Cab Gr 3
Elateridae	8	2	4		1	2		1	3	17	37
Curculionidae	3		2	3			1	4		41	14
Cantharidae			7	8	22	18	9	2			
Mordellidae	1	1	2	3				1	25	7	4
Platypodidae			6								25
Scarabaeidae	6		4				1	1	3	3	3
Nitidulidae			2		2		3			1	13
Cerambicidae		1	3	2	6				1		5
Ptilodactylidae	1	3			7	3	1		2	1	
Chrysomelidae				5	3	3	2	1	1		2
Cucujidae		1	1	2		1		3			1
Callliriphidae			3		4		2				
Meloidae										2	6
Scolytidae	4		1					2	1		
Coccinellidae		1		3		2					
Tenebrionidae		1				1			1		2
Lampyridae			1		2		2				
Cleridae	1								2	1	1
Eucnemidae					3						1
Malachiidae			1								2
Anthicidae									2		
Anobiidae	1										1
Bostrichoidae			1								
Histeridae										1	
Staphylinidae											1
Melandryidae											1
Total	25	10	38	26	50	30	21	15	41	74	119

FT 1 = Fig Tree #1 **MF 1** = Middleham Falls Site 1 **Cab 1** = Cabrits Site 1 **Cab 3** = Cabrits Site 3
FT 2 = Fig Tree #2 **MF 2** = Middleham Falls Site 2 **Cab 2 =** Cabrits Site 2
Gr = Ground **Air** = Aerial

Figure 1: Beetle Richness over 3 Habitats

(FT 1 = Fig Tree #1, FT 2 = Fig Tree #2, MF 1 = Middleham Falls Site 1, MF 2 = Middleham Falls Site 2, Cab 1 = Cabrits Site 1, Cab 2 = Cabrits Site 2, Cab 3 = Cabrits Site 3 Gr = Ground, Air = Aerial)

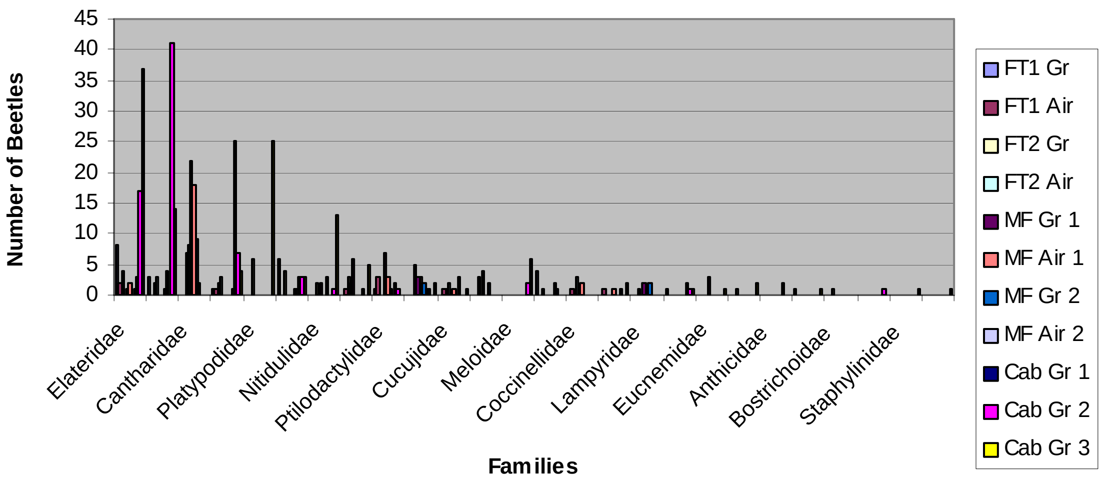


Figure 2: Fig Tree #1

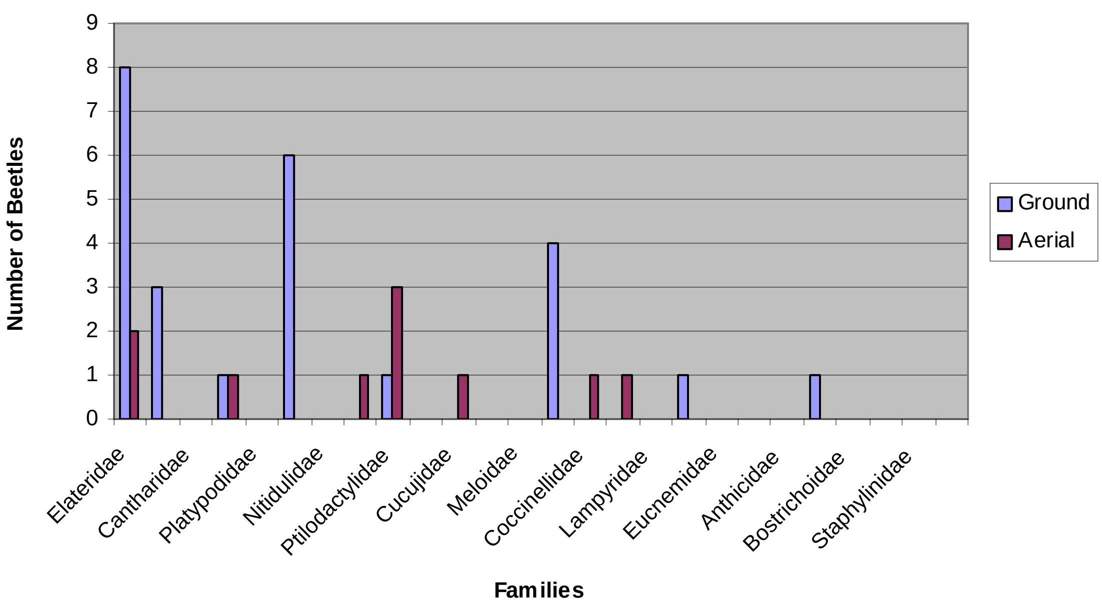


Figure 3: Fig Tree #2

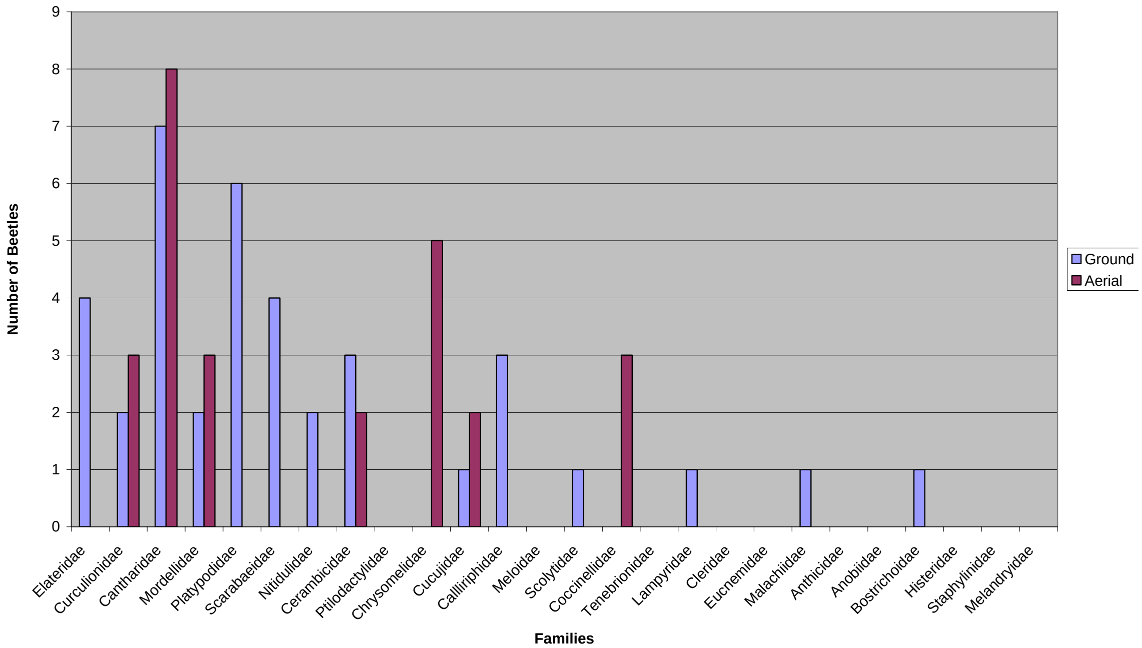


Figure 4: Middleham Falls Site #1

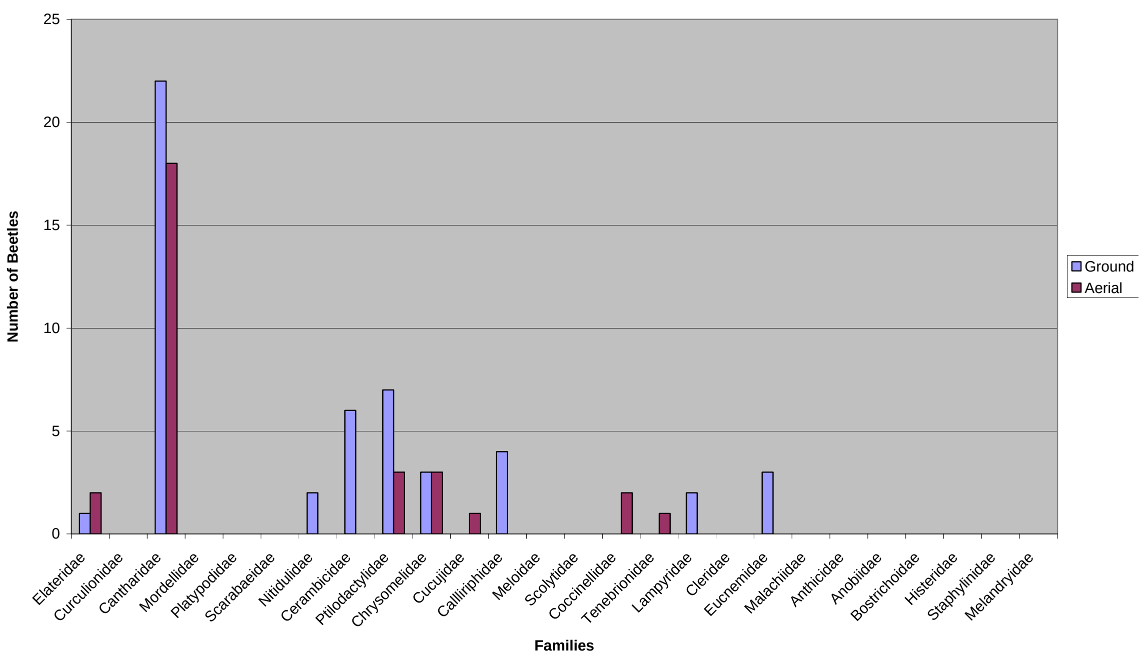


Figure 5: Middleham Falls Site #2

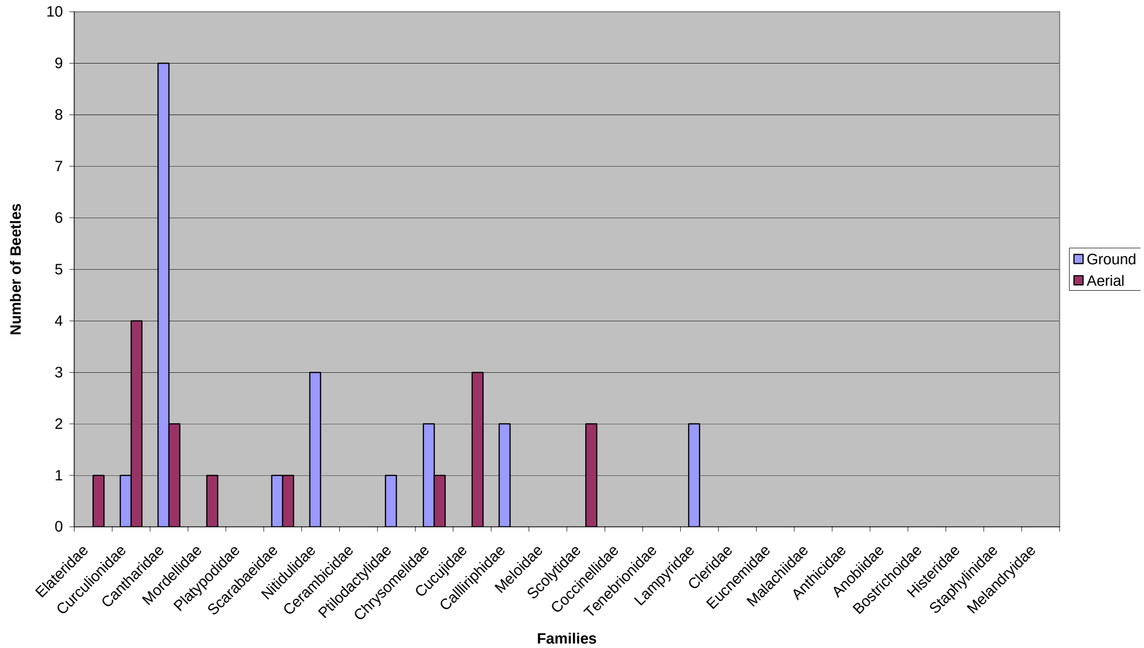
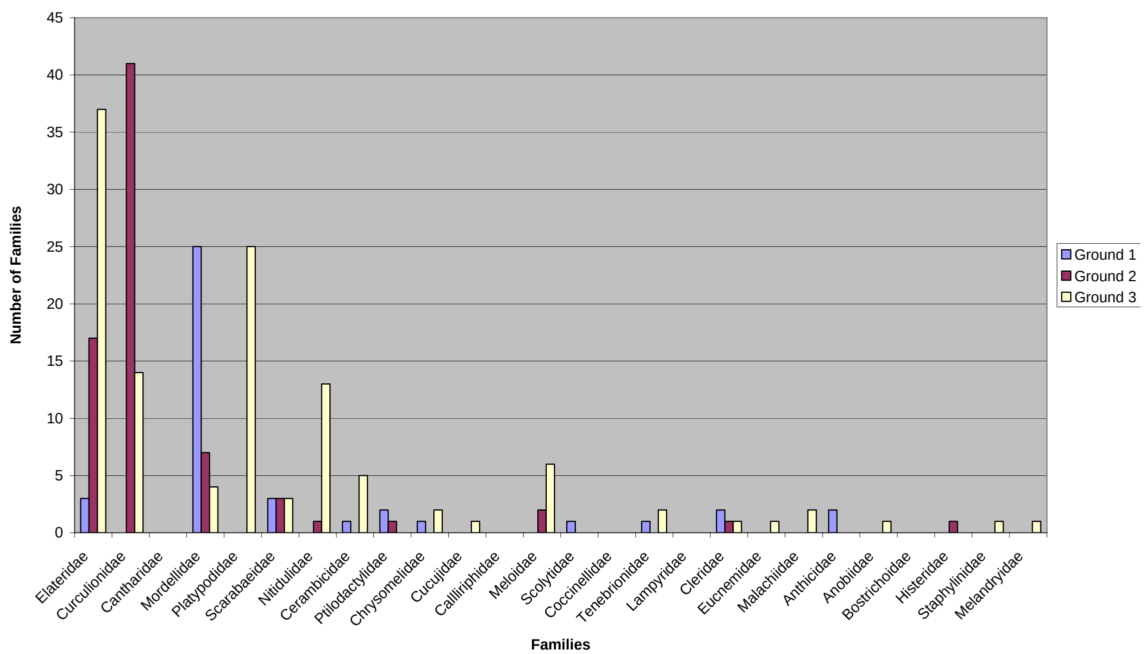


Figure 6: Cabrits Ground Traps



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Future Research Tips

1.) Expect to use funnel traps, but use them in longer intervals at each location

2.) Bring more 95% alcohol

3.) Try to have an aerial trap for every ground trap, out one at all locations.

4.) Try sweep netting all locations for one day or equal amounts for each locations.

5.) Try to make sure all traps or samples are out equal amounts of time.

6.) Consider longer ropes for climbing and hanging traps. Always take too much rope.

7.) Start on sample identification as soon as possible.

8.) Be extra careful of not mixing or mislabeling samples.

9.) Have previous knowledge of beetles and climbing.

10.) Due to the short time here, do not over collect.