A Diversity Study of Leaf Litter Ants of

The Primary and Secondary Forests of Dominica

Submitted By:

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To:

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Introduction

In Dominica, as in many other tropical environments, the rainforests can be divided into certain associations based upon the degree to which a particular forest has been disturbed. It is the affect of this disturbance on the natural flora of ants in a primary forest versus a secondary forest that I will be researching in my project. I will be looking at how the bio-diversity of Formicidae in primary rainforests compares to the bio-diversity of Formicidae in secondary rainforests.

The first type of forest in Dominica is primary forest, which is described in the Conversion of Tropical Moist Forest manual as forest that "has been undisturbed for a long time, at least decades and sometimes even centuries." More specifically primary forest has reached a state of maturity that is often considered to be the ultimate state of diversity and complexity. It has also been noted that even the slightest change in or disturbance of a primary forest can have drastic affects on the diversity of the flora and fauna which defines it. Primary forest can also be described as forest that has never been disturbed and which does not contain cultivated crops. This is the form of primary forest, which I will be using in my research. In Dominica this type of forest is mostly located in the higher elevations were it would be very difficult to grow and cultivate crops.

Due to the cultivation of bananas and other non-native fruits a good amount of the

Dominica. As alluded to before, given sufficient time secondary forests can return to the high levels of diversity and complexity of a primary forest. Once a primary forest has been cleared and left to re-grow there is rapid growth of new biomass which will peak at approximately fifteen years (Johnson, 1977). In this process "pioneering" or invading species of plants and other low lying vegetation will begin to disappear and their remnants will provide the nutrients required for the growth of larger more long lived trees that will make up the primary forest.

Given the above definitions of primary and secondary forests we can see that there is a greater diversity of plants in a primary forest as compared to the secondary forests. When we look at the leaf litter, or collection of fallen plant debris, we see that the litter is a reflection of the types of plants that are present in the forest. Since there is a difference between the bio-diversity of a primary forest versus a secondary forest there must also be a difference between the leaf litter of the two different types of forest.

In my research project I will examine how this difference in the diversity of the leaf litter affects the diversity of the populations of the family Formicidae. One good reason for studying Formicidae as opposed to another family is that they are ubiquitous in tropical forests. Also since Formicidae is omnivorous as a family their livelihood would depend on the diversity of the food supply in a particular site. Thus the greater the diversity of the flora and fauna that make up the leaf litter of a particular site the more likely that site will be able to support large numbers of ants.

Since primary forests exhibits more diversity in the make up of its leaf litter it should posses larger numbers of ants than would secondary forest, which is less diverse. Secondly, the diversity of the ants found in primary forests leaf litter should be greater

than that of secondary forest. This will also be a reflection of the difference in the diversity of leaf litter between primary and secondary forests.

Methods and Materials

Materials List

1. Boiquip Corp. Litter-Sifting Device
2. Plastic bags
3. Portable Berlese funnels
4. Alcohol (80 %)
5. Plastic bowls
6. Sharpie marker
7. Dissecting scope
8. Soft forceps
9. Book
10. Tunsram 40 watt 240 volt light bulbs

Methods

I took my primary forest samples at Syndicate National Park and Middleham forest. Syndicate National Park is a tropical rainforest and is situated at an elevation of 1700 feet, GPS (15°31′ 23″N, 61° 24′ 57″ W). Middleham is also a tropical rainforest and is 2350 feet above sea level, GPS (15° 21′ 06″ N, 61° 20′ 06″W). Finally there is the secondary forest, Mt. Joy. Mt. Joy is a tropical rainforest located at an elevation of 2200 feet, GPS (15° 20′ 58″N, 61° 21′ 50″ W). For each location I chose three large buttress trees that were each approximately ten paces apart from each other.

At each tree I collected five handfuls of leaf litter. I then filled the litter-sifting device with all five handfuls of litter and then collected only the humus layer of soil, for arthropod removal. The litter-sifting device filtered out the large particles of leaves and other debris. Once I had filtered out all the soil I put the soil sample into a plastic storage bag and would mark the sample number, type of forest, location, weather conditions, and

date on the plastic bag using the Sharpie marker.

I took the samples back to the station and put them into the Berlese funnels in order to filter out most of the fauna that was present. I allowed each sample to remain in the Berlese funnel for approximately eight hours. After eight hours I took the samples back to the lab and sorted all the ants out. I first sorted the ants into morphospecies based upon their appearance. Then I proceeded to key out the ants to subfamily, using Bolton (1994) and stored them in glass vials filled with alcohol. In each vial I placed three labels, one with the collecting data, one with the morphospecies letter, and a third with the subfamily name.

Results

Number of Ants and Number of Species Per Site

Middleham	Pseudomyrmicinae # of Ants	Pseudomyrmicinae # of Species	Formicinae # of Ants	Formicinae # of Species	Ponerinae # of Ants	Ponerinae # of Species	Myrmicinae # of Ants	Myrmicinae # of Species
1	8	2	4	2	3	1	10	1
2	0	0	3	1	1	1	0	0
3	0	0	1	1	12	2	0	0
Total	8	2	8	4	16	4	10	1

Syndicate	Pseudomyrmicinae # of Ants	Pseudomyrmicinae # of Species	Formicinae # of Ants	Formicinae # of Species	Ponerinae # of Ants	Ponerinae # of Species	Myrmicinae # of Ants	Myrmicinae # of Species
1	1	1	0	0	2	1	5	1
2	11	1	0	0	38	3	27	1
3	6	1	0	0	16	2	27	1
Total	18	3	0	0	56	6	59	3

Mt. Joy	Pseudomyrmicinae # of Ants	Pseudomyrmicinae # of Species	Formicinae # of Ants	Formicinae # of Species	Ponerinae # of Ants	Myrmicinae # of Species	Myrmicinae # of Ants	Myrmicinae # of Species
1	0	0	15	2	8	1	163	5
2	0	0	0	0	7	2	17	3
3	0	0	2	1	15	2	13	1
Total	0	0	17	3	30	5	193	9

Diversity of Ant Species Per Site

Site	Subfamily	Species	Rep 1	Rep 2	Rep 3	Sum	pi	lnpi	pi*lnPi
Middleham	Pseudomyrmicinae	A	2			2	0.05	-3.04	-0.14
	Pseudomyrmicinae	B	6			6	0.14	-1.95	-0.28
	Formicinae	A	1			1	0.02	-3.74	-0.09
	Formicinae	B	3		1	4	0.10	-2.35	-0.22
	Formicinae	C	0	3		3	0.07	-2.64	-0.19
	Ponerinae	A	3			3	0.07	-2.64	-0.19
	Ponerinae	B	0	1	7	8	0.19	-1.66	-0.32
	Ponerinae	C	0		5	5	0.12	-2.13	-0.25
	Myrmicinae	A	10			10	0.24	-1.44	-0.34
Total						42		H =	2.02
H prime									2.2
Syndicate	Pseudomyrmicinae	A		11		11	0.08	-2.50	-0.21
	Pseudomyrmicinae	C	1		6	7	0.05	-2.95	-0.15
	Ponerinae	A		22	4	26	0.19	-1.64	-0.32
	Ponerinae	B	2	4	12	18	0.13	-2.01	-0.27
	Ponerinae	C	1	12		13	0.10	-2.33	-0.23
	Myrmicinae	B	5	27	27	59	0.44	-0.82	-0.36
Total						134		H =	1.53
H prime									2.00
Mt. Joy	Formicinae	D	12			12	0.05	-2.99	-0.15
	Formicinae	E	3			3	0.01	-4.38	-0.05
	Formicinae	F			2	2	0.01	-4.78	-0.04
	Ponerinae	C	8	6	15	29	0.12	-2.11	-0.26
	Ponerinae	D		1		1	0.00	-5.48	-0.02
	Myrmicinae	A	2	15		17	0.07	-2.64	-0.19
	Myrmicinae	B	156		13	169	0.71	-0.35	-0.25
	Myrmicinae	C	2			2	0.01	-4.78	-0.04
	Myrmicinae	D	2	1		3	0.01	-4.38	-0.05
	Myrmicinae	E		1		1	0.00	-5.48	-0.02
Total						239		H =	1.07
H prime									2.3

Number of Ant Morphospecies Per Site

Site	Number of Species
Middleham	9
Syndicate	6
Mt. Joy	10

Figure 1

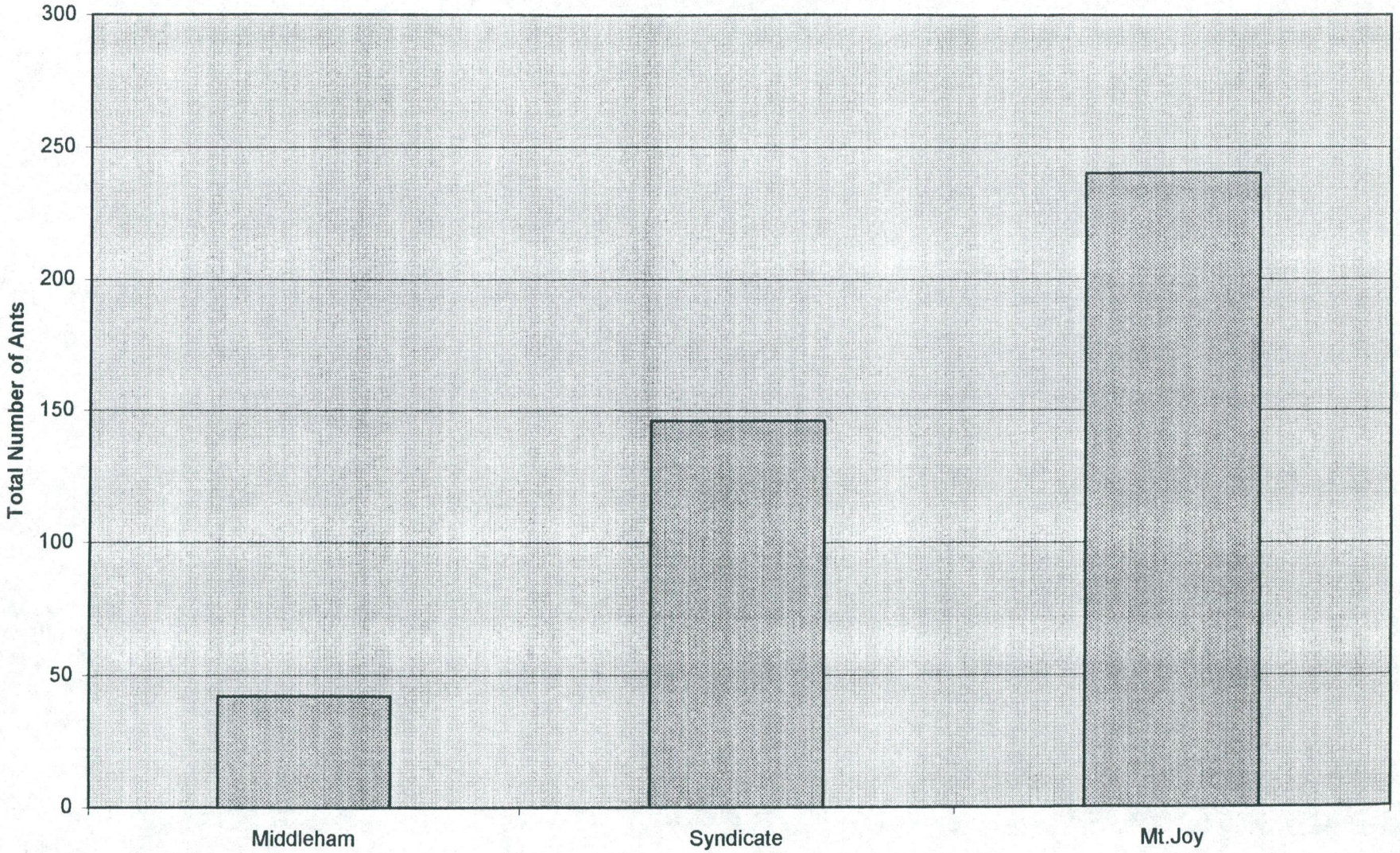

300
250
200
150
100
50
0
Total Number of Ants
Middleham
Syndicate
Mt.Joy

Figure 2

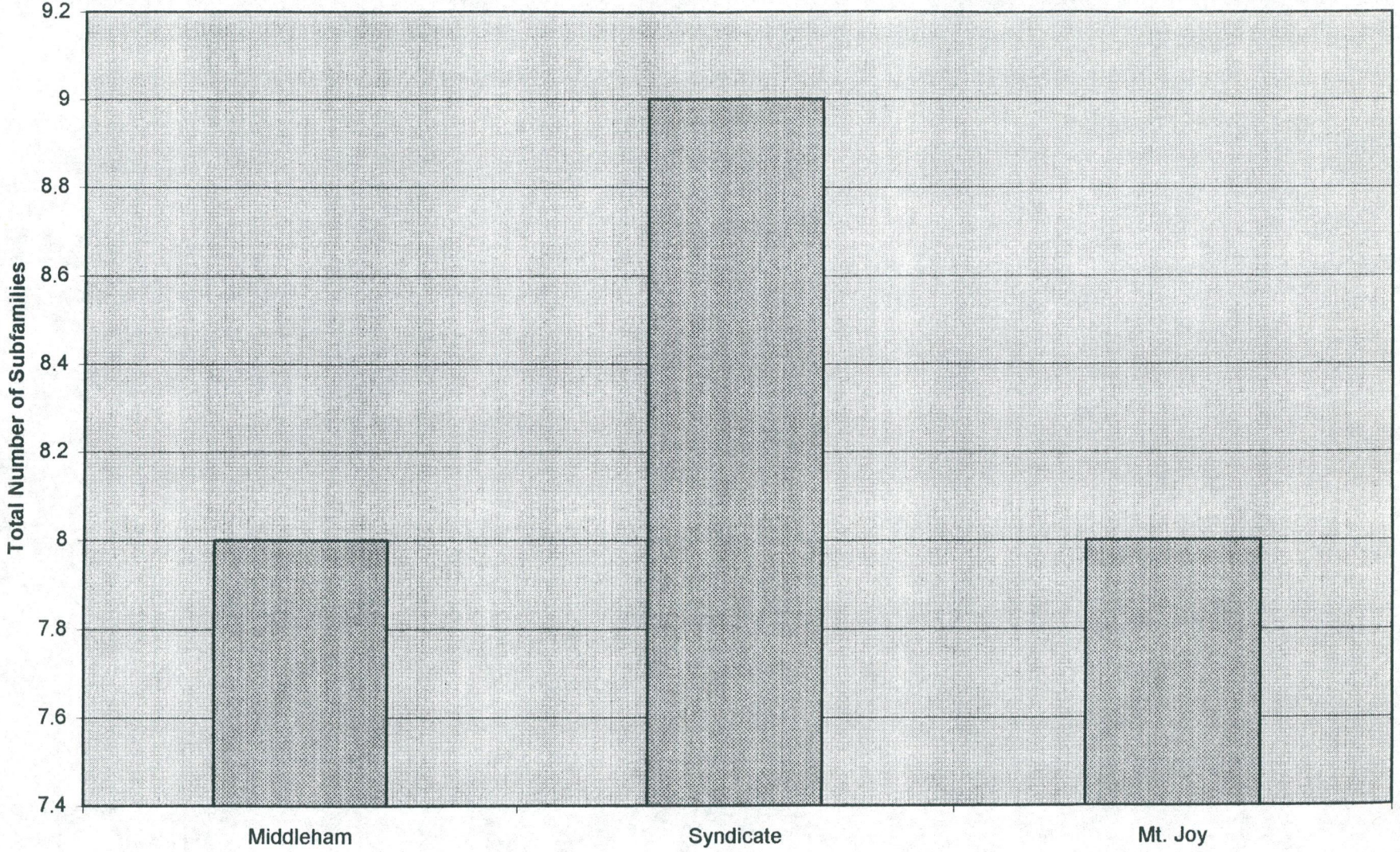

9.2
9
8.8
8.6
8.4
8.2
8
7.8
7.6
7.4
Total Number of Subfamilies
Middleham
Syndicate
Mt. Joy

Figure 3

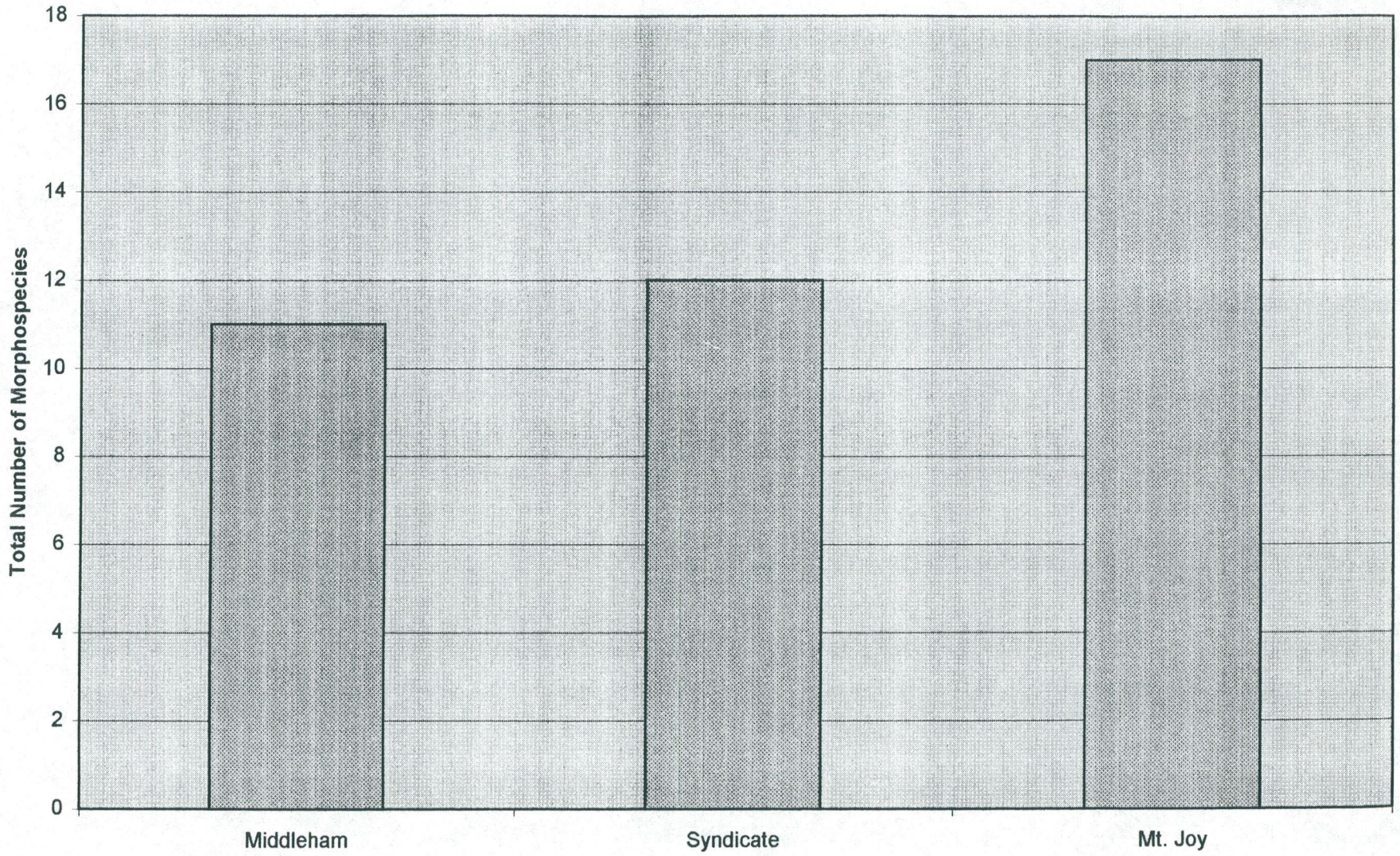

Total Number of Morphospecies
18
16
14
12
10
8
6
4
2
0
Middleham
Syndicate
Mt. Joy

Figure #4

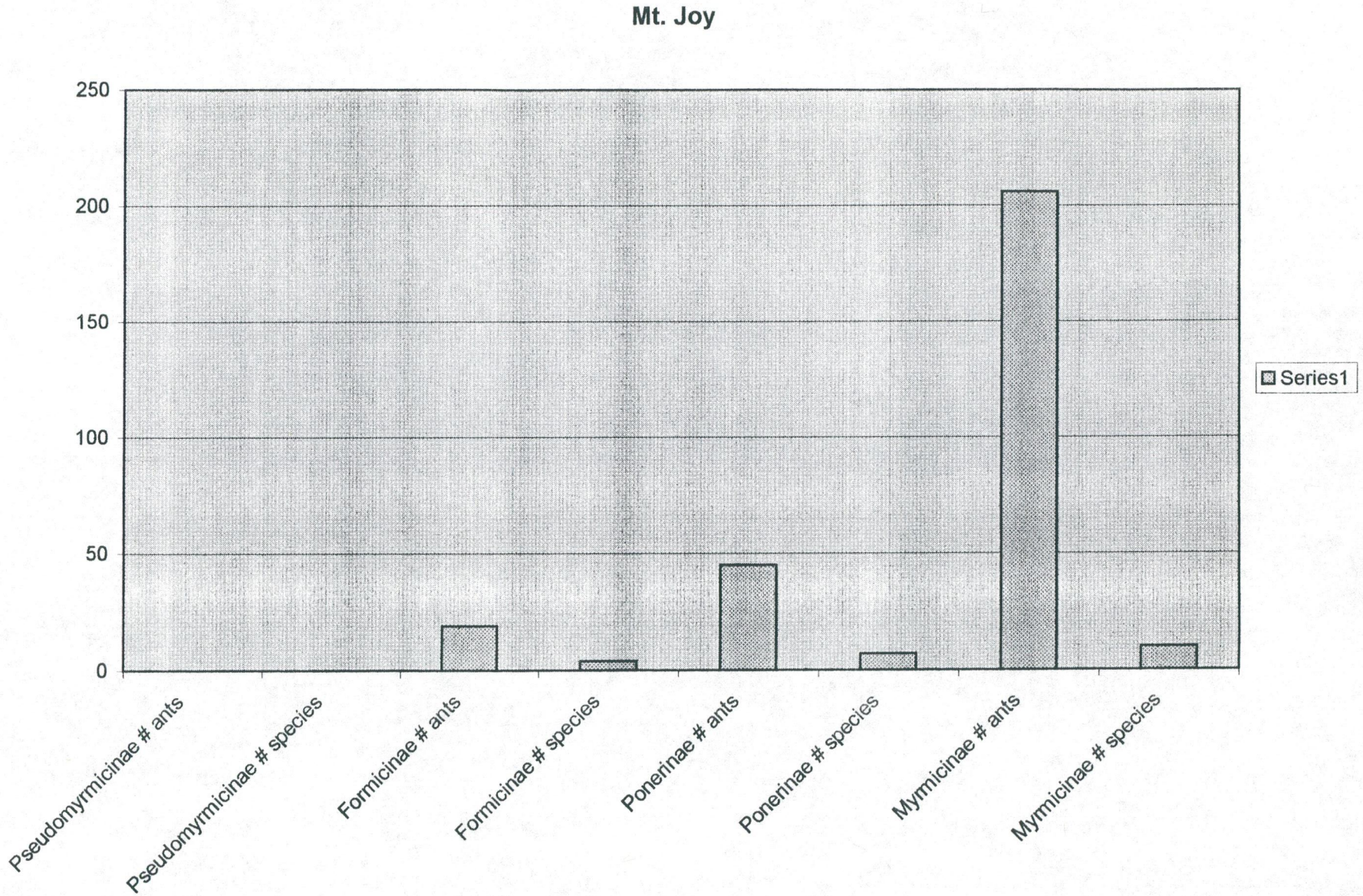

Mt. Joy
250
200
150
100
50
0
Series1
Pseudomyrmicinae # ants
Pseudomyrmicinae # species
Formicinae # ants
Formicinae # species
Ponerinae # ants
Ponerinae # species
Mymicinae # ants
Mymicinae # species

Figure #5

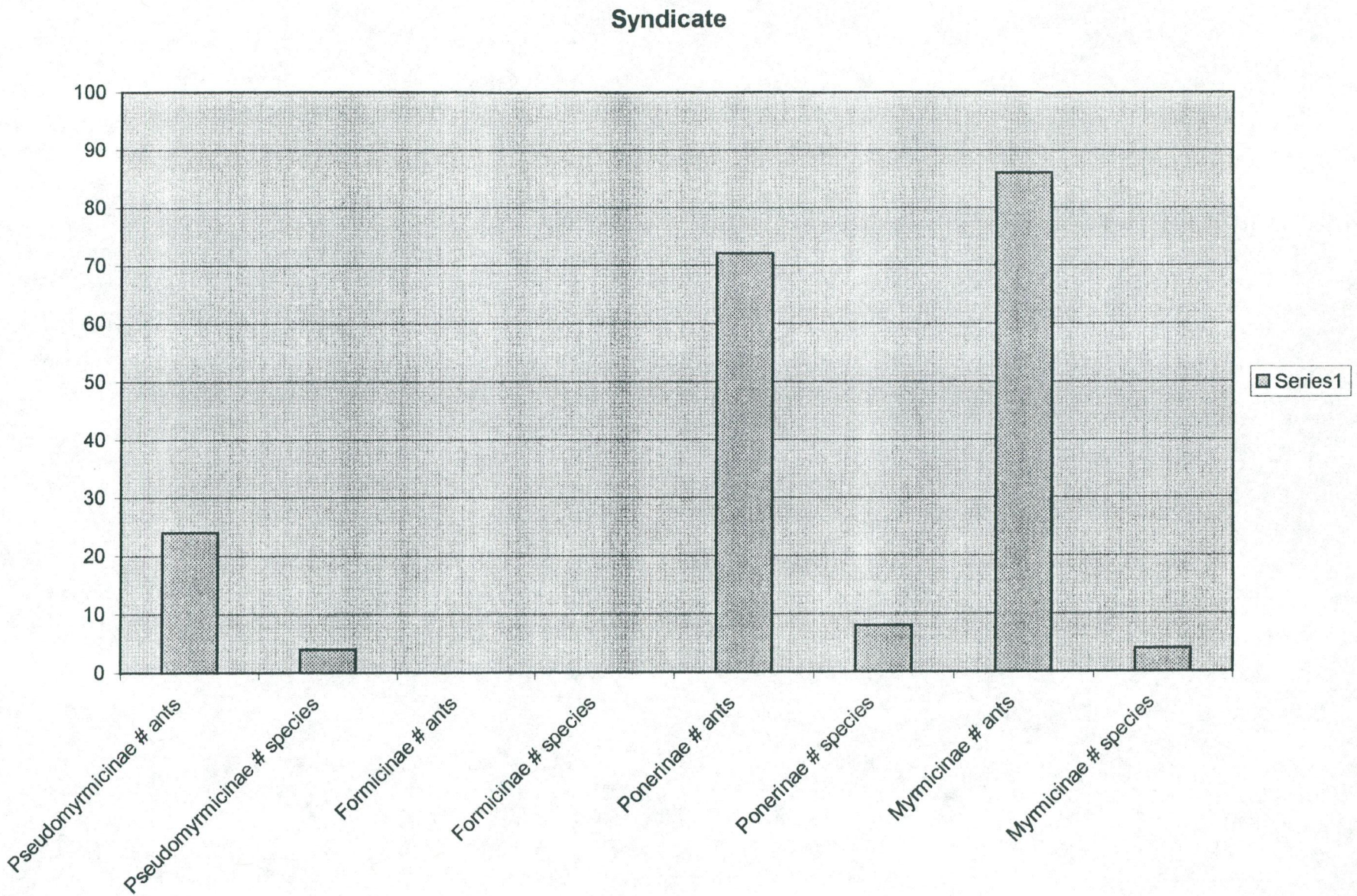
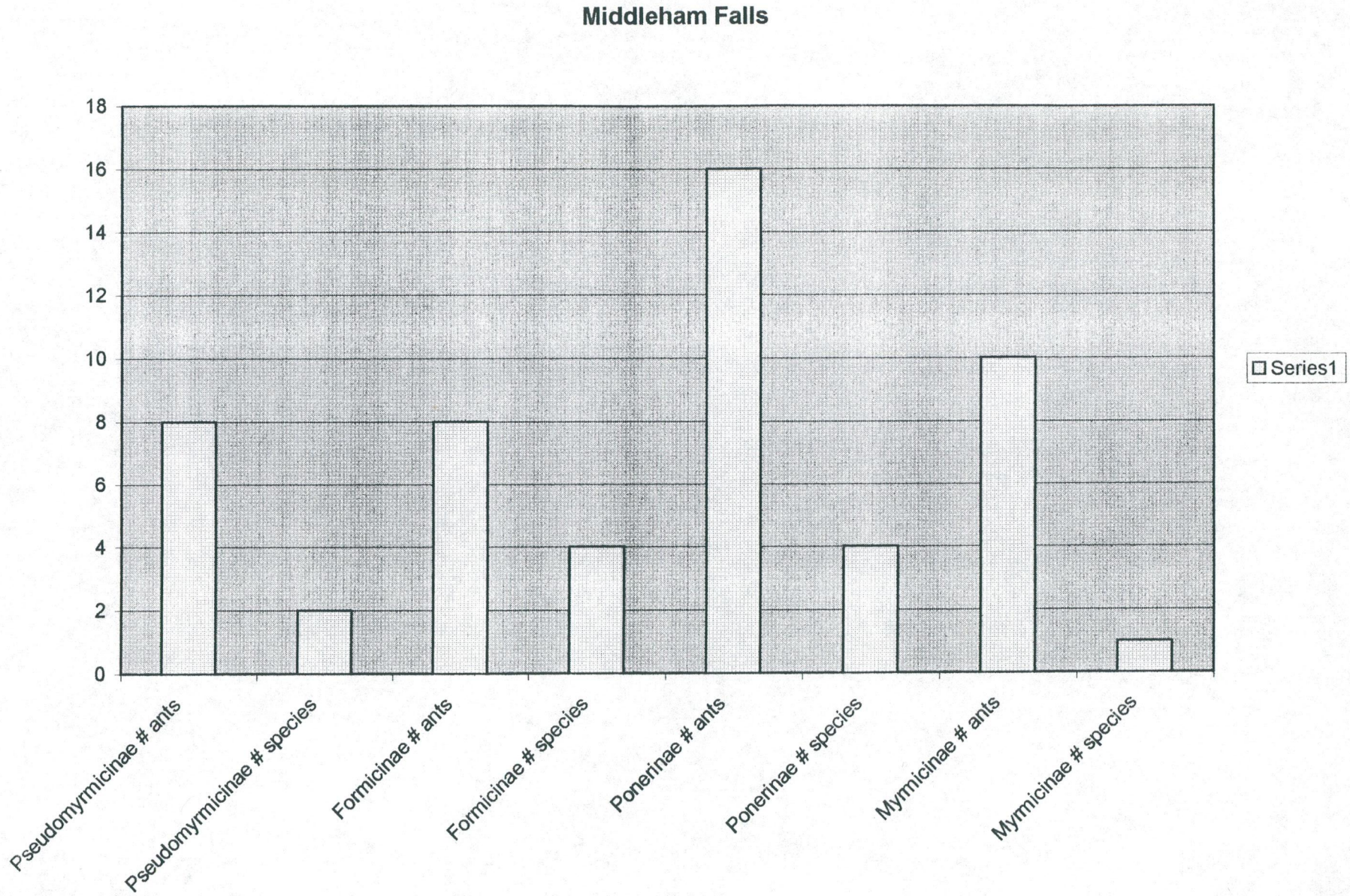

Syndicate
100
90
80
70
60
50
40
30
20
10
0
Pseudomyrmicinae # ants
Pseudomyrmicinae # species
Formicinae # ants
Formicinae # species
Ponerinae # ants
Ponerinae # species
Mymicinae # ants
Mymicinae # species
Series1

Figure #1e


Middleham Falls
18
16
14
12
10
8
6
4
2
0
Pseudomyrmicinae # ants
Pseudomyrmicinae # species
Formicinae # ants
Formicinae # species
Ponerinae # ants
Ponerinae # species
Mymicinae # ants
Mymicinae # species
Series1

Discussion

My first hypothesis was that there would be larger populations of Formicidae in primary forest as compared to secondary forest. However, the results show that the total number of ants is greater in secondary forest (Mt. Joy) than in primary forest (Syndicate or Middleham, Figure 1). From the same figure we can also see that the numbers of ants are greater at the Syndicate site than at the Middleham site.

One possible reason that the ant populations are greater in the secondary forest than in the primary forest is that the soil of the Dominican secondary forest is moister than that of the primary forest. This difference in moisture is most likely due to the decreased canopy cover in a secondary forest as compared to a primary forest. Since there is less canopy cover in a secondary forest when it rains the water reaches the ground faster than it would in a primary forest. The increased moisture may provide more favorable conditions for the support of large populations of ants. Increased moisture would allow for increased flora which in turn leads to increased fauna, which all contributes to a rich leaf litter that would support large numbers of ants.

My second hypothesis was that there would be increased diversity in the primary forest as compared to the secondary forest. If we look at the results we see that two different conclusions can be made based on the type of data. If we look at Figure two, we see that all three exhibit basically the same number of subfamilies, except for Middleham that has one more subfamily. Therefore the diversity, at the level of subfamilies, in primary and secondary forest is essentially the same.

However, Mt. Joy clearly has more morphospecies than either of the two primary forest sites, (Figure 3). From these results we would assume that the secondary forest of

Dominica is more diverse than the primary forest of Dominica. Before we can make this conclusion we must first state how diversity may be defined. One way to define diversity is to simply look at the number of different morphospecies that are present in a given site and then state that the site with the greater number of morphospecies is the most diverse. This is the type of definition that was used in the above conclusion. Another way to look at diversity is to not only look at the relative number of different morphospecies but to also examine the distribution of these morphospecies in a particular site. These relationships are more easily seen in Figures four through six.

For instance if we look at the Mt. Joy sample we see that the fauna consists of ten different morphospecies of ants. However, the vast majority of the ants found in the leaf litter at Mt. Joy are of the same family, Myrmicinae, (Figure 4). In particular there is a single morphospecies that makes up the vast majority of ants, morphospecies Myrmicinae B. If we were to define diversity according to the actual distribution of morphospecies than the Mt. Joy site would not be considered very diverse.

One way to measure diversity according to distribution of species is the Shannon Weiner Index, $H' = \text{sum } (p_i)(\ln p_i)$. In the Shannon Weiner Index the sum of ants of a certain species, occurring in a particular site, is tallied and then the pi of that sum is taken. After which the natural log of the second answer is taken, and a third value is acquired. This third value is then multiplied by pi and raised to the natural log of pi. Finally this fourth value is summed and a diversity index is acquired. This index represents both the total number of species present and the relative evening of their distribution in the samples. This index can be then be compared to its maximum value, which is the natural log of the number of morphospecies occurring in a particular site. A

maximum value occurs when all species are present in equal numbers.

If we look at the diversity index of the Mt. Joy site we see that the H prime, the maximum diversity index, is 2.30, however H, the actual diversity index for the site is only 1.07. As we can from these results the Mt. Joy site is not a very diverse site. If we look at the Syndicate site we see that the H prime is 1.95 and H for this site is 1.53. In comparing the H and H prime we see that the Syndicate site is relatively diverse. However if we compare the differences between H prime and H of Syndicate and Mt. Joy we see that Syndicate is more diverse than Mt. Joy. The difference between the H prime and the H for Syndicate is .42, however for Mt. Joy it is 1.23.

We can view the relative diversity of Middleham in much the same way. The H prime for the Middleham site is 2.20 while the H is 2.02. From these results we could say that this site was quite diverse. If we then compare the difference between the H prime and the H for the Middleham site with that of Syndicate and Mt. Joy we see that Middleham site is the most diverse. The difference between the H prime and the H for Middleham is .18, which is less than the difference for Syndicate as well as Mt. Joy.

These results confirm my hypothesis that the Formicidae fauna is more diverse in the primary forests of Dominica than in the secondary forests of Dominica. This greater diversity is most likely due to the greater diversity of flora and fauna in a primary forest as compared to a secondary forest. We can also conclude that the secondary forest of Dominica posses larger quantities of the Family Formicidae than does the primary forests of Dominica. This difference between secondary and primary forests may be due to increased moisture in the soil of secondary forests as compared to primary forests.

Bibliography

Bolton, Barry. 1994. Identification Guide to the Ant Genera of the World. Harvard University Press. Cambridge, Mass.

Myers, Norman. 1980. Conversion of Tropical Moist Forests. National Academy of Sciences. Washington, D.C.