Survey of Insect Biodiversity in Arboreal and Ground Habitats on the island of Dominica

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Abstract

The tropical rainforest is among the most diverse habitats on earth, and canopy of the rainforest is said to contain a large portion of that diversity. Originally this project's goal was to sample the diversity of ants at varying heights of the rainforest trees, but after collecting very few ants and many other insects it evolved into a general survey of insect diversity at varying heights of a tree in the rainforest. It was hypothesized that the diversity and abundance of insects would be highest in the upper parts of the trees, and decrease moving towards the ground. To test this, baited traps were raised into two trees at various heights in order to sample the insects present there. The orders gathered included Coleoptera, Collembola, Dermaptera, Diptera, Ephemeroptera, Hemiptera, Hymenoptera, Lepidoptera, Orthoptera, and Psocoptera. The results indicated that insect species diversity and abundance was greatest near the ground, and decreased as height increased, contradicting our hypothesis.

Introduction

The canopy of the rainforest is where the most diverse abundance of life is said to occur. E. O. Wilson's “Biodiversity” (1988) has an excellent chapter on the tropical forest canopies diversity which highlights the expected abundance of life to be found. Wilson mentions that the species found in the canopy are often very specialized, and it was expected that by sampling at a wide range of heights, it would be possible to capture species that are specialized for specific heights, and so demonstrate some of that biodiversity. The problem is that it is very difficult to look into this elevated realm and see what it has to offer. A way must be found to bring an individual up to it, or bring its species down to an individual. The latter was the opted for method in this case since climbing was not possible. Since the original goal of this project was to capture ants, a rather unorthodox trap was raised to various heights in a tree so that ants would crawl onto and into it where they would become trapped. This team originally attempted to expand upon a 2001 study by Jessica R. Weems (2001) on ant species diversity at different heights along a *Ficus insipida* tree. The intention was to include more types of trees and compare the data. When so very few ants were actually gathered compared to the other insects, the team looked at Michelle Woods (2008), Biodiversity of Arthropods in the Canopy at the Archbold Tropical Research and Education Center paper as a new project, similar studies have occurred around the world like (Balatibat 2009). The purpose became to focus on comparing the diversity of insect orders at different heights of trees. It was expected that greater insect diversity would be found in the canopies.

Materials and Methods

The traps used in this study were based on ones used in a previous study on arboreal ant biodiversity (Oliveira-Santos et al 2009), with one smaller cup glued to the inside of a larger one. The smaller cup contained bait, in this case sardines and peanut butter, and the larger one contained a pool of propylene glycol that acted as a killing agent. Four wooden skewers were put through the top and bottom of the larger cup, both to create access to the trap for flightless insects and to anchor the trap against the tree. A length of string was attached to a weight and launched over a branch of a tree, the trap was tied to the string and hoisted into the tree, and each end of the string was staked to the ground (Figures 1, 2). Two trees were selected for the survey, one a *Samanea saman* near the entrance of the Springfield research station (Tree 1), and one a *Ficus citrifolia* next to the Checkhall river, also on the station property (Tree 2). There were three traps in each tree, and one trap at the base of each tree on the ground. The trap labels consist of two numbers separated by a decimal (#.#). The first number is either a 1 or a 2 and is designating the tree, Tree 1 (by the Springfield Research and Education Center entrance) or Tree 2 (by the Checkhall river) respectively. The second number is a number ranging between 1 and 4 where 1 designates a ground level trap, 2 a low level, 3 a medium level and 4 the highest level trap for that tree. The traps in Tree 1 were placed at heights of 0 m, 3.35 m, 9.67 m and 18.16 m, and the traps in Tree 2 were placed at heights of 0 m, 4.13 m, 9.8 m and 14.7 m (Figure 3). The numbering for the tree a trap is in and which trap it is is denoted by the tree number, then a decimal, then the trap number. This means that the lowest trap at the stream, the ground trap, is Trap 2.1 at 0 m and the highest trap at the station is Trap 1.4 at 18.16 m. The traps were left in the trees for 48 hours, with the traps in Tree 1 being brought down at 24 hours to evaluate their effectiveness, whereupon additional bait was added and they were sent back up for another 24 hours. The specimens retrieved from the traps were placed in Isopropyl alcohol, and then identified to order.

Results

Ten orders of insects and entognathous hexapods were found in all of the traps combined. Out of all of

the traps, Trap 2.1, the ground trap at the river, had the greatest diversity with eight orders represented, followed by 2.3 and 1.2 with five orders each (Figure 4). Of the orders collected, Hymenoptera was represented by the greatest number of specimens at 42 specimens, with a majority of those specimens being male ants of one species. The second most represented group, or most represented if the male ants are disregarded, was Diptera with 33 specimens, then Collembola with 12 (Figure 5, Table 1). Diptera and Hymenoptera were also the only orders that were represented in all traps, with the next most common, Collembola and Coleoptera, only occurring in four out of the eight traps (Table 1). Initially, at ground level, Hymenoptera made up a majority of specimens collected. However, as height increased the number of Hymenoptera present decreased while the number of Diptera increased, until Diptera become the dominant taxon. The number of orders found also decreased with increased height in the tree from eight orders on the ground to four orders at greatest height (Figures 6 - 9). In addition, the total number of specimens collected was greatest at ground level with 51 specimens, followed by the median height with 22 (Figure 10). Other observations of note include Coleoptera not having a presence on the ground and Hemiptera only being found in the highest and lowest traps.

Discussions

It was expected that the number of orders and specimens collected would be greater the higher in the trees one was able to sample. However the data collected conflicts with this expectation and some research, but agrees with others. A study of an Indonesian rainforest found that 70% of arthropods occur in soil and leaf litter while only 14% in the canopy (Stork 1988). A study of an Australian tropical rainforest found that the the diversity was roughly equal between the ground and canopy environments (Stork & Grimbacher, 2006). In this study on the Archbold Tropical Research and Education Center in Dominica the greatest diversity occurred at the lowest and middle elevation and otherwise decreased as height increased. There are a number of reasons why this tendency towards greater abundance and diversity nearer to the ground might occur. Not only do the insects on the ground have access to whatever food is growing there, they also have access to dead material that has fallen from higher in the canopy. When plants or animals die, they will often fall from the trees to the ground, which would increase availability of food for scavengers and other detritivores, increasing overall diversity. In addition, flightless insects are forced to move along branches to travel from place to place on a tree, which are relatively narrow corridors that create more interaction between insects. Compared to the insects in the trees, the space available to insects on the ground allows more free movement without specific lanes of travel, meaning that insects can go around or miss each other entirely. Fewer interactions creates less competition, and allows more insects to coexist without excluding each other. In regards to the inverse relationship of Hymenoptera and Diptera, the flies specialize in laying eggs in rotting material, as opposed to the parasitize or generalist Hymenoptera. As the sardines began to rot, they sought out the traps to lay eggs in, and there was more bait remaining in the traps the higher one went on the tree as there were fewer things up high to consume it, making the higher traps more attractive to them.

While the data collected appears to be consistent with other scientific literature, there were issues with the study that could have negatively impacted it. Events of note that likely affected these data includes heavy rainfall washing some traps out and high winds that despite the tethers partially spilled traps 2.2 and 2.3. In some traps the bait was partially missing, indicating that a larger vertebrate may have stolen part or all of the bait. In addition, these traps were designed to capture terrestrial ants and were constructed and baited in such a way, which may have impacted their ability to attract and trap winged and otherwise more mobile prey.

If the conclusions from this study are taken as valid, then that would help to guide further research down more helpful avenues. As it appears that most diversity is found at ground level, a similar experiment to this one involving more ground level traps placed in a number of different habitats would give the broadest picture of diversity in the region of the study. Alternatively, studies could be performed exclusively in the canopy in order to determine which conditions lead to lower diversity than other parts of the forest. In any case, this further research could lead to a greater understanding of the forests of Dominica, how the insects in them relate to one another, and how best to help conserve the ecosystem of the “nature island”.

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Figures

Fig 1. A picture of one of the traps used, showing the skewers in the top and bottom of the trap, and how the trap was attached to the string.

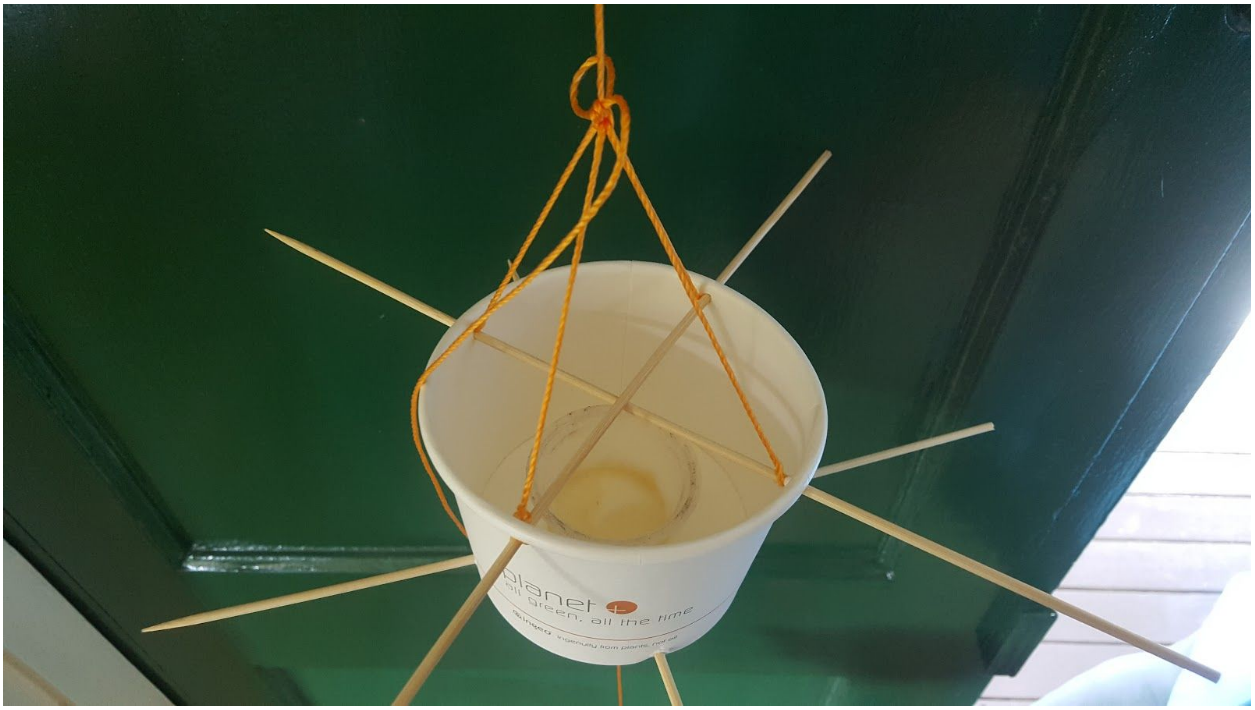


Fig 2. A second view of the trap, showing the bait cup inside of the larger trap cup.

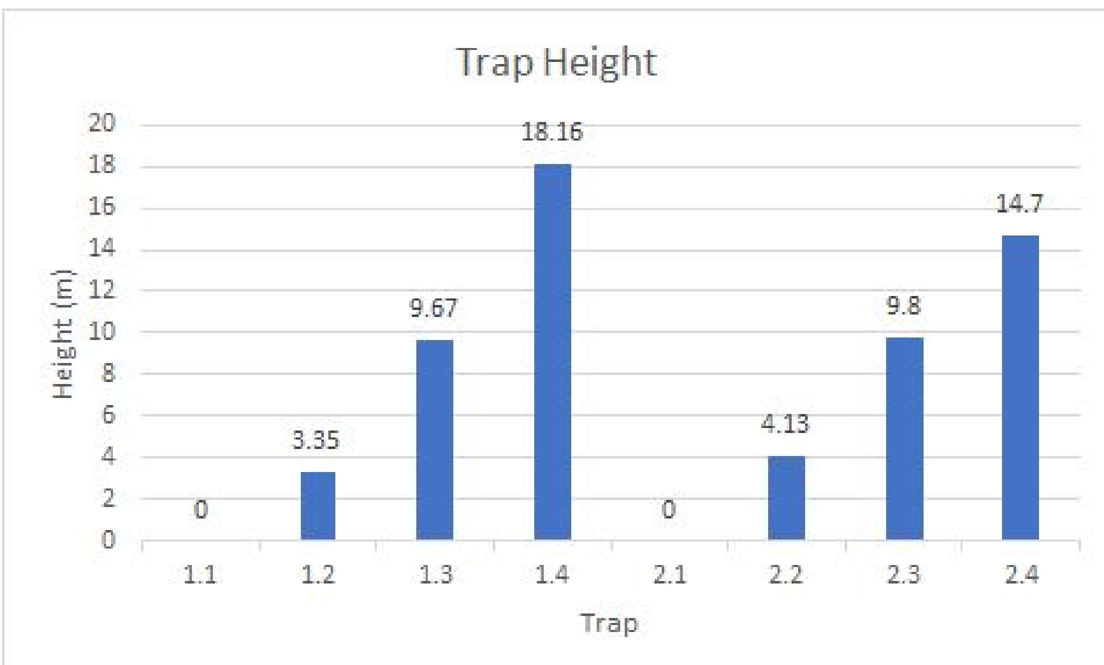


Fig 3. A display of the traps and their respective heights

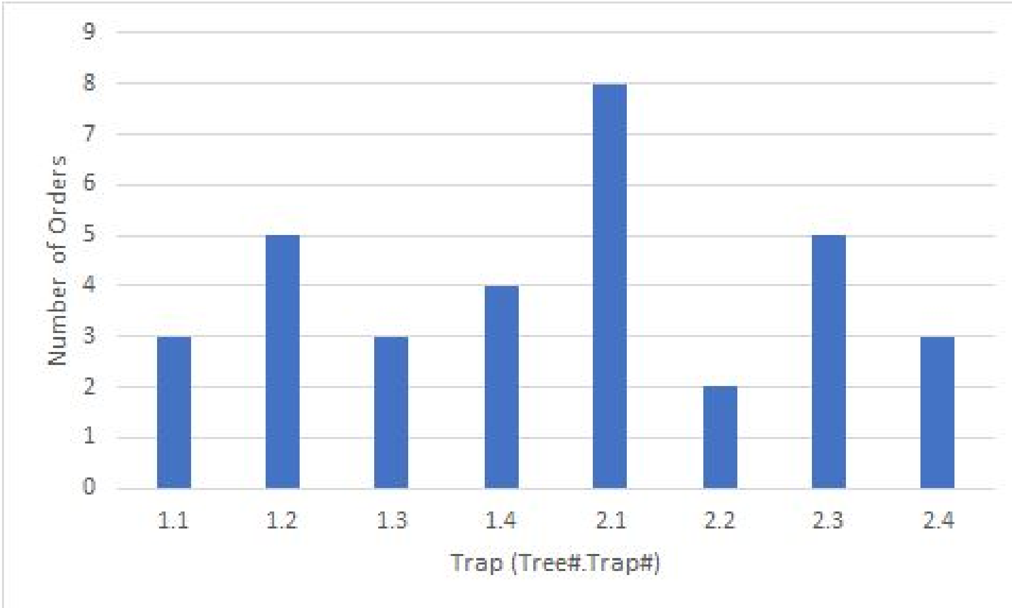


Fig 4. The number of orders found at each trap.

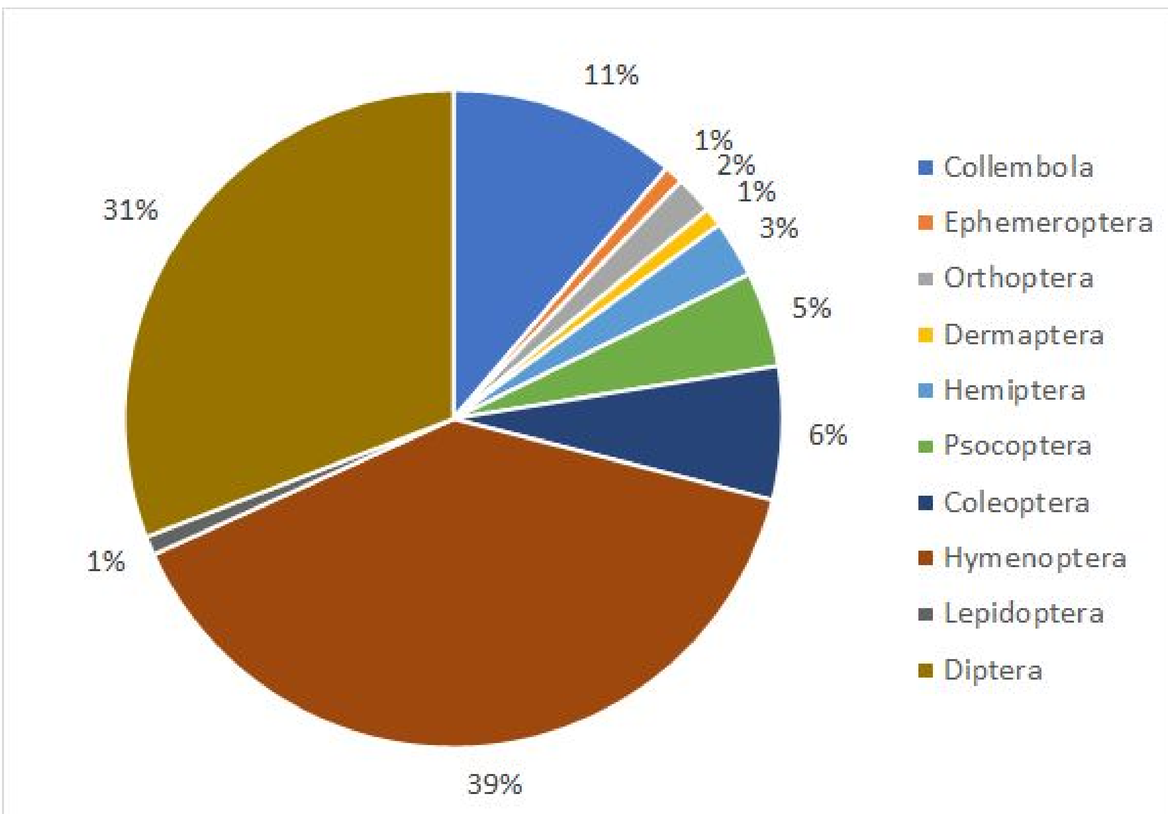
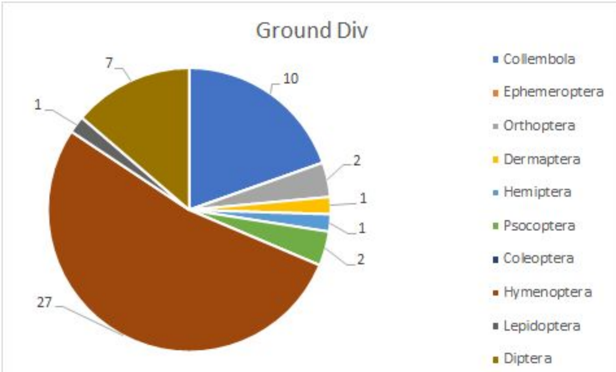
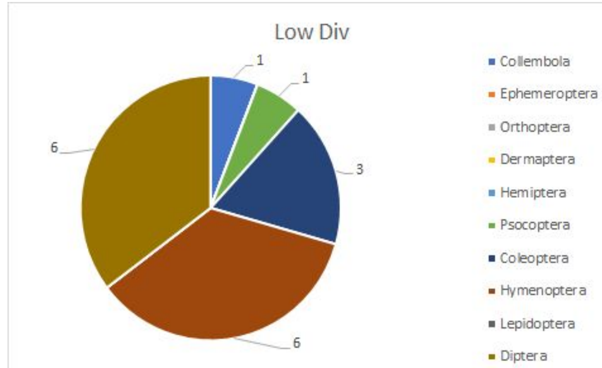
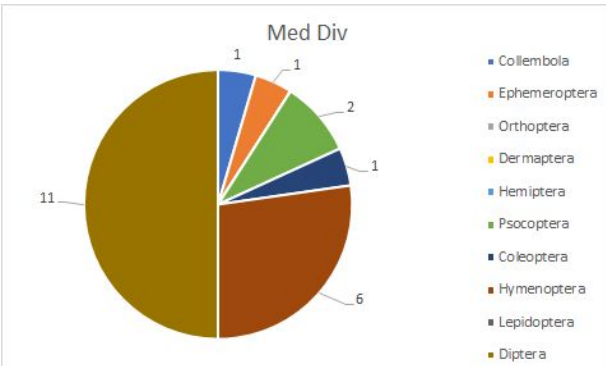


Fig 5. A graph of the proportion of each order found in the traps.







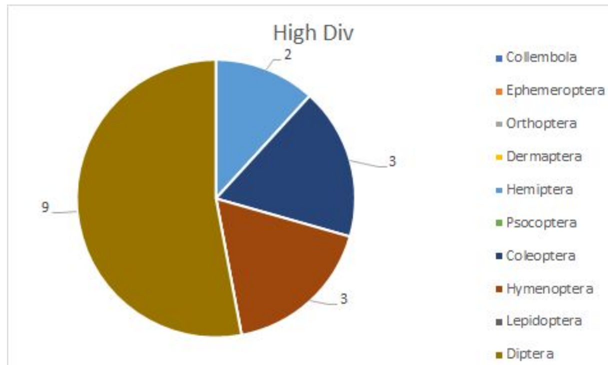


Fig 6, **7**, **8** & **9** show the Order diversity through the number of individuals per order at the combined ground (.1), low (.2), medium (.3) and high (.4) levels of the trees respectively.

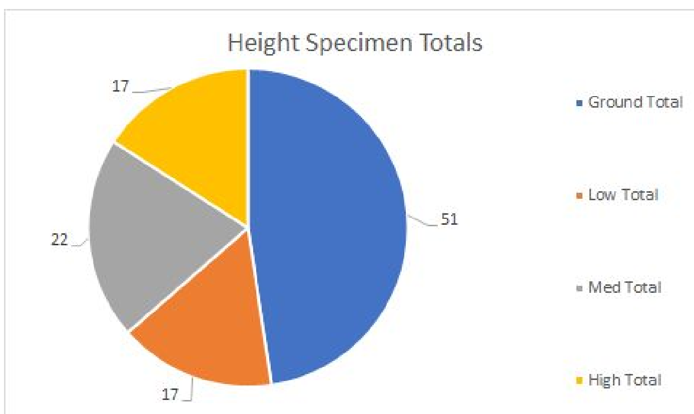


Fig 10. Shows a comparison of the total number of specimens at the combined tree heights.

Orders		2.1	2.2	2.3	2.4	1.1	1.2	1.3	1.4	Total
Collembola		5		1		5	1			12
Ephemeroptera				1						1
Orthoptera		2								2
Dermaptera		1								1
Hemiptera		1							2	3
Psocoptera		2					1	2		5
Coleoptera				1	2		3		1	7
Hymenoptera		6	1	2	2	21	5	4	1	42
Lepidoptera		1								1
Diptera		3	2	2	2	4	4	9	7	33
Total # of Orders		8	2	5	3	3	5	3	4	

Table 1. The number of specimens of each order found at each trap.