Preliminary Inventory of Hemiptera: Cicadellidae, Membracidae, Fulgoromorpha and others of Finca Las Piedras

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Abstract

Insects are by far the most diverse and abundant animals in tropical forests. And yet, only 2 million species have been identified off of the 5 to 10 million species that might exists on Earth. Insects' inventories are always needed to stablish the baseline of the abundance, taxonomy, systematics, distribution, and natural history of this incredible group of animals. This study explores the diversity of a vastly unexplored group of insects: the order Hemiptera at Finca Las Piedras, Madre de Dios, Southeastern Peru. Observations were conducted while walking on trails with a total of 13 days of casual encounter surveys. Out of the 190 individuals found, an estimated 120 distinct species were recorded. By studying Hemiptera insects, this preliminary inventory set the foundation for anyone else interested in studying these remarkable creatures in this biodiversity hotspot. Emerging from the dense foliage and particularly enjoying the light gaps and forest edges during a light shower, these leafhoppers, treehoppers, planthoppers and many others are one to look out for.

Introduction

Throughout the Amazon Rainforest, the biodiversity of insects knows no bounds. Around each tree, under each leaf lies the possibility of stumbling upon species that sport vibrant iridescence, prominent protrusions, or some other sort of indescribable feature. While the South American fauna is most often associated with the largest and most bodacious of the arthropods such as the Hercules Rhino Beetle, *Dynastes hercules*, or any of the Blue Morpho butterflies from the *Morpho* genus, one group of insects has strayed away from the spotlight. When one exclaims the word "Hopper" during a trail escapade, the most common image that comes to mind is that of a glaring grasshopper or katydid from the Orthoptera. However, under the order known as *Hemiptera* or the "True Bugs", lies a peculiar group of animals that display a particular beauty. Hailing from the suborder Auchenorrhyncha, various families and infraorders known as Leafhoppers, Planthoppers, and Treehoppers or Cicadellidae, Membracidae, Fulgoromorpha respectively, flourish in the lush lowland rainforest.

Every individual comes equipped with its own unique set of spots, stripes, horns and possibly even an array of extraordinary accessories such as a tail composed of wax. Although remarkable from a visual standpoint and often a prize shot for any macro photographer, their skittish nature, miniature size and complex sets of behavior have kept these animals under the radar. This has led to a substantial lack in studies and understanding on the topic of these creatures, especially when

compared to the countless other types of arthropods.

Coinciding with the vast biological inventories being kept at the Finca Las Piedras research and education system within the Madre de Dios region of Peru, an inventory and accompanying field guide was to be created for the members of Auchenorrhyncha residing in the region. With such a project, a general perception of diversity amongst each group was extracted, alongside the interpretation of trends that incorporate environmental and situational factors to build a clearer picture as to how these nearly invisible invertebrates fit into the ecosystem. The presence of an introductory field guide and groundworks of an inventory also sets a foundation for any future researchers interested in studying these insects later or any outside sources seeking data from the region.

Method

Due to time constraints and the overall practicalities of obtaining a diverse physical copy of multiple species only a few millimeters in length by hand, a photographic inventory was chosen over the collection of specimens.

Over the course of two weeks composed of five days each with an additional third week consisting of three more days, a survey of a selected area was performed to capture on camera all individuals of suitable family that came within range of the macro lens.

The surveying began with a trial run known as Day0 throughout the Finca Las Piedras campgrounds. Vegetation of interest was investigated as the equipment was adjusted for optimal use and trends began to shape into place. Following the initial findings, the search extended past the living quarters across into the agriculture areas and forest edge throughout Day1 and Day2. This included the trail entrances of the *Aguaje* region as well. Heading towards the main forest trail system, Day3-Day6 consisted of exploring segments of the *Lindero*, *Castaña* and *Tapir* regions. Throughout the denser regions of foliage, plants and particularly light gaps were sought from head level and below. Following brief searches across the Morfo area and native food forest from Day7 and Day8, the surveys had reached all accessible points of the property. Having identified the most biodiverse regions, the following Day9-Day12 time periods consisted of patrolling the *Lindero*, *Castaña*, and *Aguaje* trails and extensions with the purpose of gathering as much data as possible

	A	B	C	D	E	F	G	H	I	J	K	L	
1	ID	Type	Time of Day	Photo View	General Location	Foliage	General Size	Species (Nicked	Weather	C,M,F	Noteable Observ	Frequency	L,D
2	NN0903.A1	Photo	Morning (8-9AM)	Lateral	Camp Edge		S	SBT	Sunny, Dry	M	Molt or Corpse		D
3	NN0903.A2	-	-	Dorsal	-		-	SBT	-	-	-		-
4	NN0903.B1	-	-	Lateral	-		S	YRT	-	M			L
5	NN0903.B2	-	-	Lateral	-		-	YRT	-	-			-
6	NN0903.C1	-	Morning (10:30-1	Lateral	Aguaje		S	LLL	-	C			-
7	NN0903.C2	-	-	Lateral	-		-	LLL	-	-			-
8	NN0903.C3	-	-	Dorsal	-		-	LLL	-	-			-
9	NN0903.D1	-	-	Lateral	-		S	FWP	-	F			-
10	NN0903.D2	-	-	Dorsal	-		-	FWP	-	-			-
11	NN0903.D3	-	-	Lateral	-		-	FWP	-	-			-
12	NN0903.E1	-	-	Lateral	-		S	FPL	-	C	Possible Nymph		-
13	NN0903.E2	-	-	Lateral	-		-	FPL	-	-	-		-
14	NN0903.E3	-	-	Lateral	-		-	FPL	-	-			-
15	NN0903.F1	-	-	Lateral	-	See 0903.F	S	SCT	-	M	Slightly Docile		-
16	NN0903.F2	-	-	Lateral	-	See 0903.F1	-	SCT	-	-	-		-
17	NN0903.F3	-	-	Lateral	-		-	SCT	-	-	-		-
18	NN0903.F4	-	-	Frontal	-		-	SCT	-	-	-		-
19	NN0903.G1	-	-	Dorsal	-		S	RFL	-	C?			-
20	NN0903.G2	-	-	Dorsal	-		-	RFL	-	-			-

Day0 Day1 Day2 Day3 Day4 Day5 Day6 Day7 Day8 Day9 Explore

Figure 1. Database of photos and locations of the Hemiptera casual surveys.

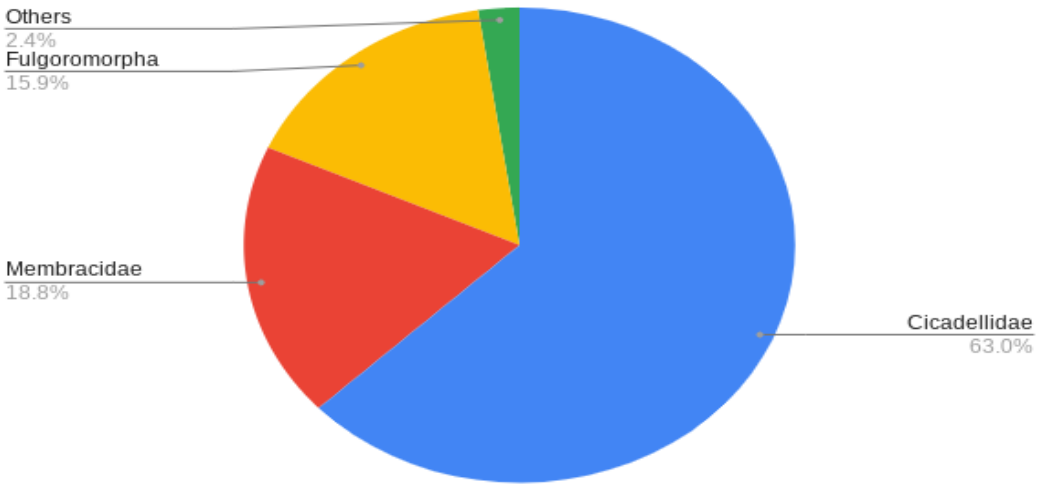

Figure 2. Proportions of Hemiptera groups found in the surveys.

having gained experience and intuition over the past 2 weeks. Maps displaying each of the daily routes are to be provided alongside the photo database.

Each individual photographed was assigned a specific code, and their respective photos given a numerical value to account for the number of images taken (see field guide for comprehensive code decipher). The data was then organized per day and matched towards the specific time conditions such as weather and location. Certain details such as photo view and type of media are additionally present to aid any future reviewers in investigating the matter. As for the ecological aspects, further variables were associated with the specimens, including any significant foliage, size, type of insect, life stage and status. If any notable observations surrounding a particular situation or individual were to be included, a section was present for such as well. After the surveying had concluded, each distinctly unique member was given a nickname to aid in identification and frequency counts for species clarification. The process of labelling the insects to their appropriate taxonomy was conducted through the uploading of media to *iNaturalist*.

Results

By the end of the thirteenth and final day of surveying, an approximate 190 individuals/groups had been catalogued. Out of those 190, an estimated 120 distinct species were recorded. The approximations are due to limiting factors on identification including aspects such as possible sexual dimorphism or the presence of nymph and adult stages that may overlap or diverge the types of insects. Depending on their identification and overall significance to the studies, a few select cases may either be redacted or added once again to the catalogue as well.

As seen in the figure above, the Leafhoppers or members of Cicadellidae were by far the most plentiful out of all the surveyed groups. Out of the total number of individuals/groups that were catalogued, an approximate 63% of them belonged to the aforementioned infraorder**.** Treehoppers (Membracidae) were the next most frequent, followed by Planthoppers (Fulgoromorpha). A few spittle bugs and two individuals of an unknown category were also documented.

In terms of species diversity however, the presence of several recurring Cicadellids

caused a drop in percentage while the Fulgoromorphs rose significantly and the Membracids also had a slight increase due to the variation in species number as seen in the figure above. Out of all the distinct species, the leafhoppers (Cicadellidae) held nearly half at 49.5% of the total. The planthoppers (Fulgoromorpha) almost halved that value at 24.8% and the Treehoppers (Membracidae) were not far behind at 22.9%. Significantly, the Fulgoromorphs appear to be more biodiverse, at least during the time and place of study, yielding a higher number of species than the Membracids despite having a fewer total number of individuals/groups.

The *Lindero* region was found to hold the highest density of the miscellaneous hoppers, with Day4 and Day10 during the daytime hours holding the two highest counts of 23 and 20 individuals/groups found. Due to the presence of logging trails from decades prior created extensive light gaps across the area, drawing out an increase in insects and allowing for visibility to be greater. The *Castaña* and *Tapir* trail provided noticeably increased counts as well with Day5, Day6, Day11 and Day12 showing results just below the *Lindero* finds. A diverse range of factors including plentiful vegetation and open space caused by trail movement and fallen logs allowed for additional favored locations for the Auchenorrhyncha members as well.

Discussion

What noticeable trends became apparent across each day?

Even across the smaller suborder Auchenorrhyncha, the diversity between species in terms of behaviour and overall living styles causes grand variations amongst themselves. This creates an illusion of great randomness when sampling such a broad group of animals, especially insects. Such a notion was increasingly present during the inventorying process, during which identifying any patterns was futile unless certain interpolations were made.

One particular aspect that stood out however, were the appearances of Membracids throughout the three weeks. Rather than

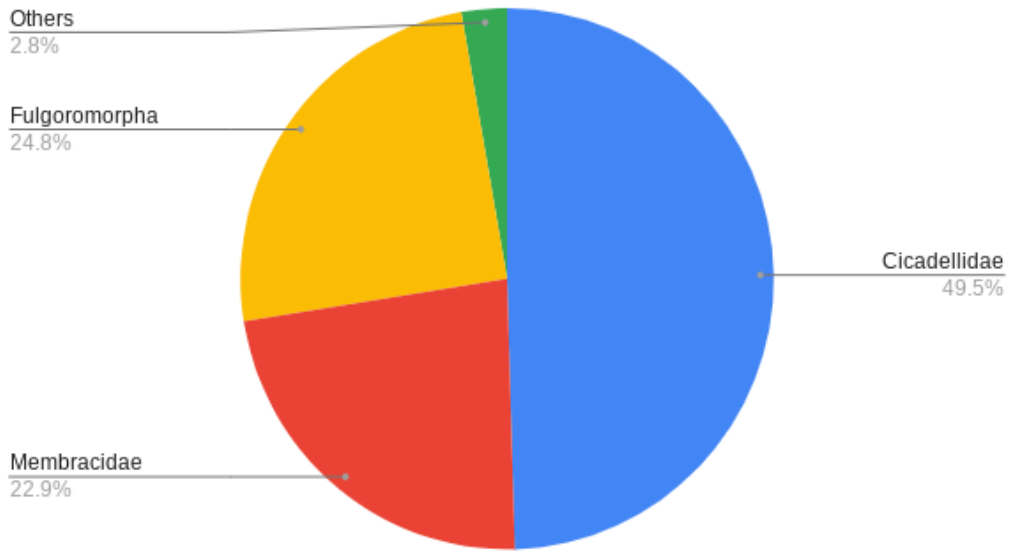

Figure 3. Proportions of Hemiptera species identified in the surveys.

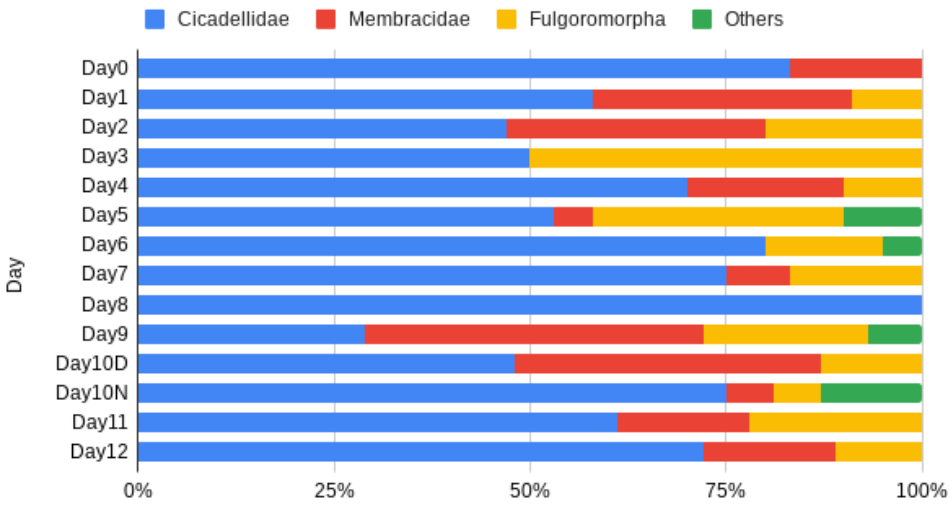

Figure 4. Proportions of insects observed per day.

appearing at what seemed to be random increments, the treehoppers presented themselves in orderly manners and grouped episodes. Once a single individual was found, other Membracids around the area or at the coinciding time were sure to be near. When the conditions had an inclination of hostility, such animals seemed to then vanish. Focusing on the treehopper family specifically allowed for more concise conclusions, due to their smaller niche ecological role.

Compiling the findings together, the apparent blotches of high and low Membracid activity become more apparent. In the graph above, the percentages of each hopper group found per day is compared to each other. However, the percentage values must be associated with certain conditions surrounding the day in focus to assess what may prompt the treehoppers to be more accessible. The Cicadellids are common across the board, but the Membracids in particular have leaps when they suddenly appear plentiful and there exist instances when they practically nonexist, even when removing the outliers.

It is also important to note that due to the lack of observations during Day3 and Day8, the two shall be omitted from the following

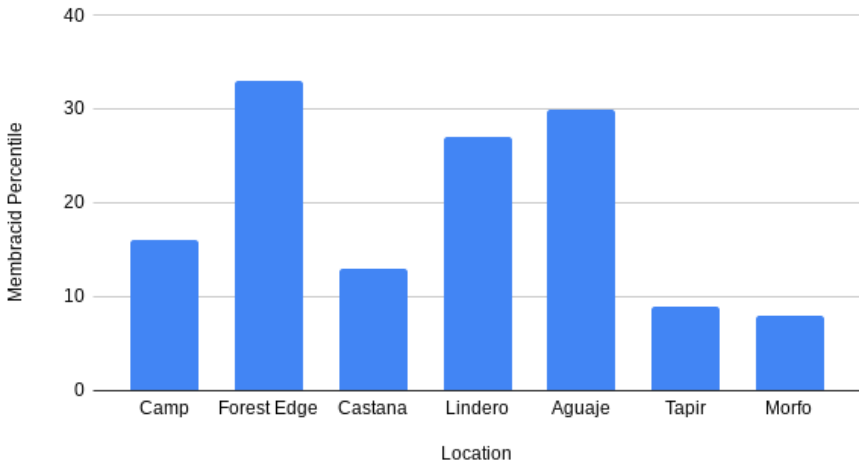

Figure 5. Proportions of Membracid insects by locations

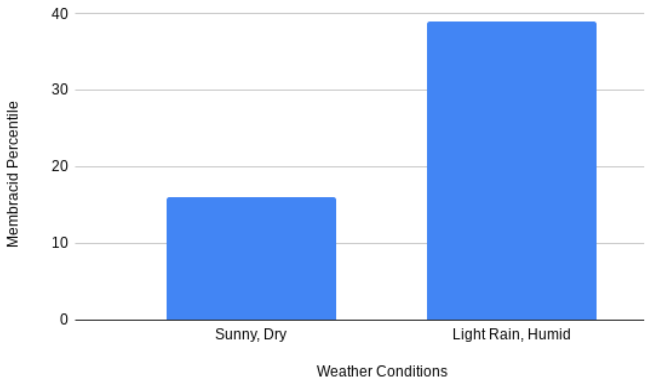

Figure 6. Proportions of Membracid insects by weather conditions.

discussions. Day10 has also been split into Day10D and Day10N to separate the day and night conditions of which varied greatly.

Were there factors relating to location and weather that contributed to higher or lower counts?

Such percentile values were then associated by location from the days during which the surveys were conducted and averaged to extract a single value per trail area. Significantly, the Forest Edge, *Lindero* and *Aguaje* regions yielded a much higher percentage value of treehopper finds.

Compared to the vast open area of the camp and the incredibly dense foliage seen in the *Castaña*, *Tapir* and Morfo regions, the Forest Edge, *Lindero* and *Aguaje* regions offer more chances for light gaps to occur. The Forest Edge allows dense foliage to meet the sun, while the *Lindero* region has an open trail network due to past logging. The *Aguaje* area as well allows for sunlight to penetrate the canopy with its swampy conditions.

Whether the light gaps genuinely attract the Membracids with the presence of new-growth and fewer predatory insects or if the unique habitats offer a better visual into their world requires more investigation. However, the relationship between the two is definitely present amongst the Finca Las Piedras.

Additionally, the humidity levels and other weather conditions were an important factor in bringing the treehoppers to light. Each of the days were associated with their noted weather conditions and the Membracid values were composed together as a mean to produce the graph seen above. Even the slightest presence of rain, whether it may be a light drizzle, upcoming or even passing showers, increased the appearances of treehoppers.

Conclusion

The hoppers of the suborder Auchenorrhynca are a terribly underrated group of insects. Whether it may be their inability to be bred and kept as domesticated insects, their skittish nature or some other unexplainable factor, they rarely ever make it to the front page of a person's mind and may continue to do so for the distant future. However, such invisibility in the public's perception does not leave them falling anywhere short of the imagination. Each of their colors or protrusions and the stunning diversity of these leaping bugs is one to invest oneself in. The goal of reaching at least 50 catalogued species was far exceeded and there now exists a foundation for anyone else interested in studying these remarkable creatures.

Emerging from the dense foliage and particularly enjoying the light gaps and forest edges during a light shower, these leafhoppers, treehoppers, planthoppers and many others are one to look out for.