Araneae Biodiversity in the Ecuadorian Chocó:
Impact of Altitude and Land Use on Spider Diversity

Araneidae: Eriophora sp. with its cockroach prey (La Hesperia Reserva Natural) Photo by: Kristin Robinson

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South America, Ecuador, Pichincha, La Hesperia

Submitted in partial fulfillment of the requirements for Ecuador Comparative Ecology and Conservation, SIT Study Abroad, Spring 2018

Acknowledgements

I would like to thank Alexandra Hoeneisen for being my mentor on this project. This project would not have been successful without her guiding advice and invaluable knowledge of the reserve. I would also like to thank her family for welcoming us to the reserve.

Thank you to Diego Pullugando for providing support to our projects, as well. I also want to thank Elsa Vergara, Mónica Merchán, and Nancy Cayambe for keeping us well fed and providing for us while we stayed at La Hesperia. Additionally, thank you to the entire La Hesperia community for being so welcoming and for teaching us about the reserve.

I would like to thank Satya Kent and Amanda Riley for their companionship, and, additionally, I would like to thank Amanda for accompanying me to my more distant nocturnal transects.

I am very grateful to Xavier Silva, Javier Robayo, and Diana Serrano for their endless assistance, support, and advice going into this project before arriving on site and while challenges occurred on site.

I would also like to thank SIT, School for International Training, for the funding and opportunity to do this research in Ecuador.

Reconocimientos

Me gustaría agradecer a Alexandra Hoeneisen por ser mi mentora durante este proyecto. No hubiera sido exitoso sin su consejo y conocimiento inestimable de la reserva. También, me gustaría agradecer a su familia por darnos la bienvenida a la reserva.

Muchas gracias a Diego Pullugando por su apoyo de nuestros proyectos. Quiero agradecer a Elsa Vergara, Mónica Merchán, y Nancy Cayambe por mantenernos bien alimentados con toda la comida rica y por ser muy acogedoras. Además, gracias a toda la comunidad de La Hesperia por ser tan acogedora y por enseñarnos su conocimiento sobre la reserva.

Me gustaría a Satya Kent y Amanda Riley por su compañía, y especialmente me gustaría agradecer a Amanda por acompañarme a mis transectos nocturnos más distantes.

Estoy muy agradecida con Xavier Silva, Javier Robayo, y Diana Serrano por su asistencia, apoyo, y consejo durante todo de este proyecto antes de llegar al sitio y mientras ocurrían los desafíos en el sitio.

También, me gustaría agradecer a SIT, School for International Training, por el financiamiento y la oportunidad para hacer esta investigación en Ecuador.

Abstract

The Tumbes-Chocó-Magdalena bioregion in the Ecuadorian Andes is one of the most biodiverse areas in the world. This ecosystem is threatened primarily by deforestation and climate change. Spiders are surprisingly very understudied in this area of the world considering their diversity, their importance as bioindicators, and the threats facing their habitats. The objectives of this study were to discover which families and genera of spiders are found within the La Hesperia reserve, to understand how altitude affects spider diversity, and to investigate differences in spider communities based on land use. Four nocturnal visual transects, 150m by 4m, at various elevations (1200.7m, 1367m, 1371.3m, 1501m) were each sampled for three days by macro-photographing spiders. The total data collection spanned 12 days and resulted in 1,318 individuals in 16 families, 33 genera, and 188 morphospecies. The most abundant families were Theridiidae (n=624, 47.2%), Araneidae (n=322, 24.4%), then Ctenidae, Pholcidae, Anyphaenidae, and other less common families. Guilds were assigned based on foraging strategy. The orb web guild (Araneidae, Tetragnathidae, Uloboridae, Synotaxidae) was the most diverse while the space web guild (Theridiidae, Pholcidae) was the most abundant but one of the least diverse. The transect with mild land use, a small bamboo plantation, nearby was more diverse than the other transect at the same elevation. The mild disturbance likely allowed for more vegetation complexity, therefore, more diversity. The 1501m transect was the least diverse and had the highest abundance of the space web guild. Diversity of spiders can increase with mild disturbance, spider diversity generally tends to decrease with elevation, and subsocial spiders are more common at higher elevations compared to low elevation social spiders.

Resumen

La biorregión de Tumbes-Chocó-Magdalena de los Andes ecuatorianos es una de las áreas más diversas en el mundo. Es un ecosistema en peligro a causa de la deforestación y cambio climático. Sorpresivamente, las arañas no son muy investigadas en esta área del mundo, aunque son muy diversas, importantes como bioindicadores, y sus hábitats son en peligro. Los objetivos de esta investigación eran para descubrir cual familias y géneros de arañas están en La Hesperia reserva, para entender como altitud afecta la diversidad de arañas, y para investigar las diferencias del uso de tierra entre las comunidades de arañas. Estaban cuatro transectos visuales y nocturnos, 150m por 4m, en elevaciones varias (1200.7m, 1367m, 1371.3m, 1501m). Muestras fueron tomadas 3 veces en la forma de fotos de arañas por cada transecto por un total de 12 días de colección de datos que resultado en 1.318 individuos en 16 familias, 33 géneros, y 188 morfoespecies. Las familias más abundantes eran Theridiidae (n=624, 47.2%), Araneidae (n=322, 24.4%), entonces Ctenidae, Pholcidae, Anyphaenidae, y otras menos comunes. Grupos de comportamiento de alimentación fueron asignados. El grupo de telas orbes (Araneidae, Tetragnathidae, Uloboridae, Synotaxidae) era lo más diverso. El grupo de telas espaciales (Theridiidae, Pholcidae) era lo más abundante pero lo menos diverso. El transecto con uso de tierra no muy intenso muy cerca, una plantación pequeña de bambú, era más diversa del otro transecto en la misma elevación. La perturbación leve probablemente permitió una mayor complejidad de la vegetación, por lo tanto, más diversidad. El transecto de 1501m fue el menos diverso y tuvo la mayor abundancia del grupo de comportamiento de alimentación de la tela espacial. La diversidad de arañas puede aumentar con disturbios leves, la diversidad de arañas generalmente tiende a disminuir con la aumentación de la elevación, y las arañas subsociales tienen más éxito en vivir en elevaciones más altas en comparación con arañas sociales de elevación más baja.

Introduction

The Tumbes-Chocó-Magdalena bioregion of Ecuador, previously called the Chocó-Darién-Western Ecuador Hotspot (Conservation International, 2005), was estimated to have experienced a reduction of local richness of about 30% as of the year 2000 as a result of human activities and changes of land use since the 1500s (Newbold et al., 2015). In a worst case future scenario where the current pasture and cropland increases in yield but also in size, urban areas grow, energy demands increase, the world population grows to 12 billion, global temperature increases by 4°C, and carbon emissions increase, there may be approximately another 10% decrease in neotropical richness between 2005 and 2095 (Newbold et al., 2015). With the change in climate, there will be a stronger reliance on local biodiversity for the continued functioning of each ecosystem (Newbold et al., 2015). However, the projection also shows that species richness will decrease in these areas. Therefore, these ecosystems may not be able to continue functioning.

The Tumbes-Chocó-Magdalena forest in the Western range of the Andes in Ecuador, where this study takes place, is within one of these biodiversity hotspots (Conservation International, 2005). These humid premontane and montane forests contain very high endemism as well, and the primary threat to this biodiversity is deforestation for logging, ranching, and agriculture (Conservation International, 2005). Additionally, as the effects of climate change become more pronounced, the tree line and ecosystem borders will move up in altitude, threatening the higher altitude flora and fauna. This is a particular risk with the endemic arthropod species in the higher altitude ranges, such as was found in a study in the Austrian Alps (Dirnböck, Essl, & Rabitsch, 2011). The risk for individual species resides in their resilience against changing habitats.

For terrestrial species that experience the highest land use pressure intensity, local richness can potentially be reduced by 76.5%, rarified richness reduced by 40.3%, and abundance by 39.5% (Newbold et al., 2015). Richness overall is reduced with proximity to roads as well. The diversity in secondary forest increases with the more mature that forest is. The secondary forest may attain a richness and diversity similar to the primary forest. However, the secondary forest's richness may be made up of newly established species and the composition will be different from the primary forest.

It is becoming increasingly important to study the effects of climate change, forest succession, and human activities such as deforestation by using bioindicators. Spiders (Araneae) only recently are becoming more frequently used as bioindicators to assess environmental changes. This is because they are generally the main arthropod predator in most ecological communities (Cardoso, Pekár, Jocqué, & Coddington, 2011). Predators are more sensitive to environmental changes because they not only face the environmental pressures themselves but rely on lower trophic levels, that are also experiencing those pressures, for survival (Cardoso et al., 2011). Even the generalist predator species which are considered to be more resilient (Amaral Nogueira & Pinto-da-Rocha, 2016), are still sensitive to environmental changes. One phylogenetic modelling study which specifically looked into predicting the habitat change of nephilid spiders, found that even the widespread generalist species would experience a habitat loss of over 50% on average by 2080 (Kuntner, Năpăruş, Li, & Coddington, 2014).

According to the World Spider Catalog, there are currently 4,088 genera and 47,505 accepted species of spiders worldwide from published scientific literature with new species, genera, and distributions being described every year (World Spider Catalog, 2018). Despite the importance of spiders as bioindicators, the threat of climate change against them, the need for investigation of bioindicators in endangered habitats, the high biodiversity, and the high endemism, there are very few identification guides on spiders in the Neotropics. There has been some research done in cloud forests on spiders, but mostly scattered and never in Ecuador other than a study by Dupérré & Tapia which also can be considered the most exhaustive study done on spiders in any neotropical cloud forest (Dupérré & Tapia, 2016). There is no clear way to identify spiders specific to Ecuador and more broadly the whole Neotropical region despite the attention more often paid to the Amazonian basin. Another project underway by Dupérré is attempting to catalog all published observations of Arachnids in Ecuador (Dupérré, 2013). The project so far has recorded 43 families and 709 species in Ecuador with the most diverse families being Araneidae (144 species), Oonopidae (89 species), Salticidae (80 species), and Theridiidae (72 species) (Dupérré, 2013). However, these numbers are low for what is likely the actual number of current spider families and species in Ecuador.

The understudied area in Ecuador and the Neotropics is surprising because it contains some of the most biodiverse areas on Earth. With funding, many new species are being found in the Chocó cloud forest every year. In 2014, 'Spider diversity in the Chocó forests of Ecuador' was a project launched as a part of the National Geographic Society/Waitt grant program (Dupérré, 2015; Dupérré & Tapia, 2016, 2017a). Through this project, many new species have been found, taxonomic revisions have been made, and the first observations in Ecuador of certain genera and species have been made (Dupérré, 2015; Dupérré & Tapia, 2016, 2017a). Researching Araneae biodiversity and endemism, and their use as bioindicators in Ecuador is important to have a better understanding of how diverse and threatened the arthropod composition is in certain conservation areas, especially as the effects of climate change and deforestation worsen. Documenting new species and biodiversity before they disappear is important to attempt to conserve and protect these species. The knowledge of these biodiverse areas becoming more public may financially assist the conservation areas that need funding, such as private reserves in Ecuador, in order to keep their land conserved.

The objectives of this study were 1) to provide information about what families and genera of spiders are found within the La Hesperia reserve in the Tumbes-Chocó-Magdalena bioregion; 2) to understand how differing levels of altitude (1200, 1370, and 1500m) affect the biodiversity of spiders; 3) to investigate whether there are differences in spider communities based on current land use.

Methodology

Study Site

This research was conducted in La Hesperia Reserva Natural in the province of Pichincha, Ecuador located approximately 100km by highway from Quito, and 50km directly from Quito (**Fig. 1a**). La Hesperia is a privately-owned reserve with the goal of conserving its 814 hectares of forest at latitude from 0º 20′ 38" to 0º 23′ 06", and an altitude between 1100 and 2040m ("La Hesperia: Biological Station," 2008). La Hesperia is in the Western range of the Andes in Ecuador in the Tumbes-Chocó-Magdalena bioregion, and contains three types of tropical cloud forest: pre-montane evergreen, low montane, and high montane ("La Hesperia: Biological Station," 2008). Over 35 years ago, a small part of the forest of La Hesperia was cut and the land used to grow coffee and sugar cane. The rest of the land was always primary forest. However, the agriculture stopped being managed, and, with a change in ownership, that same land that was already cut was converted to pasture. Of the 814 hectares, approximately 80 are used for pasture, and 80 are secondary forest. In 1988, it was decided to make La Hesperia a private reserve ("La Hesperia: Biological Station," 2008).

Figure 1. Map of the study site at La Hesperia. a) This map shows the location of La Hesperia in relation to Quito, the capital of Ecuador. **b)** This map shows the four transects and their locations within the La Hesperia reserve with the highway for reference. The slightly lighter green color in the center of the upper part of the map shows where the cleared areas are that are used for ranching and agricultural activities. The boundaries of La Hesperia are not shown on this map, and the map only shows part of the reserve, not the full property.

Transect Locations

Four transects, 150m long and 4m wide, were set up during the days of April 16th through the 19th (**Fig. 1b**). Though not frequently experiencing human traffic, these transects did mostly follow the preestablished trails because of the steep terrain present at La Hesperia and the dense understory. These two reasons essentially made it not feasible to create a transect perpendicular to a trail.

The Low transect had an average altitude of 1200.7m and was located between the coordinate of S 00°20'56.0"W 078°51'03.4" and S 00°20'56.7"W 078°51'06.4". The beginning of the trail is about 10m away from the private dirt road used to access the reserve from the highway. The forest here was a mix of secondary and primary. There was less detritus and leaf litter in some areas likely due to heavy rainfall shifting it downhill. There was a small and recent landslide present near the 100m mark of the transect. The vegetation was more mature and taller than the Bamboo transect, and larger trees were present. The underbrush was not as thick in most areas. There were some small bamboo plants present along the transect.

The Bamboo transect had an average altitude of 1367m and was located between the coordinates of S 00°21'03.5"W 078°51'03.0" and S 00°21'03.8"W 078°51'07.8". The beginning of the transect was located in a forest close to the pastures and pens of sheep, goats, and chickens. The end of the transect was located near to several groves of giant bamboo being grown for use in construction (**Appendix 1A**). There was a small dirt road in this area used to access the bamboo. The transect consisted of tall grasses and young plants surrounded by taller trees with less canopy density. There was evidence of reforestation occurring here.

The Laguna transect had an average altitude of 1371.3m and was located between the coordinates of S 00°21'15.3"W 078°50'53.6" and S 00°21'18.7"W 078°50'51.9". The transect was located in a mixture of primary and mature secondary forest. The transect was nearby to a lagoon (located to the Northeast of the transect) which was created by the construction of a small levee in order to continue the dirt road across and have the water flow beneath. There was a steep drop on the East side of the trail. One bamboo bridge, approximately 5m long, was a part of the transect between 18m and 23m because it could not be avoided. Some terrestrial spiders were occasionally present on the bridge. Small 2-3m wide mudslides were present on this transect along with an unfrequently used large mammal trail. There were also areas of thick mud present.

The High transect had an average altitude of 1501m and was located between the coordinates of S 00°21'51.9"W 078°50'43.2" and S 00°21'56.2"W 078°50'43.4". The transect was located in primary forest with a steep drop on the West side of the transect, because of this reason the transect followed the trail. The transect consisted of the trail covered in short vegetation, less underbrush than the other transects, tall trees, and the presence of some cecropia trees. The southernmost point of the transect was 175m away from a small tributary stream only a couple centimeters deep and about 0.25m across. There was little disturbance that could be visually observed, besides the evidence of previous landslides and the creation of the trail. The landslides left fallen trees over the trail and a forest gap.

Nocturnal Visual Transect Methodology

Nocturnal visual transects were used rather than pitfall traps because pitfall traps can flood and fail with too much rainfall which is a concern in the rainy season of the cloud forest (Moore, 2015). For this reason, it is acknowledged that this study was focused less on terrestrial species. Additionally, nocturnal transects were used because spiders in tropical regions are more active at night and some only active at night (Green, 1999). Though ideal to collect data during the day and night, this study was restricted to nocturnal spiders in order to increase the ability to find the spiders and to have a more complete sample to assess nocturnal biodiversity.

The transects were marked with colored string every 25m. At each 25m mark, the canopy cover was recorded with a spherical densiometer, leaf litter depth was measured with calipers, vegetation disturbance, and description of landscape and understory were recorded. The distance from bodies of water was also recorded which was checked with maps. Leaf litter depth was measured because of its greater impact on the spider communities than leaf litter composition (Bultman & Uetz, 1982). Photos were taken of each site to also describe the habitat. The coordinates and elevation were obtained through using a Garmin GPSmap 64s.

Sampling occurred from April 17th-19th, April 22th-26th, and April 28th-May 1st for a total of 12 sampling days. Sampling was not done on April 27th because there was a strong storm that prevented any data collection. These transects were checked during the nights of these dates from 19:00 to 22:00. Each transect was done on a different day due to time constraints. Temperature and humidity were collected at each transect every day during data collection with a digital temperature/humidity meter along with the time at the start and end, and description of how weather changed throughout data collection. Meteorological conditions were described as the presence or absence of clouds, rain or mist present during or before time of study, amount of precipitation on day of study measured with a rain gauge, presence of wind, moon phase, and description of whether the moon is blocked by clouds. The transect was walked slowly while searching from 1.5m in height and below, and searching rocks, plants, webs, under leaves, and under leaf litter to collect data in all possible microhabitats (Amaral Nogueira & Pinto-da-Rocha, 2016; Moore, 2015). All spiders with a body size of 1mm and larger (excluding legspan) were photographed and identified. Medium to large spiders could also be spotted from seeing their eyes reflect the light of the headlamp.

All spiders within the transect were immediately photographed close up with a Nikon D3300 DSLR camera on the spot it was found before it might have been disturbed. Photos were taken of the dorsal, lateral, and ventral sides, if possible. A photo was also taken with a gridded sheet of paper as the background when needed to get an approximate measurement of size. The location along the transect, time, and photograph number were recorded.

All spiders were identified down to the family level using guides and down to genus level when possible (Dupérré, 2013; Huber, 2000; Jocque & Dippenaar-Schoeman, 2007; Wegner, 2011). Individuals were categorized into morphospecies, and species when possilbe.

No specimens were killed, harmed, or preserved in this study.

Statistical Analysis

To assess diversity, iNext software (Chao, Ma, & Hsieh, 2016) was used to calculate species richness (q=0), the Shannon diversity index (q=1), and the Simpson diversity index (q=2). Graphs were created using iNext to show the extrapolated diversity, sample coverage, and diversity profiles which compare changes in diversity over a continuous x-axis of the order of q.

Due to the changes in elevation between the transects, the Bamboo transect can only be compared with the Laguna transect because they were sampled at the same elevation. To assess the elevation differences, the Low, Laguna, and High transects were compared.

Guilds were used to additionally assess diversity of spider groups based on different foraging strategies (Cardoso et al., 2011). The 8 guilds of a worldwide study done by Cardoso et al. were used for this study: (1) sensing web weavers, (2) sheet web weavers, (3) space web weavers, (4) orb web weavers, (5) specialists, (6) ambush hunters, (7) ground hunters and (8) other hunters (Cardoso et al., 2011). A detailed phylogeny of spider families with guild assignments can be found in the Cardoso et al. paper. Four of the families were split into subfamily groupings in order to sort them into guilds because there were distinct foraging strategies in the families. Linyphiidae is one of these families that was divided into two guilds: the subfamilies Linyphiinae and Micronetinae were placed in the sheet web guild, and Erigoninae with the other subfamilies were placed into the other hunter guild. Another exception was made for this study: the fishing spider (Dolomedes sp.) in the family of Pisauridae was classified as a specialist because of its specialized hunting on top of water which differentiates the genus from the family guild classification.

It would be more effective to classify guilds more specifically if the information for genus and species of this area was available. For example, dividing hunting behavior as sit-and-wait, sit-and-pursue, and active hunting (Schmitz & Suttle, 2001). However, a more universal method of classification was needed since it was only possible to identify down to morphospecies in this study, such is the case for much of the research done on tropical spiders where only morphospecies are identified and there can be the presence of several undescribed species (Cardoso et al., 2011).

A one-way ANOVA test was also performed using VassarStats software with a Tukey HSD *post hoc* test. The predetermined level of significance was established to be p>0.05.

Results

Overall Biodiversity

From 12 days of data collection at 4 transects, 1,318 individuals were found and classified into 16 families, 33 genera, and 188 morphospecies (**Appendix 2A, Appendix B)**. Five individuals could not be classified into families and are listed as unknown. The most abundant families were Theridiidae with 3 genera and 26 morphospecies (n=624, 47.2%), Araneidae with 7 genera and 82 morphospecies (n=322, 24.4%), Ctenidae with 3 genera and 13 morphospecies (n=87, 6.6%), Pholcidae with 2 genera and 7 morphospecies (n=69, 5.2%), Anyphaenidae with 2 genera and 10 morphospecies (n=68, 5.1%), Tetragnathidae with 1 genus and 6 morphospecies (n=55, 4.2%), Clubionidae with 1 genera and 8 morphospecies (n=27, 2.0%), Linyphiidae with 4 genera and 12 morphospecies (n=26, 2.0%), and Uloboridae with 2 genera and 9 morphospecies (n=22, 1.7%) (**Fig. 2**). The other families had fewer than 0.5% of the total family sampled composition with 2 or fewer genera and 4 or fewer morphospecies. The combined samples of all 4 transects found the sample coverage altogether to be 92.18% complete. With iNext software, the species richness and extrapolated species richness was calculated (**Appendix 3A**).

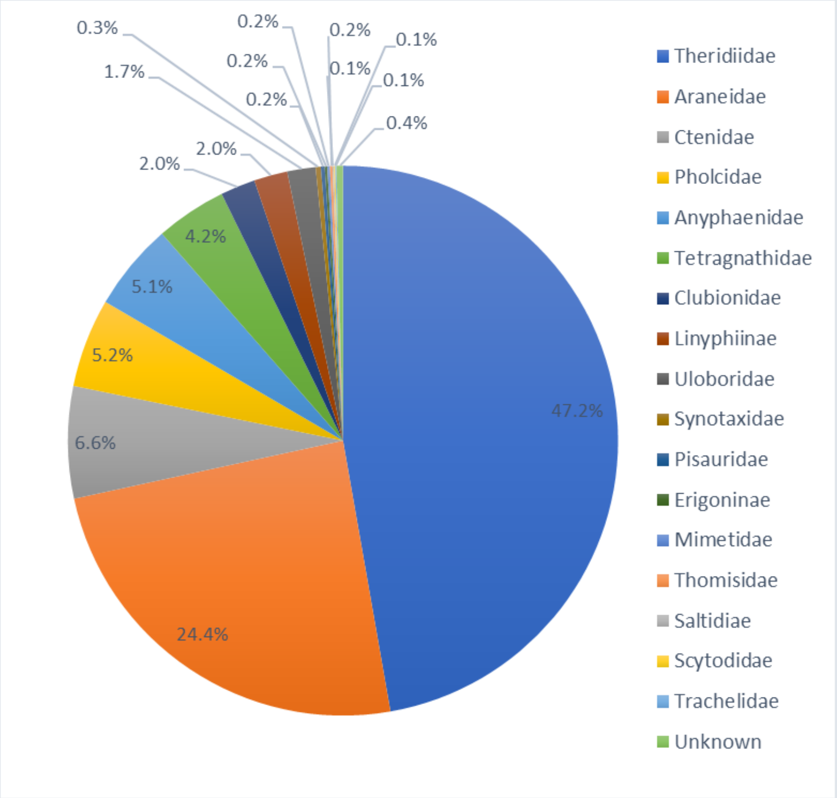


Figure 2. Spider family composition. The 17 families/subfamilies are in order from largest to smallest, including the unknown family group with 5 individuals.

Guilds

Six of the eight guilds (Cardoso et al., 2011) were found at La Hesperia: space web (Theridiidae, Pholcidae), orb web (Araneidae, Tetragnathidae, Uloboridae, Synotaxidae), other hunters (Ctenidae, Anyphaenidae, Clubionidae, Erigoninae, Saltidiae, Scytodidae), sheet web (Linyphiinae), specialist (Mimetidae, Trachelidae, Pisauridae: Dolomedes sp.), and ambush hunter (Thomisidae). Additionally, unknown was listed for the morphospecies without family identifications. Of all the individuals, 52.5% were in the space web guild, 30.5% orb web, 14.1% other hunters, and 2.0% sheet web (**Fig. 3a**). However, the space web guild with the families Theridiidae and Pholcidae was found to be less diverse than the other hunter guild in all orders of q other than q=0 (**Fig. 3b**). The orb web guild was the most diverse guild.

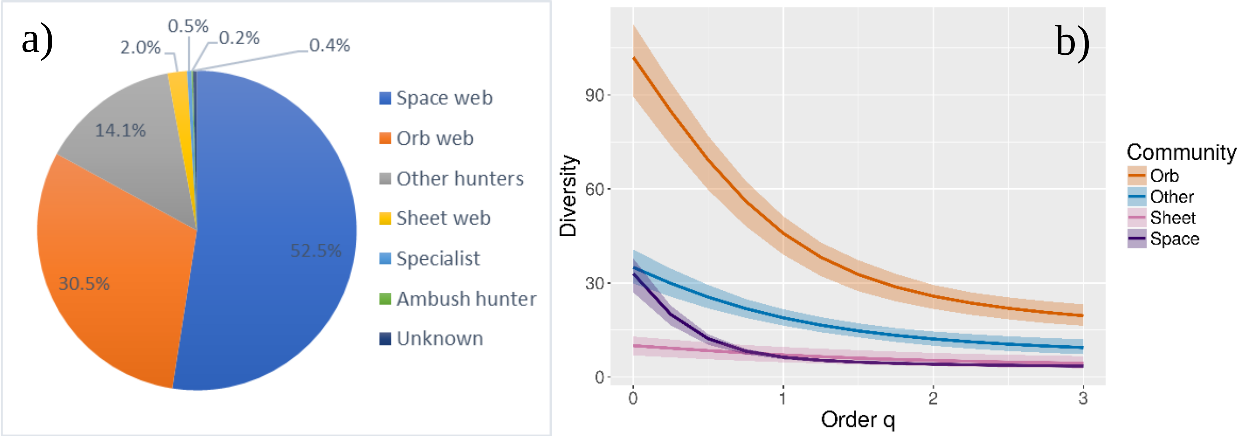


Figure 3. Guild abundance and diversity. a) Abundance of each guild across all transects. **b)** Diversity profile of the four most abundant spider guilds. The faded area is the 95% confidence interval. This graph was created with iNext software.

Transect Comparisons

The Low, Laguna, and High transects had similar family compositions (**Fig. 4a, c, d**): Theridiidae (43.1-61.5%) is the most abundant followed by Araneidae (14.9-28.5%). For the Bamboo transect (**Fig. 4b**), Araneidae was most abundant (36.5%) followed by Theridiidae (26.5%). The Bamboo transect had the highest percentage of Araneidae of all the transects, the highest percentage of Ctenidae (10.8%), the highest percentage of Tetragnathidae (10.0%), the highest of Clubionidae (4.0%), and the highest of Anyphaenidae (7.6%). The High transect had the most Theridiidae present (61.5%).

The guild composition of the transects more clearly shows that the Low, Laguna, and High transect all have high abundances of the space web guild followed by the orb webs, then the other hunters, then the sheet webs, and then the small percentages of the ambush and specialist hunters (**Fig. 5a, c, d**). The Bamboo transect had the most orb web spiders followed by the space web, and then the other hunters (**Fig. 5b**).

A graph of the diversity profiles of all four transects shows the differences in diversity with different values of q (**Fig. 6, Appendix 4A**). At q=0, the species richness measure, the High can be seen as having a lower diversity than the Low and Laguna transect. There is no significant difference between the diversities of all the transects at q=0. At q=1, the Shannon index, the Bamboo transect's diversity 95% confidence interval overlaps with the Low transect's confidence interval. The High transect is significantly lower than all, and the Laguna is significantly lower than the Bamboo. At q=2 and q=3, the Bamboo is significantly more diverse than all other transects, and the High transect is significantly less diverse than all other transects while the diversity of the Low and Laguna transects is not significantly different.

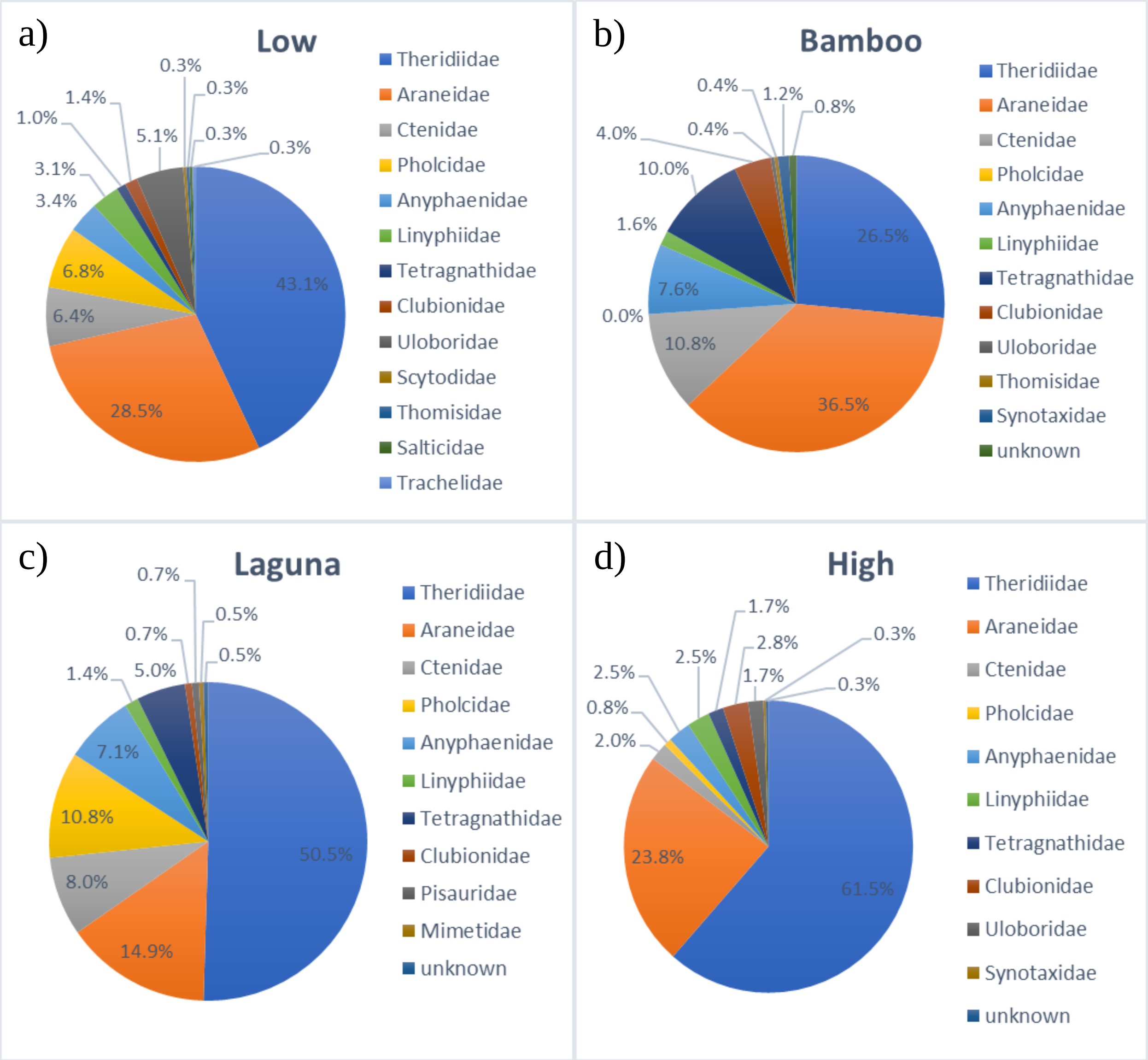


Figure 4. Family composition of each transect. a) The Low transect (1200.7masl) had 13 families. **b)** The Bamboo transect (1367masl) had 11 families and an unknown family group. **c)** The Laguna transect (1371.3masl) had 10 families and an unknown family group. **d)** The High transect (1501masl) had 10 families and an unknown family group.

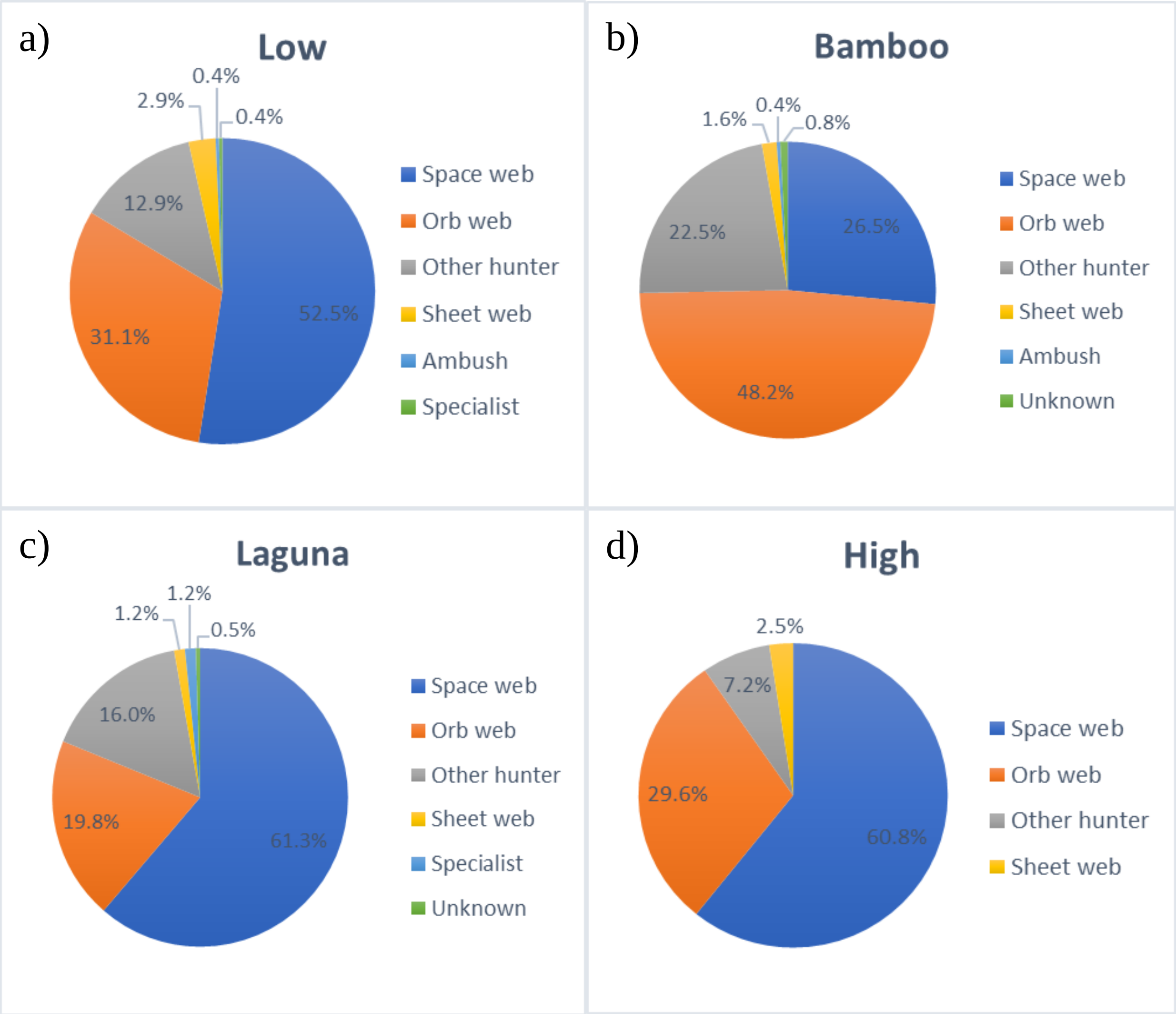


Figure 5. Guild composition of each transect. a) The Low transect (1200.7masl) had 6 guilds. **b)** The Bamboo transect (1367masl) had 5 guilds and an unknown group. **c)** The Laguna transect (1371.3masl) had 5 guilds and an unknown group. **d)** The High transect (1501masl) had 4 guilds.

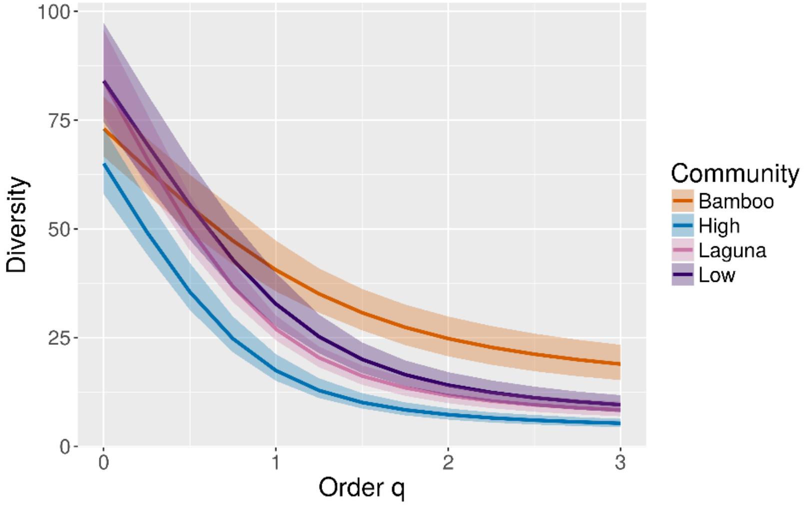


Figure 6. Diversity profile of all transects. The diversity of the 4 transects compared to continuous q values. The faded area is the 95% confidence interval.

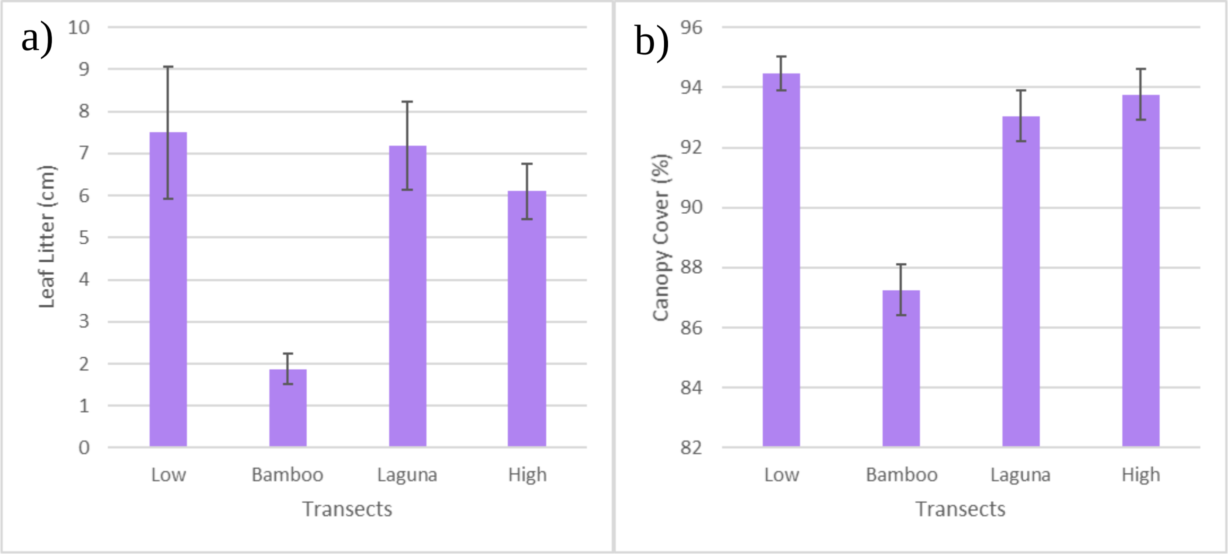


Figure 7. Leaf litter and canopy cover for each transect. a) A one-way ANOVA was used to compare the Low (M=7.50, SE=1.57), Bamboo (M=1.87, SE=0.360), Laguna (M=7.186, SE=1.042), and High (M=6.10, SE=0.651) transects with VassarStats software (F(3,24)=6.58, p=0.0021). A Tukey HSD post hoc test was run with VassarStats software. The bamboo transect was significantly lower than all the other transects (Tukey HSD test, p<0.05). No other transects were significantly different from each other. **b)** A one-way ANOVA was used to compare the Low (M=94.47, SE=0.558), Bamboo (M=87.26, SE=0.857), Laguna (M=93.05, SE=0.860), and High (M=93.76, SE=0.847) transects with VassarStats software (F(3,24)=17.41, p<.0001). A Tukey HSD post hoc test was run with VassarStats software. The bamboo transect was significantly lower than all the other transects (Tukey HSD test, p<0.01). No other transects were significantly different from each other.

The leaf litter and canopy cover of bamboo transect were significantly lower than the other three transects (**Fig. 7a, b**). The leaf litter was at least 4.23cm lower. The canopy cover was a percentage 5.79 lower.

The presence of previous small-scale landslides occurring on the transects was noted, but no statistics were run on these microhabitats present on the transect. This is because the results would not be reliable since the methods of this study did not allow for complete sample coverage of terrestrial spiders.

No correlation was found with the abundance of spiders and guilds with precipitation, temperature, humidity, or moon phase. Despite the two storms on the night of April 24th after data collection and on the night of the 27th that resulted in rainfall accumulations of 3.1cm and 2.8cm, respectively, no effect was found on abundance.

Discussion and Conclusions

The objectives of this study were 1) to provide information about what genera and species of spiders are found within the La Hesperia reserve in the Tumbes-Chocó-Magdalena bioregion; 2) to understand how differing levels of altitude within the reserve (1200, 1370, and 1500m) affect the biodiversity of spiders; 3) to investigate whether there are differences in spider communities based on land use for bamboo cultivation.

Overall Biodiversity and Guilds

It was found that Theridiidae (3 genera, 26 morphospecies, n=624, 47.2%) was the most abundant family followed by Araneidae (7 genera, 82 morphospecies, n=322, 24.4%), Ctenidae, Pholcidae, Anyphaenidae, Tetragnathidae, Clubionidae, Linyphiidae, and then followed by the less common families. In a study by Dupérré & Tapia, the most abundant family was Oonopidae while the most abundant arboreal family was Theridiidae and it was also considered to be the most diverse of all families in that study (Dupérré & Tapia, 2016). This study differed by having a higher abundance of Ctenidae and Pholcidae, and a lower abundance of Linyphiidae than other cloud forest studies (Dupérré & Tapia, 2016). Following Theridiidae, the most diverse families were Oonopidae, Tetragnathidae, Linyphiidae, Anyphaenidae, and Salticidae (Dupérré & Tapia, 2016). In this study, Araneidae was the second most abundant but the most diverse. Of the 4 most abundant guilds, the orb web guild was the second most abundant and the most diverse as well, while the space web (Theridiidae and Pholcidae) was one of the least diverse guilds. Anyphaenidae, like the Dupérré & Tapia study, was the 5th most diverse family in this study. This further demonstrates that Anyphaenidae is a major component of family composition in the Ecuadorian Chocó.

The lack of Oonopidae, Zodariidae, and Salticidae in this study is likely due to the methodology used. These are important families to the overall composition of spiders in the Chocó (Dupérré & Tapia, 2016). However, as was previously stated in the methodology, this study did not focus as much on terrestrial spiders or diurnal spiders because only nocturnal visual transects were used in this study.

Oonopidae, the family of goblin spiders, have been shown to be very common and important part of the Chocó spider community, but are found under leaf litter and rocks (Dupérré & Tapia, 2017b). Theridiosomatidae and Symphytognathidae, though not the most abundant, have been found in a previous study in the Ecuadorian Chocó (Dupérré & Tapia, 2017a). They are tiny cryptic spiders that create webs close to the ground in low vegetation or leaf litter. These also likely should have been found in this study but because of a lack of sample coverage of terrestrial species they were not found. Ctenidae may also have been found to be even more abundant and diverse if pitfall trapping had been used. They are most commonly found on the ground and litter, suggesting that focusing a terrestrial sampling approach would be more effective at collecting abundance and diversity data on this family (Dupérré, 2015). However, pitfall trapping is not the only method that should be used to assess ground dwelling spiders because there is a stratification of spider families present in the different levels of leaf litter (Wagner, Toft, & Wise, 2003). Stratified litter-grab technique could be used along with pitfall trapping.

In the Moore paper, at the Rio Zuñac reserve on the Eastern Andes in Ecuador, the most common families were Pholcidae (30.2%), Araneidae, and Salticidae (Moore, 2015). Salticidae likely was more common because it is a generally diurnal family the methodology of that project was completed during the day. However, the Moore study also did not effectively sample terrestrial species due to the flooding and failing of the pitfall traps. It is possible that Pholcidae could be more common on the Amazonian side of the Andes, but study by Moore does not have complete sample coverage. The study claims 99.4% completeness, but only 169 individuals were collected in the study. The completeness is not accurate with that small of a sample size. Therefore, the biodiversity cannot be compared to this study. Although, it would be important to compare results from this study on La Hesperia a mostly primary forest reserve with the biodiversity of other reserves and with other areas that may be more secondary or have become deteriorated and deforested. It could provide insight into how Chocó cloud forest may change with more deforestation occurring in Ecuador and other neotropical countries.

Transect Comparisons

The Bamboo transect was more diverse than the Laguna transect in all diversity measures other than species richness. The space web guild (Theridiidae, Pholcidae) was much more abundant in the Laguna transect than the Bamboo transect. The orb web guild (Araneidae, Tetragnathidae, Uloboridae, Synotaxidae) was more abundant in the Bamboo transect than the Laguna. The Bamboo transect also had the highest number of web-less hunters (Ctenidae, Clubionidae, Anyphaenidae, and Thomisidae).

This difference in diversity is likely because of the mild disturbance in the form of mild-intensity land use for a bamboo plantation. Mild intensity land use tends to increase diversity (Teodoro, Muñoz, Tscharntke, Klein, & Tylianakis, 2011). This is also supported by the intermediate-disturbance hypothesis which states that an intermediate level of disturbance results in higher diversity than too little or too frequent/more intense disturbance. Because spiders, as predators that are sensitive to the environment, are often used as bioindicators of the arthropod community at large, this possibly could also indicate that a similar diversity affect is occurring to the arthropod community in this area. More research would need be done on this to know if spider diversity can be used as an indicator of that. Even though the biodiversity may not represent pristine forest, it represents a mild disturbance in a very small localized area of the reserve like what can happen with small mild landslides, storms, or fires (Geertsema & Pojar, 2007). In areas where forms of agriculture and ranching are present, there can be distinct communities (Teodoro et al., 2011). All of which contribute to the overall biodiversity of that area.

The higher abundance of Araneidae and other orb weavers as well as the web-less hunters could be caused by the presence of different vegetation in this area as well. Vegetation complexity has been found to be a strong way to predict the richness of Araneidae, Thomisidae, and possibly also Clubionidae in a region (Jiménez-Valverde & Lobo, 2007). Herbaceous vegetation also is the main factor for the diversity of spiders with webs (Jiménez-Valverde & Lobo, 2007). This is related to the need for these spiders to have areas to attach their webs, and the need for web-less spiders have areas to hunt/ambush their prey, and it is related to the presence of prey in the area. This provides evidence that the vegetation is more complex in the Bamboo transect because that is what is needed for these families and guilds to thrive. This may be because the disturbance in the area was mild allowing for more complex vegetation to exist there. If vegetation cover is preserved in areas of more intensive habitat pressure such as grazing or cutting down areas, the diversity of arboreal spiders can still be somewhat preserved as long as the level of intensity of disturbance can be managed (Jiménez-Valverde & Lobo, 2007).

Additionally, vegetation structure is more important than size of habitat for Araneidae (Amaral Nogueira & Pinto-da-Rocha, 2016). All orb weavers are considered to be resilient because they are generalist predators like many other spiders which allows them to be more resilient to habitat fragmentation despite being predators (Amaral Nogueira & Pinto-da-Rocha, 2016). Linyphiidae, Araneidae, and Thomisidae are also the most numerous families of ballooning spiders (Jiménez-Valverde & Lobo, 2007). They are able to disperse long distances which also increases their resilience to habitat fragmentation. La Hesperia like many other reserves could, in time, become forest fragments if the habitats around these reserves destroyed. These large fragments are important at preventing diversity reductions, and they support rich and diverse spider communities (Amaral Nogueira & Pinto-da-Rocha, 2016). However, it is important to preserve and research more about the biodiversity in these reserves to understand how forest fragmentation will affect the less resilient species and the prey to the resilient species.

Diversity of arboreal spiders was also found to be correlated with vegetation height while terrestrial spider diversity is correlated to leaf litter depth (Green, 1999). The canopy cover and leaf litter are significantly lower in the Bamboo transect while the other transects showed no significant difference. While canopy cover is not vegetation height, there is not a correlation in this study like is shown in the study by Green. There is high diversity of spiders including the orb web guild and the terrestrial hunters which are mostly included in the other hunter guild. It is likely that because of incomplete sampling of the terrestrial spiders that they would actually be more diverse than what this study found.

The High transect, at an elevation of 1501m, had the lowest diversity compared to the Low (1200.7m) and the Laguna transect (1371.3m) which were not distinguished as one being significantly more diverse than the other. Although, the Low transect is on average more diverse. The guild composition between these three transects is fairly similar. The main differences are that the High transect has the most spiders that spin webs, and the lowest number of other hunters, most of which are terrestrial or sub-terrestrial hunters. The High transect had no specialist or ambush hunters.

The High transect also had the highest number of Theridiidae individuals. This is not a very diverse family in this study. The majority of this family in this study consisted of 2 morphospecies in the Theridion genus (**Appendix 5A**). These are subsocial spiders. When they are born they share the same web and natal nest as their siblings, and they hunt together. In their adult life, they have their own web. Mothers do not share nests and do not communally care for egg sacs and offspring.

Subsocial spiders tend to be found at these higher elevations while other related social spiders are found at lower elevations (Purcell, 2011; Purcell & Avilés, 2007). For example, subsocial spiders in Anelosimus (another genus of Theridiidae) are found at higher elevations while social Anelosimus are found at lower elevations and lower latitudes (Purcell & Avilés, 2007). It has been hypothesized that subsocial spiders are more common at a higher altitudinal range while fully social spiders tend to reside at lower elevations because subsocial spiders are much less able to live in lowland rainforests due to higher predation, more intense precipitation, and larger prey size (Guevara & Avilés, 2015b, 2015a; Purcell, 2011). This is because maternal death is more common at lower altitudes due to more predation, so more females in a nest to care for eggs is beneficial (Guevara & Avilés, 2015a; Purcell, 2011). Single female nests tend to fail more often because of the heavier rainfall at lower elevations in the tropics (Guevara & Avilés, 2015a; Purcell, 2011). It takes less energy when all females are creating the silk-intensive nests, and they are more easily able to guarantee replacing themselves by having many daughters. Subsocial spiders tend to have more solitary females and smaller nest sizes.

As was mentioned previously, the primary error of the methodology presented in this paper is the incomplete sampling of terrestrial species. Some combination of leaf litter sifting, stratified litter-grab technique, and pitfall traps checked frequently to avoid flooding would allow for the characterization of ground-dwelling spiders. There was also no preservation in alcohol and microscope used in this study which would allow for more certain identification on certain microscopic diagnostic characteristics of spiders such as genitalia (Amaral Nogueira & Pinto-da-Rocha, 2016). Only spiders 1mm and larger were recorded as data due to the inability to identify anything smaller with the equipment outlined in the methodology of this paper.

This study was unable to analyze the effects of landslides on spider diversity. However, this could be studied with effective methods to measure terrestrial spider diversity around landslides. The use of pitfall traps and litter sifting would help increase the completeness of the terrestrial spider sample. Other forms of land use should be researched in relation to spiders as bioindicators of arthropod community composition.

Future studies should continue to fill the gap of knowledge of spiders in the Ecuadorian Chocó in order to understand how biodiverse this area is before the overall biodiversity falls, and to establish spider bioindicators in order to measure the changes that happen to this endangered ecosystem that is also a biodiversity hotspot.

Bibliography

Amaral Nogueira, A. do, & Pinto-da-Rocha, R. (2016). The effects of habitat size and quality on the orb-weaving spider guild (Arachnida: Araneae) in an Atlantic Forest fragmented landscape. *Journal of Arachnology*, *44*(1), 36–45. https://doi.org/10.1636/P15-19.1

Avilés, L., Agnarsson, I., Salazar, P. A., Purcell, J., Iturralde, G., Yip, E. C., … Bukowski, T. C. (2007). Altitudinal Patterns of Spider Sociality and the Biology of a New Midelevation Social Anelosimus Species in Ecuador. *The American Naturalist*, *170*(5), 783–792. https://doi.org/10.1086/521965

Bultman, T. L., & Uetz, G. W. (1982). Abundance and community structure of forest floor spiders following litter manipulation. *Oecologia*, *55*(1), 34–41. https://doi.org/10.1007/BF00386715

Cardoso, P., Pekár, S., Jocqué, R., & Coddington, J. A. (2011). Global patterns of guild composition and functional diversity of spiders. *PLoS ONE*, *6*(6). https://doi.org/10.1371/journal.pone.0021710

Chao, A., Ma, K. H., & Hsieh, T. C. (2016). iNEXT (iNterpolation and EXTrapolation) Online. Retrieved May 10, 2018, from http://chao.stat.nthu.edu.tw/wordpress/software_download/

Conservation International. (2005). Ecosystem Profile: Chocó-Manabí Conservation Corridor: Colombia and Ecuador. Retrieved May 6, 2018, from https://www.cepf.net/sites/default/files/final.choco-darien-westernecuador.choco_.ep_.pdf

Dirnböck, T., Essl, F., & Rabitsch, W. (2011). Disproportional risk for habitat loss of high-altitude endemic species under climate change. *Global Change Biology*, *17*, 990–996. https://doi.org/10.1111/j.1365-2486.2010.02266.x

Dupérré, N. (2013). Araneae of Ecuador: 43 Families, 709 Species. Retrieved May 6, 2018, from http://aracnidos.otonga.org/CSS/Araneae.html

Dupérré, N. (2015). Description of a new genus and thirteen new species of Ctenidae (Araneae, Ctenidae) from the Chocó region of Ecuador. *Zootaxa*, *4028*(4), 451–484. https://doi.org/10.11646/zootaxa.4028.4.1

Dupérré, N., & Tapia, E. (2016). Overview of the Anyphaenids (Araneae, Anyphaeninae, Anyphaenidae) spider fauna from the Chocó forest of Ecuador, with the description of thirteen new species. *European Journal of Taxonomy*, *255*, 1–50. https://doi.org/10.5852/ejt.2016.255

Dupérré, N., & Tapia, E. (2017a). On some minuscule spiders (Araneae: Theridiosomatidae, Symphytognathidae) from the Chocó region of Ecuador with the description of ten new species. *Zootaxa*, *4341*(3), 375–399. https://doi.org/10.11646/zootaxa.4341.3.3

Dupérré, N., & Tapia, E. (2017b). The goblin spiders (Araneae , Oonopidae) of the OTONGA Nature Reserve in Ecuador , with the description of seven new species. *Evolutionary Systematics*, (1), 87–109. https://doi.org/10.3897/evolsyst.1.14969

Geertsema, M., & Pojar, J. J. (2007). Influence of landslides on biophysical diversity - A perspective from British Columbia. *Geomorphology*, *89*, 55–69. https://doi.org/10.1016/j.geomorph.2006.07.019

Green, J. (1999). Sampling Method and Time Determines Composition of Spider Collections. *Journal of Arachnology*, *27*, 176–182. https://doi.org/10.2307/3705982

Guevara, J., & Avilés, L. (2015a). Ecological predictors of spider sociality in the Americas. *Global Ecology and Biogeography*, *24*, 1181–1191. https://doi.org/10.1111/geb.12342

Guevara, J., & Avilés, L. (2015b). MULTIPLE TECHNIQUES CONFIRM ELEVATIONAL DIFFERENCES IN INSECT SIZE THAT MAY INFLUENCE SPIDER SOCIALITY.

Ecology, *88*(8), 2015–2023.

Huber, B. A. (2000). New World Pholcid Spiders (Araneae: Pholcidae): a Revision At Generic Level. *Bulletin of the American Museum of Natural History*, *254*(1), 1. https://doi.org/10.1206/0003-0090(2000)254<0001:NWPSAP>2.0.CO;2

Jiménez-Valverde, A., & Lobo, J. M. (2007). Determinants of local spider (Araneidae and Thomisidae) species richness on a regional scale: Climate and altitude vs. habitat structure. *Ecological Entomology*, *32*(1), 113–122. https://doi.org/10.1111/j.1365-2311.2006.00848.x

Jocque, R., & Dippenaar-Schoeman, A. S. (2007). *Spider Families of the World* (2nd ed.). Tervuren, Belgium: Royal Museum for Central Africa.

Kuntner, M., Năpăruş, M., Li, D., & Coddington, J. A. (2014). Phylogeny Predicts Future Habitat Shifts Due to Climate Change. *PLoS ONE*, *9*(6), e98907. https://doi.org/10.1371/journal.pone.0098907

La Hesperia: Biological Station. (2008). Retrieved May 4, 2018, from http://www.lahesperia.com/

Moore, M. (2015). Spiders of the Cloud Forest: A Census of Spiders in the Río Zuñac Cloud Forest Reserve. *Ecuador: Comparative Ecology and Conservation, SIT Study Abroad*.

Newbold, T., Hudson, L. N., Hill, S. L. L., Contu, S., Lysenko, I., Senior, R. A., … Purvis, A. (2015). Global effects of land use on local terrestrial diversity. *Nature*, *520*, 45–69.

Purcell, J. (2011). Geographic patterns in the distribution of social systems in terrestrial arthropods. *Biological Reviews*, *86,* 475–491. https://doi.org/10.1111/j.1469-185X.2010.00156.x

Purcell, J., & Avilés, L. (2007). Smaller colonies and more solitary living mark higher elevation populations of a social spider. *Journal of Animal Ecology*, *76*, 590–597. https://doi.org/10.1111/j.1365-2656.2007.01228.x

Schmitz, O. J., & Suttle, K. B. (2001). Effects of Top Predator Species on Direct and Indirect Interactions in a Food Web. *Ecology, 82*(7), 2072–2081.

Teodoro, A. V, Muñoz, A., Tscharntke, T., Klein, A., & Tylianakis, J. M. (2011). Early succession arthropod community changes on experimental passion fruit plant patches along a land-use gradient in Ecuador. *Agriculture, Ecosystems and Environment*, *140*, 14–19. https://doi.org/10.1016/j.agee.2010.11.006

Wagner, J. D., Toft, S., & Wise, D. H. (2003). SPATIAL STRATIFICATION IN LITTER DEPTH BY FOREST-FLOOR SPIDERS. *The Journal of Arachnology*, *31*, 28–39.

Wegner, G. S. (2011). Spider Identification Guide. BASF Corporation.

World Spider Catalog. (2018). World Spider Catalog. https://doi.org/10.24436/2

Appendix A

Appendix 1A. Bamboo transect at 150m mark looking toward 125m mark. This was the most open area of the transect right towards the end of the transect.

Family name	**Common name (Jocque & Dippenaar-Schoeman, 2007)**
Theridiidae	Cob Web Spiders, Gumfoot Web Spiders
Araneidae	Orb Weavers
Ctenidae	Wandering Spiders (or Tropical Wolf Spiders)
Pholcidae	Cellar Spiders
Anyphaenidae	Ghost Spiders, Tube Spiders
Tetragnathidae	Long-jawed Orb Weavers
Clubionidae	Sac Spiders
Linyphiidae	Hammock-web Spiders/Dwarf Spider
Uloboridae	Cribellate Orb Weavers or Hackled Orb Weavers
Synotaxidae	Chicken-wire-web Spider
Pisauridae	Nursery Web Spiders/Fish-eating Spider
Mimetidae	Pirate Spider
Thomisidae	Crab Spider
Saltidiae	Jumping Spider
Scytodidae	Spitting Spider
Trachelidae	Ground Sac Spider

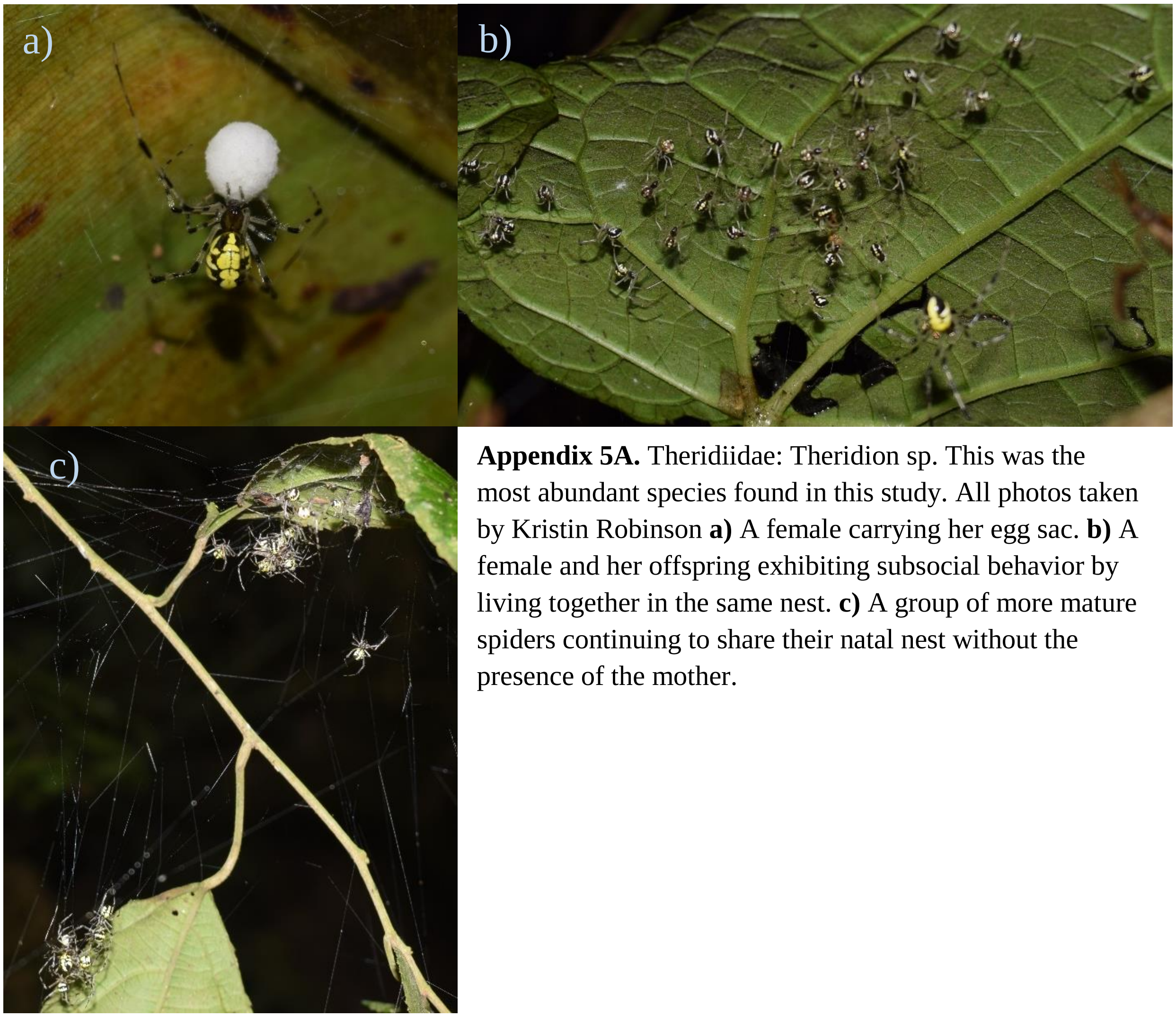
Appendix 2A. Common names of spider families in this study.

Sample size	Order of q	Estimated diversity	Estimated sample coverage	0.95 confidence interval diversity upper limit	0.95 confidence interval diversity lower limit	0.95 confidence interval coverage upper limit	0.95 confidence interval coverage lower limit
1318	0	188.0	0.92	205.95	170.05	0.93	0.91
1318	1	40.33	0.92	44.84	35.83	0.94	0.91
1318	2	13.73	0.92	15.68	11.79	0.94	0.91

Appendix 3A. Overall observed diversity.

Transect	n	Order of q	Estimated diversity	Estimated sample coverage	0.95 confidence interval diversity upper limit	0.95 confidence interval diversity lower limit	0.95 confidence interval coverage upper limit	0.95 confidence interval coverage lower limit
Low	292	0	84.00	0.83	94.47	73.53	0.86	0.79
Low	292	1	32.71	0.83	38.21	27.20	0.86	0.79
Low	292	2	14.05	0.83	17.31	10.79	0.87	0.79
Bamboo	249	0	73.00	0.86	82.16	63.84	0.90	0.82
Bamboo	249	1	40.52	0.86	46.92	34.13	0.89	0.82
Bamboo	249	2	24.75	0.86	29.14	20.36	0.90	0.82
Laguna	424	0	84.00	0.90	95.35	72.65	0.93	0.88
Laguna	424	1	26.92	0.90	30.16	23.68	0.93	0.88
Laguna	424	2	11.65	0.90	13.62	9.68	0.92	0.88
High	353	0	65.00	0.90	75.25	54.75	0.92	0.87
High	353	1	17.40	0.90	20.18	14.63	0.92	0.87
High	353	2	7.27	0.90	8.77	5.78	0.93	0.87

Appendix 4A. Observed diversity for each transect. n=sample size.



Appendix 5A. Theridiidae: Theridion sp. This was the most abundant species found in this study. All photos taken by Kristin Robinson **a)** A female carrying her egg sac. **b)** A female and her offspring exhibiting subsocial behavior by living together in the same nest. **c)** A group of more mature spiders continuing to share their natal nest without the presence of the mother.

Appendix B: Raw Data

Low Transect

Theridiidae	Argyrodes (6 msp., n= 48)	Theridion (4 msp., n= 79)				127
Araneidae	Araneus (16 msp., n=27)	Cyclosa (1 msp., n=2)	Eriophora (3 msp., n=8)	Mangora (11 msp., n=33)	Micrathena (7 msp., n=14)	84
Ctenidae	Ctenus (1 msp., n=8)	Cupiennius (4 msp., n=10)	Enoploctenus (1 msp., n=1)			19
Pholcidae	Pholcus (4 msp., n=19)	Spermophora (1 msp., n=1)				20
Anyphaenidae	Hibana (2 msp., n=7)					7
Linyphiidae	Erigone (1 msp., n=1)	Frontinella (3 msp., n=6)	Pityohyphantes (2 msp., n=2)			9
Tetragnathidae	Leucauge (3 msp., n=3)					3
Clubionidae	Clubiona (3 msp., n=4)					4
Uloboridae	Miagrammopes (1 msp., n=2)	Uloborus (4 msp., n=13)				15
Scytodidae	Scytodes (1 msp., n=1)					1
Thomisidae	Epicadus (1 msp., n=1)					1
Salticidae	unknown (1 msp., n=1)					1
Trachelidae	Trachelas (1 msp., n=1)					1
Total						292

Bamboo Transect

Theridiidae	Argyrodes (3 msp., n=38)	Theridion (3 msp., n=27)	unknown (1 msp., n=1)				66
Araneidae	Alpaida (1 msp., n=3)	Araneus (13 msp., n=20)	Eriophora (4 msp., n=7)	Mangora (8 msp., n=18)	Micrathena (7 msp., n=36)	Verrucosa (4 msp., n=7)	91
Ctenidae	Ctenus (2 msp., n=5)	Cupiennius (6 msp., n=22)					27
Anyphaenidae	Hibana (5 msp., n=19)						19
Linyphiidae	Frontinella (1 msp., n=1)	Pityohyphantes (2 msp., n=3)					4
Tetragnathidae	Leucauge (3 msp., n=25)						25
Clubionidae	Clubiona (4 msp., n=10)						10
Uloboridae	Miagrammopes (1 msp., n=1)						1
Thomisidae	unknown (1 msp., n=1)						1
Synotaxidae	Synotaxus (3 msp., n=3)						3
unknown	unknown (2 msp., n=2)						2
Total							249

Laguna Transect

Theridiidae	Argyrodes (7 msp., n=50)	Theridion (9 msp., n=164)							214
Araneidae	Alpaida (1 msp., n=2)	Araneus (12 msp., n=23)	Cyclosa (1 msp., n=1)	Eriophora (2 msp., n=5)	Mangora (7 msp., n=12)	Micrathena (7 msp., n=18	Verrucosa (1 msp., n=1)	unknown (1 msp., n=1)	63
Ctenidae	Ctenus (3 msp., n=11)	Cupiennius (7 msp., n=23)							34
Pholcidae	Pholcus (5 msp., n=46)								46
Anyphaenidae	Hibana (6 msp., n=27)	unknown (1 msp., n=3)							30
Linyphiidae	Frontinella (3 msp., n=4)	Neriene (1 msp., n=1)	Pityohyphantes (1 msp., n=1)						6
Tetragnathidae	Leucauge (3 msp., n=21)								21
Clubionidae	Clubiona (2 msp., n=3)								3
Pisauridae	Dolomedes (1 msp., n=3)								3
Mimetidae	Ero (1 msp., n=2)								2
unknown	unknown (2 msp. n=2)								2
Total									424

High Transect

Theridiidae	Argyrodes (6 msp., n=43)	Theridion (9 msp., n=174					217
Araneidae	Araneus (7 msp., n=12)	Cyclosa (1 msp., n=1)	Eriophora (1 msp., n=15)	Mangora (2 msp., n=3)	Micrathena (6 msp., n=51)	Verrucosa (2 msp., n=2)	84
Ctenidae	Cupiennius (5 msp., n=7)						7
Pholcidae	Pholcus (2 msp., n=3						3
Anyphaenidae	Hibana (4 msp., n=9)						9
Linyphiidae	Frontinella (3 msp., n=4)	Pityohyphantes (3 msp., n=5)					9
Tetragnathidae	Leucauge (3 msp., n=6)						6
Clubionidae	Clubiona (6 msp., n=10)						10
Uloboridae	Uloborus (4 msp., n=6)						6
Synotaxidae	Synotaxus (1 msp., n=1)						1
unknown	unknown (1 msp., n=1)						1
Total							353