Spring 5-11-2012

The Identification of Arachnid Species in the Cockscomb Basin Wildlife Sanctuary

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THE IDENTIFICATION OF ARACHNID SPECIES IN THE COCKSCOMB BASIN WILDLIFE SANCTUARY

by

Lauren Kathryne Auer

A Thesis

Submitted to the Honors College of
The University of Southern Mississippi
in Partial Fulfillment
of the Requirements for the Degree of
Bachelor of Science
in the Department of Biological Sciences

May 2012
Approved by

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Abstract

Despite the known diversity of arachnids in neotropical ecozones there has been little considerable movement towards creating a collective means for identification of arachnids in Belize. Previous studies on ecotourism indicate positive trends between biodiversity education and conservation concern. This study was conducted to engage in a field-based study of arachnids in the Cockscomb Basin Wildlife Sanctuary to determine the most frequently encountered arachnid species. For this study, four separate locations were surveyed within the Sanctuary: three trail sites and the main camp area. Each site was surveyed during two alternate time periods to account for diurnal and nocturnal species. While surveying the site, arachnids were visually identified along with microhabitat description to observe any habitat preference. Specimens were collected for subsequent identification and validation of the visual identifications performed on site. The preliminary data suggest that the most frequently encountered arachnids collectively among the surveyed sites included members of Araneae families: *Theraphosidae, Lycosidae, Salticidae,* and *Hersilidae.* In addition, species of the orders Scorpiones and Amblypygi were frequently encountered. The data will be incorporated to create a user friendly identification resource for the native guides and future visitors to the sanctuary. By creating and providing this resource to the Cockscomb Sanctuary it will contribute to the greater scope of environmental education by achieving increased awareness of the area’s biodiversity.

**Keywords:** arachnids, Belize, Cockscomb Basin Wildlife Sanctuary, identification
THE IDENTIFICATION OF ARACHNID SPECIES IN THE COCKSCOMB BASIN WILDLIFE SANCTUARY

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Chapter 1  Problem Statement

Ecozone, is a biogeographical term that has conservation implications; there are eight biogeographical ecozones developed by the World Wildlife Federation, each categorized by the collective distribution patterns of evolutionarily similar animal and plant species. The neotropical ecozone contains some of the greatest species richness of flora and fauna of any ecosystem on planet Earth. The neotropical ecozone extends upward from South America through Central America and into Mexico and the Caribbean Islands (Olsen, et. al., 2001). Arthropods account for a considerable portion of this richness, yet scientists estimate that they have identified less than 20% of the arthropod species that dwell in the tropical ecosystems (Godfray, Lewis, & Memmott, 1999). Although not the most species rich class of arthropods, Arachnids are broken down into eleven orders with the more commonly known Araneae order (spiders) having greater than 40,000 described species in the tropics (Platnick, 2008).

Despite the diversity of arachnids in the neotropic ecozone there has been no considerable movement towards creating a collective means for identification of arachnids in Belize. Belize is located in the upper part of Central America sharing a border with Guatemala and the Caribbean Sea as illustrated in Figure 1.
On a previous trip to the region in May of 2010 for a class in Tropical Ecology with Dr. Aimée Thomas our group was unable to easily identify encountered arachnid species because of the lack of previous research efforts in population studies of arachnids within Belize. One resource that was available was Steven Reichling’s *Tarantulas of Belize* (2003), which is an overview of tarantula species in Belize, but does not include any other arachnids in its scope. The lack of a comprehensive resource for easy identification indicated that there was a gap in this area of knowledge. The aim of this project was to conduct a field based study of arachnids in the Cockscomb Basin Wildlife Sanctuary and to incorporate the data to create a user friendly identification resource for the native guides and future visitors to the sanctuary. By creating and providing this resource to the Cockscomb Sanctuary, this project contributes to the greater scope of environmental education by achieving increased awareness of the area’s biodiversity. Although the Cockscomb Sanctuary is a federally established and protected preserve, studies have shown that the direct threat to tropical rainforest land in Central America is development encroachment of the local residents and commercial interests. Conversely, in Davies and Cahill’s
book *Environmental Implications of the Tourism Industry* (2000), they reference several studies that indicate the positive correlation between environmental education and preservation of ecosystems through tourism.

A pivotal component of this research project was to incorporate the data into a resource that is serviceable to the target audience. As much as it would enhance the overall final product; a high gloss, multipage identification guide is not financially reasonable. Also, for this research project to be successful, the comprehensive skills of the intended audience were taken into account. Generally, the visitors to the Cockscomb Wildlife Sanctuary are not well versed in arachnids, nor are they likely to consult a cumbersome guide including the rarest and most obscure arachnids in the region. Both guides and visitors alike will want to familiarize themselves with species that they will most likely encounter while in the sanctuary. With this in mind, when condensing the field data into the identification guide, the scope of the research was narrowed into finding the most frequently encountered species of arachnids found in the Cockscomb Basin Wildlife Sanctuary.
Chapter 2  Influential Literature

This research study involves a significant amount of field work and before addressing the central focus of the study one should be familiar with the surrounding environment of the field sites. The World Wildlife Federation categorizes and defines the earth into eight ecoregions or ecozones (Olsen et al., 2001). The collaboration organized the ecoregions through the cumulative distribution of organisms that appear to have evolved in a similar manner. Additionally, the study initiated by Godfray, Lewis and Memmott (1999) provided useful background information into the biogeography that shapes the region and site that my research project was conducted. Godfray, Lewis and Memmott (1999) examined the causes into the extent of arthropod diversity in the tropical ecozones in comparison to Charles Darwin’s estimate of the diversity in the tropics based on his findings from field studies done in the region. In this study’s methodology it explains how they were able to establish a species inventory using low technological methods in which the field conditions were similar to those in the Cockscomb Basin Wildlife Sanctuary.

Norman Platnick, an authority on arachnids, in collaboration with others, created the World Spider Database, which is an extensive catalog of the taxonomic information of spider species throughout the globe. Since specimens collected in this study needed to be identified, this database was a key component of this research project. The database provided extensive taxonomic information for each species and also included detailed descriptions of the genera within each family. Also included within the database is a brief description of the genera’s geographical range. When collecting field data for this research project, The World Spider Catalog was critical in authenticating the taxonomic information of found species (Platnick, 2008). Another, resource that was necessary to complete preliminary identifications was
Tarantulas of Belize by Steven Reichling (2003). In his book, Reichling provides thorough examination of the nine tarantula species that can be found in Belize. For each species Reichling aptly distinguishes the morphology and distinguishing characteristics of each species as well as the prevalence and geographical distribution of each tarantula. This work was the primary reference for the identification of tarantula species while conducting the field work for this study. Reichling’s work is very comprehensive and the provision of color photographs aided in identification. Reichling’s work was also the only resource that examined arachnids within Belize specifically; however, its scope is narrowed to only tarantula species (Reichling, 2003). For arachnid specimens of the Araneae order that are not tarantulas, identification was accomplished primarily through the use of Spiders of North America: An Identification Manual (Ubick, Paquin, Cushing, & Roth 2005). This work by Ubick et al. (2005) is a dichotomous key manual to identify members of the Araneae order. This work was exceptionally useful in identifying the collected specimens down to Family and often genera (Ubick et al., 2005).

In order to analyze collected specimens from the Order Scorpiones, Walter Reed Biosystematics Unit (WRBU) provided a computerized dichotomous key for the identification of North American scorpions. The WRBU is a national organization to conduct systematic research on medically significant arthropods. The identification resource was constructed by Dr. Scott A. Stockwell (Stockwell, 2010).

In Davies and Cahill’s work “Environmental implications of the tourism industry” (2000), they discuss positive and negative aspects that the tourism industry generates across multiple environmental targets. In the researchers’ section on education, they addressed the potential benefits of ecotourism to raise revenue for protected areas. Tour guides and operators play a considerable role in educating visitors of their impact on the environment. One method
that Davies and Cahill identify to extend this message of minimizing negative environmental impact and conservation to visitors is for the guides or operators to provide individuals with information packets on the history of the site or information regarding the local flora and fauna (Davies & Cahill, 2000). In a study done in 2003 on the impact of ecotourist on Howler Monkey populations at an archeological reserve in Belize, the researchers propose that an increase in environmental education and conservation might encourage ecotourists to become aware of the importance of ecological conservation and maintaining biodiversity (Grossberg, Treves & Naughton-Treves, 2003). These studies give reasonable justification for the beneficial effects of this research project which is to create awareness for the biodiversity of arachnids in the Cockscomb Wildlife Sanctuary, which is a major environmental attraction for tourism in Belize.

Similar to Davies and Cahill’s work, James D. Nation’s book, The Maya Tropical Forest: People, Parks and Ancient Cities, (2006), analyzes the impact that the native Maya of Belize and Guatemala have on the preservation of their tropical ecosystem. One of the main points addressed in this work was how increasing the awareness of biodiversity and conservation can be achieved through the Maya people on multiple levels. Conservation of the tropical forests provides not only land management positions, but for Central America is a large commercial draw for tourism; which in turn provides economical stimulation to the region. Also, the education of future generations generates awareness of the regions unique biodiversity and the importance of environmental preservation.
Chapter 3 Methodology

The goal of this project was to determine the most frequently encountered species of arachnids for visitors in the Cockscomb Basin Wildlife Sanctuary (CBWS). On May 14th, 2011 Dr. Aimée Thomas and I traveled to the CBWS (16° 46’29”N 88° 27’21”W) for eight days to survey and collect representative specimens of arachnids at determined study sites. The Cockscomb Basin Wildlife Sanctuary is located in the southern part of Belize in the Maya Mountain Range. The CBWS was established as a Jaguar Preserve in 1986 and encompasses approximately one hundred and fifty square miles of tropical rainforest (Belize National Parks, 2012). The CBWS has a rich diversity of flora and fauna and provides visitors the opportunity to observe the organisms in a natural setting. Figure 2 shows a map of Belize with the CBWS colored in red.

Figure 2. Map of Belize with the Cockscomb Basin Wildlife Sanctuary in red. (Travel Belize, 2010)
Study Sites

The study sites were determined in conjunction with a fellow undergraduate researcher conducting a separate study. Additionally, these sites were selected because they are highly traversed by visitors to the CBWS. The three hiking trails serve as branching points to many additional trails. Three hiking trails were chosen in addition to the Visitors’ Information Center and main camp grounds. The three trails used were: Tiger Fern Trail, Ben’s Bluff Trail, and the Gibnut Loop; part of the Green Knowledge Trail. These trails can be seen on a trail map for the Cockscomb Basin in Figure 3.

Figure 3. Trail map of the Cockscomb Basin Wildlife Sanctuary. (Belize National Parks, 2012)
Each study site was surveyed twice during the research period: once in the morning and once at
night. The order in which the sites were surveyed was determined by random selection. For each
of the three trail sites, a section of the trail path was observed for approximately one and half
hours. For the Information Center and main campgrounds, the lawn and area immediately
surrounding the buildings was surveyed.

Gibnut Loop Trail Site (16.786°N, 88.456°W)

The Gibnut Loop site is part of a larger trail body known as the Green Knowledge Trail. The
surveyed trail section had a narrow trail path with varying terrain levels. The leaf litter to
either side of the trail path was exceptionally dense. The trees were not particularly large in girth
and mostly consisted of palm species. The grass cover for both the trail path and sides was
minimal. At the beginning of the surveyed section the trail path ran parallel to a stream. The
stream had a steep bank with a broad stream bed, shallow water levels and was fairly stagnant.
After decline to the stream bed the main trail body made a steep incline. Midway down the
surveyed trail path there was a steep-banked ditch spanned by a log bridge. Insect presence was
noticeably plentiful.

Ben’s Bluff Trail Site (16.777°N, 88.458°W)

The Ben’s Bluff Trail diverged from the River Path Trail and subsequently forked from
the Curassow Trail. The surveyed trail section began after the bridge crossing and continued
along the trail path. The waterway at the origin point of the surveyed section was a broad, deep
stream that, according to trail maps, was a branch of the South Stann Creek River. The bridge
was wood planked with cement pillars. Along the edges to either side of the bridge there was a
cement wall bank extending down into the water. The shallower stream areas had noticeable
plant life. Small fish were observed and the insect life was significant. The surveyed trail path was broad with a dirt base and ample leaf litter scattered directly on the path. The undergrowth of either side of the trail path had dense live vine and other vegetative cover. Palm trees and fern species largely composed the flora for the surveyed area. Fallen limbs and palm fronds were observed on both sides of the trail path. The overall elevation of the path trended gradually upwards.

Tiger Fern Trail Site (16.732°N, 88.453°W)

The Tiger Fern Trail directly branched off from the main access road. The surveyed trail area initiated after the first water crossing and continued up the trail path. The stream was shallow with strong-flowing water movement and traversed by non-connecting stone squares. The trail rose steeply from the stream crossing and continued overall to make a gradual incline. The trail floor was dirt with minimal leaf litter directly on the path. The canopy was densely packed with large-girthed trees as well as palm species. Felled limbs and exposed root balls occurred on both sides of the surveyed trail path. The undergrowth on either side of the trail path was primarily composed of leaf litter, but medium-sized vegetation was observed on both sides of the surveyed trail path.

Information Center and Main Camp Site

The Information Center and Main Camp site was situated in a cleared area to the right of the main access road. The surveyed area consisted of nine buildings positioned in a landscaped clearing. The vegetation immediately surrounding the Information Center and Camp site was dense, cut grass as well as some planted trees. The surveyed area was transected with brick
pathways leading between buildings. The Information Center and Camp site served as a central launch point for many trail paths as well as lodging for overnight visitors to the Sanctuary.

**Survey Methods**

During the observation period, Dr. Thomas and I walked along the pathway scanning the trails’ substrate, tree trunks and vegetation for arachnid species. A start time was recorded and observation continued for approximately an hour and half. While walking, no extraneous movements were made to deviate from the trail way, disturb fallen limbs, or act atypical from the manner of a general hiker. The surveyed trail area was distinguished by using natural land markers so that the survey area was consistent between the morning and evening observations. Arachnids observed were sight identified and a tally method was employed to keep track of the frequency of encounter. Also noted was the trending environmental location for each arachnid family. For the evening observation periods it was necessary to employ the use of a headlamp.

**Collection Methods**

Prior to traveling to the Cockscomb Basin Wildlife Sanctuary to begin our collection of arachnids, my advisor and I applied for a collection and transportation permit (Appendix A) in order to collect arachnids in the Sanctuary and then to transport our specimens back into the United States. During the observation periods for each surveyed site, representative specimens of those observed in the field were collected for further identification and to serve as voucher specimens. I used two main methods of collection to collect and preserve the arachnid specimens in the field. The first technique employed was a sweep net as seen in Figure 4 below:
Arachnids that were collected in the sweep net were transferred into a collecting jar and the lid sealed. The sweep net afforded us the ability to collect specimens out of reach as well as those displaying aggressive behavior. The specimens were then transferred from the collecting jar to a jar with a 75% ethanol solution for preservation.

The second and main collection technique used was hand collection. For this method, the specimens were captured by hand and encouraged by hand or funneled by paper into a dry collection jar. The 75% ethanol solution was then added to the dry collection jar to preserve the specimen.

Initially, one of the collection methods to be used was a pitfall trap, as illustrated in figure 5.
Figure 5. Pitfall trap illustration. (Illinois Natural History Survey, 2011)

Pitfall traps are ideal for collecting wandering spider species as well as tarantulas. According to Steven Reichling’s *Tarantulas of Belize* (2003), several species of tarantula are known to inhabit the area. Pitfall traps are simple in construction, and are created by taking a two liter soda bottle and cutting off the top portion with the lid still intact. With the lid facing down to create a funnel, the lid portion is filled with the ethanol preservative. The entire trap is buried so that the opening of the funnel is at ground level. (Ubick et. al., 2005). However, due to park regulations that restricted digging, we were not able to construct pitfall traps for this study.

Some of our collections took place at night, and it was necessary to employ the use of headlamps to spot the greenish eye shine of arachnids such as wolf spiders. Once the arachnid was spotted, it was then collected by sweep net or encouraged into a collecting jar (Kaston, 1978).

**Data Recording Methods**

Each representative specimen collected was recorded with a unique identification code. The identification code was placed inside the vial with the specimen and included the date of collection, time, and field site. Also, a detailed physical description of the arachnid and its environment was documented. In addition to the collection of voucher specimens, photographs were taken of the arachnids as they were observed in the field site. The camera used was my personal camera, a Nikon D3100 Digital SLR. In the event that my pictures would not develop clearly, I coordinated with Megan Chevis who used her Canon Rebel Ti 1, with macro lens attachment, for field photography.
Identification Methods

Once the voucher specimens were collected, an initial identification of the specimens was made. The specimens were identified using a microscope in conjunction with several identification manuals. For the members of Order Araneae, the identification guide used was *Spiders of North America* by Dr. D. Ubick et al. (2005). For specimens in Order Scorpiones the identification guide used was created by Walter Reed’s Biosystematics Unit, *Key to Genera of North American Scorpiones* (Stockwell, 2010). The tarantula species observed in the field were identified through previous familiarity with the family, as well as, Steven Reichling’s *Tarantulas of Belize* (2003). After preliminary identifications were made, experts in the arachnid families were consulted to verify or amend the preliminary identifications. The American Arachnological Society’s database of publications was essential in locating experts to validate the collected specimens. Dr. Darrell Ubick, from the Department of Entomology at the California Academy of Science was consulted on the specimen preliminarily identified to be in the Araneae Family Hersiliidae. Dr. Ubick confirmed the specimen to be in the Family Hersiliidae and from his familiarity with the genera in the Central American region was able to confirm the genus to *Neotama* (D. Ubick, personal communication, January 28th, 2012). Initially, Dr. Jürgen Gruber, curator of the Entomological Collection at the Naturhistorisches Museum Wien in Vienna, Austria, was consulted for the specimens that were preliminarily identified to be in the Arachnid Order Opiliones, Families Cosmetidae and Phalangiidae. However, Dr. Gruber confessed that he was not familiar with North American Opiliones Families and recommended fellow colleague Dr. James Cokendolpher, from the Department of Invertebrate Zoology at the Museum of Texas Tech University in Lubbock, Texas (J.Gruber, personal communication, January 20th, 2012). Dr. Cokendolpher was able to confirm the Families of the Opiliones, but has not reached an
affirmative conclusion on the respective genera (J.Cokendolpher, personal communication, January 24th 2012). For the Lycosid specimens, Dr. Aimée Thomas recommended Dr. Gail Stratton from the Department of Biology at the University of Mississippi in Oxford, Mississippi. In communications with Dr. Stratton, she agreed to receive the specimens and validate the preliminary identifications. As of communications with Dr. Stratton in February she was still in the process of confirming the preliminary identifications (G.Stratton, personal communication, February 26th, 2012). There was difficulty trying to find an expert for the Amblypigid specimen. Dr. Peter Wyegoldt’s name occurred frequently on journal papers associated with Amblypigids. Dr. Peter Weygoldt is Professor Emeritus at Albert-Ludwigs University in Freiburg, Germany. However, in communication with Dr. Weygoldt he confessed that he was not familiar with Amblypigids in the Belize region and recommended a fellow colleague Dr. Roger Santer (P.Weygoldt, personal communication, January 26th, 2012). Dr. Roger Santer, a junior professor at the University of Limerick in Limerick, Ireland, was consulted and he too confessed that he was not familiar with the Amblypigids in the Belize region. He made recommendations for colleagues that might have some familiarity with the Order, but these individuals were not available for consultation (R. Santer, personal communication, January 18th, 2012). Preliminary identification of the specimens from the Araneae Family Salticidae proved difficult and inconclusive. Dr. G.B. Edwards, curator of the Florida State Collection of Arthropods in Gainesville, Florida, was consulted to assist with the identifications. In communication with Dr. Edwards he discussed how he has been unable to identify the specimens down to the species level and he feels that there is the possibility that the specimen, referred to as the “Sunshine Salticid”, maybe an undescribed species. As of communications with Dr. Edwards in February he had yet to be able to identify the specimens (G.Edwards, personal communications, February
22\textsuperscript{nd}, 2012). The scorpion identification key from Walter Reed’s Biosystematics Unit was able to preliminarily identify the scorpion specimen to the Family Buthidae. Dr. Lorenzo Prendini, Curator of the Division of Invertebrate Zoology at the American Museum of Natural History in New York City, New York, examined the specimen and confirmed it was in the Family Buthidae. He was further able to identify the specimen down to species level. After confirming the identification Dr. Prendini asked if the specimen could remain as part of the AMNH’s Invertebrate collection as they do not have a wide diversity of arachnid specimens from the Central American region (L. Prendini, personal communication, January 25\textsuperscript{th}, 2012).
Chapter 4   Results

Table 1 below details the individual identification results of the specimens collected during the survey period in the Cockscomb Basin Wildlife Sanctuary. Due to the limitations of the identification manual used, some specimens were only identified to genus. Due to national regulations regarding the collection of tarantulas, tarantulas observed during the survey period were photographed and site identified. The identification results of the non-captured arachnids are described in Table 2.

Table 1. Identification results of collected arachnid specimens from the Cockscomb Basin Wildlife Sanctuary, Belize

<table>
<thead>
<tr>
<th>Specimen ID</th>
<th>Order</th>
<th>Family</th>
<th>Genus</th>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS #1</td>
<td>Scorpiones</td>
<td>Buthidae</td>
<td>Centruroides</td>
<td>Centruroides gracilis</td>
</tr>
<tr>
<td>CS #2</td>
<td>Araneae</td>
<td>Lycosidae</td>
<td>Allocosa</td>
<td>Allocosa spp.</td>
</tr>
<tr>
<td>CS #3</td>
<td>Opiliones</td>
<td>Cosmetidae</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TF #1</td>
<td>Araneae</td>
<td>Salticidae</td>
<td>Paradamoetas</td>
<td>Paradamoetas sp.</td>
</tr>
<tr>
<td>TF #2</td>
<td>Araneae</td>
<td>Salticidae</td>
<td>Unknown</td>
<td>sp. 1</td>
</tr>
<tr>
<td>TF #3</td>
<td>Araneae</td>
<td>Lycosidae</td>
<td>Allocosa</td>
<td>Allocosa spp.</td>
</tr>
<tr>
<td>TF #4</td>
<td>Araneae</td>
<td>Lycosidae</td>
<td>Allocosa</td>
<td>Allocosa spp.</td>
</tr>
<tr>
<td>TF #5</td>
<td>Araneae</td>
<td>Pisauridae</td>
<td>Pisaurina</td>
<td>Pisaurina spp.</td>
</tr>
<tr>
<td>TF #6</td>
<td>Amblypigi</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TF #7</td>
<td>Araneae</td>
<td>Hersiliidae</td>
<td>Yabisi</td>
<td>Yabisi spp.</td>
</tr>
<tr>
<td>TF #8</td>
<td>Ixodida</td>
<td>Ixodidae</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TF #9</td>
<td>Araneae</td>
<td>Lycosidae</td>
<td>-Failure to Identify Due to Damage</td>
<td></td>
</tr>
<tr>
<td>BB #1</td>
<td>Araneae</td>
<td>Trechaleidae</td>
<td>Trechalea</td>
<td>Trechalea sp.</td>
</tr>
<tr>
<td>GG #1</td>
<td>Araneae</td>
<td>Ctenidae</td>
<td>Cteninae</td>
<td>Cteninae spp.</td>
</tr>
<tr>
<td>GG #2</td>
<td>Opiliones</td>
<td>Phalangiidae</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2. Identification results of non-collected arachnids from the Cockscomb Basin Wildlife Sanctuary, Belize

<table>
<thead>
<tr>
<th>Non-Capture</th>
<th>Order</th>
<th>Family</th>
<th>Genus</th>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red Rump Tarantula</td>
<td>Araneae</td>
<td>Theraphosida</td>
<td>Brachypelma</td>
<td>Brachypelma vagans</td>
</tr>
</tbody>
</table>
The following data tables (Tables 3 – 6) describe the collection results for each field site including the start and end time for the survey period, as well as the observed frequency of the arachnids encountered during that observation.

Table 3. Identification results for information center and main camp site

<table>
<thead>
<tr>
<th>Camp Site</th>
<th>Arachnid</th>
<th>Observed Frequency</th>
<th>Habitat</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 15th, 2011</td>
<td>Lycosidae</td>
<td>14</td>
<td>Grass</td>
</tr>
<tr>
<td>8:30 am – 10:00 am</td>
<td>Theraphosidae</td>
<td>3</td>
<td>Burrows, Under Crate</td>
</tr>
<tr>
<td></td>
<td>“Red Rumped Tarantula”</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Scorpiones</td>
<td>2</td>
<td>Kitchen &amp; Dorm Rafters</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Camp Site</th>
<th>Arachnid</th>
<th>Observed Frequency</th>
<th>Habitat</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 19th, 2011</td>
<td>Ambypigidi</td>
<td>3</td>
<td>Guest House</td>
</tr>
<tr>
<td>8:00 pm – 9:30 pm</td>
<td>Opiliones (Cosmetidae)</td>
<td>1</td>
<td>Campsite Water Pipe</td>
</tr>
<tr>
<td></td>
<td>Lycosidae</td>
<td>7</td>
<td>Grass, Building Bases</td>
</tr>
<tr>
<td></td>
<td>Scorpiones</td>
<td>1</td>
<td>Rafter Information Center</td>
</tr>
<tr>
<td></td>
<td>Deinopis</td>
<td>1</td>
<td>Fence Railing</td>
</tr>
</tbody>
</table>
Table 4. Identification results of Tiger Fern Trail site

<table>
<thead>
<tr>
<th>Tiger Fern Trail Site</th>
<th>Arachnid</th>
<th>Observed Frequency</th>
<th>Habitat</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 16&lt;sup&gt;th&lt;/sup&gt;, 2010</td>
<td>Salticidae “Sunshine”</td>
<td>49</td>
<td>Leaf Litter, Root Ball, Tree Trunk</td>
</tr>
<tr>
<td></td>
<td>Salticidae “Red &amp; Black”</td>
<td>1</td>
<td>Leaf Litter</td>
</tr>
<tr>
<td></td>
<td>Opiliones (Phalangidae)</td>
<td>1</td>
<td>Tree Base</td>
</tr>
<tr>
<td></td>
<td>Opiliones (Cosmetidae)</td>
<td>1</td>
<td>Tree Base</td>
</tr>
<tr>
<td></td>
<td>Lycosidae “Light Variety”</td>
<td>6</td>
<td>Leaf Litter, Root Ball</td>
</tr>
<tr>
<td></td>
<td>Lycosidae “Dark Variety”</td>
<td>52</td>
<td>Leaf Litter, Tree Trunk</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tiger Fern Trail</th>
<th>Arachnid</th>
<th>Observed Frequency</th>
<th>Habitat</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 16&lt;sup&gt;th&lt;/sup&gt;, 2011</td>
<td>Lycosidae “Dark Variety”</td>
<td>63</td>
<td>Leaf Litter</td>
</tr>
<tr>
<td></td>
<td>Lycosidae “Light Variety”</td>
<td>1</td>
<td>Leaf Litter</td>
</tr>
<tr>
<td></td>
<td>Hersiliidae</td>
<td>26</td>
<td>Tree Trunk with Lichen</td>
</tr>
<tr>
<td></td>
<td>Ambypigidi</td>
<td>2</td>
<td>Palm Trunk</td>
</tr>
<tr>
<td></td>
<td>Scorpiones</td>
<td>1</td>
<td>Under Fallen Limb</td>
</tr>
<tr>
<td></td>
<td>Opiliones (Cosmetidae)</td>
<td>3</td>
<td>Leaf Litter</td>
</tr>
<tr>
<td></td>
<td>Opiliones (Phalagidae)</td>
<td>1</td>
<td>Tree Trunk</td>
</tr>
<tr>
<td></td>
<td>Theraphosidae</td>
<td>1</td>
<td>Burrow</td>
</tr>
<tr>
<td></td>
<td>“Red Rumped Tarantula”</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ixodida</td>
<td>1</td>
<td>Pant Leg</td>
</tr>
</tbody>
</table>
Table 5. Identification results of Ben’s Bluff Trail site

<table>
<thead>
<tr>
<th>Arachnid</th>
<th>Observed Frequency</th>
<th>Habitat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lycosidae “Dark Variety”</td>
<td>77</td>
<td>Trail Path, Leaf Litter</td>
</tr>
<tr>
<td>Lycoside “Light Variety”</td>
<td>5</td>
<td>Trail Path</td>
</tr>
<tr>
<td>Salticidae “Sunshine”</td>
<td>57</td>
<td>Leaf Litter, Trail Path</td>
</tr>
<tr>
<td>Scorpiones</td>
<td>1</td>
<td>Under Fallen Limb</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Arachnid</th>
<th>Observed Frequency</th>
<th>Habitat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lycosidae (Dark Variety)</td>
<td>271</td>
<td>Trail Floor</td>
</tr>
<tr>
<td>Lycosidae (Light Variety)</td>
<td>5</td>
<td>Leaf Litter</td>
</tr>
<tr>
<td>Pisauridae</td>
<td>2</td>
<td>Palm Frond</td>
</tr>
<tr>
<td>Hersiliidae</td>
<td>10</td>
<td>Tree Trunks w/ Lichen</td>
</tr>
<tr>
<td>Opiliones (Cosmetidae)</td>
<td>34</td>
<td>Tree Trunks</td>
</tr>
<tr>
<td>Ambypigidi</td>
<td>1</td>
<td>Tree Base</td>
</tr>
<tr>
<td>Scorpiones</td>
<td>1</td>
<td>Rock Crevice</td>
</tr>
</tbody>
</table>
Table 6. Identification results of Gibnut Trail site

<table>
<thead>
<tr>
<th>Arachnid</th>
<th>Observed Frequency</th>
<th>Habitat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salticidae “Sunshine”</td>
<td>71</td>
<td>Leaf Litter</td>
</tr>
<tr>
<td>Lycosidae (Dark Variety)</td>
<td>169</td>
<td>Leaf Litter</td>
</tr>
<tr>
<td>Lycosidae (Light Variety)</td>
<td>1</td>
<td>Leaf Litter</td>
</tr>
<tr>
<td>Hersiliidae</td>
<td>3</td>
<td>Tree Trunks w/ Lichen</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Arachnid</th>
<th>Observed Frequency</th>
<th>Habitat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lycosidae (Dark Variety)</td>
<td>64</td>
<td>Leaf Litter</td>
</tr>
<tr>
<td>Lycosidae (Light Variety)</td>
<td>1</td>
<td>Leaf Litter</td>
</tr>
<tr>
<td>Hersiliidae</td>
<td>26</td>
<td>Tree Trunks w/ Lichen</td>
</tr>
<tr>
<td>Ambypigidi</td>
<td>2</td>
<td>Palm Trunk</td>
</tr>
<tr>
<td>Scorpiones</td>
<td>1</td>
<td>Leaf Litter</td>
</tr>
<tr>
<td>Opiliones (Cosmetidae)</td>
<td>3</td>
<td>Leaf Litter</td>
</tr>
<tr>
<td>Opiliones (Phalangidae)</td>
<td>1</td>
<td>Leaf Litter</td>
</tr>
</tbody>
</table>

The following graph (Figure 6) illustrates the overall frequency of the arachnids encountered. The individual bars of the graph have been subdivided to depict the evening and morning observation periods. Within the divisions between morning and evening observation periods the frequency with which each arachnid was observed in that period is displayed numerically.
Figure 6. Observation results of arachnids in the Cockscomb Basin.

The following graph (Figure 7) represents the prevalence of each arachnid observed in the study.
Figure 7. Overall arachnid observation frequency.
Chapter 5  Conclusion

The premise for this research was to expand and bridge knowledge gaps within Arachnid research, as well as, create awareness among visitors to the Cockscomb Basin of the diversity of arachnids that inhabit the area. The data were then used to create an identification poster for visitors to be familiar with and to self identify the arachnids that they might encounter while hiking. Despite the diversity of arachnids in the tropical areas of Central America there was no considerable literature contributing towards creating a collective means of identification or awareness for arachnids in Belize, specifically in the Cockscomb Basin Wildlife Sanctuary.

When trying to identify the collected specimens the gap in arachnid identification, particularly in the Central American Region, began increasingly apparent. Frequently in the preliminary identifications, specimens were only able to be identified down to genera. This was both due to the limitations of our primary identification resource, *Spiders of North America* (2005), as well as, the significant gap in knowledge of the arachnids of the region. This was further exemplified in the validation process. After the preliminary identifications the specimens were sent to arachnologists that were experts in a particular arachnid Order or Family. Many of the arachnologists consulted expressed not only interest in the project at large, but also concurred with the gap in awareness of the Arachnid diversity in the Central American region. Several specimens were asked to be donated to collections in order to aid in future research.

A main focus of this research was to determine the most frequently encountered arachnid species in the Cockscomb Basin Wildlife Sanctuary. During the eight observation periods over the four different sites it became very apparent that members of the Lycosidae family in the
Araneae order were by far the most prevalent Arachnid encountered. Collectively the lycosids accounted for about 85 percent of the total number of arachnids observed (figure 7). The number observed only represented a small fraction of the number that were most likely present at the field site, but were not within site. Within the lycosids two varieties were observed at the field sites: dark and light variety. The two varieties were distinguished in that the “dark” lycosid were predominantly a dark brown to almost black coloration, whereas, the “light” lycosid had a crème to nearly clear coloration. Representative specimens from the lycosid family are thought to be members of the genus *Allocosa*; however, due to the vast numbers of species within this genus and the limitations of the identification key the specimens were unable to be further identified down to species. As illustrated in graph 6, the lycosids were most frequently observed arachnids in the evening observation periods. Both the frequency of observation as well as the trend towards the evening observation period was expected since according to the family description in *Spiders of North America* (2005), lycosids are ubiquitous throughout North America and active nocturnal predators.

After Lycosidae, members of the Order Araneae Family Salticidae were the most frequently observed arachnid. One variety, referred to as the “sunshine salticid”, was observed across all four observation sites. Conversely to the lycosids, the sunshine salticid was not observed in the evening observation periods and its movement appears to be limited to diurnal activity. Preliminary identification of the representative specimen proved difficult with *Spiders of North America* (2005). The voucher specimens were sent to an expert in the salticid family at the University of Florida whom has not been able to identify the sunshine salticid to existing salticid genera (G. Edwards, personal communication, February 21st, 2012). This insinuates the possibility that this specimen may be an undescribed species within the salticid family. Another
Salticid specimen was collected at the Tiger Fern trail site, but no other similar salticids were observed and thus that particular specimen was not relevant to determining the most frequently observed arachnids.

Another arachnid that was observed in significant numbers across all four field sites was a member of the Araneae Family Hersiliidae. These arachnids were commonly referred to as “lichen spiders” as they were nearly always seen in the anterior down position on the lichen patches of trees. These spiders were exceptionally cryptic in their coloration and as a result their observation frequency might be much lower than what was actually present in the field. As seen in graph 1 the lichen spider also appears to be more prevalent during nocturnal observations.

Members of the Arachnid Order Opiliones were also frequently observed across all four survey sites. Within Opiliones the two main families observed were Cosmetidae and Phalangiidae. Members of the Cosmetidae family were observed in a much greater frequency than those of Phalangiidae. However, both families trended towards nocturnal activity.

During our observations at the Ben’s Bluff Trail Site two specimens of the Araneae Family Pisauridae were observed. This observation was expected as the Ben’s Bluff Trail Site had a large body of water as part of the surveyed area. In the Family description for Pisauridae, from *Spiders of North America*, they are described as being predominately associated with bodies of water.

The other Arachnid orders that were observed during the observation periods were Scorpiones, and Amblypygi. Members of the Araneae Family Theraphosidae were also encountered. What may account for the low observation frequency among members of the Order Scorpiones could be their preference to seek shelter in burrows and under fallen vegetation.
Frequently the scorpions observed in this study were seen under fallen vegetation, rock crevices, and among storage materials around the camp site. The observed frequencies of scorpions during this study were nearly evenly distributed between the morning and evening observation periods. Conversely, the members of Order Amblypygi that were observed trended towards nocturnal activity which is concurrent with Jan Beccaloni’s general description in *Arachnids* that this order is predominantly a nocturnal hunter (2009). Of the tarantulas described in Reichling’s *Tarantula’s of Belize* (2003) the only tarantula observed during this study was the Mexican Red Rump Tarantula, a member of the Araneae Family Theraphosidae. This tarantula species has a broad diversity range from Mexico throughout Central America. While not observed in as great of frequency as the lycosids or salticids, the Red Rump Tarantula should be encountered by visitors to the Cockscomb Basin as a majority of those encountered were observed around the main camp site. Outside of the scheduled observation periods, the tarantulas were typically seen in close proximity to the locations in which they were observed during the scheduled observation period which seemed to indicate the possibility of burrows throughout the campsite.

**Future Considerations**

Future work in this field would be very beneficial to both the region as well as the field of Arachnology. This study could further be improved upon by using the same methodology and survey sites, but conducting the study during the rainy season which typically occurs from June to about November. This study was conducted in May of 2011 during which Belize was in transition from the dry season to the rainy season. The area had not received the significant increase in rainfall that hallmarks the season change. It would be interesting to see if there is a change in observation frequencies or change in the diversity of arachnid orders observed. The Cockscomb Basin Wildlife Sanctuary receives visitors year round and a significant discrepancy
in observation frequencies between the seasons could possibly decrease the effectiveness of the identification guide to visitors. Overall, by taking into account both a dry and wet season study, a more complete of the most frequently encountered arachnid species in the Cockscomb Basin would be possible.

Additionally, another facet of this study that would be beneficial to study further would be to analyze the effectiveness of the identification poster to the visitors of the region. This could be accomplished by providing a survey for the visitors that takes into account their knowledge of arachnids upon their arrival in the Sanctuary and then re-survey the individuals upon their departure. Additional questions could poll the visitors on their use of the guide as well as their opinions on its effectiveness to them and improvements they feel need to be made. Ideally the length of the visitor survey would span the duration of a year as to get an ample and diverse survey pool. From these data the identification guide can be altered to further improve its service to the visitors as well as gain an understanding of the effectiveness of biodiversity education.
Acknowledgements

I would like to extend a special thanks to the following individuals who helped make this opportunity possible:

Dr. C. Chevis, William Thompson, Megan Chevis, Emily Hankins, Dr. Weygoldt, Dr. D. Ubick, Dr. J. Gruber, Dr. Lorenzo Prendini, Dr. A. Brescovit, Dr. G. Stratton, University of Southern Mississippi’s Honors College and especially Dr. Aimée Thomas - From that first class of Biology 111 to Graduation Day thank-you for being there every step of the way.
Referenced Literature


Stockwell, S. (2010). Key to the genera of North American scorpions. Walter Reed Biosystematics Unit, online at http://wrbu.si.edu/scorpions/SC_key_NA/nakey01.html


Appendix A

FOREST DEPARTMENT
Ministry of Natural Resources and the Environment
Forest Drive, Belmopan, Belize
Tel: (501) 822-1524 Fax: (501) 822-1523
General email: fdsecretary@mnrei.gov.bz

Aimee K. Thomas
Cockscomb Basin Wildlife Sanctuary
Stann Creek District,
Belize, C.A.

May 11, 2011

SCIENTIFIC COLLECTION/RESEARCH PERMIT
WILDLIFE PROTECTION ACT NO. 4/1981

Permission is hereby granted to the above-named and address to do Research/Collection in the country of Belize subject to the following conditions:

1. The permit is:
   a) Valid for Aimee K Thomas and companions as listed below only.
   b) Valid until May 10, 2012

2. This permit provides research/collection to be done at Cockscomb Basin Wildlife Sanctuary only.

3. The permit allows the holders to do research entitled: Spiders of Cockscomb Basin Wildlife Sanctuary.

4. The objectives of the research is to describe the natural history of the spiders found in Cockscomb Basin Wildlife Sanctuary.

5. The researcher is permitted to collect spiders except tarantulas using the following methods:
   (1) Use rope to mark off transect area and set quadrats to sample within each transect,
   (2) Collect spiders using nets and pitfall traps (make holes the size of a two liter bottle for pitfalls)
   (3) All holes must be refilled after completion of this project

6. The permit holder must supply the Forest Department and the Belize Audubon Society with both digital and hard copies of final reports and posters at the end of the Project.

7. This permit may be cancelled at anytime not withstanding condition 1(b) above at the discretion of the Minister of Natural Resources and the Environment.

8. The permit holder shall make provision to accommodate Forest Department Staff on field trips as convenient to both parties.
9. Research fee has been paid vide Treasury Receipt No. 00343206 dated 30th May 2011.

Wilber Satilde
Chief Forest Officer

Cc: CFO
    File
    O.I.C. Orange Walk

Companions list
Megan Chevis  Undergraduate Research Student  Field Assistant
Lauren Auer  Undergraduate Research Student  Field Assistant