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Analysis of Common Tick Species Collected from the Chattanooga-Hamilton Region of Tennessee and the Correlation to Reported Cases of Tick-Borne Diseases

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by

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Running Title: Hamilton County Tick Analysis

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Abstract

Amblyomma americanum, Dermacentor variabilis, Ixodes scapularis, and *Rhipicephalus sanguineus* are three-host ticks commonly found in the Chattanooga-Hamilton region of Tennessee. The first three species are medically important because they are known to transmit Ehrlichiosis, Rocky Mountain spotted fever, and Lyme disease, respectively. *Rhipicephalus* is not known to vector any pathogens infecting humans; therefore, not clinically significant. The focus of this study was to correlate the population of *A. americanum, D. variabilis,* and *I. scapularis* in the Chattanooga region to reported cases of tick-borne diseases. There was a direct relationship between the frequency of *D. variabilis* and the reported cases of Rocky Mountain Spotted Fever. However, *I. scapularis* was not as prevalent as *A. americanum* but there were still more cases of Lyme disease than of Ehrlichiosis. The results suggest that other factors are involved in the occurrence of tick-borne diseases in a specific area besides species frequency.

Introduction

Ticks are primarily known for their clinical importance as vectors of certain diseases. In fact, this is the reason why these organisms have been given much attention by researchers. Many people believe that ticks are insects; however, ticks have eight legs, as oppose to insects that possess only three pairs of legs. Ticks belong to the class Arachnida along with spiders, mites, and scorpions. This class is further divided into the subclass Acari, which consists of just ticks and mites (Service, 1996). Within the subclass Acari there are two tick families: Argasidae (soft ticks) and Ixodidae (hard ticks). This study deals with the Ixodidae family.

According to previous research (Service, 1996), there are about 672 identified hard tick species worldwide belonging to 13 genera. *Amblyomma, Dermacentor, Ixodes, Haemaphysalis,* and *Hyalomma* are the five genera with medical significance. Ticks are often classified as being one-host, two-host, or three-host ecto-parasites. *Amblyomma, Dermacentor, Ixodes,* and *Rhipicephalus* are three-host parasites, which indicate that these ticks leave their host to develop and molt between each life cycle stage. Therefore, each developmental stage must locate an

appropriate host. Though *Rhipicephalus sanguineus* is a three-host tick, it does not pose a major threat to humans since their preferred host is the domestic dog; hence their common name—brown dog tick. Unlike the other three species, the brown dog tick favors the indoors and is able to pass its entire life cycle indoors, which gives it less opportunity to transmit pathogens. In a domestic environment, all stages of *R. sanguineus* might end up feeding on the same dog (if there is only one or a few dogs present). Some researchers have asserted that *R. sanguineus* as a possible human disease vector, but these findings have been outside the United States (Goddard 2000).

Ixodid ticks have four stages to complete their life cycle: egg, larvae, nymph, and adult. Once a female and male have mated on a host, the female feeds on that same host for up to 4 weeks and then drops to the ground. The male dies shortly after mating. The female finds shelter under leaves, rocks, shrubs, detritus, and lays eggs several weeks or months after feeding. The ixodid female can lay only one batch of eggs in her lifetime and dies soon after (Weber, 1984). She will often lay 1000-8000 eggs a batch, and in some cases she can lay up to 20,000. Ten to twenty days after the eggs are laid, they develop into six-legged larvae (seed ticks) and remain inactive for a few days. Then they become mobile and begin using their questing techniques to find a suitable host and feed. Questing techniques of all tick stages include climbing on the edge of vegetation and, with the aid of their front legs, detecting stimuli such as: carbon dioxide, vibrations, warmth, and host odors (Evans, 2000). The larvae feed for 3-7 days, and then drop off and remain inactive for 3-6 days until their blood-meal has been thoroughly digested. At this time the larvae molt into an eight-legged nymph. The nymphal feeding behavior is similar to that of the larvae stage except that nymphs feeds slightly longer, and remain inactive for a longer period in order to completely digest their blood-meal. Then, nymphs molt into a female or male

ixodid adults. Adult ticks remain inactive for about 7 days, and then begin questing for a host to feed on. Most ixodid ticks mate on their host, and the cycle continues (Service, 1996).

Due to the multiple host requirements of *Amblyomma americanum, Dermacentor variabilis,* and *Ixodes scapularis*, they are known to transmit several kinds of infectious agents. Common hosts for most hard ticks range from small mammals such as rodents, dogs, and cats, to bigger animals such as horses, cattle, and humans. Globally, many types of tick-borne diseases are transmitted to humans. Probably the most dangerous aspect of tick-related diseases is that most tick bites are overlooked. Ticks have the ability to embed their mouthparts into the skin of the host and release anesthetic chemicals enabling them to go unnoticed for a long period of time. This is when transmission of infectious agents occurs. The purpose of this research is twofold: to analyze the structural features that differentiate the common tick genera of the Chattanooga-Hamilton region, and to find out whether there is a direct relationship between the tick population frequencies and reported cases of tick-borne diseases in this area.

Tick Anatomy

Ticks are often mistaken for insects such as fleas, which can jump from place to place. However, unlike popular belief, ticks do not have the capability to jump. Their mode of locomotion is either by crawling on their four pairs of legs or attached to a host. Adult ticks are dorsally flattened and have distinct dorsal features that help taxonomist differentiate between species. All ticks have a scutum (dorsal shield), four pair of legs with claws at the ends, festoons, and a capitulum, which consists of a hypostome, a pair of palpi, and a base (Figure 1).

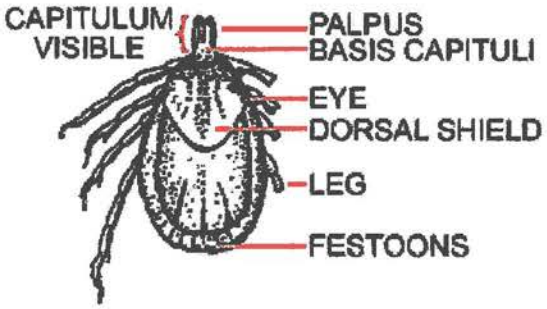

Figure 1. The hypostome is not labeled in this picture; it is located between the palps (Hildreth, 2003).

The capitulum, also referred to as the 'false head' is used by researchers to accurately classify tick species. For example, *Dermacentor, Amblyomma, Ixodes,* and *Rhipicephalus* have four distinctly shaped capitula that group them into their corresponding genera. Not only is the capitulum important in identifying a tick's genera, but also, it conveys information on how the tick will embed itself into the host (Lancaster, 1973). Figure 2 shows the main parts of the capitulum.

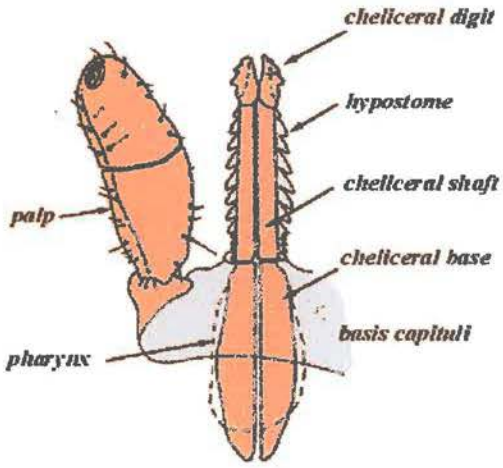

Figure 2. This is a dorsal view of all the parts of the capitulum of ixodid ticks. (Hildreth, 2003).

The larger, posterior, pear-shaped section of the body is called the scutum. This is a hard, chitinous shield, which extends over the whole dorsal surface of the male but covers only a small portion of the dorsum behind the head of female ticks. When the male feeds on a host, its body is incapable of becoming greatly enlarged because it is constrained by the scutum. On the other hand, the female's body is capable of considerable enlargement, and therefore able to feed for longer periods of time, and is nearly always bigger than the males (Service, 1996).

The body of a tick may be divided into capitulum (mouthparts) and idiosoma (body). The idiosoma in turn is comprised of the podosoma (limbs) plus the opisthosoma (torso). The scutum has bilateral cervical and lateral grooves, varying in depth and length in different species. The body of the female tick may have a pair of lateral marginal grooves behind the scutum, while posterior, lateral and median grooves are usually present on the dorsum in both sexes. The posterior border of the body is frequently notched or indented, forming the "festoons" (Figure 1), which generally number eleven (Weber 1984).

Differentiating Species

The main differences between the four species of ticks in this study are the patterns on the scutum, and the shape of the capitulum. *A. americanum* ticks are reddish-brown. Unfed females have a prominent white spot on the scutum, which correlates with this species' common name, the Lone Star tick. However, when the female is engorged, the white spot is not easily visible. The male does not carry this distinguishing spot; instead, the festoons on the posterior part of the scutum have white markings. Festoons are small rectangular areas separated by grooves along the posterior margin of the dorsum of both males and females. *A. americanum's* capitulum has a triangular base and long, slender palpi on either side of the hypostome (Figure 3), which

emerges from the anterior portion of the capitulum. The long hypostome of *A. americanum* allows better anchoring into the host's skin during feeding.

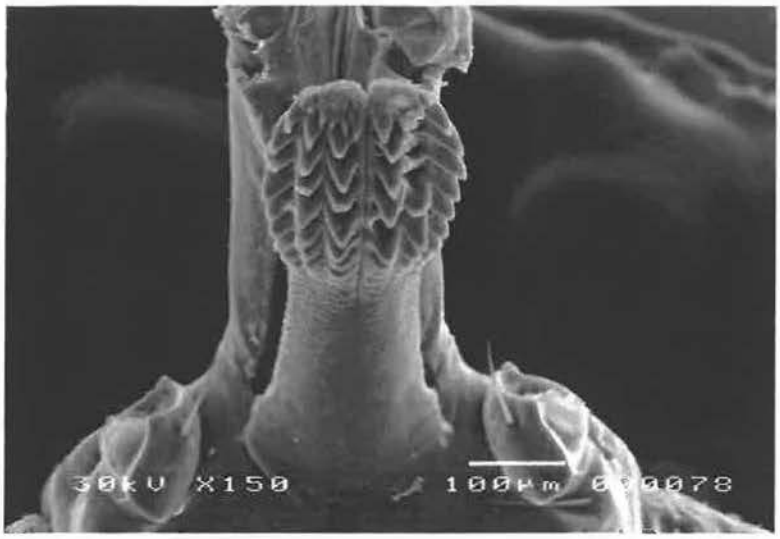

Figure 3. . Scanning Electron Microscope Photograph of *A. americanum* (ventral view). Notice the denticles (teeth) do not cover the entire hypostome. (Hildreth, 2003)

Dermacentor variabilis, commonly known as American dog ticks are also reddish-brown. The male is easily identified by the silvery-white indentations all over its scutum. Unfed females have the same silvery-white markings on the scutum, which are also hard to see when the female is engorged (Drummond, 1990). The capitulum of *Dermacentor* is much shorter than *Amblyomma, Ixodes,* and *Rhipicephalus.* The base of the capitulum is rectangular with short, stubby palpi on the side of the relatively short hypostome. The short capitulum does not allow *Dermacentor* to embed its hypostome deep into the host's skin (Figure 4). Therefore, it compensates by secreting larger amounts of a cement-like substance found in their saliva, which aids in anchoring to the host.

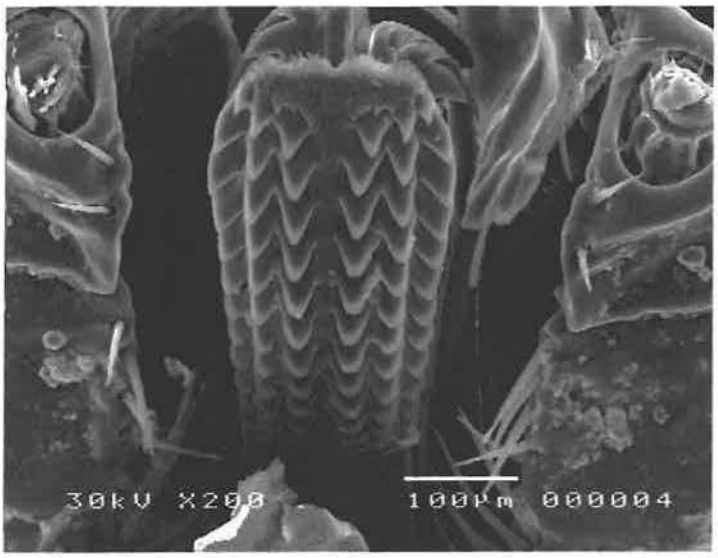

Figure 4. Scanning Electron Microscope Photograph of *D. variabilis* (ventral view). The denticles are ordered in six rows that line up the entire hypostome. (Hildreth, 2003)

If not carefully observed *R. sanguineus* can be easily confused with the American dog tick. They are both similar in body coloration and size. However, unlike *D. variabilis*, the brown dog tick does not have any ornamentation on its back. Though they are of the same size, the brown dog tick tends to be more elongated than *D. variabilis.* The key identification characteristic of *R. sanguineus* is found in the hexagonal-shaped base of the capitulum (Drummond, 1990). The hypostome is shorter compared to *A. americanum* and *I. scapularis*, but still slightly longer than *D. variabilis* (Figure 5). Note also the size of the denticles; they are larger, but arranged in the same six rows as *D. variabilis* and *A. americanum.*

Figure 5. Ventral view of *R. sanguineus'* hypostome. Unlike the other three genera, *Rhipicephalus* has large denticles all around its hypostome. Overall, this genus is quite similar to *D. variabilis*, except for the distinguishing hexagonal-shaped capitulum on *R. sanguineus* (Hildreth, 2003).

Ixodes scapularis is the species that people hear about the most because of its association with Lyme disease. This tick is the smallest one of the three mentioned in this report. *I. scapularis*, also known as the deer tick or black-legged tick has a very dark brown body and black legs. Its capitulum is similar to that of *Amblyomma* in that it is long and slender with a triangular base (Drummond, 1990). Figure 6 shows a palpus on the left side with the hypostome next to it. The *Ixodes* hypostome is about the same length as *Amblyomma*, except that it has more denticles along the body of the hypostome and they are randomly attached. There is no conclusive evidence on the importance of random vs. uniformly attached denticles; however, the higher number of denticles on the deer tick's hypostome might correlate with its ability to feed on its host longer, thus increasing the incidence of pathogen transmission.

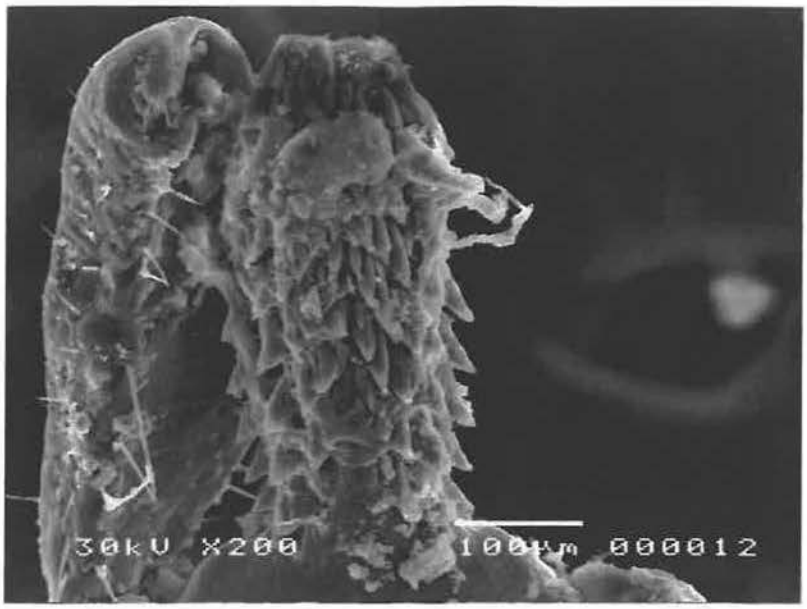

Figure 6. Ventral view of *I. scapularis'* hypostome. Unlike *Amblyomma* and *Dermacentor*, the denticles are not arranged in six rows. The denticles also appear sharper that the other two hypostomes. Although the hypostome is long and slender like *Amblyomma*, the denticles cover the entire hypostome of *I.scapularis* (Hildreth, 2003).

The Tick's Bite

The capitulum that was analyzed in the preceding section is the main anatomical part that is involved in the tick's bite. Once the tick has latched onto a host using its small claws located at the end of each leg, it attempts to migrate toward favorable areas on the host. These areas include the axillaries, groin, and neck region of the host. Whether it is able to reach these preferred feeding areas or not, the tick will feast when the opportunity arrives. Ticks use the chelicerae at the tips of the hypostome to penetrate into the host's skin. The palpi move out of the way and sit laterally on the skin while the tick feeds. Only the hypostome, which has denticles around the body and a pair of chelicerae at the penetrating end, imbed into the skin. Once the hypostome is inserted into the skin, the denticles anchor the tick to the skin and make it

difficult to pull the tick out. Also, most ticks secrete a cement-like substance to reinforce their attachment to the host (Vredevoe, 2003). The tick forms a pool of blood to feed on by using its chelicerae to cut blood vessels under the dermis. To prevent blood from clotting and ensure uninterrupted blood flow, ticks release saliva that contains certain anticoagulants into the wound. The inoculation of saliva into the host body is the key link to diseases transmission. The ticks that harbor pathogens transmit them to their host animals including humans. In order to receive an adequate meal, the tick will feed for several days. Ticks do not feed fast because this would mean they would have to cut more blood vessels, which would alert the host and endanger the tick's survival. Evans (2000) found that it usually takes 24-48 hrs for an infected tick to effectively transmit an infectious agent. The longer ticks remain attached to their hosts, the higher the probability they will transmit pathogens. Therefore, the faster the tick is removed, the better.

Materials and Methods

Tick Collection.

Ten veterinary clinics in the Chattanooga-Hamilton Region were contacted and asked to save any ticks found on domestic animals (Figure 7). The following veterinary clinics in the Chattanooga-Hamilton region collaborated in collecting ticks from the pets that were treated in their facilities:

1. Middle Valley Animals Hospital at 6310 Hixson Pike
2. Animals Clinic East at 1414 Gunbarrel Rd.
3. Animal Clinic Inc. at 2223 E. 23rd St.
4. East Brainered Animal Hospital at 8488 E. Brainerd Rd.
5. Northgate Animal Hospital at 1600 Hamill Rd, Hixson
6. Brainerd Hills Veterinary Hospital at 6724 E. Brainerd Rd.
7. Ashland Terrace Animal Hospital at 907 Ashland Terrace

8. Ooltewah Animal Clinic at 5617 Main St.
9. White Oak Mountain Veterinary Hospital at 5620 Ooltewah Ringold Rd.
10. East Ridge Animal Hospital at 3702 Ringold Rd.

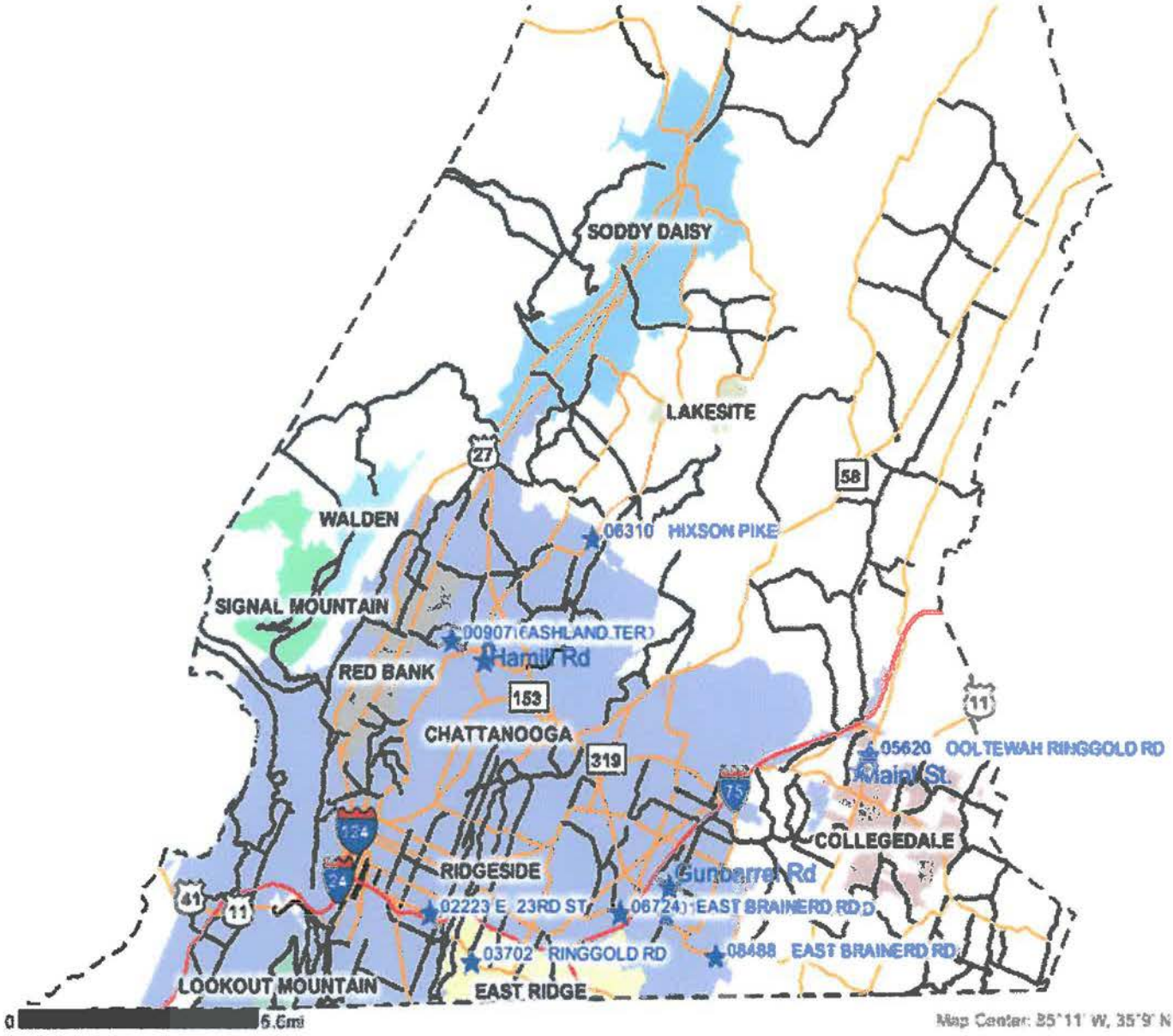

Figure 7. Chattanooga-Hamilton region animal clinic locations

Each blue star indicates the location of the 10 animal clinics that supplied ticks for this study.

All ticks were carefully removed with small forceps in order to grab the ticks' hypostome located at the point of attachment to the host body. This assures preservation of anatomical features that help identify the genus and species. Ticks were kept in vials at the animal clinics and then transported to the research laboratory. Seventy-five percent ethanol was added to each vial for further preservation of the ticks. Accurate record was kept by labeling the vials with the date and animal clinic location. Collection time was from the last week of May to the first week of August (12 weeks).

Species Identification

All ticks were identified by using a dissecting microscope and pictoral tick identification keys (Lancaster, 1973; Drummond, 1990; Weber, 1984). Once identified, their genus and species, sex, and life cycle stage were recorded.

Disease Correlation Investigation

Statistical records on tick-borne diseases for years 1995-2001 were obtained from The Hamilton County Health Department (data from 2002 and 2003 were not available). Relevant epidemiological information was also taken from the website of Center for Disease Control.

Results and Discussion

Table 1 shows total quantity of ticks collected during the 12+ weeks of collection. After identification ticks were categorized by species. All of the 1276 ticks collected in this study fell under four particular species. *D. variabilis* was the most abundant (36%), followed by *R. sanguineus* (35%), and then *A. americanum* (28%). The main vector for Lyme disease, *I*

scapularis, was the least species (1%) identified among the ticks collected in the Chattanooga-Hamilton area (Figure 8).

Rhipicephalus sanguineus, as mentioned, is a domestic tick and can pass its entire life cycle indoors. The abundance of this particular species was expected because all ticks were collected from domestic animals at local animal clinics. *D. variabilis*, on the other hand, are not indoor ticks. The common name, American dog tick, can be misleading since this tick does not entirely feed on dogs. The larvae and nymphal stages of this species prefer to feed on smaller animals like rodents and rabbits that serve as pathogen reservoirs (Vredevoe, 2003).

The common name of *D. variabilis* was adapted because most adults of this species seem to prefer dogs for feeding and mating. The large collection of American dog ticks in this study is closely related to the outdoor contact of most domestic animals. Backyards, farmlands, and forest area are commonly inhabited by this tick species, which are avidly looking for a host to feed on. *D. variabilis* was the most numerous species collected during the course of this research (Figure 8). These results correlate with the high incidence of Rocky Mountain spotted fever (RMSF), which has been documented in the Chattanooga-Hamilton region (Figure 9), and all of Tennessee (Figure 10). Table 2 shows the percentage of state-wide tick-borne diseases reported in the Chattanooga-Hamilton region. Furthermore, figure 9 depicts a decline in RMSF from 1998-2001, which may be due to increased public awareness as a result of education programs conducted by veterinary clinics and county health departments.

Amblyomma americanum is the least host-specific of all the three-host ticks (Goddard, 2000). This tick has been found on deer, dogs, rabbits, ground-feeding birds, rodents, cattle, horses, and humans. However, in this study, *A. americanum* came only from the animals (cats and dogs) that were brought to the veterinary clinics. Further investigation on the population of

A. americanum in wild animals needs to be explored in future studies. Although the population of *A. americanum* is relatively high in Hamilton County, but there was only one case of Ehrlichiosis in this county between 1995 and 2001. This could be attributed to several factors like public awareness about ticks and their diseases transmission potential, preventive measures, and a decline in the natural pathogen reservoir.

Out of the 1276 ticks in this study only 1% were identified as *I. scapularis* (Figure 8). Figures 9, 10 and Table 2 show a decrease in cases of Lyme disease from 1995 to 2001. The decline in Lyme disease cases could be attributed to several factors, one of which is the low vector population (Figure 8). However, the low population of *I. scapularis* collected may be due to the season during which this study took place. Therefore a low *I. scapularis* population may not be the reason for the decline of Lyme diseases in the Chattanooga-Hamilton region. Unlike the other three species which are mostly active in the spring and summer months, *I. scapularis* is more active in the fall and winter months. Although the four species in this study are common to the Chattanooga-Hamilton region, the host availability or weather conditions are usually not the same from one year to the next. These two factors can play key roles in determining the year's population of a particular tick species.

Table 1. Data showing total number of ticks collected during the study and categorized according to species

Tick Species	*Quantity*
Amblyomma americanum	353
Dermacentor variabilis	457
Ixodes scapularis	20
Rhipicephalus sanguineus	446
Total	1276

Table 2. Percentage of Tick-Borne cases in TN reported in the Chattanooga-Hamilton Region

Year	Ehrlichiosis (%)	Lyme (%)	RMSF (%)
1995	0	21	22
1996	0	8	17
1997	20	0	8
1998	0	7	10
1999	0	8	13
2000	0	11	2
2001	0	7	2

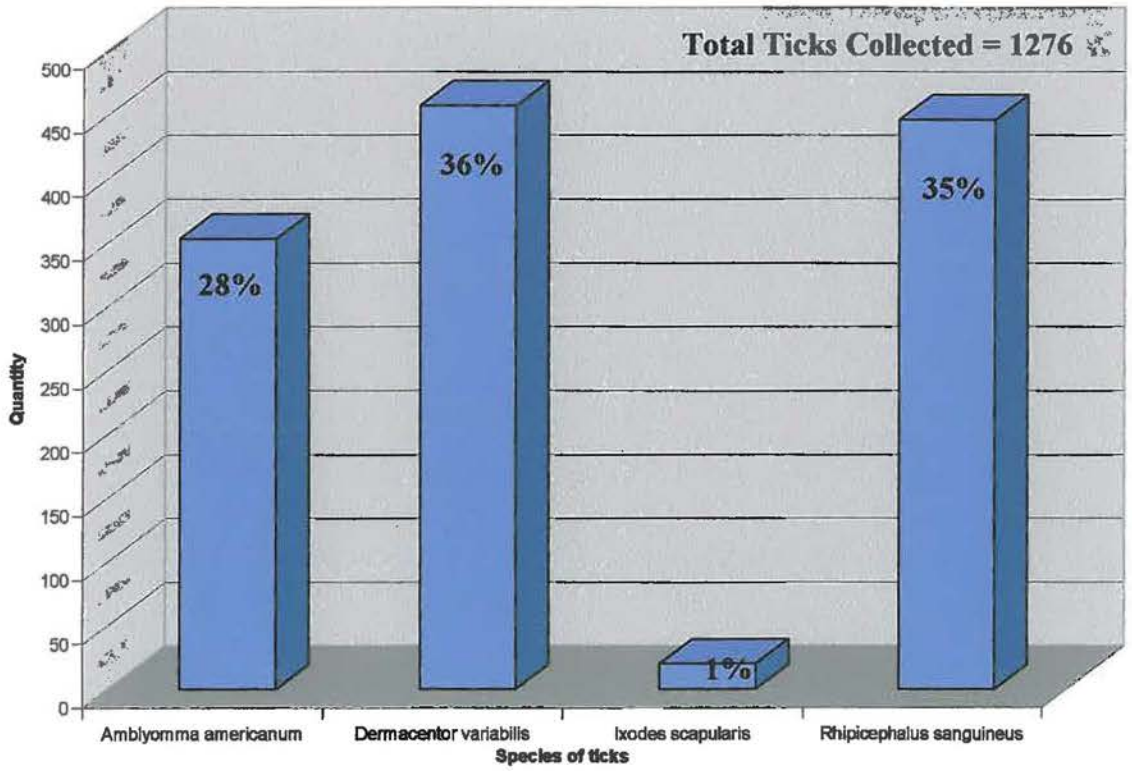

Figure 8. Species of ticks removed from dogs and cats of the Chattanooga-Hamilton Region.

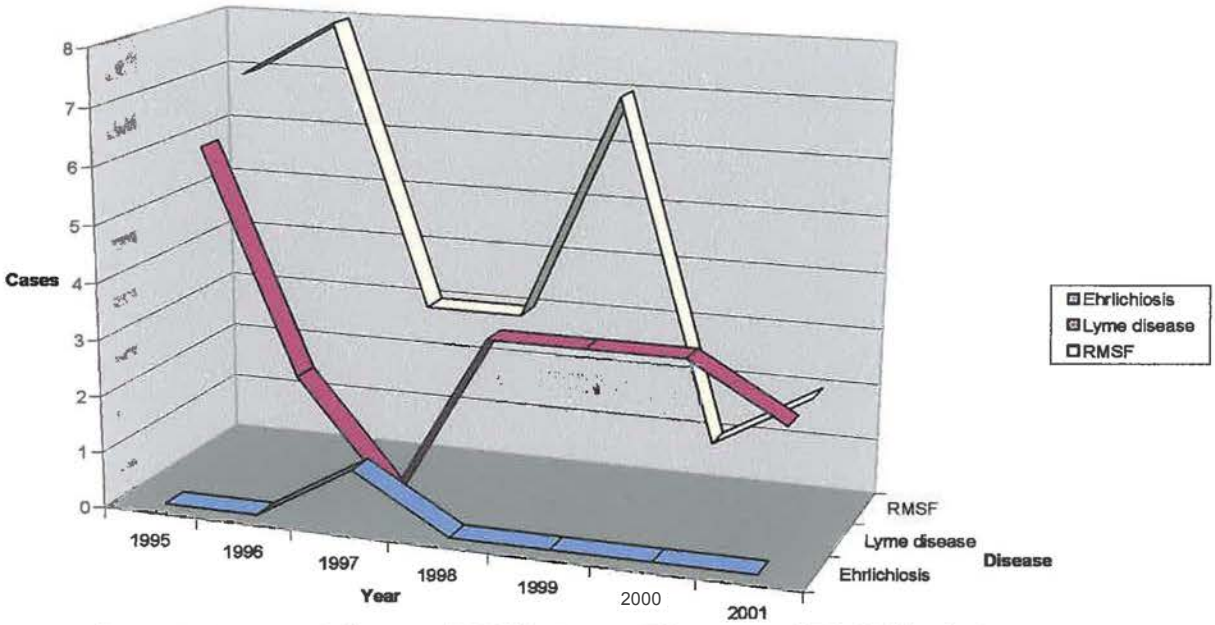

Figure 9. Reported Cases of RMSF, Lyme Disease, and Ehrlichiosis in the Chattanooga Hamilton Region. (1995-2001)

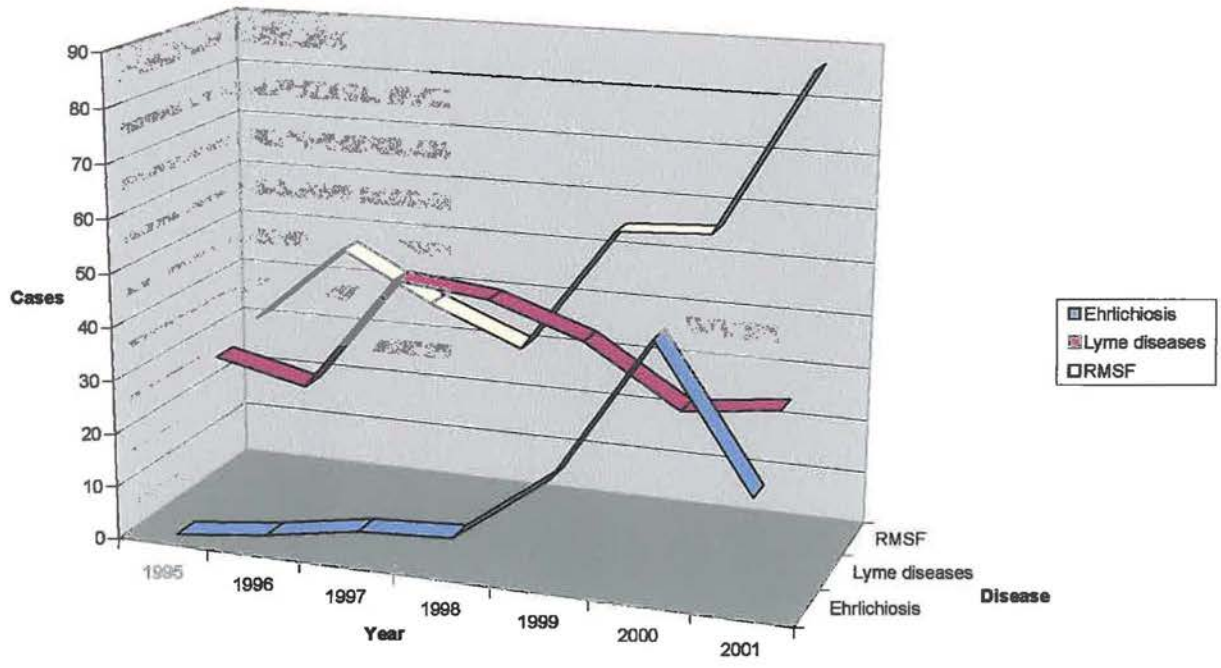

Figure 10. Reported Cases of RMSF, Lyme Disease, and Ehrlichiosis in Tennessee (1995-2001).

Tick-borne Diseases

The three medically significant tick species that are discussed in this study are probably the most important vectors of zoonotic diseases in humans. Zoonotic diseases usually affect animals, but can be transmitted to humans. The lone star tick, the black-legged tick, and the American dog tick are found throughout the United States and some parts of Mexico. However, their level of distribution varies in different regions of North America.

Dermacentor variabilis is the main vector of Rocky Mountain Spotted Fever (RMSF), and is also notorious for causing tick paralysis. The American dog tick is commonly encountered feeding on dogs and other domestic pets, as well as humans. This species is widely distributed in the US, but its population is concentrated in the southeast United States. The larvae, nymphs, and adults are active from spring to fall, and they overwinter in the soil (Drummond, 1990). Rocky Mountain spotted fever is caused by a rickettsial group of bacteria called *Rickettsia rickettsi*. According to data compiled by the Centers for Disease Control about 600 cases of RMSF are reported each year (Goddard, 2000). Before the discovery of tetracycline and other related antibiotics, 30% of those infected with this diseases died. Now, despite the availability of effective treatment and advances in medical care, approximately 3%-5% of individuals who become ill with RMSF still die from infection because many people are still not aware of the symptoms, the connection it has with ticks, and the need of immediate treatment. Symptoms of this disease include high fever, chills, lower back pain, and a brownish/grayish rash on all the extremities. *Rickettsia rickettsi* is maintained in nature by a complex life cycle involving ticks and mammals. Humans are considered to be accidental hosts and are not involved in the natural transmission and cycle of this pathogen (Goddard, 2000).

Tick paralysis is also linked mainly to American dog ticks; however, this is not an infection but a disorder related to inoculation of toxins from the tick's bite. As stated earlier, *D. variabilis* has a short capitulum, which means it does not embed its mouthparts too deep into the skin when it feeds. Therefore its hypostome is mainly anchored to the host's dermis with the cement secreted in the tick's saliva. Instead of releasing an anti-coagulant, it releases powerful enzymes that dissolve host tissue. Research shows (Arroyo 1998) that the toxin diffuses and then acts by diminishing the release of acetylcholine at the motor nerve junction. This results in muscle paralysis similar to the flaccid paralysis caused by the botulism pathogen. Arroyo (1998) proposed that tick paralysis arises in susceptible hosts due to an "idiosyncratic reaction to components in the tick's saliva."

Amblyomma americanum commonly inhabits regions from central Texas to the Atlantic coast and north to Iowa and New York. All developmental stages are commonly found during the spring and summer months. *A. americanum* is the major vector of human monocytic ehrlichiosis (HME). Goddard's (2000) research shows a few cases of the lone star tick transmitting Lyme disease, and Rocky Mountain Spotted Fever (RMSF). However, Drummond's research (1990) indicates that *A. americanum* is not a major source for either of these two diseases. Human monocytic ehrlichiosis (HME) is caused by a gram-negative, pleomorphic coccobacilli that primarily infects circulating leukocytes. Unlike RMSF, there is usually no rash that accompanies this disease; however, fever, chills, muscle aches, eye pains, nausea, and vomiting are among the common symptoms of HME. *Ehrlichia* reservoirs have been identified as the white-tailed deer and the lone star tick itself (Goddard, 2000). However, the promiscuity of the lone star tick makes it hard to ascertain a reservoir.

The black-legged tick, *I. scapularis*, prefers to feed on white-tailed deer in the adult stages, and also feed on humans. Immature stages feed on lizards, and small mammals. According to Gullo's research (1998), about 20 different species of mammals and birds can serve as natural reservoirs for Lyme disease, but the white-footed mice and white-tailed deer are the most common reservoirs. The etiological agent of Lyme disease is called *Borrelia burgdorferi*, and belongs to the spirochete group of bacteria. Unlike *A. americanum* and *D. variabilis*, adults of *I. scapularis* are active during the fall and winter seasons. Symptoms of Lyme disease are divided into three stages. First stage includes flu-like symptoms and a bull's eye rash (erythema chornicum migrans) at the site of tick bite. The second stage involves cardiovascular and central nervous systems. Third stage is characterized by oligoarthritis and advanced cases of CNS disorders (Gullo, 1998). Although Lyme disease has been considered as the leading vector-borne disease in the United States by the Centers for Disease Control, new cases of these diseases are progressively decreasing because of increase awareness and preventive measures taken by the Hamilton County Public Health Department. Table 3 summarizes the information mentioned as well as the common treatments for each disease.

Disease	Pathogen	Vectored by	Symptoms	Treatment
Lyme Disease	*Borrelia burdorgeri*	*I.scapularis* Deer tick	Bull's Eye Rash, flu-like symptoms, neurological abnormalities, arthritis	Amoxicillin Ceftriaxone
Human Monocytic Ehrlichiosis	*Ehrlichia chaffeensis*	*A.americanum* Lone Star Tick	Fever, headache, myalgia, anemia	Tetracycline Doxycycline
Rocky Mt. Spotted Fever	*Rickettsia rickettsii*	*D.variabilis* American Dog Tick	Fever, headache, myalgias, malaise, vomiting, rash	Tetracycline Chloramphenicol

Figure 12. Summary of tick-borne diseases addressed in this study.

Conclusion

Even though the general public is aware of the relationship between ticks and infectious diseases, there are still several hundred cases reported in the United States each year, which suggests that many people are not taking preventive measures. The single digit cases of tick-borne diseases in the Chattanooga-Hamilton region are relatively low, but could be reduced further with increased public education and awareness. The data collected in this study was valuable in documenting the presence of tick vectors and tick-borne diseases in this region. However, due to such a short-term study, no conclusive correlations between the Chattanooga-Hamilton region tick populations and reported tick-borne diseases can be made at this time. Furthermore, to establish a relationship between the population densities of certain tick species and the diseases they transmit, more long-term studies must be conducted. Tick populations over a period of several years, and seasonal variations of tick populations could be correlated with reported incidents of these tick-borne diseases.

As for preventive measures, most of the animal clinics that collaborated in this study provide various chemicals for eradication of ticks from pets, and provide ample information to alert pet owners about tick-borne diseases. When ticks are not molting, they are looking for a host on which to attach. It is important that people take special precaution when taking their pets for a walk, or go out on leisure hikes. For more information on preventive measures, pet owners can contact their local animal clinics.

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Middle Valley Animal Hospital at 6310 Hixson Pike,
Animals Clinic East at 1414 Gunbarrel Rd.
Animal Clinic Inc. at 2223 E. 23rd St.
East Brainered Animal Hospital at 8488 E. Brainerd Rd.
Northgate Animal Hospital at 1600 Hamill Rd, Hixson
Brainerd Hills Veterinary Hospital at 6724 E. Brainerd Rd.
Ashland Terrace Animal Hospital at 907 Ashland Terrace
Ooltewah Animal Clinic at 5617 Main St.
White Oak Mountain Veterinary Hospital at 5620 Ooltewah Ringold Rd.
East Ridge Animal Hospital at 3702 Ringold Rd.

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*Thank **You!***

Southern Scholars Honors Program
Senior Project

SOUTHERN ADVENTIST UNIVERSITY

Southern Scholars
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Name Astrid von-Walter Date 4/16/04

Major Biology

A significant scholarly project, involving research, writing, or special performance, appropriate to the major in question, is ordinarily completed the senior year. The project is expected to be of sufficiently high quality to warrant a grade of A and to justify public presentation.

Under the guidance of a faculty advisor, the Senior Project should be an original work, should use primary sources when applicable, should have a table of contents and works cited page, should give convincing evidence to support a strong thesis, and should use the methods and writing style appropriate to the discipline.

The completed project, to be turned in in duplicate, must be approved by the Honors Committee in consultation with the student's supervising professor three weeks prior to graduation. Please include the advisor's name on the title page. The 23 hours of credit for this project is done as directed study or in a research class.

Keeping in mind the above Senior Project description, please describe in as much detail as you can the project you will undertake. You may attach a separate sheet if you wish:

This project focuses on the various species of ticks common to the Chattanooga-Hamilton Region. The ticks in this study were collected off of domestic animals from the area animal clinics. After collection and identification, data was gathered from the Hamilton Co. Health Dept. to find out whether there ~~was~~ is a direct relationship between the tick population & the reported cases of tick-borne diseases in this area.

Signature of faculty advisor Lafawn Bulle Expected date of completion 3/26/04

This project has been completed as planned (date) 4-16-04

This is an "A" project V This project is worth 2-3 hours of credit V

Advisor's Final Signature Lafawn Bulle

Chair, Honors Committee _____ Date Approved _____

Dear Advisor, please write your final evaluation of the project on the reverse side of this page. Comment on the characteristics that make this A "quality work.

Final Evaluation

Astrid started this research project in May of 2003. She began her work by gathering all the materials needed for the project and organizing a work station in the research laboratory. Then, she was on task contacting all local Veterinary Clinics and collecting the ticks they saved for her project. She also obtained statistical data on tick-borne diseases in the Chattanooga-Hamilton area.

Astrid spent quite a bit of time on identifying the species of tick by using pictorial guides. She did a meticulous job in analyzing the characteristics of hard ticks in order to classify them correctly. She properly documented the results of her study by entering the data into a well-organized log sheet.

In order to study the correlation between the population of ticks and the cases of tick-borne diseases in the Chattanooga-Hamilton area, she obtained statistical data from Hamilton County Health Department.

Astrid's research is the first of its kind in the Hamilton County. Her work will set a stage for future researchers to look further into the trends of tick populations and the surge or decline of tick-borne diseases in Southeast Tennessee. Her research is not only original, but also a high quality work.

SOUTHERN SCHOLARS SENIOR PROJECT

Name: Astrid von-Walter Date: 12/10/03 Major: Biology

SENIOR PROJECT

A significant scholarly project, involving research, writing, or special performance, appropriate to the major in question, is ordinarily completed the senior year. The project is expected to be of sufficiently high quality to warrant a grade of A and to justify public presentation.

Under the guidance of a faculty advisor, the Senior Project should be an original work, should use primary sources when applicable, should have a table of contents and works cited page, should give convincing evidence to support a strong thesis, and should use the methods and writing style appropriate to the discipline.

The completed project, to be turned in in duplicate, must be approved by the Honors Committee in consultation with the student's supervising professor three weeks prior to graduation. Please include the advisor's name on the title page. The 2-3 hours of credit for this project is done as directed study or in a research class.

Keeping in mind the above senior project description, please describe in as much detail as you can the project you will undertake. You may attach a separate sheet if you wish:

Tick-borne diseases have been a serious concern in many areas of the United States. The fluid exchange that occurs between host and tick during feeding is the source of pathogen transmission. This study will investigate whether any correlations exist between tick species commonly found on domestic dogs and rats and the documented cases of tick-borne illness in Hamilton County and the surrounding counties in the last 5-10 years.

Specific Aims

I. To analyze the different tick species commonly found on domestic dogs and rats in Hamilton County.

II To examine if the documented cases of tick-borne illness in Hamilton County within the last 5-10 years correlate with the tick species.

Signature of faculty advisor Linda Ann Szalai Expected date of completion March 19, 2004

*Primary Research Supervisor: Dr. Safawo Gullo (signature not available)

Approval to be signed by faculty advisor when completed:

This project has been completed as planned:_____

This in an "A" project:_____

This project is worth 2-3 hours of credit:_____

Advisor's Final Signature_____

Chair, Honors Committee_____ Date Approved:_____

Dear Advisor, please write your final evaluation on the project on the reverse side of this page. Comment on the characteristics that make this "A" quality work.