

2007

Chagas in culture and place: a mixed methods approach to a new medical geography of Chagas disease in Los Tuxtlas, Mexico

Frances Heyward Currin Mujica

Louisiana State University and Agricultural and Mechanical College, fcurri1@lsu.edu

Follow this and additional works at: https://digitalcommons.lsu.edu/gradschool_dissertations



Part of the [Social and Behavioral Sciences Commons](#)

Recommended Citation

Mujica, Frances Heyward Currin, "Chagas in culture and place: a mixed methods approach to a new medical geography of Chagas disease in Los Tuxtlas, Mexico" (2007). *LSU Doctoral Dissertations*. 2115.

https://digitalcommons.lsu.edu/gradschool_dissertations/2115

This Dissertation is brought to you for free and open access by the Graduate School at LSU Digital Commons. It has been accepted for inclusion in LSU Doctoral Dissertations by an authorized graduate school editor of LSU Digital Commons. For more information, please contact gradetd@lsu.edu.

CHAGAS IN CULTURE AND PLACE: A MIXED METHODS APPROACH TO A
NEW MEDICAL GEOGRAPHY OF CHAGAS DISEASE IN LOS TUXTLAS,
MEXICO

A Dissertation

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

in

The Department of Geography and Anthropology

by
Frances Heyward Currin Mujica
B.A. The University of Memphis, 1999
M.A. LSU, 2002
August 2007

*In Memory of
Bob and Lucy Currin
The Very Rev. Lynwood Magee
Dan and Matthew McConnell*

ACKNOWLEDGEMENTS

I would like to take this opportunity to acknowledge the many people and groups who supported the completion of this dissertation. First, I would like to thank the Department of Geography and Anthropology for the training and financial support given to me during my doctoral studies, as well as the Louisiana State University Graduate School.

I must also thank my dissertation committee. Your patience and guidance throughout this process were unparalleled. Especially Dr. Miles Richardson, Dr. Helen Regis and Dr. Michael Leitner, thank you for all your expertise and guidance. Most importantly, I must extend my deepest gratitude to Dr. Andrew Curtis who gave me this incredible opportunity to experience a new avenue of research and who guided me through the process.

To my American friends and colleagues, most especially the Fagan family, Dr. J.W. Mills, Mr. and Mrs. Mcconnell, and Samantha Euraque your continuous encouragement, steady guidance, and perfect friendships have gotten me through. Dr. Sarah E. Hinman, the world's best editor, without whom I would never have lasted, your constant and steady guidance through this process will always be remembered, thank you! And to the Boyer family, whose artistic talents and undying friendship continue to bless my life. I could not ask for more perfect friends.

In addition I must also extend a note of gratitude to the Universidad Nacional Autonoma de Mexico's Los Tuxtlas Biological Field Station for their support while conducting the field research necessary for the completion of this project. I must also include a special thanks to my friends and colleagues in Mexico, most especially Don

Domingo Velazco and family, who guided me through the region and gave important insight into the communities I studied. And to Bióloga Rosamond Coates, without whose help and constant encouragement I would never have gathered the information for this project, I am forever indebted. Also to all those participants of this project, thank you for your patience and support.

Finally, I must extend a special note of thanks to the wonderful and loving members of my family especially Jeannie Magee, Thomas Currin, Anne Pontius, Louise Haney, and Maria Fernandez. Your constant love and belief in my abilities, when I sometimes lost my way, made this whole process possible. And to my husband, Jesus, my best friend and constant companion, for all your love, support, understanding, and tireless effort throughout this process, I would never have been able to finish without you. Thank you all.

TABLE OF CONTENTS

Acknowledgements	iii
List of Tables	ix
List of Figures	xii
Abstract	xvi
Chapter	
1 Introduction: Chagas in Culture and Place	1
1.1 Introduction	1
2 New Medical Geography, Mixed Methods, and Disease Inequalities: A Review of the Literature.....	6
2.1 Introduction	6
2.2 From Traditional Medical Geography to New Medical Geography	8
2.3 Place and New Medical Geography	15
2.4 Theoretical Frameworks	17
2.5 Mixed Methods and the New Medical Geography	23
2.6 Inequalities and the New Medical Geography	25
3 A New Medical Geography of Chagas Disease	29
3.1 Introduction.....	29
3.2 Carlos Chagas and His Disease	30
3.3 Epidemiology of Chagas Disease	32
3.3.1 Transmission Cycles	33
3.3.2 Geographic Distribution	35
3.3.3 The Parasite	38
3.3.4 The Vector	42
3.3.5 Mammalian Reservoirs	46
3.3.6 Modes of Infection	47
3.3.7 Stages of Human Chagas Disease.....	49
3.4 Epidemiology of Chagas Disease in Mexico	51
4 A New Medical Geography of Chagas Disease: A Case Study in Los Tuxtlas	56
4.1 Introduction	56
4.2 Geography of the Sierra de Los Tuxtlas	57
4.3 Settlement Patterns in Sierra de Los Tuxtlas	58
4.3.1 Recent Historical Patterns	59
4.3.2 Present-Day Populations	60
4.3.3 The Study Communities	60
4.4 Methods in the Field	61
4.4.1 First Days in the Field	62

4.4.2	Data Collection Methods	67
4.4.2.1	<i>Triatoma dimidiata</i> Collections	68
4.4.2.2	The House Type Surveys.....	71
4.4.2.2.1	Building Materials	72
4.4.2.2.2	Structural Gap	73
4.4.2.2.3	Window Screens	73
4.4.2.2.4	Number of Domestic Animals Near the Home	73
4.4.2.2.5	Porch Gates	74
4.4.2.2.6	Other Buildings	74
4.4.2.2.7	The Kitchen Garden	74
4.4.2.3	Phase III: The Interviews	74
4.4.3	The CODES-GIS	79
5	Identifying the Vector Landscape in Los Tuxtlas: Analysis of the House Type Surveys and the <i>Triatoma dimidiata</i> Collection Data	82
5.1	Introduction	82
5.2	The Survey Data	84
5.2.1	Structural Materials in the Study Region	85
5.2.2	Community Specific Domicile Data	94
5.3	Geographic Results from the Collection of <i>Triatoma dimidiata</i>	107
5.3.1	<i>Triatoma dimidiata</i> Collection Indices	118
5.4	Diagnosis of <i>Trypanosoma cruzi</i> Infections in the Collected <i>Triatoma dimidiata</i>	120
5.5	Identifying Correlations between House Type Surveys and Collected Vectors	123
5.6	Discussion	128
5.6.1	Observed House Type Discussion	128
5.6.2	Observed <i>Triatoma dimidiata</i> Collections Discussion	129
6	<i>Chinches</i> , Chagas, and Culture: Anthropocentric Investigation of Disease Knowledge and Place	133
6.1	Introduction	133
6.2	Results from the Chagas Disease Interviews	134
6.2.1	Chagas Disease Interview Results from the Participants who Collected <i>Triatoma Dimidiata</i>	142
6.2.2	Results and Chi-Squared Analysis of Cross-Community Data	143
6.3	Discussion of Disease Knowledge and Place	146

6.3.1	Gendered Knowledge (Qualitative Perspective)	151
6.3.2	Correlations with Gender (Quantitative Perspective)	153
6.3.3	<i>Oportunidades</i>	155
6.4	Results from the Participant Socioeconomics and Landscape Change Interviews	156
6.5	Discussion	161
6.5.1	Influences of Vegetation Changes on Transmission	163
6.6	Collaboration with Dr. Rojas Saiz	164
6.6.1	Results	165
7	Reflections from the Field	167
7.1	Introduction	167
7.2	The Long Ride In	168
7.3	The Field Station	170
7.4	First Days in the Field	173
7.5	Community Reflections	174
7.5.1	Community A	174
7.5.2	Community B	177
7.5.3	Community C	178
7.5.4	Community D	180
7.5.5	Community E	182
7.5.6	Community F	183
7.6	Observations from Weekly Visits	185
7.6.1	Community A	185
7.6.2	Community B	186
7.6.3	Community C	187
7.6.4	Community D	188
7.6.5	Community E	189
7.6.6	Community F	190
7.7	Car Troubles	190
7.8	Conclusions	192
8	Conclusion	193
8.1	Introduction	193
8.2	Summary of Conclusions	194
8.3	Future Projects and Recommendations	196
8.3.1	Baseline Data Collection	196
8.3.2	Intervention Strategies	198
8.4	Significance to Non-Traditional Chagas Disease Regions	199
	References	202
	Appendix A: House Type Survey	232
	Appendix B: Interview Questions	234

Appendix C: <i>Triatoma dimidiata</i> Collection Information	238
Appendix D: <i>Triatoma dimidiata</i> Photographs	240
Appendix E: Results of Blood Collections	244
Appendix F: CBCSF Pamphlet	246
Vita	247

LIST OF TABLES

Table 3.1: Important Vectors for <i>T. cruzi</i> in the Americas (source Zeledon 1974)	43
Table 3.2: Relevant Mexican Species and their Related States (Guzman-Brancho 2001)	53
Table 4.1: Number of Recorded Houses in 2005 per Community	61
Table 4.2: Number of <i>Triatoma dimidiata</i> Collected from each Community	70
Table 5.1: Most Common Wall Types	86
Table 5.2: Roof Materials for Each Community	87
Table 5.3: Floor Types for Each Community	88
Table 5.4: Structural Gaps found between the Wall and Roof for all Communities	90
Table 5.5: Structural Gaps found between the Wall and Floor for all Communities	90
Table 5.6: Structural Gaps found in the Walls for all Communities	90
Table 5.7: House Types that Contained Window Screens	91
Table 5.8: House Types that contained Porch Gates for all Communities	92
Table 5.9: House Types that were documented with Ceilings for all Communities.	92
Table 5.10: Participating Houses Documented with Gardens	93
Table 5.11: House Type Survey Data from Community A	95
Table 5.12: House Type Survey Data from Community B	97
Table 5.13: House Type Survey Data from Community C	100
Table 5.14: House Type Survey Data from Community D	103
Table 5.15: House Type Survey Data from Community E	103
Table 5.16: House Type Survey Data from Community F	108

Table 5.17: <i>Triatoma dimidiata</i> Indices for the Six Studied Communities	119
Table 5.18: <i>T. cruzi</i> Results from the 2005 Collected Vector Data	121
Table 5.19: House Type Wall Material (Chi-Squared including the Station)	125
Table 5.20: House Type Roof Material (Chi-Squared including the Station)	125
Table 5.21: House Type Floor Material (Chi-Squared including the Station)	125
Table 5.22: Structural Gaps Found between the Wall and Roof (Chi-Squared including the Station)	126
Table 5.23: Structural Gaps Found between the Wall and Floor (Chi-Squared including the Station)	126
Table 5.24: Structural Gaps Found in the Walls (Chi-Squared including the Station)	126
Table 5.25: Chi-Squared Interpretation between Communities in relation to Wall Material	127
Table 5.26: Chi-Squared Interpretation between Communities in relation to Roof Material	127
Table 5.27: Chi-Squared Interpretation between Communities in relation to Floor Material	128
Table 6.1: Gender of Interview Participants	135
Table 6.2: Participants who initially acknowledged knowing the <i>chinche</i>	136
Table 6.3: Participants who could actually describe the <i>chinche</i>	136
Table 6.4: Participants who acknowledged finding the vector in their home	138
Table 6.5: Participants who claimed to know about Chagas Disease	139
Table 6.6: Participants who could describe Chagas Disease	139
Table 6.7: Participants who were able to link the <i>Triatoma dimidiata</i> with Chagas Disease	141

Table 6.8: Cross-Community Comparison of Participants who could link <i>Triatoma dimidiata</i> with Chagas Disease	142
Table 6.9: Participants in Chagas Disease Interview by Community	143
Table 6.10: Cross-Community Comparison of Chagas Disease Interview Data	144
Table 6.11: Chi-Squared Cross-Community Comparison of Interview Results for those Participants who could describe the <i>Chinche</i> accurately	145
Table 6.12: Chi-Squared Cross-Community Comparison of Interview Results for those Participants who could describe the Chagas disease accurately	145
Table 6.13: Chi-Squared Cross-Community Comparison of Interview Results for those Participants who could link the vector with Chagas Disease accurately	146
Table 6.14: Percentage of Participants who were able to describe the link between the vector and Chagas Disease by Community	147
Table 6.15: Chi-Squared Results of Participants sorted by Gender who acknowledged they knew about Chagas Disease	153
Table 6.16: Chi-Squared Results of Participants sorted by Gender who could correctly describe all Aspects of Chagas Disease	154
Table 6.17: Chi-Squared Results of Participants sorted by Gender who Acknowledged Knowing the <i>Chinche</i>	154
Table 6.18: Chi-Squared Results of Participants sorted by Gender who could correctly describe the <i>Chinche</i>	154

LIST OF FIGURES

Figure 1.1: Participating Study Communities in Los Tuxtlas, Municipio, San Andres, Veracruz, Mexico	3
Figure 3.1: Geographic Distribution of the Human Infections of Chagas Disease in the Americas (Schmunis 1994)	36
Figure 3.2: Geographic Distribution of Incidences in the Americas (Schmunis 1994)	37
Figure 3.3: Stages of <i>T. cruzi</i> (adapted from Bastien 1998; Illustration by Boyer 2007)	40
Figure 3.4: Lifecycle of <i>T. cruzi</i> (adapted from Bastien 1998; Illustration by Boyer 2007)	42
Figure 3.5: Geographic distribution of the important species of Triatomine in Mexico((A) <i>Triatoma barberi</i> ; (B) <i>Triatoma dimidiata</i> ; (C) <i>Triatoma gerstaeckeri</i> ; (D) the <i>Phyllosoma</i> complex (Guzman-Brancho 2001))	54
Figure 4.1: Participating Communities in Los Tuxtlas, Mexico	57
Figure 4.2: First Field Map for Community A	64
Figure 4.3: First Field Map for Community B	64
Figure 4.4: First Field Map for Community C	65
Figure 4.5: First Field Map for Community D	65
Figure 4.6: First Field Map for Community E	66
Figure 4.7: First Field Map for Community F	66
Figure 4.8: Specimen Cups Distributed to Local Participants	69
Figure 4.9: Gut Contents on Filter Paper	71
Figure 4.10: Sampling <i>Triatoma dimidiata</i> in the Field	71
Figure 4.11: Sample Page of Chagas Database	80
Figure 4.12: Resulting Maps from Uploaded Chagas Field Data	81

Figure 5.1: Study Communities in Los Tuxtlas, Mexico	83
Figure 5.2: Proportion of Wall Type Material in Each Community	86
Figure 5.3: Proportion of Roof Type Materials in Each Community	88
Figure 5.4: Proportion of Floor Type Materials in Each Community	89
Figure 5.5: Wall Type Survey Data from Community A	95
Figure 5.6: Roof Type Survey Data from Community A	96
Figure 5.7: Floor Type Survey Data from Community A	96
Figure 5.8: Wall Type Survey Data from Community B	98
Figure 5.9: Roof Type Survey Data from Community B	98
Figure 5.10: Floor Type Survey Data from Community B	99
Figure 5.11: Wall Type Survey Data from Community C	100
Figure 5.12: Roof Type Survey Data from Community C	101
Figure 5.13: Floor Type Survey Data from Community C	101
Figure 5.14: Wall Type Survey Data from Community D	104
Figure 5.15: Roof Type Survey Data from Community D	104
Figure 5.16: Floor Type Survey Data from Community D	105
Figure 5.17: Wall Type Survey Data from Community E	105
Figure 5.18: Roof Type Survey Data from Community E	106
Figure 5.19: Floor Type Survey Data from Community E	106
Figure 5.20: Wall Type Survey Data from Community F	108
Figure 5.21: Roof Type Survey Data from Community F	109
Figure 5.22: Floor Type Survey Data from Community F	109
Figure 5.23: Household Representations of Collected Vector Data from Community A	111

Figure 5.24: Household Representations of Collected Vector Data from Community B	112
Figure 5.25: Household Representations of Collected Vector Data from Community C	114
Figure 5.26: Household Representations of Collected Vector Data from Community D	115
Figure 5.27: Household Representations of Collected Vector Data from Community E	117
Figure 5.28: Household Representations of Collected Vector Data from Community F	117
Figure 5.29: Household Representations of <i>T. cruzi</i> Results from the 2005 Collected Vector Data (Community B)	122
Figure 5.30: Household Representations of <i>T. cruzi</i> Results from the 2005 Collected Vector Data (Community C)	122
Figure 5.31: Household Representations of <i>T. cruzi</i> Results from the 2005 Collected Vector Data (Community E)	123
Figure 6.1: Distribution of Study Communities in Los Tuxtlas, Mexico	134
Figure 6.2: Gender of Participants who participated in Chagas Disease Interviews	135
Figure 6.3: Cross-Community Comparison of Participants who accurately describe <i>Triatoma dimidiata</i>	137
Figure 6.4: Cross-Community Comparison of Participants who could accurately describe Chagas Disease	140
Figure 6.5: Cross-Community Comparison of Participants who could link <i>Triatoma dimidiata</i> with Chagas Disease	141
Figure 6.6: Non- <i>Chinche</i> (left) with <i>Chinche</i> (right) Collected during Field Season	150
Figure 7.1: Main access road into region prior to paving	171
Figure 7.2: Main access road into region after paving	171
Figure 7.3: Sleeping area in room	172

Figure 7.4: Office area in room 172

Figure 7.5: Access path to Community A 175

Figure 7.6: River mouth between Community F (on the left) and its
neighboring Community (to the right) 184

ABSTRACT

This project is concerned with a new medical geography approach to investigating Chagas disease in Los Tuxtlas, Mexico which focuses on the intersection of disease risk and place. More specifically this work will describe the domestic cycle of Chagas disease and the cultural factors that perpetuate its transmission in six communities in the Los Tuxtlas region, Municipio San Andres, Veracruz State, Mexico. Using several collection techniques, such as interviews and house type surveys, as well as identifying and collecting the vector *Triatoma dimidiata* (including testing them for the parasite *Trypanosoma cruzi*), this dissertation describes the characteristics of the Chagas landscape in this region. During a five month field season, 58 *Triatoma dimidiata* were collected from the domestic habitat. In addition, nearly 400 interviews were conducted with project participants leading to the conclusions that although the Chagas disease landscape is present in this region, it is not a well known disease among local residents.

CHAPTER 1 INTRODUCTION: CHAGAS IN CULTURE AND PLACE

1.1 Introduction

Throughout history societal development and disease exposure have been linked. Exposure through trade, landscape modifications in order to meet basic needs, and in some cases, environmental modifications because of pressure to improve living standards are examples of human developmental patterns which have led to contact with new pathogens. Malaria, leishmaniasis, and Chagas disease are only a few examples of environmentally constrained diseases that have become major public health problems in the developing world as local habitats have changed (Fonaroff 1968; Prothero 1961; Nogueira 1977; Miles 1976 Roundy 1980; Walsh et al. 1993). These diseases do not need humans to help them survive but because settlements have intersected with their respective habitats people have now been incorporated into the lifecycle of the disease.

The issue of geographic scale also becomes important when considering the impact environment and culture play on disease distribution. These scales can range from regional associations between development along coastal areas where the mosquito, *A. aegypti*, the vector for dengue fever in Thailand can be found (Wellmer 1983) to the conditions of a suburban backyard where humans have encroached on the natural habitat of the tick carrying Lyme disease (Burgdorfer et al. 1985). With each new human induced environmental manipulation, many previously sylvatically restricted diseases are becoming major health problems. Another example of an infectious disease of increasing concern, and whose emergence is at least partly due to human environmental encroachment is Chagas disease.

This dissertation will focus on identifying and describing the landscape of Chagas disease in the Tuxtlas region of Mexico primarily at the level of communities and individual domiciles (Figure 1.1). These communities will henceforth be referred to by their assigned label¹. With recent development into uninhabited tropical forested areas, scientists believe that the communities in this region are at risk for contracting Chagas disease (Ramsey et al. 2003; Personal Communication 2005; Ramsey et al. unpublished manuscript 2005), a view only beginning to be accepted by the Mexican government (Personal Communication 2005; Attran 2006). It is hypothesized that certain cultural and behavioral patterns exhibited in this region increase the likelihood of Chagas infection. It is the intention of this study to identify these risks and show any spatial patterns, including landscape change, in and among the communities that may contribute to the risk of exposure to the vector. Adding further credence to this landscape, this project will also try to identify the presence of the vector and parasite within the study communities. It is hypothesized that if the vector is found in these communities then local residents will be able to describe this vector and its relationship to the disease.

In order to accomplish the goals set forth in this dissertation a link must be formed with the relevant geographic (and health) literature. Therefore chapter two will situate the dissertation within a *new* medical geography by describing the differences in methodological approaches employed by traditional medical and health geographies and by combining techniques to create a complimentary view of the study of health and disease. This approach relies on the intersection of Chagas disease and place. Therefore, chapter one will also discuss what is meant by place in geography. Additionally, a brief

¹ It was decided at the start of this project that complete anonymity would be given to all participants. Because findings could potentially be sensitive with relation to the disease we informed each participant their names and community names would never be used. This decision also complies with IRB regulations.

discussion of the methods and techniques employed in the research process will also be addressed.

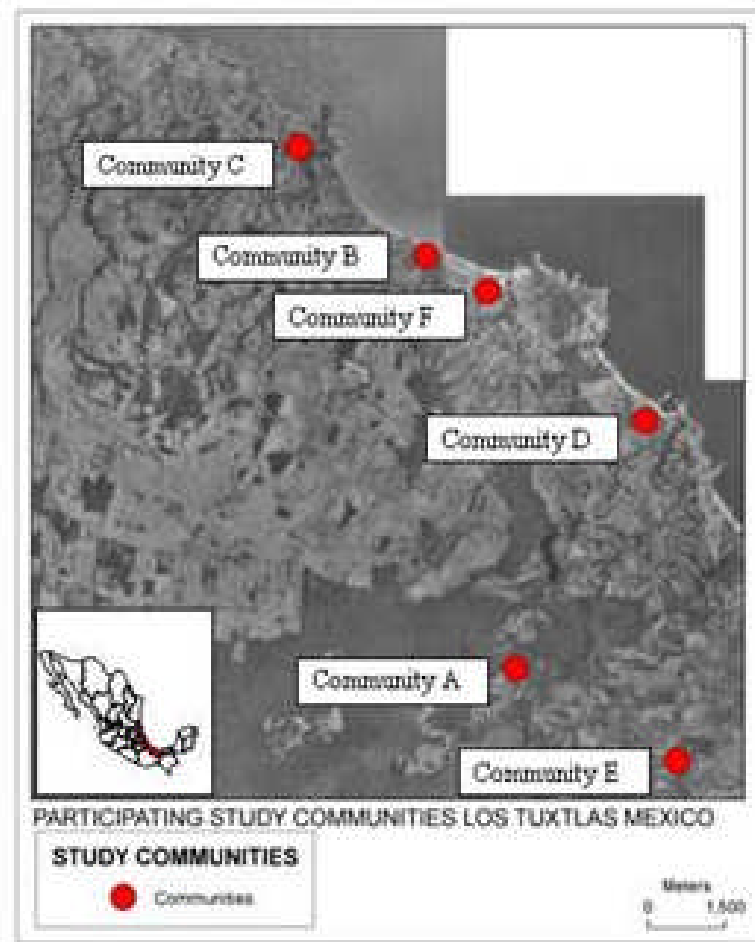


Figure 1.1: Participating Study Communities in Los Tuxtlas, Municipio, San Andres, Veracruz, Mexico²

Chapter three provides an introduction to Chagas disease, beginning with a brief history of the disease and continuing with its epidemiology in the Americas; including a discussion of the parasite, the vector, its transmission methods, human incidences and geographic distribution. The chapter concludes with a detailed discussion of its significance in Mexico including morbidity and mortality figures associated with the

² North is found at the top of all maps included in this dissertation. All aerial photographs used in the creation of the maps in this dissertation were provided by the *Instituto Nacional de Estadística, Geografía e Informática* (INEGI 1990).

disease and its significance in the State of Veracruz, in which the communities of study are found.

Chapter four will provide an overview of the geography of the Tuxtlas region, including its physical and human geography, and then present the methods chosen to carry out the project objectives. These techniques include: the process of community selection, techniques used to collect the vector *Triatoma dimidiata* (including testing for the parasite *T. cruzi*), identifying important house-type characteristics, carrying out two interviews with participants that include ascertaining local knowledge about Chagas disease, and family information including recollections about landscape changes that will help determine how the Chagas landscape has varied over time.

Chapter five will use data collected during the 2005 field season in Los Tuxtlas to develop the Chagas disease landscape. This landscape will be primarily constructed of risk factors, such as house type construction, as well as vector identification, and parasite recognition, in connection with human-vector contact in the six studied communities. These examined risk factors create a place-specific investigation which will contribute to the larger Chagas disease literature.

In order to identify the cultural factors of Chagas disease specific to Los Tuxtlas two scheduled interviews were conducted with the project participants. These interviews are discussed in chapter six. The interviews used in this project intended to capture local knowledge, local knowledge networks, and ideas concerning disease in place. The information contained in the interviews provides additional insight into our understanding of the Chagas disease landscape.

In chapter seven I will describe some of my field experiences while collecting data for this dissertation. These reflections add a personal element to the Chagas landscape developed in this project. The day-to-day experiences I collected will add to the overall goal of this work; creating a layer of human interaction that may help to highlight and exemplify the kind of mixed methods with which this dissertation is infused. This chapter may also provide future researchers with an insight into what might be expected while conducting similar fieldwork.

This dissertation concludes with a discussion of the research's contribution to the literature, recommendations for future projects, as well as possible implications for the United States. As we shall see in this text, Chagas disease is a disease of the poor in Los Tuxtlas and exhibits similar patterns as in other disease prone countries. Education and eradication programs relevant to both the disease and vector will be addressed. In addition, the incidences of infection have now expanded beyond the borders of traditional Chagas disease prone countries and particular attention will be paid to the risk faced by communities in the United States.

CHAPTER 2 NEW MEDICAL GEOGRAPHY, MIXED METHODS, AND DISEASE INEQUALITIES: A REVIEW OF THE LITERATURE

2.1 Introduction

From miasmatic theory to germ theory, scientific ideas concerning disease causation have changed dramatically over the last two hundred years (Mitman and Numbers 2003). These changes have encompassed paradigm shifts in terms of discounting miasmatic theory for germ theory, to methodological approaches in academia designed to study these changes. From the perspective of medical geography, a common factor in understanding disease, and health, is the importance of place.

Place as a conceptual research approach to understanding the spatial structure of disease is more than cartographic visualization and spatial analysis, but also includes the importance of context. According to M. Richardson (Lecture Notes 2004) place is not a single construct, but instead, is an interaction of three distinguishing characteristics; a natural setting, unique behavior within that natural setting, and a unique image associated with that setting. One place is distinguished from another through the construction of these unique characteristics. This concept of place is, then, an essential aspect of determining how Chagas disease, considered the disease of the poor and the focus of this dissertation, manifests itself differently in Los Tuxtlas, Mexico compared to other regions with similar physical, human, and vector geographies.

Before proceeding, it is important to define a few key concepts relevant to this dissertation. Although used interchangeably in many circles, *disease and illness* are now defined conceptually after Leon Eisenberg (1977) from the late 1970s. Today many other

social science disciplines, including geography (Meade and Earickson 2000; Gatrell 2002) have come to also recognize Eisenberg's distinction while conducting medical-related research. According to Eisenberg (1977) *disease* is a convenient concept used by health professionals to explain sickness based on a scientific rationalization. Conversely illness may incorporate the "sick" person's perceptions of their ill-health. This term is based on the cultural or community concept of sickness and health rather than solely the scientifically recognized description of a particular disease.

Secondly one must be familiar with several terms associated with identifying disease causation and risk when considering infections like Chagas disease. The first of these terms, *pathogen*, refers to an organism or substance which can cause disease (Meade and Earickson 2000). For example the protozoa *Leishmania* is the pathogen for Leishmaniasis, while *Trypanosoma cruzi* is the pathogen for Chagas disease (Herrer and Christensen 1976). Often pathogens must be transmitted from animal to animal or from animal to human in order to complete an infection cycle. The transmitter, or *vector*, is the organism that carries or transmits the pathogen (WHO 1991). The mosquito, *A. aegypti*, is the arthropod vector for dengue fever in Thailand (Wellmer 1983) while the triatomine bug is the vector for Chagas disease in the Americas. Sometimes an animal can carry a pathogen, facilitating disease spread, without the pathogen causing harm to that specific animal (WHO 1991). This animal is referred to as a *reservoir host*, an example being the opossum in the transmission of the pathogen associated with Chagas disease (Ruiz-Piña and Cruz-Reyes 2002). In other circumstances the pathogen, while residing in the animal, causes damage to that animal, but remains an important component in the cycle of disease transmission. When this is the case the animal is

simply called a host (Eldrige and Edman 2004). Humans can be considered a host to the Chagas disease pathogen. Once infected, people can be severely affected by the parasite, in many cases resulting in death (Cedillos 1987).

This chapter will situate this dissertation within a *new* medical geography by describing the differences in methodological approaches employed by traditional medical and health geographies and combining techniques to create a multifaceted view of the study of health and disease. This approach relies on the intersection of Chagas disease and place. Therefore, it is important to discuss what is meant by place in geography. Additionally, a brief discussion of the methods and techniques employed in the research process are also addressed.

2.2 From Traditional Medical Geography to New Medical Geography

In the last decade, medical geography has undergone a methodological expansion from a human geography sub-discipline solely reliant on quantitative methods and spatial analysis to one that includes qualitative techniques associated with a socially oriented research agenda (Kearns 1993; Curtis and Taket 1996; Dyck 1999; Elliott 1999; Meade and Earickson 2000; Gatrell 2002; Symth and Thomas 2005). This evolution falls within the larger paradigm shift in human geography towards a more theoretically informed emancipatory research scheme (Eyles and Smith 1988; Opie, A. 1992; Kearns 1993; Kearns 1996). Additionally, this shift was concomitant with the World Health Organization's (WHO 1957) revisiting of health from a strictly biomedical standpoint to one including a total sense of well-being. Place, in this definition, becomes an important element in the investigation of health for an individual (Jones and Moon 1993; Kearns

and Joseph 1993; McIntyre et al. 1993; Dyck 1999; Elliott 1999; Kearns and Moon 2002; Andrews and Kearns 2005).

Following the lead of the WHO, health research began to emphasize the need to focus on human factors associated with well-being and disease (Department of Health and Social Security 1980; White 1981). Factors including culture, politics, and economics can all shape human environments and play important roles in explaining health disparities. These disparities can also be described as creating spatial variation in social vulnerability (Eyles et al. 1993; Evans et al. 1994; Curtis et al. forthcoming).

The environment (or neighborhood) in which a person lives can have a direct or indirect impact on his/her health (Haddock 1979). For example, indigent urban populations in the United States often live in close proximity to environmental polluters, which may directly lead to poor health. In addition, the stress associated with *believing* that proximity may lead to poor health can also make the individual more vulnerable to sickness (Curtis and Leitner 2006).

In the socio-ecological model, which includes the interaction of humans and their physical environment, the concept of place became an important focus (White 1981; Kearns 1993; Kearns 1994). Place became the stage for the interaction of both the physical and social environment, thus making possible a holistic examination of health (Department of Health and Social Security 1980; Kearns and Moon 2002). For the majority of health research the investigation of place is still based on tangible findings which can lead to policy implications. Identified risk factors can include the domicile (house-type materials), the surrounds of the domicile (identifying standing water near the home, or neighborhood stressors), or through human activity needs (the availability of

potable water) (Lewis and Mayer 1988; Lang, N. 1991; Litva and Eyles 1994). By addressing and correcting such human induced environmental risks, researchers placed emphasis on prevention. The idea that prevention should be the focus instead of waiting for the disease to surface insured the importance of place. Place as a theoretical metaphor for cultural perceptions about health was not as important as identifying environmental causes of diseases that put human populations at risk. As place is an essential element of geography, it is only natural that the sub-discipline of medical geography saw this expansion as an outlet for new methodological approaches. In 1993, the discipline saw a call by Robin Kearns (1993: 140) in his paper *Place and Health: Towards a Reformed Medical Geography* to “explore the development of the link between place and health in medical geography.” He called attention to the need to consider the interaction of place on health (Kearns 1993). His new perspective called for a redirection of medical geographic work from solely treatment-orientation to one focused on prevention, following the lead of the WHO. In 1994, Kearns once again urged medical geographers to follow the path set forth by other health-related fields, and insisted that in order to fully understand the health/place relationship it must be scrutinized in a social context.

medical geography should be resituated within social geography. This call is based on recent interest in the health/place relationship in policy and research which has highlighted the irrevocably social nature of medicine and health (Kearns 1994: 111)

Slowly, as evidenced in the geographic literature, there was a shift from the ideas of traditional medical geography to a more place-oriented health geography (Jones and Moon 1993; Kearns and Joseph 1993; McIntyre et al. 1993; Dyck 1999; Elliott 1999; Mohan 2000a; Mohan 2000b; Kearns and Moon 2002; Andrews and Kearns 2005). For example, Susan Elliot comments:

questions of the intersection of individual level biological and behavioral variables with social and environmental factors are central to the health geography research agenda (Elliott 1999: 241).

This new geography of health and health care approach that has emerged during the last 15 years has made an important impact on traditional medical geography, bringing the impact of place into the fore and calling for the socio-ecological model of health to replace that of biomedicine (Johnston et al. 2000; Kearns and Moon 2002; Andrews and Kearns 2005). The geography of health and health care turned away from a focus on disease and disease services and instead towards a concentration on health and wellness that called for a more theoretically informed sub-discipline (Kearns and Moon 2002). Those interested in the new geography of health and health care also expanded techniques to include qualitative methodologies.

In 1994, however, traditional medical geographers registered a rebuttal to Kearns' call for a new sub-discipline (Mayer and Meade 1994). Jonathan Mayer (1982; 1984) and Melinda Meade (1977; 1986; 1990; 1992; 1994) argued that Kearns neglected the disease ecology approach. According to Mayer and Meade (1994:103) the disease ecology tradition, "considers the numerous social, economic, behavioral, cultural, environmental, and biological factors, which create disease in specific places at specific times." In other words, the study of how humans interact in place and potentially put themselves at risk for disease was already established. Indeed, the sub-discipline of medical geography already offered a multifaceted interface to the study of diseases and their distribution over time and space (Mead and Earickson 2000; Prothero and Davenport 1986).

The study of geographically determined spaces or regions and their associated disease ecology is an established approach in medical geography (Mead and Earickson 2000). Meade and Earickson (2000) identify four regions that specifically relate to our understanding of disease/health in a geographic context: biomes, realms of evolution, cultural realms, and natural nidus (each of which will be explained below). With each regional progression the land area being studied decreases, culminating with a site-specific community investigation as will be conducted in this dissertation.

The first of these region types is based on predetermined geographic biomes that include climate, latitude, and altitude (Meade and Earickson 2000). These biomes are recognized as representing specific locations around the world, such as tropical rainforests or temperate mid-latitude coastal zones. Within these biomes naturally occurring flora and fauna can be identified and linked to disease patterns and distribution. For example, in the tropical rainforest biome, certain species of mosquitoes have been linked to the transmission of hemorrhagic dengue fever, these vectors not being present in other biomes around the world (Halstead 1980). As mentioned previously, human interaction with the physical environment, or more specifically, rural development pushing settlements into areas where pathogens and vectors reside can introduce humans into the disease cycle (Roundy 1980). Similarly, Chagas disease transmission to humans in the Americas is often an unfortunate result of development in the tropics (Haddock 1979; Weil 1981; Dias 1987; Barrow 1988). As natural habitats for the triatomine bug vector of Chagas disease, are destroyed, so the insect is drawn into settlements resulting in the home being incorporated into the transmission cycle of the disease.

The second region discussed by Meade and Earickson (2000) is also defined by biotic environments but has an evolutionary process focus. Realms of evolution are the places in which flora and fauna evolved separately, and these realms have consequences for disease patterns. Animals, insects, bacteria, viruses, have all evolved in association with geographic variation (Garrett 1994; Alchon 2003). For example, the bacterium *shigellois*, found in Old World tropical areas, is believed to have moved across the Bering Strait with early migrants and has been identified in the skeletal remains of populations who settled in tropical environments of the Americas (Alchon 2003). Although these species may originally be location-specific, environmental change and international movement of people have fostered diffusion outside natural ecotopes or environments. The most widely studied example of this has been termed the Columbian Exchange (Crosby 1974; Crosby 1976; Meade and Earickson 2000). Diseases including smallpox and typhoid were brought by European explorers to the Americans while syphilis and Chagas disease made the return trip to Europe carried by these same explorers (Denowitz 1997; Alchon 2003).

Cultural regions, which are larger than a single community but usually smaller than an entire continent, comprise the third of Meade and Earickson (2000) regions. This type of region consists of particular cultures and their practices that can bring humans into contact with diseases, or in some instances, act as a protection. Home construction materials, occupation, food preferences, technological advances, or behavioral choices, all contribute to cultural influences on human health. For example, populations that allow domesticated animals such as dogs and cats in their homes can potentially introduce a contact mechanism for tick-born disease (Wellmer and Jusatz 1981).

Similarly, food taboos, associated with certain cultures have kept them safe from tapeworms in under-cooked meat (Markell and Voge 1986).

The last region described by Mead and Earickson (2000) is termed natural nidus. This incorporates how disease moves and maintains itself in small community environments. This realm is most concerned with transmission cycles of both the agent and vector and its relationship with other animals including humans (Roundy 1980). Geographers are uniquely positioned to combine all the physical, biotic, and cultural aspects that contribute to the continual transmission of diseases at this community scale.

Diseases function at a variety of geographic scales; each of these regions contains disease systems and distribution mechanisms dependent on that scale. Geographers can compare diseases globally by selecting regions with similar climatic and ecological environments to determine, what, if any, differences exist. If, within these similar global environments differences are found, then a natural point of investigation is the culture and the landscape created by that culture associated with a site-specific community or place.

This dissertation combines aspects of both medical geography and the geography of health, and as such, it could be called a new medical geography (Dyck 1999; Elliott 1999; Parr 2002). The investigation does not focus on spatial analysis nor does it rely on social theory to explain the domestic colonization of *Triatoma dimidiata* and the transmission of *T. cruzi* in the study area (Dyck 1999; Parr 2002). Rather, several techniques are used in conjunction to examine Chagas disease in the Los Tuxtlas region of Mexico. This examination develops a unique concept of place related to the six communities investigated. In order to explain how this dissertation uses a different

approach, the following section explores definitions of place with regard to how it is used in health studies. Since the concept of place has changed over time in medical geography, it is important to understand the differences in the use of place in the more traditional context of this sub-field and in the context of this dissertation.

2.3 Place and the New Medical Geography

Place plays a significant role in the identification and prevention of diseases. As Kearns and Moon (2002: 610) tell us, “places matters with regard to health, disease, and health care.” Where people live and how they see themselves in place can affect their health, positively or negatively. The concept of place has, much like medical geography, also evolved in geographic research. Traditional geographers were solely interested in the positivistic definition of place, using the term as a generic, generalization for geographic representations (Harvey 1969). In the 1970s, however, humanistic geographers began using the concept of place as a subjective distinction between research sites (Gregory 1978; Guelke 1978). The identification of site-specific characteristics were used to describe place as a subjective phenomenon in geographic space (Anderson 1991; Creswell 1996). The concept of place became all-inclusive. Descriptions of place included both the physical characteristics, such as vegetation and climate, and the human elements, such as house-types and food production methods, all of which made that place unique. Geographers then took the exploration of place a step further. They began to examine how these place-specific characteristics could affect identity and social relationships. Medical and eventually health geographers realized that these identifiable characteristics of place were influential in explaining patterns of ill-health (Litva and Eyles 1994; Kearns 1994; Kearns 1997; Luginaah et al. 2000; Chacko 2005). Thus, the

cultural expressions used to define place became markers for identifying risk factors in health studies (Baxter, Eyles, and Williams 1992; Eyles et al. 1993; Luginaah et al. 2000; Chacko 2005; Bailey et al. 2006). Several avenues for place-based investigations developed in the health research paradigm in geography. For the purpose of this project two approaches will be discussed; place as specific localities and place represented in cultural landscapes. This combination of uses helps to explain the new medical geography of Chagas disease employed in this paper.

The first way that health geographers consider place is as specific localities (Joseph and Chalmers 1996; Luginaah et al. 2000; Wakefield and Elliot 2000; Barnett 2000; Kearns and Moon 2002; Wakefield and McMullan 2005). Works related to this idea range from community reaction to health threats, to the restructuring of health services in specific rural and urban communities (Joseph and Chalmers 1996; Luginaah et al. 2000; Wakefield and Elliot 2000; Barnett 2000; Wakefield and McMullan 2005). We can therefore find in these health geographers' research, reflections of places as they relate to health and illness (Kearns and Moon 2002). These authors consider place as an experience of both literal and experienced localities (Kearns and Moon 2002). These papers allow for a deeper understanding of specific localities, including its physical and human geography, and an associated health perception. The environmental parameters for Chagas disease are widespread throughout the Americas; therefore, it is necessary to isolate and specify the physical and human environment of Los Tuxtlas as a specific place different from other places where this disease is found.

The second way in which health geographers have considered place is through the perceptions of landscape (Dear and Wolch 1987; Gesler 1992, Parr and Philo 1995; Parr

1997; Williams 1999; Dyck et al. 2005). These studies emphasize culture as an important aspect of place, and the elements of culture as affecting health and disease transmission. The idea of landscape was adopted from other geographers such as Cosgrove (1998), who were interested in the theoretical idea of the term. Among these theoretical uses of landscape such metaphors as therapeutic landscapes were created (Gesler 1992; Williams 1999; Andrews 2004; Smyth 2005; Moon, Kearns, and Joseph 2006). Others look at landscapes as they reflected cultural ideas of despair and institutionalization (Dear and Wolch 1987; Parr 1998). Of course cultural landscapes, or the cultural expression in the physical environment, have a long tradition in geography, for example the seminal work of Carl Sauer (1963). Within these communities, however, medical and health geographers have now developed methods to thoroughly investigate diseases and their relation to human health.

2.4 Theoretical Frameworks

Central to this dissertation is the identification of the Chagas landscape in the Los Tuxtla region of Mexico. This is accomplished by combining anthropological, geographical, and epidemiological techniques to create a biosocial investigation of the disease (Farmer 2001). Many modes of inquiry have been used for investigations into diseases like Chagas; however, for this dissertation two are prioritized: human ecology (Mead and Earickson 2000) and cultural epidemiology (Inhorn and Brown 1996; Weiss 2001; Taieb et al. 2005). These will be combined into what is termed the mixed method approach by Abbas Tashakkori and Charles Teddlie (1998; 2007), allowing for a more thorough examination of health in general and more specifically Chagas disease in the six communities in the Tuxtlas region.

Human ecology is a broad theoretical framework that has been used by several disciplines to discern if patterns exist across time and space in relation to how humans interact with their environments (Barrows 1923; Croll, 1983; Papanek 1984; Hawley 1986; Steiner and Nauser 1993; Dangana and Tropp 1995; Meade and Earickson 2000). Medical geographers have specifically applied this framework when considering disease. The human ecology of disease, according to Meade and Earickson (2000: 29) is

concerned with the ways human behavior, in its cultural and socioeconomic context, interacts with environmental conditions to produce or prevent disease among susceptible people.

Humans manipulate their environments to better suit their situations. This action disturbs the natural order in the surrounding environment which in turn can increase the likelihood of humans interacting with disease vectors (Haddock 1979; Roundy 1980). By understanding the relationship between humans and their environment in regard to preventing or contracting diseases, one can better understand potential risks and how to mitigate susceptibility.

For example, through the pursuit of a better life (home, family, and income) many of the families may create environments conducive to contracting Chagas disease (Haddock 1979; Bastien 1998; Prata 1999). Clearing of land for farming and ranching purposes in sparsely populated areas have changed the natural environment and allowed the agents of Chagas disease to enter the everyday human environment. It is this adapted and manipulated local environment of the study communities that will be explored in the Tuxtla region.

In discussing human health in relation to the methodology of human ecology, according to Mead and Earickson (2000), one must look at three factors: habitat,

population, and behavior in order to better understand the relationship between people and their pathogenic environment. These three factors directly and indirectly affect human health. Habitat is explained as the, “part of the environment within which people live” (Meade and Earickson 2000: 32). This includes both naturally occurring phenomenon such as insects and plants, as well as the built environment, including homes, work spaces, and healthcare facilities. Within this habitat, people may act as possible disease hosts. Some populations have genetic predispositions that help them to deal with specific disease (Meade and Earickson 2000). In addition, within this population there may exist certain behaviors or “the observable aspects of culture” (Mead and Earickson 2000: 32), that may increase risk from diseases or even prevent them.

For example, the aboriginal population called the Fore found in New Guinea ate the flesh of dead relatives which resulted in the contraction of the degenerative neurological disorder, *Kuru* (Lendembaum 1970). Using a Chagas disease exposure risk example, the cultural phenomenon of eating triatomine bugs in Bolivia as part of a ritualistic healing practice has also resulted in human infection (Bastien 1998). Although triatomine bugs alone are not infective agents, they can cause infection when they are carrying the parasite *T. cruzi* and are ingested by humans.

These three factors together define the human ecology of disease and in so doing structure the research methods to be employed. The incorporation of the above three elements into the study of Chagas disease allows for a better understanding of the relationship between humans and their habitat aiding in our conceptualization of the geography of risk in these places. This methodological approach, however, does not necessarily leave room to incorporate a community’s own cultural perception of illness.

Indeed, because much of the medical geography literature lacks the exploration of cultural perceptions it is important to incorporate the theoretical framework of cultural epidemiology (Trostle and Sommerfeld 1996; Weiss 2001). This method allows for the combination of both qualitative and quantitative techniques to investigate the context and concepts of illness (Weiss 2001). According to Weiss (2001: 21), “the interrelationship between quantitative and qualitative data is a priority for cultural epidemiology.” The three factors which are principle to an investigation in human ecology: habitat, population, and behavior, will be combined with cultural epidemiology to allow for both an *etic* description of Chagas disease and an *emic* representation of Chagas disease in the Tuxtlas (terms explained below) (Weiss 2001).

Although the concept and investigation of culture has been incorporated into many of the social science disciplines, including geography, it is an established central theme in anthropological investigations. More recently this discipline has incorporated into its realm of investigation the study of illness and health, termed medical anthropology. Within this sub-field (Goodenough 1963), anthropologists while studying specific cultures, began describing the principles and practices of cultural beliefs and rituals on health and health related issues (Trostle 1986; Baer, Singer and Susser 2003). The sub-discipline of medical anthropology was born when anthropologists became involved with international health initiatives and public health issues.

Within this sub-discipline, anthropologists began incorporating terms from other subfields in anthropology in order to explain the culturally oriented investigation into health and perceptions of illness. Use of the terms *emic* and *etic* in discussions of disease and illness in communities were borrowed from linguistics in order to more fully explain

cultural perceptions (Headland et al. 1990). *Emic* perspectives are considered the insider's point of view in relation to a certain phenomena while the *etic* perspective is based on an outsider's view. These terms were easily applied to medical studies in anthropology as researchers began explaining both how cultures perceived their health and illness, while at the same time linking these explanations to scientific causative factors of disease for a wider scientific audience. Although these attempts were meant to establish links between anthropology and medicine, anthropologists were primarily focused on the subjective inquiry into health providing a contrasting approach to the more objective view utilized by epidemiologists.

Epidemiology, by definition, is the, "study of the distribution and determinants of disease" (Lilienfeld 1976: 185). Those who work in this field are primarily concerned with how and by what means a disease is distributed in a certain environmental context, thus establishing the relationship between a disease and the population it has affected. The final product of these investigations is the eradication or control of that particular disease.

Some epidemiologists have incorporated questions concerning the effects of culture on health (Berkman 1980, Cassel 1964, Cassel et al. 1960, Marmot 1981; Berkman and Kawachi 2000). However, few have conducted their research with the explicit objective of identifying exactly which cultural practices affect the distribution of specific diseases or increase the risk for contracting an illness. Although social and behavioral epidemiology has existed in theory for some time, few have used these methods in unison to cross-culturally investigate specific groups and the diseases that plague them (Heggebhougen 1986).

It is with the combination of medical anthropological theory and the quantitative investigation methods of epidemiology that these two separate disciplines have come to create a cohesive investigative structure. According to Baer, Singer, and Susser (2001: 26),

Epidemiology brings a rigorous scientific approach, an emphasis on quantitative data collection, and a specific applied orientation. Anthropology's contribution includes an emphasis on intensive qualitative investigation of behaviors and social relations in context and a keen awareness of the importance of culture (and meaning) in shaping people's behavior as well as their willingness to change behavior to accommodate public health dictates.

The union of these two disciplines, however, has not been greeted with overwhelming support. As Hahn (1995:101) put it, "some anthropologists neglect the objective world or would wish it away...while most epidemiologists would dispense with subjectivity entirely if they could." Incorporating an anthropological perspective in this dissertation will provide context and description to culture-specific phenomenon related to Chagas disease.

Therefore, using geographical techniques often employed in the human ecology perspective, such as those associated with defining cultural landscapes of disease through the identification of habitats, populations, and behaviors, it is possible to identify factors related to Chagas disease in Mexico. Additionally, using cultural epidemiology to address culture specific disease determinants, one can begin to realize the purpose of this project which is to identify and describe the Chagas disease landscape in six communities in Los Tuxtlas, Mexico.

2.5 Mixed Methods and the New Medical Geography

As mentioned in the previous section by combining human ecology and cultural epidemiology, this dissertation will better be able to combine investigation techniques and create a thorough “new” medical geography of Chagas disease. In the following quotation, Patton suggests that mixing methods is an appropriate technique, not an abnormality and should be used in the health research pursuit.

Rather than believing that one must choose to align with one paradigm or another, I advocate a paradigm of choices. A paradigm of choices rejects methodological orthodoxy in favor of methodological appropriateness as the primary criterion for judging methodological quality. The issue then becomes whether one has made sensible decisions given the *purpose of the inquiry and the questions being investigated* (Patton 1990:39; emphasis added)

The combination of traditional medical geography and geography of health methods allow for this “paradigm of choices” (Patton 1990: 39). Interestingly, the call in the 1990s for qualitative analysis in medical geographies did not simply suggest the abandonment of quantitative inquiry but, instead, a combination of the two (Kearns 1993; Kearns 1994; Elliot 1999; Dyck 1999). The mixed method approach has been used in many academic disciplines in their research agendas, from health professionals looking at women in early pregnancy (Jomeen and Martin 2005) to geographers looking at class and politics (Brown, Knopp, and Morrill 2005). The combination of quantitative variables with qualitative analysis allows researchers the ability to broaden the scope of their projects and their results. A good example of this type of approach is illustrated by Skelly et al. (2002: 159) where both qualitative and quantitative techniques were used to analyze “socio-spatial knowledge networks, for examining and understanding the spatial aspects of knowledge” of health beliefs in a rural community. In so doing, the research

team utilized interviews with community members to create a contextual basis for statistical exploration of knowledge networks within the community. The combination of spatial analysis and ethnography gave the researchers a better understanding of how several ethnic groups think about their health and health care options.

There are several ways in which the mixed method approach can be applied to research. Creswell (2006), in an extensive literature review of this subject, defined five reasons for using the mixed method approach. The first, triangulation, is defined as simply the convergence of results of mixed studies (Creswell 2006). The second is termed complimentary, where mixed methods were used to examine different aspects of the same phenomena. Initiation, the third method, is used to find contradictions in ideas or to add new perspectives to research topics. The fourth approach is coined development. When using this particular perspective, researchers sequentially incorporate a mixture of methods so that one method is used to inform a second. The final approach, termed expansion, involves mixing methods to add breadth and scope to a project (Creswell 2006). For example, the use of surveys and ethnography employs several analysis techniques thus engaging a wider audience. The approach in this dissertation goes beyond triangulation and allows for a mixing of methods throughout the study (Tashakkori and Teddlie 2007). Thus, the mixed method approach used here embraces the expansion approach as both quantitative analysis and qualitative techniques are used throughout the study.

My participation in this project has gone through several evolutions culminating in the techniques used during my field season from February 2005 to June 2005 when I collected the majority of my data. In the final evolution I used several

modes of inquiry including house type surveys, scheduled interviews, and the voluntary collection of insects in order to gather both quantifiable and qualitative information necessary to detail and describe the Chagas landscape in this region. These techniques allow me to understand the *emic* perspectives in relation to Chagas disease and to collect quantifiable data such as construction materials and numbers of bugs that can later be represented spatially, thus capturing geographic variation in the Chagas landscape.

2.6 Inequalities and the New Medical Geography

As shown above, place matters in the relationship between humans and their health. What has not been discussed is how health and diseases are not equally distributed throughout society or even equally distributed within the same place. These inequalities do not simply express difference in social status, although this aspect of inequality is important and will be addressed below, but we must also consider the ways in which the differences in place affect inequalities in health. This section will address the literature associated with inequalities of health and discuss how these issues will be addressed in this work in relation to the new medical geography and place.

Many researchers, such as Michael Hayes (1999), have voiced that *The Black Report* (Department of Health and Social Security 1980) has been one of the most influential twentieth-century documents in the investigation of health inequalities. The report documents inequalities in the health of British citizens related to events beyond biological differences among groups of people. It also documents the history of inequality research. According to *The Black Report* (Department of Health and Social Security 1980), traditional works associated with inequalities in health focus on one of two ideas: either biological differences or socio-economic differences. Biological

differences causing variations in health outcomes have been widely discussed but have little bearing on the present investigation (Department of Health and Social Security 1980). The second theme, however, deals with occupation and income and how this impacts access to healthcare (Department of Health and Social Security 1980).

Encapsulated in one's occupation are a number of elements that can also affect health and access to health care including housing, education, and access to health insurance. These factors interact with each other to influence health and the type of health care a person receives. An aspect of this equation that was overlooked as simply a determinant of social class is the location of residence. This has also been identified as an important element of health status and as an important variable in the inequality equation.

Therefore place, yet again, plays an important role in health. Smith and Easterlow (2005) describe the relationship between geography and inequalities in health and how this relationship revolves around a set of simple questions. How much, and in what ways does place affect health (Smith and Easterlow 2005)? Despite the focus on and importance of place in understanding health inequalities, geographers did not spearhead this investigation (see Macintyre et al. 1993, 1997, 2002, 2004; Ellaway et al. 2001; Smith and Easterlow 2005). Rather, medical sociologists were responsible for the inclusion of place in the inequality debate in Canada and the United Kingdom.

Medical sociologists explored the differential impact of place on human health and how these differences are locked into the kinds of places we live, resulting in spatial inequalities in health (House 2002). As a result of geographers being slow to enter this inequality debate, Robin Mitchell posed an important question to this investigation:

Are geographical inequalities in health and illness just a reflection of socio-economic differences among their inhabitants (composition) or do

places add their own contribution to patterns of health variation (context)?
(Mitchell et al. 1998: 4)

As a result of this article, geographers entered the investigation (Curtis et al. 2003; Smith and Easterlow 2005). Using multilevel modeling, geographers like Ducan et al. (1998) are now examining how modeling techniques can be used to determine health inequalities by combining different geographic aggregations to explain context, by including both individual health outcomes and neighborhood risks.

Equally important to the development of geography in health inequality research was the commentary in *Environment and Planning A* in which Danny Dorling (2001:1335) declares, “You’re a product of your geography.” This statement solidified the ideas in the geography of inequalities that context, and thus place, is important. Smith and Easterlow (2005: 177) reiterate this point in their pronouncement “that where people come from (and particularly the circumstances they lived in as children) has a bearing on health outcomes.”

Since these first papers appeared, there has been a substantial amount of work on this topic within geography (Curtis et al. 2003; Smith and Easterlow 2005; Bolam, Murphy and Gleeson 2005; Tobias and Searle 2006). These works now go beyond the initial use of modeling to incorporate qualitative analysis in the quest to define not only where disease is located, but to thoroughly investigate cultural causes of health inequalities (Bolam, Murphy and Gleeson 2005; Tobias and Searle 2006). It is with this last set of papers that include qualitative methods that this research is situated.

What we shall see in this investigation is that not only do socio-economic differences contribute to health inequalities, but place-specific attributes contribute to the manifestation of Chagas disease in the study area. Where we live matters because of our

physical environment and the cultural practices that have developed, thus increasing our risk exposure. In addition to the differences in places, there are also variations in health equality among people of the same community or even the same household. These inequalities exist because of unequal access to health promoting initiatives. As we shall see in the following pages, context of place and Chagas disease has a bearing on a lifetime of health or illness.

CHAPTER 3 A NEW MEDICAL GEOGRAPHY OF CHAGAS DISEASE

Dos los tres elementos que forman parte de la transmisión de la enfermedad: el parásito que lo produce, el vector que la transmite y el hombre que la sufre... (Briceño-Leon 1990: 29)³

3.1 Introduction

American trypanosomiasis, or Chagas disease, is a protozoan zoonotic disease caused by the hemoflagellate *Trypanosoma cruzi* and is endemic to the Americas (Schmunis 1994). Chagas disease is primarily transmitted to vertebrate hosts through the feces of the hematophagous insect included in the subfamily Triatominae (Schmunis 1994). It is estimated that nearly 18 million people in Latin America had been infected with Chagas disease and that another 120 million were at risk (WHO 1991; CDC 2006; Dorn 2007). As noted by Joao Dias and Charles Schofield (1999: 103),

Chagas disease is one of the most serious parasitic diseases of Latin America, with a social and economic impact far outweighing the combined effects of other parasitic diseases such as malaria, leishmaniasis and schistosomiasis.

Chagas disease is ranked third by the WHO (1991) among infectious diseases in the Americas only after AIDS and tuberculosis, thus exemplifying its significance to morbidity and mortality rates in the region (Ramsey unpublished manuscript 2005). In many countries, particularly in South America, control programs exist to prevent future generations from becoming infected. In Mexico, however, until recently there has been little surveillance or control in relation to this disease even though there was a high seroprevalence found in the *First National Seroepidemiological Survey* in 2000 (Ramsey unpublished manuscript 2005).

³ There are three elements that form the transmission cycle of the disease: the parasite that produces the disease, the vector that transmits the disease, and the human that suffers...

This chapter provides an introduction to the disease, beginning with a brief history of the disease and continuing with its epidemiology in the Americas; including a discussion of the parasite, the vector, its transmission methods, human incidences and geographic distribution. The chapter will conclude with a detailed discussion of its significance in Mexico including morbidity and mortality figures associated with the disease and its significance in the State of Veracruz, in which the communities of study are found.

3.2 Carlos Chagas and His Disease

While helping to control the spread of malaria in the Rio das Velhas Valley of Brazil, in a town called Lassance, Dr. Carlos Chagas first noticed an illness among several of his patients that did not seem to correlate with any known disease symptoms (Bastien 1998; Prata 1999). He had been called to this region because of the thousands of immigrant railway workers who were dying while trying to complete the railroad from Rio de Janeiro to the northern city of Belem. Once in Lassance he set up a small clinic in a railroad car and began treating the workers for primarily malaria and syphilis (Briceño-Leon 1990; Bastien 1998). However, after several weeks he noticed that several of his patients had unusual symptoms, similar to those attributed to a parasitic infection, that at first he associated to syphilis. His curiosity was peaked when one of the railroad engineers brought him an arthropod insect known as a *barbeiro* which was infesting the barracks of the workers and biting them while they slept (Bastein 1998). He decided to prolong his stay in Lassance in order to more fully understand this insect's habits (Bastein 1998).

While studying the *barbeiro* (which has now been identified as *Triatoma infestans*) Chagas began dissecting them and noted some flagellates inside their lower intestines (Bastein 1998). He identified the flagellates as part of the family trypanosomidae and named it *Schizotrypanum cruzi* (Lainson 1990) after his mentor Oswaldo Cruz. Later this parasite would be renamed *Trypanosoma cruzi* (*T. cruzi*). Chagas was still uncertain if this new parasite was the cause of the unknown illness although he noted that the new parasite resembled *Trypanosoma brucei gambiense* which is responsible for African sleeping sickness (Bastein 1998). According to Bastien (1998), Chagas hypothesized that *T. cruzi* was either naturally occurring in the arthropods or that they were one stage of a parasite that could be transmitted to humans. He then began testing animals and humans assumed to have died from the strange disease.

It was not until April 1909 that Chagas documented the first cases of human and animal *T. cruzi* infection. He spent the night with a family who had a sick cat in which he found the parasite. He returned to the house three weeks later to treat a child, Rita, that had become ill (Bastein 1998). He examined her blood and also found the parasite, thus identifying *T. cruzi* infection in humans. Three days later she died of what is now known as parasitism related to acute Chagas disease (Lewinsohn 1981).

What is interesting about the discovery and history of Chagas disease is that Chagas found the parasite and vector long before the disease was actually described. It took another ten years for this to occur and another forty before Chagas disease was seen as a serious health problem in Brazil (Prata 1999). However Chagas did make some important observations in terms of the epidemiology of the disease. As noted by Aluizio Prata (1999) Chagas realized that the disease was most prevalent in the poor populations

of Brazil because of the numerous places inside the homes and in the walls where the bugs could hide. He also noted that infection rates seemed to follow the paths of expansion into uninhabited forested areas. He hypothesized that because of the size of the bugs and their preference to hide in dark places during the day they could easily be transported in luggage and carried to urban areas, thus potentially infecting a whole different socioeconomic class in Brazil. These findings, although not readily accepted during Chagas' life have become well documented today (Zeledon 1974; Pavlone 1988; Carcavallo 1999).

3.3 Epidemiology of Chagas Disease

Chagas disease, as previously mentioned, is endemic to the Americas, indeed archeologists have found evidence of the disease in Andean mummies dating back to A.D. ~400 (Rothhammer et al. 1985; Fornaciari 1992; Arriaza 1995; Aufderhide et al. 2004). Some also speculate that Charles Darwin may have contracted Chagas disease while in the Americas with its symptoms being described in his many journals (Adler 1959; Woodruff 1965; Aufderhide et al. 2004). As noted by Carlos Chagas nearly a century ago this disease is most commonly found among the poor populations in Latin America (Briceño-León 1987,1990, 1993; Ramsey et al. 2003; Ramsey and Schofeld 2003; Eldrige and Edman 2004). Ramsey et al. also noted this fact and said:

In most Latin American countries, at-risk endemic areas are rural populations, because of precarious housing and close contact with sylvan vector-reservoir habitats (Ramsey et al. 2003: 912).

Related to the construction of dwellings and environmental conditions present in these poor communities, this disease has become, “one of the most important and widespread insect-vector diseases in the New World (Eldrige and Edman, 2004: 285). Although

Chagas disease was first documented in rural areas it has now become a problem in urban and periurban areas as well (Turner 1969). Usually associated with rural to urban migration, these periurban communities or edge cities, more commonly known as squatter settlements, are noted as sites for infestation (Turner 1969). More recently however, researchers particularly in Mexico, have documented urban and suburban infestations (SOH 1994; Ramsey et al. 2003). Many of these urban sites are outside the natural ranges of any of the known vectors, leading researchers to the conclusion that the infested households hold strong ties to rural communities (Alvarez 2003). These ties can be either through family contact or vacation trips, with destinations being where rates of infestation and infection are much higher. The returning families bring back the vectors themselves or the parasite in their blood (Ramsey and Schofeld 2003).

3.3.1 Transmission Cycles

Chagas disease is a zoonotic disease or “an infectious disease of nonhuman vertebrate animals that is secondarily transmissible to humans” (Eldridge and Edman 2004: 165). There are three transmission cycles of Chagas in which the vector participates; sylvatic (wild transmission), domestic (transmission to humans); and peridomestic (attraction of the vector to homes by synanthropic animals and lights) (Briceno-Leon 1990; Briceño-León 1993; Schmunis 1994; Gurtler et al. 1997; Wastavino, G., et al. 2004; Segura and Escobar-Mesa 2005).

In its sylvatic cycle the vector lives and feeds in the nests of mammals such as opossums and other wild rodents, completely separate from the human environment (Zeldon 1974, 1983). The domestic cycle, which now maintains the disease in humans, is most frequently found in rural areas where there has been uncontrolled development into

the vectors habitat and more recently in periurban areas associated with rural migrants (Turner 1969; Weil 1981). In the rural domestic cycle researchers have established relationships between infestation rates and house-type construction as well as the kind and amount of non-human vertebrates allowed to live in and around the house (Brener 1994; Sarquis et al. 2006) (see the section on Mammalian Hosts). Houses with construction materials that allow cracks in walls, such as adobe and wattle and dab, give the vectors places to hide during the daytime (Koberle 1968; Laranja 1956; Zeledon 1974; Briceno-Leon 1990; Briceño-León 1993; WHO 1996; CDC 2006). Equally, some species of this vector can camouflage themselves in dirt, thus homes built with either a space between the ground and the floor of the house or houses with unfinished dirt floors provide vectors with convenient hiding places (Zeledon 1969). Roofing materials and structure also play a role in infestation rates. Homes built using palm fronds as roofing material replicate the natural habitat of one species of the vector which allows for an easy transition into the domestic cycle (Lent and Wygodzinsky 1979). Likewise, homes built with rafters give the vector places to hide away from the ground during the day and also facilitate infection from contaminated feces dropping onto humans (further explanation in the section entitled Modes of Transmission) (Schofield 1979). Also it has been noted that these vectors will hide behind pictures, under beds, in clothes, behind furniture, and anywhere else in the house where they can rest undisturbed during the day (Minter 1978).

The peridomestic or third cycle, provides the link between the sylvatic and domestic systems (Schmunis 1994; Sarquis et al. 2006). This cycle explains the relationship between non-human vertebrates who move freely in and out of the home attracting vectors closer to the domicile or even transporting them in on their fur. The

vector is also attracted to the lights of the house and can be drawn to the house during the night (Schmunis 1994).

3.3.2 Geographic Distribution

Climate plays a part in the reproduction of the Chagas vector making them seasonally dependent thus geographically restricted (Forattini 1972). Vectors are restricted to the Neotropics covering a geographical area from 42°N latitude to 43°S latitude (World Health Organization 1990; Schmunis 1994; Eldridge and Edman 2004). The northern border for this area extends from Northern California to Maryland in the United States, while its southern boarder extends from the Patagonia region of Argentina and across into Chile.

The vector for Chagas disease is more widespread than the incidences of domestic and peridomestic human infection rates appear. As one can see from Figure 3.1, parts of Mexico and the United States are not included in the geography of human infection, however, human infection in these areas has been found (Schiffler et al. 1984; Woody and Woody 1995; Herwaldt et al. 1998; Dorn et al. 2007). In addition, as of 2006 there have been 6 reported cases of insect-transmitted Chagas disease in the United States (Schiffler et al. 1984; Woody and Woody 1995; Herwaldt et al. 1998; Dorn et al. 2007). Although this number is small in comparison to the infection rates of Latin America, these cases are significant in extending the previously known geographic distribution of human infections. The vector-to-human transmission, which were previously restricted to the Mexico/United States boarder and California, have now been documented in Tennessee and Louisiana (Beard et al. 2003; Dorn 2007).



Figure 3.1: Geographic Distribution of the Human Infections of Chagas Disease in the Americas (Schmunis 1994)

In the Pan-American Health Organizations 1994 publication *Chagas' disease and the Nervous System*, chapter author Gabriel Schmunis created a four tiered grouping system related to the geographic distribution of human infections in the Americas and their related control programs. Those countries in Group One represent the highest incidence of human infection but also have control programs in place to facilitate eradication (see Figure 3.2). The countries in Group Two again have a high incidence of human infection though control programs are in their infancy and therefore not as effective in the eradication of the vector as Group One. Those countries in Group Three have had documented cases of human infection but have no control programs in place while Group Four illustrates those countries with insufficient evidence for infection and no control programs. Figure 3.2 illustrates these criteria and thus one can infer as to why Chagas is still a major public health issue in many countries in Latin America.

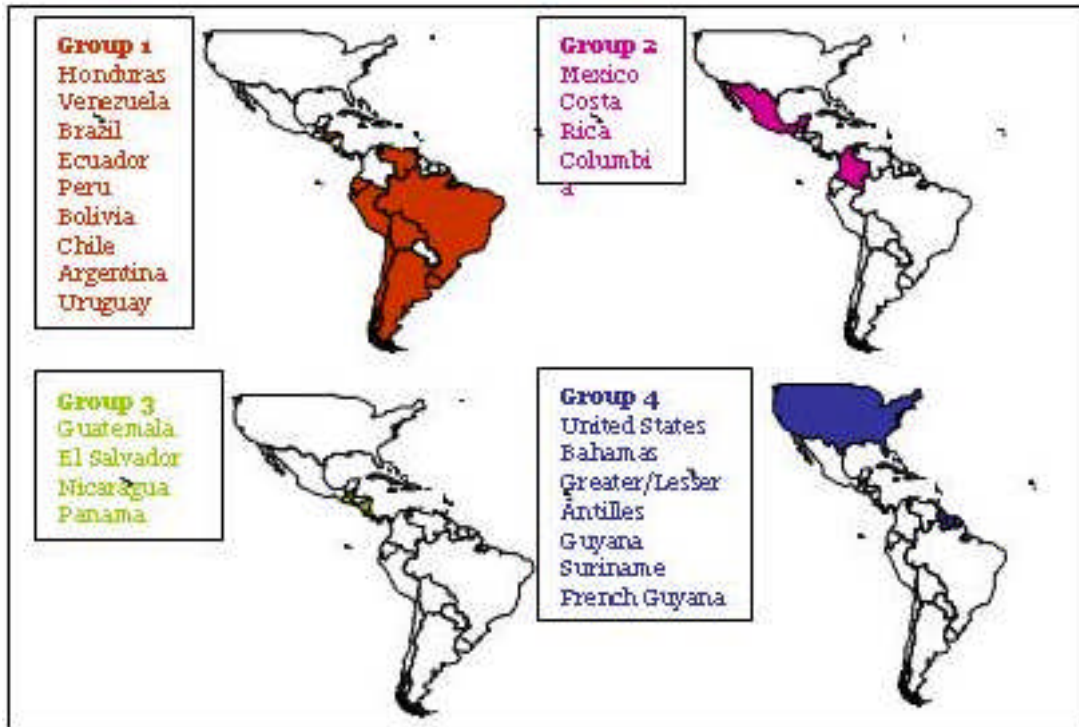


Figure 3.2: Geographic Distribution of Incidences in the Americas (Schmunis 1994)

As mentioned previously, although Chagas disease is endemic to the Americas, vector to human infections are restricted to predominantly Latin American countries (Briceno-Leon 1990; Briceño-León 1993; Dorn, Monroy and Curtis 2007). Within these countries infection has been primarily restricted to the poor (Briceno-Leon 1990; Briceño-León 1993; WHO 1996; Wastavino et al. 2004; Segura and Escobar-Mesa 2005). Movement from one place to another within these countries is common and has been associated with increases of the Chagas vector in and around urban areas (Zuna 1979; Haddock 1979; Kirchhoff and Neva 1985).

Latin America as a region has also seen massive migration patterns to other parts of the world as residents seek life improvements such as higher education and professional careers (Kirchhoff 1989). Probably as a result of these migration patterns,

Chagas disease has been detected in the blood supplies of many other countries, including the United States.

The United States has also been an important destination for Latin American immigrants. Today the issue of Latin American immigration patterns is at the fore of political dialogue. In relation to immigration patterns in the last several decades health officials now suspect that an estimated 100,000 Latin American immigrants living in the United States are infected with this disease (CDC 2002; CDC 2006; CBCSF 2006). Additionally, Chagas disease has now been documented in the blood and organ supply in parts of Southern California and Southern Florida (see conclusions for further information) (CDC 2002; CDC 2006; CBCSF 2006). Health officials are confident that Chagas disease is being carried into the United States by a large portion of the Latin American immigrant population but also admit that one transplant recipient's death was caused by a person born in the United States (but had traveled extensively to endemic areas) (Hagar and Rahimtoola 1991; Herwaldt 2000; Kirchhoff 1993; Pearlman 1983; Woody and Woody 1955; CDC 2002; CDC 2006; CBCSF 2006).

3.3.3 The Parasite

The parasite associated with Chagas disease is called *T. cruzi* (*T. cruzi*). It belongs to the subkingdom Protozoa, phylum Sarcomastigophora, subphylum Mastigophora, class Zooastigophorea, order Kinetoplastida, family Trypanosomatidae, genus *Trypanosoma*, and species *cruzi* (Lansion 1979; Bastien 1998). *T. cruzi* can be further classified into the special stercorian section because of where the infective stage of the parasite develops and how it is then transmitted to a mammalian host.

This particular parasite, and trypanosomes in general, fit into the order Kinetoplasida because they contain flagellum and a kinetoplast. The kinetoplast is unique to this order and has been described as, “sausage or disc-shaped” (Bastien 1998: 159). Contained in the kinetoplast is the organelle’s mitochondrial DNA which gives rise to the mitochondria. The single mitochondrion that develops in the kinetoplast is the center for respiration and energy production for the organism (Lainson 1979; Bastien 1998). Within the kinetoplast network there are mini-circles and maxi-circles that act as the brain for the mitochondria, dictating the replication rate and survival of the mitochondria during the cell cycle (Marsden 1983; Bastien 1998). Containing only one nucleus, trypanosomes reproduce asexually through binary fusion (Miles 1980; Bastien 1998).

Unique to the family Trypanosomatidae and thus the reason *T. cruzi* is included, are the different organisms life-stages. In this family an organism’s lifecycle can begin in the intestines of a blood sucking invertebrate vector and end in the blood or tissue of a vertebrate host (Lainson 1979; Bastien 1998). Once in the vertebrate host the organism multiplies via intracellular stages, which allows *T. cruzi* to be included in a special subgenus *Schizotrypanum* (Bastien 1998). As previously mentioned, *T. cruzi* is further categorized into the special section stercorarian because the parasite’s infective stage develops in the digestive tract of the vector and infects mammals through its feces. It is the only human trypanosome that is transmitted from an invertebrate vector to a vertebrate in this way. The other section associated with the Trypanosomatidae family is called Salivaria and includes the African trypanosomes (transmitters of African sleeping

sickness), and *Trypanosoma rangeli*, a nonpathogenic species found in South America. Transmission of the parasite in this subfamily is through the saliva of the vector.

There are two typical shapes the trypanosome species takes; elongated with a single flagellum or rounded with a short flagellum. The flagellum acts as a fin, attached to the parasite's membrane, which moves the parasite by undulating. The flagella also help the parasite attach themselves to the walls of the gut of the insect or its salivary glands.

In the lifecycle of the parasite *T. cruzi* there are three stages that are important in the relationship with humans; epimastigotes, trypomastigotes, and amastigotes (see Figure 3.3). Within the midgut of the insect vector epimastigotes rapidly multiply by binary fusion and create a reservoir of parasites which maintain the infection in the insect (Marsden 1983; Bastien 1998). From the midgut the longer epimastigotes (~35-40 microns) wiggle their way into the rectum of the insect adhering themselves to the epithelium of the rectal glands using their flagella (Marsden 1983; Bastien 1998).

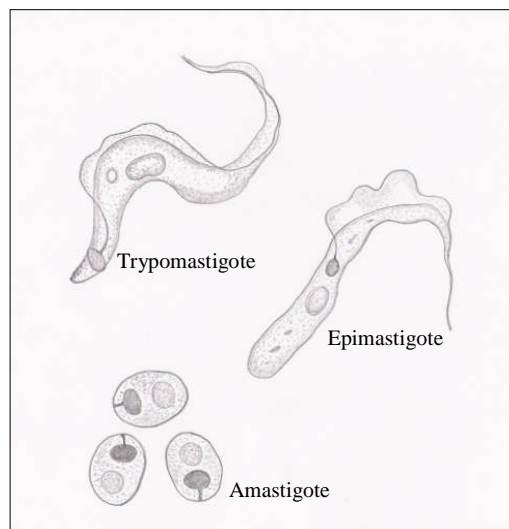


Figure 3.3: Stages of *T. cruzi* (adapted from Bastien 1998; Illustration by Boyer 2007).

Once in the rectum the epimastigotes develop into metacyclic trypomastigotes (Marsden 1983). This form of the parasite no longer divides and very actively swims without restraint in the rectal lumen (Marsden 1983; Bastien 1998). This portion of the lifecycle can take from six to fifteen days depending on the insect's stage of development and on the relative temperature of the environment the insect lives in (see section The Vector) (Marsden 1983; Bastien 1998).

The mytacyclic trypomastigotes are the form of the parasite that infects humans through the feces of the tritomine bugs. As mentioned previously, this portion of the parasites lifecycle does not reproduce in the rectum of the insect but once they have entered the cells' of mammals they begin reproducing again by binary fusion (Marsden 1983; Bastien 1998). These newly formed organisms are called amastigotes and cluster together in cells quickly making them burst and releasing the parasites into the bloodstream of the infected mammal. This allows the process to happen again frequently and rapidly in other cells. While this process is taking place these reproducing amastigotes also form trypomastigotes that circulate in the bloodstream and are ingested by other feeding triatomine bugs. This reproductive cycle is constantly happening in the host, thus hungry bugs can possibly be infected at any time. However, it is believed that the trypomastigotes that are circulating during the chronic phase of the disease are more infective to the insects then during the acute phase (Marsden 1983; Bastien 1998). During the acute phase the mammal's immune system is constantly attacking the trypomastigotes thus making them harder to ingest by the triatomine bugs (Solari et al. 1992) (Figure 3.4).

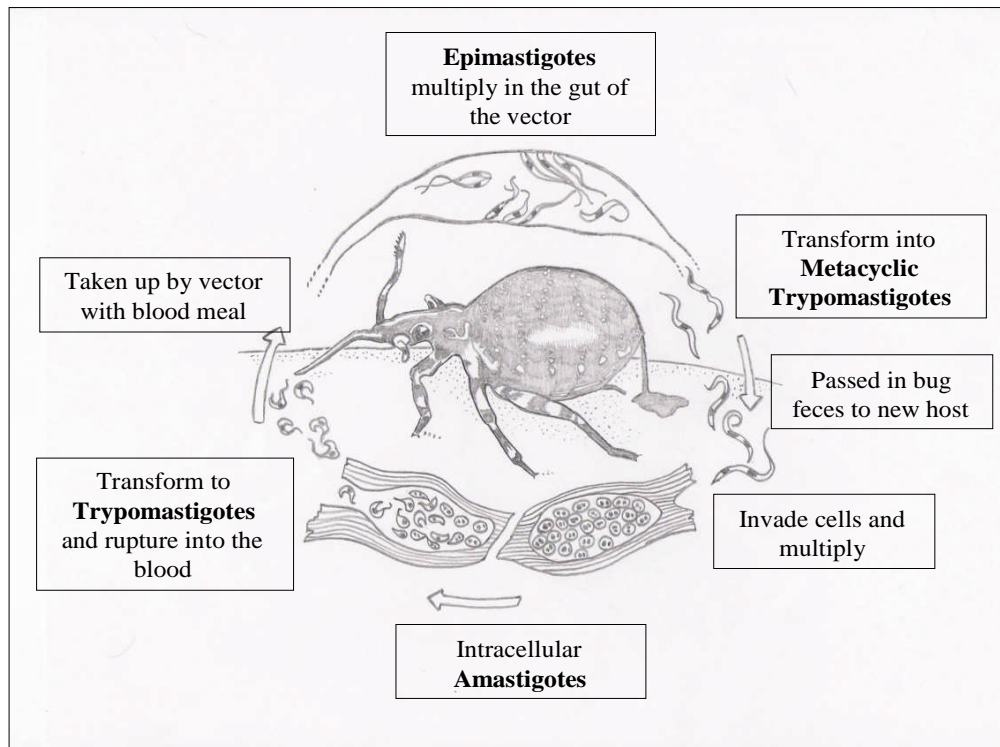


Figure 3.4: Lifecycle of *T. cruzi* (adapted from Bastien 1998; Illustration by Boyer 2007)

3.3.4 The Vector

The vector for the *T. cruzi* parasite are insects that belong to the Hemiptera order, Reduviidae family, and Tritominae subfamily, collectively called triatomine bugs (Carcavallo 1987). The Hemiptera order contains about 4,000 species of blood-sucking bugs which have two pairs of wings and special mouth parts made specifically for piercing and sucking blood (Brenner 1987; Bastien 1998). Another characteristic of this order is that they develop through incomplete metamorphosis; from egg to nymph to adult with no larval stage (Lent and Wygodzinsky 1979; Bastien 1998).

In the Americas there are about 100 species of triatomine bugs and at least 50 of these species have been documented as being infected with *T. cruzi* (Zeledon 1974; Carcavallo 1987). According to Zeledon (1974) and others (Schofield 1979; Carcavallo

1987; Schmunis 1994) only a few species are important in the transmission of *T. cruzi* to humans. These include, *Triatoma infestans*, *Triatoma dimidiata*, *Triatoma barneri*, *Triatoma sordida*, *Triatoma brasiliensis*, *Panstrongylus megistus*, and *Rhodnius pallescens* (see Table 3.1 for appropriate countries). The important species for this study is *Triatoma dimidiata*, as this is found in and around the Tuxtla region of Mexico (Zeledon 1974; Carcavallo 1987; Schmunis 1994; Guzman-Bracho 2001; Wastavino et al. 2004; Ramsey et al. 2004; Sugura and Escobar-Mesa 2005). *Triatoma dimidiata*, has also been well documented as being infected with *T. cruzi* (Segura and Escobar-Mesa 2005, Yamagata and Nakagawa 2006; Dumonteil et al. 2006).

Table 3.1: Important Vectors for *T. cruzi* in the Americas (source Zeledon 1974)

Insect	Country
<i>Triatoma infestans</i>	Argentina, Bolivia, Brazil, Chile, Paraguay, Peru, and Uruguay
<i>Triatoma dimidiata</i>	Ecuador, Mexico, and Central America
<i>Triatoma barneri</i>	Mexico
<i>Triatoma sordida</i>	Argentina, Bolivia, Brazil, and Paraguay
<i>Triatoma brasiliensis</i>	Brazil
<i>Panstrongylus megistus</i>	Brazil
<i>Rhodnius pallescens</i>	Panama
<i>Rhodnius prolixus</i>	Colombia, México, Venezuela, and Central America

The reproductive cycle for the triatomine bugs vary significantly between species (Zeledon 1974). In species such as *R. prolixus* and *T. infestans*, the reproductive cycle, during optimum conditions, can take as little as five months, thus allowing for two full cycles per year. Dias (1955) documented two generations of *T. infestans* in Brazil during his field observations. In other species such as *T. dimidata*, the reproductive cycle can take as little as one year, under optimum conditions, and as much as two years, when blood-meal sources are not abundant (Zeledon 1974).

There are various aspects that can affect the triatomine bugs' reproductive cycle. Most important of these aspects are temperature and the frequency of feeding habits (Zeledon 1974). Regions with little variation in mean temperature, such as those found below the Tropic of Cancer and above the Tropic of Capricorn, show reproduction rates at optimum capacity (Brenner 1987). Hotter months, (usually associated with the summer months) see a higher degree of breeding and hatching of eggs along with a higher degree of *T. cruzi* transmission (WHO 1991). Additionally some species are not as aggressive in their feeding habits and can go long periods without feeding which lengthens the period of time between reproductive cycles (Zeledon 1974). There is also a difference between species and the number of eggs that are produced in a female bug's lifetime. This number ranges from 300 for *P. prolixus* to nearly 1000 by *T. dimidiata* (Zeledon 1974).

The origin of the Triatomine bug is sylvatic and as there is evidence of human infection around A.D. 400 it would appear that there have always been varying degrees of domestication among the members of this species. There are species that still live and prefer wild animals and their habitats for their blood-meal source. *Paratriatoma hirsute* and *Triatoma protracta* can still be found in rodent burrows while the South American species of *Psammolestes* and *Triatoma delpontei* can be found in bird's nests (Zeledon 1974). Other species can be found in armadillo burrows as well as caves inhabited by bats (Zeledon 1974). Some of these species have been known to visit human habitats during the night.

Triatomines are nocturnal and are known to be attracted to light and heat. Thus, as humans have moved into formerly sylvatic habitats these bugs are drawn to the houses

by the lights; however this does not mean that they can successfully breed in these human ecotopes (Zeledon 1974). According to C.J. Schofield (1979), there is little information on how the colonization process takes place specifically, although many have speculated.

One well-known explanation describing the process of *R. prolixus* infestations was put forth by Gamboa (1965). This species lays eggs on the fronds of palm trees. In many parts of Latin America, specifically Gamboa's (1965) study country of Venezuela, these fronds are used for roofing material. When humans use these fronds the eggs, which are strongly attached, are brought into the home and eventually hatch and mature, thus creating the link for domestic colonization (Gamboa 1965).

Other passive forms of infestation may occur when wood is stacked in piles outside the house then brought in for use in the kitchen. There has been evidence of *T. soridida* being carried into homes in this fashion (Schofield 1979). However, there has also been evidence of active infestation by the triatomines when adult bugs are found with freshly laid eggs. *T. infestans* is a good example of this. This bug has a walking distance of up to 60m and is now rarely found in its natural ecotope (Schofield 1979).

Rodrigo Zeledon (1974) discussed several factors that he felt are necessary for adaptation and infestation into the human ecotopes. The first of these are related to the species of the triatomine themselves. They must possess the, "physiological ability, alimentary eclecticism, natural aggressiveness, duration of life cycle, biotic potential and protective mechanisms" in order to successfully adapt to the human environment (Zeledon 1974: 54). In addition there are also anthropocentric and environmental factors that also help in adaptation. For example the, "sanitary conditions in houses, [the] type of construction, [the] education level of the inhabitants, [the] climatic conditions, [and the]

natural enemies and competitors” already inside the house, play a role in infestation rates (Zeledon 1974: 54). Also included in the anthropocentric factors are the number and kinds of animals living in or near the home

3.3.5 Mammalian Reservoirs

There are 150 documented species of mammals that can act as reservoirs for Chagas disease (Zeledon 1974). The most important in association with human infection are the synanthropic animals, or animals associated with human habitations. These animals range from household pets including dogs, cats, and guinea pigs to cattle, pigs, and rats. Also in this group are animals that live in the sylvatic arena but can come into contact with humans and their dwellings. These animals include opossums, raccoons, deer, foxes and any other animals that may live in environments that have been deforested or encroached upon by humans.

Most important for this project are the synanthropic animals that live in and around the house. According to Coimbra (1988) and others (Arance 1994; Gurtler 1998; Zeledon et al. 2001; Ramsey 2003; Segura and Escobar-Mesa 2005; Zeledon and Rojas 2006) the number of animals present in the yards and their accessibility to the house is an important factor in infestations. Also the accessibility of homes to opossums has been linked to domestic infestations (Ruiz-Pina and Cruz-Reyes 2002). In rural Mexico this animal is suspected as being the link between the sylvatic and peridomestic environments (Ruiz-Pina and Cruz-Reyes 2002). The presence of other mammals such as dogs, cats, rabbits, and rodents, create the link between the peridomestic and domestic environment. Having these types of animals present gives the insect daily access to blood-meals. In many rural Latin American households these animals have free access to all living spaces

both during the day and at night. For the transmission of Chagas disease in the Tuxtla region, having the animals in the house at night when the insect feeds increases the chances that the bug will have access to human blood-meals as well.

Chickens, although not a host for the parasite, also attract the insect into the house as a blood-meal source (Dias 1985; Segura and Escobar-Mesa 2005; Zeledon and Rojas 2006). These animals are an important part of many rural Latin American subsistence bases. Families rely on the chicken for food as well as monetary exchange potential, in the selling of eggs and offspring. These animals are carefully tended and although the adults do not sleep in the house their young can be found in the house during the night. This further increases the chance of transmission to humans.

3.3.6 Modes of Infection

There are several known ways in which a human can become infected with *T. cruzi*. These include vector transmission, transmission through infected blood and organs, congenital transmission, and oral transmission. Each method has its consequences to the continued presence of the disease in the Americas.

The first method is associated with socio-economically depressed rural communities that have close contact with the vector. As previously mentioned, the triatomine bugs are nocturnal feeders making them extremely dangerous when infesting domiciles. Once in the home the triatomines bite the victim, and while they feed, defecate, the feces containing the parasite (Dorn 2007). Transmission may occur immediately if the triatomine was feeding near a mucus membrane (mouth or eye) where the feces have direct access to the blood stream. Transmission through skin penetration from a bite does not occur immediately; instead the bitten party must scratch the wound

thus allowing the parasite access to the blood stream. Because these insects feed at night, the act of scratching is often unconscious during sleep and human infection is often unknown.

The second means of transmission is via blood transfusion or organ transplantation (Carrasco et al. 1990; Kramer 1993; Rangel et al. 1998; Moraes-Souza 1999). Although blood can be tested and treated for *T. cruzi* there are still incidences of blood transfusion acquired Chagas disease (Rassi and Rezende 1976; Dias and Brener 1984; Schmunis 1985). As mentioned before, there has been a steady flow of intra-national migration from rural endemic areas to urban areas, and internationally to other Latin American countries as well as to the United States and Europe. This movement can unknowingly expose people in non-endemic regions to Chagas disease through the acquisition of infected blood and organs (Grant et al. 1989; Kirchhoff 1989; Nickerson 1994; Schmunis 1991; Skolnick 1989; Wendel and Diaz 1992).

A third means of transmission is through the placenta of an infected mother (Bittencourt 1976; Howard and Rubio 1968). Congenital Chagas disease is not only a problem in rural areas, as some researchers feel this could potentially be a factor in the increase in incidence rates in non-endemic areas due to expectant infected mothers migrating and then giving birth to infected babies (Azogue et al. 1981; Azogue 1985; Moya and Barousse 1984). Also associated with infected mothers is the possible transmission through breast milk, although this is extremely rare (Bittencourt et al. 1988).

Oral transmission is the final mode of disease transmission. This relates to the exposure of the parasite through contaminated food. This transmission mode can occur inside the home or from materials brought into the home that were previously infected.

The success of transmission depends on the vectors favored resting position. If the vectors prefer to reside in the rafters of the home then transmission can occur when infected feces drop from the ceiling into food or directly onto humans (Zeledon 1974; Ponce 1973). There have also been cases of humans becoming infected after eating foods which were contaminated with infected opossum urine and brought into the home and consumed (Zeledon 1974). This type of infection often occurs in areas where foodstuffs are kept outside the house or in uncovered containers (Briceño-Leon 1990; Bastien 1998).

3.3.7 Stages of Human Chagas Disease

There are three stages in the parasites' infection in humans; acute, indeterminate, and chronic (World Health Organization 1990; DCTD 1996; Eldrige and Edman 2004). Various organs can be affected at anytime during the acute and chronic stages while the indeterminate stage is usually asymptomatic. Death occurs most often in the acute and chronic stages.

The acute stage, the first stage of Chagas disease, occurs just after infection. Although a human of any age can contract Chagas disease, this stage is most noticeable in children under the age of 10 (World Health Organization 1990). There is often inflammation at the portal of entry, or chagoma (World Health Organization 1990). A very famous chagoma called Romana's sign is associated with infection via infected feces in the eye causing swelling. This type of infection can last for up to 60 days (WHO 1990). Romana's sign should not be confused with conjunctivitis created when uninfected feces enter the eye. This type of ocular infection last for a much shorter period of time, usually only a week (WHO 1990; WHO 1999). Other symptoms

associated with this stage are fever, enlarged liver and spleen, aedema, and swollen lymph-nodes (WHO 1990; WHO 1999).

Some eight to ten weeks after infection, the indeterminate stage begins. This stage may last several years or indefinitely (WHO 1990). The intermediate stage is usually asymptomatic but blood smears indicate the presence of the parasite. An estimated 50-70 percent of the people in the intermediate phase never develop chronic complications (WHO 1990; CDC 2006). The remainder, however develop into the chronic phase.

In the chronic stage of Chagas disease, usually ten to twenty years after infection, nearly 30% of those diagnosed suffer from cardiac, digestive, or neurological damage (Camara-lobes 1962; Da Silveira 1976; Atias 1980; WHO 1990; CDC 2006). Cardiac damage occurs most frequently (an estimated two thirds of documented chronic cases involve the heart) and poses the greatest risk (CDC 2006). This form results in the enlargement of the heart muscle ending in pulmonary embolism and sudden death (Feit et al. 1983; WHO 1990). Chronic Chagasic heart disease has been suggested as the leading cause of cardiomyopathy in endemic regions of Central and South America (CDC 2006). Chronic Chagasic megaesophagus and megacolon are the digestive outcomes of the disease and are found less often than the cardiac forms. Lesions may form in the esophagus or colon causing difficulty eating and digesting food. In rare cases Chagasic lesions in the brain have been found causing severe neurological problems in chronic patients.

3.4 Epidemiology of Chagas Disease in Mexico

Of the primary Latin American countries associated with endemic Chagas disease, Mexico, according to Carmen Guzman-Bracho (2001), is one of the last to perform any large-scale investigation or implement control programs related to *T. cruzi* infection and transmission (Attran 2006). For many years Chagas disease was not considered a major public health risk in Mexico, although the country has a large number of the vectors traditionally associated with *T. cruzi* transmission as well as the socioeconomic and ecological conditions that are similar to other known endemic countries (Schettino et al. 1988; Dumonteil 1999; Guzman-Brancho 2001; Ramsey 2003; Wastavino et al. 2004; Segura and Escobar-Mesa 2005; Attran 2006). Additionally, in 1992, the *First National Seroepidemiological Survey* was conducted and found that Chagas disease seroprevalences was 1.6%, an important number considering the disease was thought not to be a true health risk in the country (Norma Oficial Mexicana 2001). It took until 2001 for the government to develop a national policy to deal with the control of the disease (Dumonteil 1999; Guzman-Bracho 2001; Norma Oficial Mexicana 2001). Incorporated into this policy is a law that now requires screening for the parasite *T. cruzi* in donated blood country-wide as well as epidemiological surveillance and vector control in some areas (Guzman-Bracho 2001). The delay of the government in its acceptance of the disease as a public health concern has now caused the exacerbation of the disease in the nations blood supply. Chagas has spread to non-endemic areas through the blood supply and in endemic areas the infections in the blood supply have reached significant proportions (Guzman-Brancho 2001; Ramsey 2003; Wastavino et al. 2004; Segura and Escobar-Mesa 2005; Attran 2006).

Identifying mortality rates associated with Chagas disease in Mexico has been problematic for researchers (Lopez-Rios 1996; Ramsey unpublished manuscript). According to the literature, many medical professionals are not experienced in identifying the disease as cause of death. Those that can, because of the lack of a national surveillance system, have no database to refer to solely related to Chagas mortality.

Since the first report of a triatomine bug in Mexico in 1928 (*Triatoma dimidiata*) some 30 other species have now been recorded in the country (Guzman-Bracho 2001; Ramsey 2003; Wastavino et al. 2004; Segura and Escobar-Mesa 2005; Attran 2006). Of these 31 species all but one, *Triatoma hegneri* found on Cozumel Island, are geographically distributed on the mainland between latitudes 32°43'45" and 14°32'45" (Guzman-Bracho 2001; Ramsey 2003; Wastavino et al. 2004; Segura and Escobar-Mesa 2005). Those found to be naturally infected with *T. cruzi* but not necessarily relevant in the human transmission cycle include *Dipetalogaster maximus*, *Triatoma hegneri*, *Triatoma lecticularia*, *Triatoma nitida*, *Triatoma peninsularis*, *Triatoma protracta*, *Triatoma recurva*, *Triatoma rubida*, and *Triatoma sinaloensis* (Guzman-Bracho 2001). Those related to the human transmission cycle of *T. cruzi* infection include *Rhodnius prolixus*, *Triatoma barberi*, *Triatoma dimidiata*, *Triatoma gerstaeckeri*, *Triatoma longipennis*, *Triatoma mazzotti*, *Triatoma mexicana*, *Triatoma pallidipennis*, *Triatoma phyllosoma*, and *Triatoma picturata* (see Table 3.2 for related state information and Figure 3.5 for geographic representation) (Guzman-Bracho 2001; Ramsey 2003; Wastavino et al. 2004; Segura and Escobar-Mesa 2005;).

Table 3.2: Relevant Mexican Species and their Related States (Guzman-Brancho 2001)

Species	State
<i>Dipetalogater maximus</i>	Baja California
<i>Rhodnius prolixus</i> ,	Oaxaca., Chiapas
<i>Triatoma barberi</i> ,	Colima, Guanajuato, Gueuerrero, Hidalgo, Jalapa., Mexico, DF, Michoacan., Moralas., Oaxaca., Puebla., Tlaxcala
<i>Triatoma dimidiata</i> ,	Campeche., Chiapas, Jalapa., Oaxaca, Puebla, Quintana Roo, San Louis Potosi, Tabasco., Veracruz, Yucatan.
<i>Triatoma gerstaeckeri</i>	Chiapas., Coahuila, Nuevo Leon., San Louis Potosi, Tamaulipas
<i>Triatoma hegneri</i>	Quintana Roo
<i>Triatoma lecticularia</i>	Nuevo Leon
<i>Triatoma longipennis</i>	Aguascalientes, Chiapas., Colima., Jalapa, Nayarit, Sinaloa, Zacatecas
<i>Triatoma mazzotti</i>	Durango, Guerrero, Michoacan, Nayarit, Oaxaca.
<i>Triatoma mexicana</i>	Hidalgo, Queretaro.
<i>Triatoma nitida</i>	Yucatan
<i>Triatoma pallidipennis</i>	Colima., Guerrero., Jalapa., Mexico DF, Michoacan., Morelos, Nayarit, Puebla,
<i>Triatoma peninsularis</i>	Baja California
<i>Triatoma phyllosoma</i>	Oaxaca, Chiapas
<i>Triatoma picturata</i>	Colima, Jalapa, Nayarit, Oaxaca
<i>Triatoma protracta</i>	Baja Calafornia, Coahuila, Chiapas, Durango, Nuevo Leon, San Luis Potosi, Sonora, Tamaulipas, Zaccatecas
<i>Triatoma recurva</i>	Chiapas, Nayarit, Sinaloa, Sonora.
<i>Triatoma rubida</i> ,	Baja California, Nayarit, Sinaloa, Sonora, Veraruz,
<i>Triatoma sinaloensis</i>	Sinaloa, Sonora

For the purpose of this study the most important potential vector of *T. cruzi* is *Triatoma dimidiata*. According to Peterson et al. (2002) *Triatoma barberi* may also poses a threat in this region, as although this species has never been recorded in Los Tuxtlas, it has been predicted in the State of Veracruz using GARP analysis (2002) (Figure 3.5).

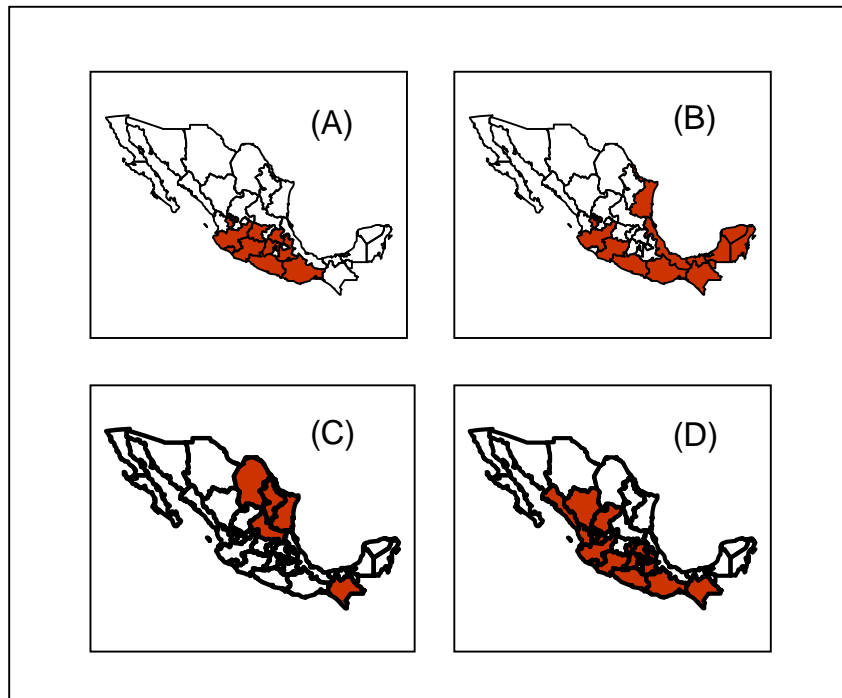


Figure 3.5: Geographic distribution of the important species of Triatomine in Mexico((A) *Triatoma barberi*; (B) *Triatoma dimidiata*; (C) *Triatoma gerstaeckeri*; (D) the *Phyllosoma* complex (Guzman-Brancho 2001))

Triatoma dimidiata can be found 500meters above sea level (masl) in most cases and its upper altitudinal parameters overlap with *Triatoma barberi* at between 1420-1780masl (Zarate 1980; Zarate and Tempelis 1981; Zeledon 1981; Zarate 1983; Zeledon; 1983; Guzman-Bracho 2001; Ramsey 2003; Wastavino et al. 2004; Segura and Escobar-Mesa 2005). It is the domestic habits and their propensity for a certain house type that make *Triatoma dimidiata* the crucial vector in the Tuxtlas region. According to Zeledon (1974, 1984, 2001) *Triatoma dimidiata* are most often found in wooden houses with dirt floors or raised floors with dirt underneath, unlike most other domesticated species which prefer to inhabit houses made of adobe or waddle and dab. This may be because the nymphs of *Triatoma dimidiata* camouflage themselves in the dirt and are most often found on the ground instead of in the walls or ceilings (Zeledon 1974; Zeledon 2001).

Triatoma dimidiata can also be found in woodpiles near houses. Some of these domestic habitat characteristics of this species are apparent in the study area.

According to statistics published in early reports from the 1980s for Mexico:

Anti- *T. cruzi* antibodies have been found, on average, in 20% of people older than 5 years who live in rural and suburban areas south of the Tropic of Cancer (Guzman-Bracho 2001: 374).

In 1989, after a two year survey of 70, 000 individuals from a representative sample of each state, the national average of anti- *T. cruzi* antibodies was 1.6% (Guzman-Bracho 2001). The highest prevalence of anti-*T. cruzi* antibodies was found in Huesteca, in the southeast region of the country including parts of Hidalgo, San Luis Potosi, Veracruz, and Tamaulipas, (Guzman-Bracho 2001). In 2000 it was calculated that an estimated 155,000 infants could become infected that year with nearly 320,000 mothers potentially infecting their newborns (Guzman-Bracho 2001). Records from the National Health Authorities in the Tuxtlas region recorded in one week in 2004 some 20 seropositive results (person communication August 2004). Chagas disease unquestionably presents a major health risk in Mexico, and the communities investigated in this study present typical locations where this risk could be considered elevated.

CHAPTER 4 A NEW MEDICAL GEOGRAPHY OF CHAGAS DISEASE: A CASE STUDY IN LOS TUXTLAS

4.1 Introduction

As described in chapter two, Chagas disease is a health risk in Mexico; however, until recently little attention has been given to its impact on some sections of the Mexican population (Ramsey 2003; Wastavino et al. 2004; Segura and Escobar-Mesa 2005; Attran 2006). In a country where over half the inhabitants live in conditions conducive to *T. cruzi* transmission, it is important to explore how to alleviate the burden of Chagas disease. It is, therefore, the intention of this project to look closely at a virtually unexplored Chagas disease affected region in the country (Figure 4.1).

This project, as was discussed in the introduction, concerns itself with the domestic cycle of Chagas disease and the cultural factors that perpetuate the transmission of the disease in six communities in the Los Tuxtlas region of Mexico. This chapter will provide an overview of the region, including its physical and human geography, and then present the methods chosen to carry out the project objectives. These techniques include: the process of community selection, techniques used to collect the vector *Triatoma dimidiata* (including testing for the parasite *T. cruzi*), identifying important house-type characteristics, carrying out two interviews with participants that include ascertaining local knowledge about Chagas disease, and family information including recollections about landscape changes that will help determine the characteristics of the Chagas landscape in this region.

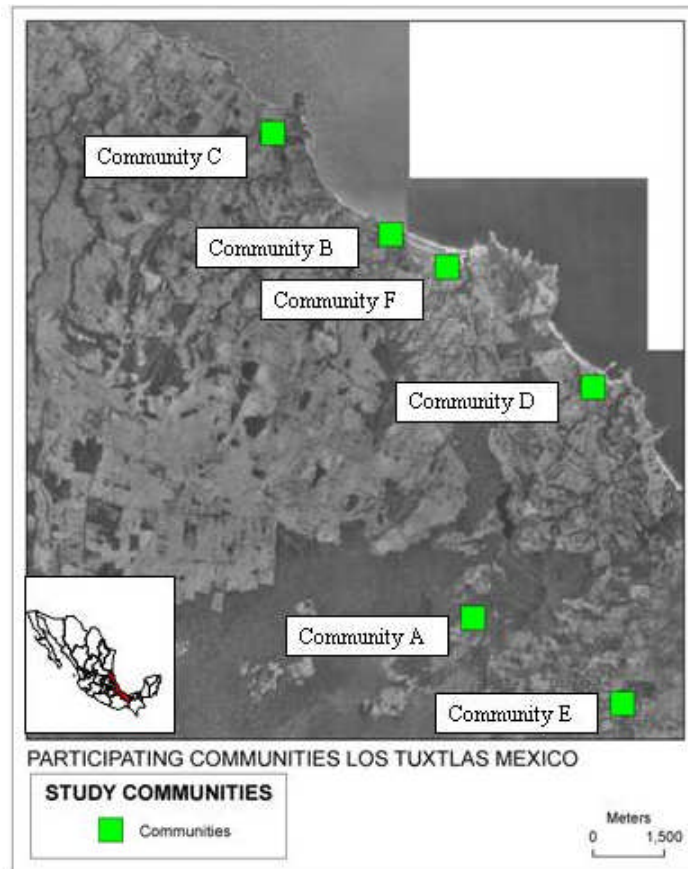


Figure 4.1: Participating Communities in Los Tuxtlas, Mexico

4.2 Geography of the Sierra de Los Tuxtlas

The Sierra de Los Tuxtlas are comprised of volcanic cones rising out of the Gulf Coastal Plain of Mexico approximately 166km south of present-day Veracruz.

According to Robert Andrie (1964), the Sierras are recent geologic features and cover an area of about 4500 square km. Maximum elevations in this region do not exceed 1660m (Andrie 1964). Located in the center of the Sierras is a volcanic crater lake called Lago de Catemaco, which separates the western portion of the mountain from the eastern portion and is surrounded by numerous other volcanic features such as cinder cones, craters, and surface basalt (Andrie 1964; Arnold III 1988). Although there is only one active volcano in the Sierras today, during ancient times the area was highly active.

The climate of the region is typical of a tropical rainforest biome. Average temperatures range from 20 to 30 degrees Centigrade. In higher elevations an additional two to three degrees Centigrade below this range is normal (Dirzo, Soriano and Vogt 1997; Geissert 2004; Soto 2004).

The Sierra de Los Tuxtlas are affected by an orographic rainfall pattern with a rain shadow on the southern side of the mountains (Arnold 1988). There is a distinct dry season in the region between January and May, but unseasonably wet weather can occur when Nortes are present⁴. Average monthly precipitation during the dry months has been noted at about 60mm while wet season average monthly precipitation is about 290 mm (Arnold 1988).

4.3 Settlement Patterns in the Sierra de Los Tuxtlas

As a result of the volcanic makeup of the Sierras, the region has always been important to human settlement. The settlements in the Sierras during ancient times have been documented as important sources for agricultural products such as cotton and cacao and rock material known as basalt⁵ for the greater Olmec population (1500BC-400BC) (Williams and Heizer 1965; Goman 1992; Santley and Arnold 1996; Laborde 2004). These pre-hispanic settlements were connected to other civilizations as far away as Central Mexico (Arnold et al. 1993; Santley 1989; Santley et al. 1989; Santley et al. 1987; Laborde 2004).

The water systems (rivers, lakes, and streams) were crucial in the establishment of contact with larger settlements in the region (Santley and Arnold 1996; Geissert 2004).

³ Nortes are local terms for unseasonable wet weather during the winter months. These storms originate in the higher latitudes and push wet cool weather into tropical zones. In climatological terms these phenomenon are simply frontal systems from the northern latitudes.

⁵ The Olmec mined basalt, a volcanic rock, for use in the construction of their colossal stone head carvings.

According to Santley and Arnold (1996) one route followed the Rio Catemaco and possibly connected the settlements in the Tuxtlas with others to the south and west. A second route noted by Santley and Arnold (1996) traverses the northeastern portion of the Sierras and ends in the Gulf of Mexico. It is believed, that the Olmecs favored this route for the transportation of the basalt heads from the Tuxtlas to San Lorenzo (Coe and Koontz 2002).

4.3.1 Recent Historical Patterns

Just prior to Spanish contact, the Tuxtla region was part of the Mexica or Aztec tribute state (Arnold et al. 1993; Santley 1989; Santley et al. 1989; Santley et al. 1987). Several large settlements including, Cosamaloapan, Tlacotalpan, and Santiago Tuxtla existed in the region, which contributed materials such as, cacao, cotton, jaguar pelts, parrots, iguana, and jade to the larger Mexica state (Laborde 2004).

When the Spanish arrived in the Sierras in the sixteenth century, there were two linguistic groups in the region; *Popoluca* and *Nahuatl*. The *Popoluca* have the longest history of residence in the Sierras, possibly since the time of Olmec occupation (Laborde 2004). The speakers of *Nahuatl*, however, are more recent and probably moved into the region during the *Mexica* occupation (Coe 1965; Scholes and Warren 1965). Hernan Cortez headed the Spanish colonization in Los Tuxtlas just a few years after the fall of Tenochtitlan in 1521. Between 1525 and 1528 the first sugar plantations and one of the first cattle ranches in the American Spanish Empire was established near the city of Santiago Tuxtla, which had also been recently developed by the Spanish (Gonzalez-Sierra 1991; Laborde 2004). This was one of the first attempts by the Spanish to develop the bovine industry in all of continental America. This industry was so successful that it

quickly occupied a large part of the Sierra de Los Tuxtlas and continues to dominate the landscape today

4.3.2 Present-Day Populations

Today, settlements in the Sierra de Los Tuxtlas seem to follow the same general patterns as initially established in the Formative Period (Stanley and Arnold 1996). The eastern portions of the Sierras are rugged, with steep peaks and rocky soils. Settlements in this area are small in both physical size and population. This eastern range contains both the central core to the Los Tuxtlas Biosphere Reserve and the study communities for this project. The Los Tuxtlas Biosphere Reserve has aided in the preservation of the old growth tropical rainforest in this part of Mexico. The Universidad Nacional Autónoma de México's (UNAM) Field Station is also located in this lush tropical forest and serves to protect the area from farmers. The western portion of the Sierras however, is much gentler in its terrain and surface soils are less rocky and more fertile. Therefore, this portion of the Sierras is more heavily settled.

4.3.3 The Study Communities

As indicated in the introduction, the six study communities are located in an approximate ten km area spanning from about 18.67 degrees latitude 95 degrees longitude at its northern most point to 18.55 degrees latitude 95 degrees longitude at its most southern point (see Figure 4.1 above for geographic representation). According to local residents these communities have existed for approximately fifty to seventy years. Of the identified six communities four, Community A, Community B, Community C, and Community D are *ejidos*, formerly government owned land that are now communally shared by local residents. The remaining two communities, Community E and

Community F are agricultural *colonios*. As displayed in Table 4.1, community sizes range from 18 houses in Community A to 250 in Community E.

Table 4.1: Number of Recorded Houses in 2005 per Community

Community	A	B	C	D	E	F
Number of Houses	~18	~32	~92	~100	~32	~250

4.4 Methods in the Field

The types of field methods used in any project must fit the region being studied. Although a particular method may work in one place it may not be accepted in another or identify key characteristics of a particular region. Therefore it is important to choose a methodology that works for the particular field site under investigation. Although methods may be chosen before entering the field, reassessment upon arrival at the site may be required if they do not suit the culture being studied. This dissertation, therefore, involves a four-phase approach to the collection of Chagas disease data. Each phase was created in order to build a representative layer in the Chagas disease landscape in Los Tuxtlas.

Phase I included mapping the selected communities, which created a physical reference for the additional layers. Phase II included the distribution of the *Triatoma dimidiata* specimen cups that allowed for the establishment of important vector information in the region. Phase III included the collection of cultural information pertinent to Chagas disease through the use of house type surveys and scheduled interviews. This allowed, for the first time, a place specific examination of Chagas disease in the region. Phase IV brought the project to a close with the analysis of the *Triatoma dimidiata* collected, for example results from the polymerase chain reaction

(PCR) of the filter papers. As this is the first study of its kind in the region, the objective behind the collection of data was to create a comprehensive understanding of the cultural epidemiology of Chagas disease in the context of Los Tuxtlas

4.4.1 First Days in the Field

The Universidad Nacional Autonomia de Mexico's Estacion Biologica Tropical de Los Tuxtlas provided the base for all fieldwork associated with this project (see chapter seven). Based on previous visit to the region several communities were discussed as possible participants in the project. It was important upon arrival to determine if the original communities assigned to this project were still applicable. After visiting eight possible locations, six were chosen. Of these six, four (Communities A, B, C, D) were identified in the original research agenda. Communities G and H, although included in the original project, were rejected because of local conflict and fluctuating population size related to the local tourism industry.

Several factors attributed to the selection of the six communities, including: willingness to participate, size, and site characteristics. Most important was the residents' willingness to participate in the project. Community size, in terms of the number of houses, was considered for the purpose of statistical evaluation. Finally, the communities' site, in relation to physical geographic features including vegetative cover, was also considered in this selection process. This attribute has been documented in the literature as being important in Chagas disease and disease transmission in general (Segura and Escobar-Mesa 2005).

Once the communities were selected each community *comisario* was approached to explain the project and gain permission to proceed with the work (see chapter seven).

The local residents elect each *Comisario*, indicating their importance and respect in the communities. Making our presence known to the local political leaders of the area and identifying our mission, helped in the communities' cooperation and tolerating of our questions.

Following site selection, each community was mapped using a Garmond hand-held 12-Channel Global Positioning System (GPS), which allowed for longitude and latitude coordinates to be collected for each participating household (Garmin eTrex series, Garmin International, Inc, Olathe, KS). Households that did not wish to participate or were not occupied during the fieldwork were excluded from these maps. Aerial photographs of the region were not available before, or upon arrival at the field site, which limited the maps to being hand drawn, not-to-scale representations of the locations (Figures 4.2-4.7).

Once the initial maps were created each house was assigned a specific identification sequence with each community given a single letter prefix (A-F), and each house in that community being assigned a single number. For example, house one of community A would be "A1". This letter and numbering sequence has no ranked significance; communities were assigned letters A-F randomly while house numbers were assigned during Phase I during an initial walk through the communities. If an insect was collected at a house then an additional number was added to the identification sequence as follows: A1-1. This allowed for a spatial representation of the six communities and a means to keep track of houses with and without recorded vectors.

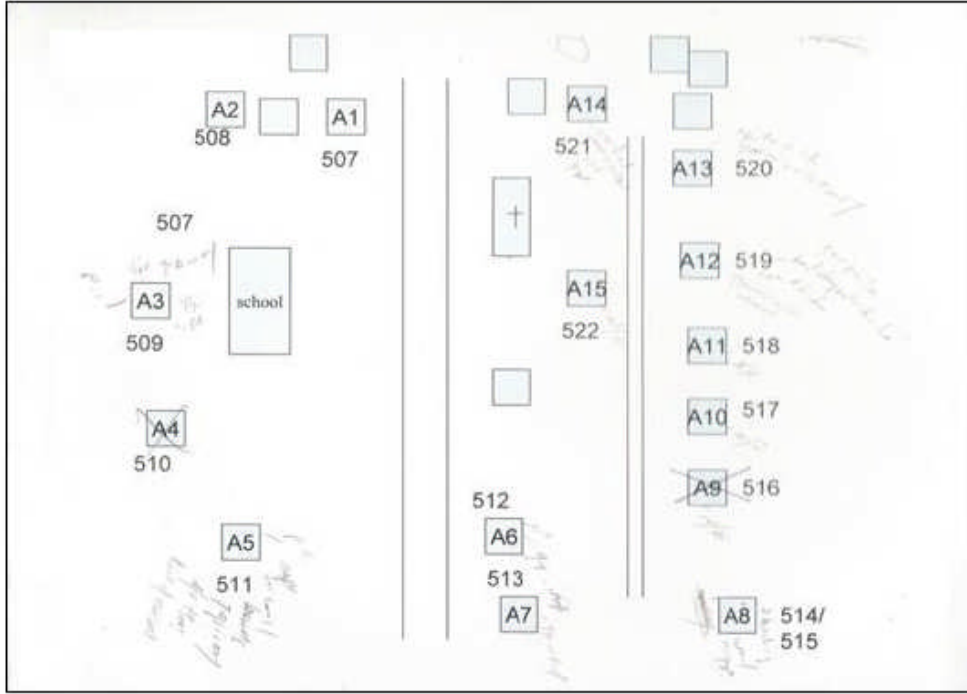


Figure 4.2: First Field Map for Community A

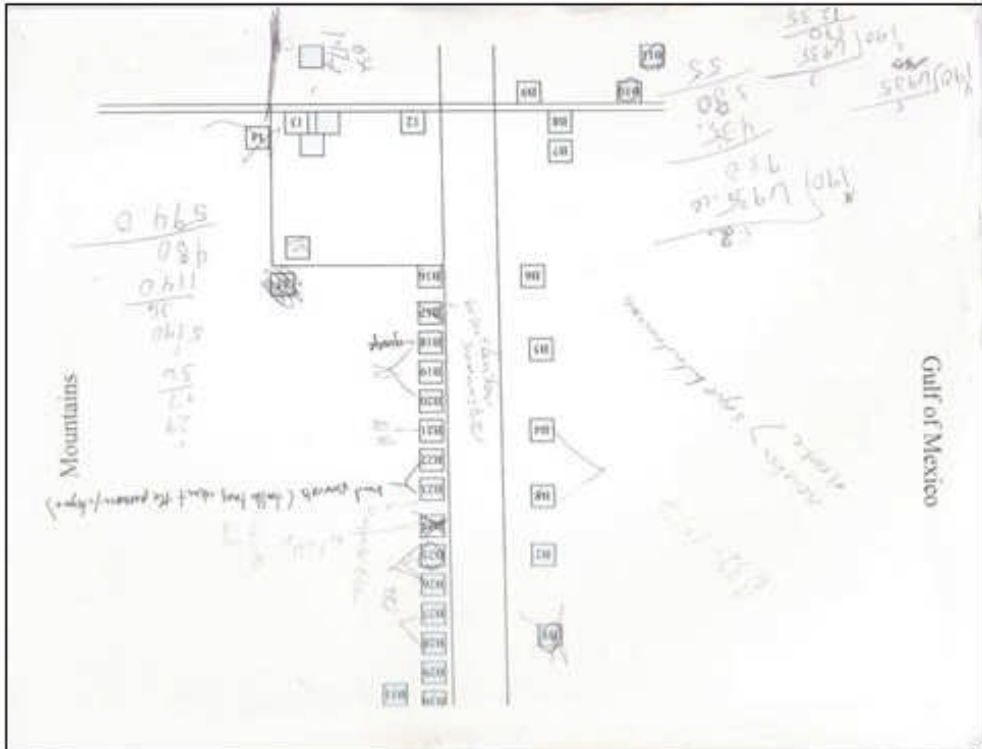


Figure 4.3: First Field Map for Community B

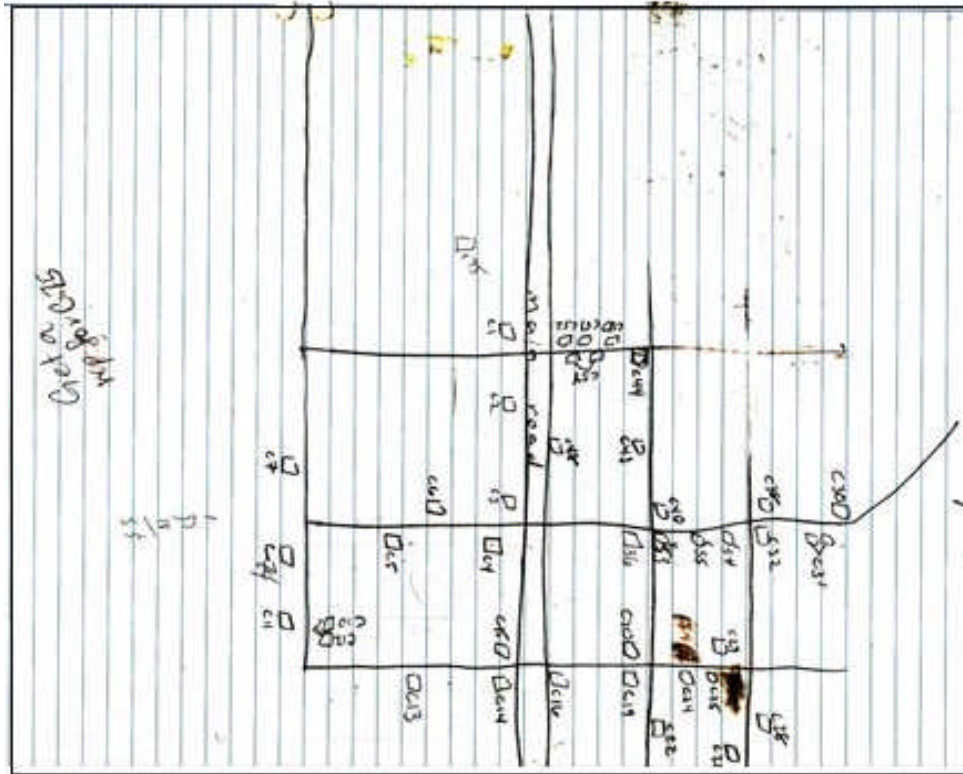


Figure 4.4: First Field Map for Community C

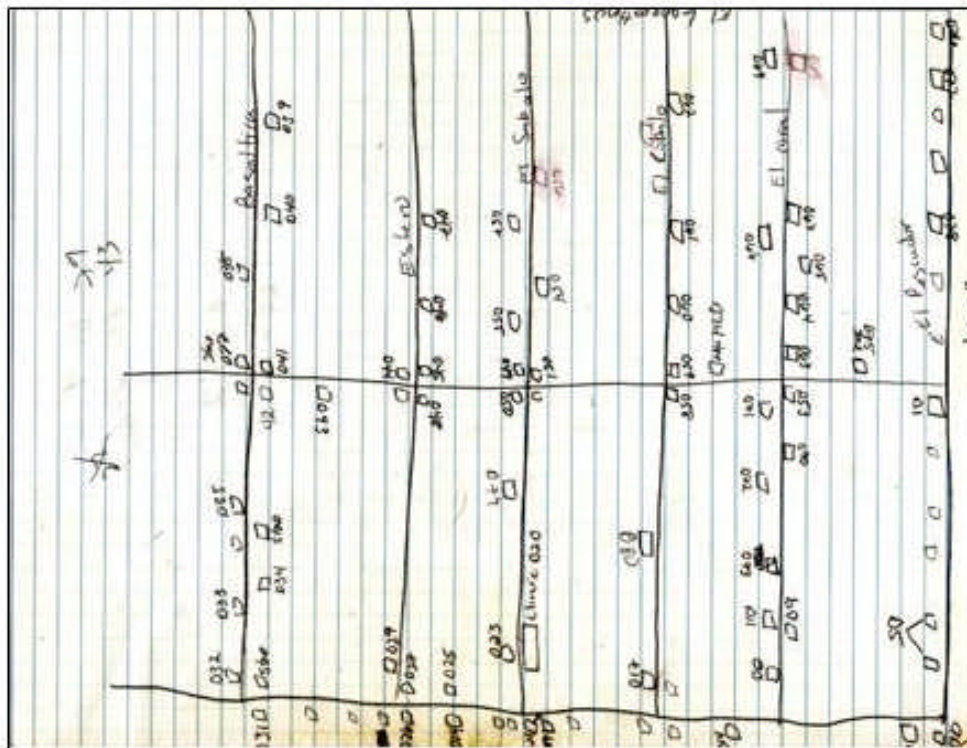


Figure 4.5: First Field Map for Community D

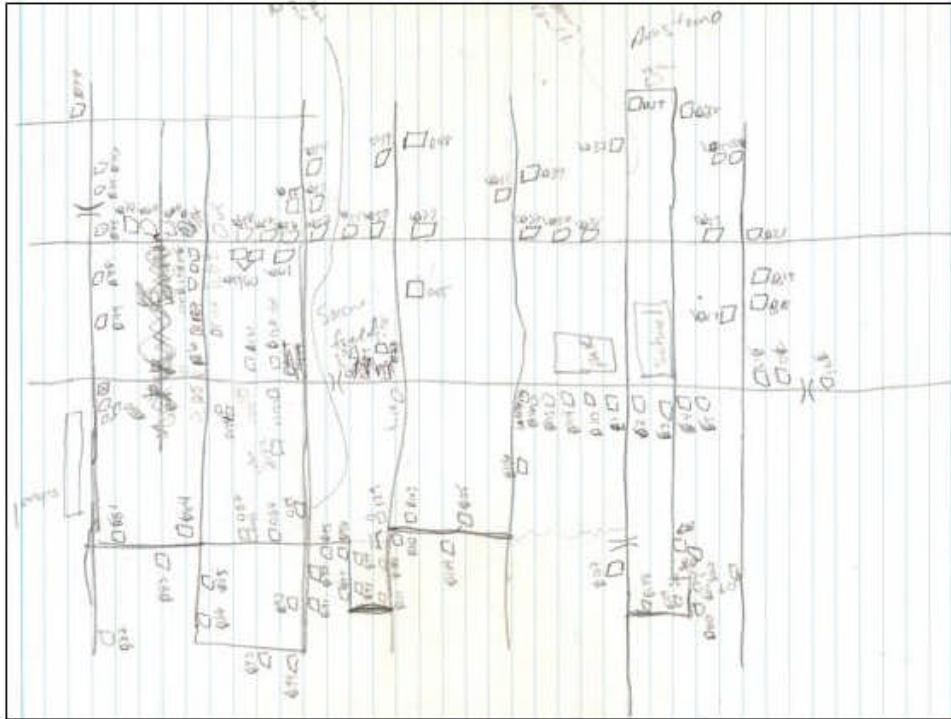


Figure 4.6: First Field Map for Community E

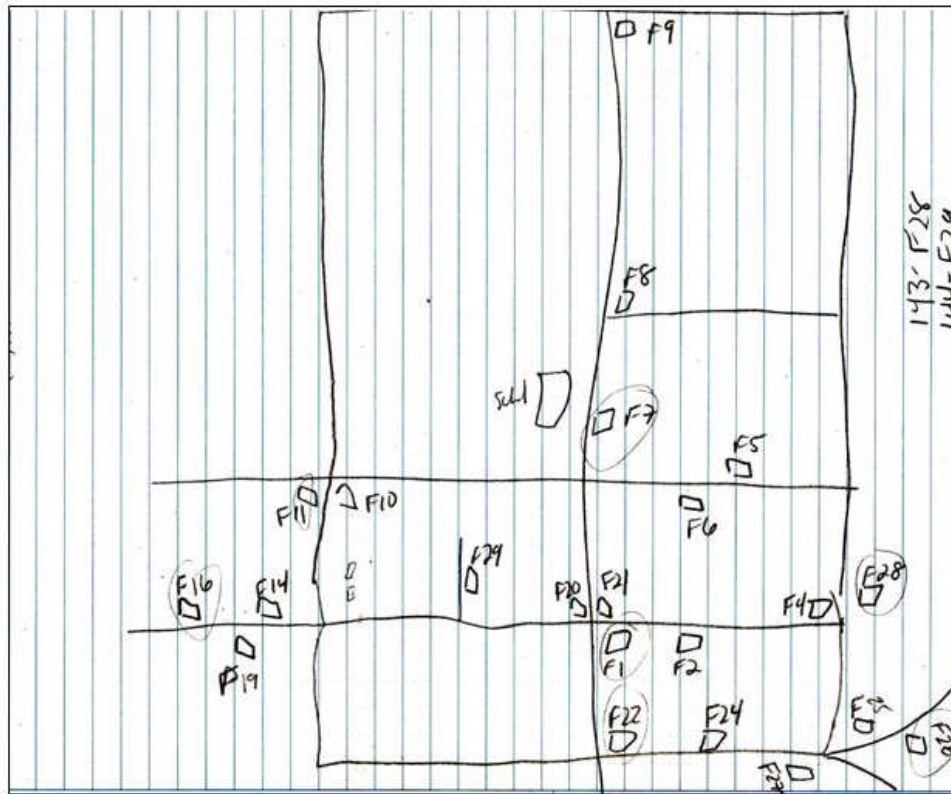


Figure 4.7: First Field Map for Community F

4.4.2 Data Collection Methods

Several data collection techniques were used during the course of this project including: house type surveys, voluntary collection of the vector *Triatoma dimidiata*, and scheduled interviews. Each technique fulfilled either a quantitative or qualitative objective described in chapter one. It was decided that one purpose of this dissertation was to collect as much information as possible in order to lay a foundation for future research in this area, including both cultural attributes and physical evidence of Chagas disease⁶. Scheduled interview questions were formulated based on the Chagas research literature and circumstances /experiences gained from the field (Briceño-Leon 1990; Bastien 1998; Prata 1999; Guzman-Bracho 2001; Segura and Escobar-Mesa 2005). The information gathered in the house-type surveys was used to establish local risk factors associated with the transmission of the disease, which will be described and assessed below. In addition, the collection techniques for the vector *Triatoma dimidiata* will also be described below.

In order to fulfill one of the final objectives of this project, the education of local populations about Chagas disease, it was important to first determine the extent of local knowledge about the disease. Therefore, the interview questions were chosen in order to identify local Chagas disease knowledge. These questions included descriptions of the vector and symptoms of the disease.

The final interview, however, intended to explore both the occupations of the local inhabitants and their perceptions of the region. This interview helps in determining

⁶ To accomplish this goal, collaboration contacts were established with other scientists familiar with identifying and describing the parasite and vector, most importantly Dr. Patricia Dorn and her team at Loyola University in New Orleans, Louisiana. A parasitologist by training, Dr. Dorn created a protocol for the collecting and sampling of the vector *Triatoma dimidiata*.

if residents are putting themselves at risk, not only within their houses, but also in their work environments. Similarly, it was of interest to this study to document the environmental changes associated with the region, as it is possible such changes can also attribute to domestic infestations, especially as the loss of natural habitats has been linked with vector infestations attributed to Chagas disease (Zeledon 1971) (this will be discussed in chapter five).

4.4.2.1 *Triatoma dimidiata* Collections

As mentioned previously information on the local cultural characteristics contributing to a Chagas landscape were to be supplemented with actual data regarding the vector, *Triatoma dimidiata*. Due to the project's large geographic area, and the numbers of families involved in the project (254 households), the voluntary collection method was used for vector acquisition (Enger et al. 2004). This approach was also taken due to limitations in entomological training, which therefore prevented other methods, such as the Gomez-Nuñez box or Personal collection methods, from being used.

During the second week and eighth week of the field-period, specimen cups with a volume of 237ml and plastic surgical gloves were distributed to each household in the communities which agreed to participate in the study (Figure 4.8). Due to the number of participant households, and a limited number of specimen cups, a second distribution period occurred eight weeks later after further supplies had arrived.

One hundred and eighty-seven cups were circulated during the first wave of distributions, while ninety-three cups were circulated during the second. During each distribution visit the families were informed as to the purpose behind the bug collection, and how these bugs should be collected. It was specified that only insects found inside

the house should be collected. Each household was also given a color photograph of the vector as an example of which bug to collect. During this phase, the details of the project were discussed with the participants making sure they understood the objectives involved. Such a detailed dialogue occurred with every phase (the vector and house type collection phase and the interview phase). These project discussions allowed for the acquisition of informed consent. Informed consent in the context of this dissertation simply describes the process of explaining a project and allowing participants to decide whether or not to participate (Mattingly 2005).



Figure 4.8: Specimen Cups Distributed to Local Participants

Once the cups were distributed, weekly trips were made to the communities to check for the presence of the vector. If a family collected an insect, the cup was taken with the insect, each cup being labeled with the appropriate house identification sequence and date, and brought back to the lab to be sampled for the parasite *T. cruzi*. The household was also given a replacement cup. During the sixteen-week period of my fieldwork some 65 insects were collected of which 58 have been positively identified as the vector *Triatoma dimidiata* (these results will be discussed more fully in chapter five) (Table 4.2).

Table 4.2: Number of *Triatoma dimidiata* Collected from each Community

Community	Number of <i>Triatoma dimidiata</i>
A	3
B	3
C	22
D	16
E	10
F	2
Field Station	2
Total	58

The sampling protocol used to identify the parasite *T. cruzi* in the vectors was established by Dr. Patricia Dorn of Loyal University, New Orleans, Louisiana. This protocol is as follows; each insect is photographed, its legs removed from the upper most joint, then the insect's abdomen is opened and the gut swabbed with a small piece of filter paper trying specifically to get as much of the stomach contents and feces on to the filter paper as possible (Figure 4.9). The legs are stored in empendorff tubes filled with ethanol/glycerol mixture, while the filter papers are stored in dry empendorff tubes. The remainder of the insect is stored in an ethanol filled container (figure 4.10). Upon completion of the fieldwork the filter papers were brought back to the United States, and delivered to Dr. Dorn. Using the PCR method (see Dorn et al. 1997 for a detailed description of this technique), the filter papers were tested for the DNA of the parasite *T. cruzi*. The legs have also been used for a separate study on the (geographic) genetic variation of *Triatoma dimidiata*.



Figure 4.9: Gut Contents on Filter Paper



Figure 4.10: Sampling *Triatoma dimidiata* in the Field

4.4.2.2 The House-type Surveys

Along with the house-location mapping and insect collection, cultural information was gathered from each community based on house-type surveys and a two-part scheduled interview. In order to more fully understand the local situation concerning Chagas disease it was necessary to document the living conditions of each family in relation to pre-described risk factors found in other Chagas disease prone areas of the

Americas (Ramsey 2003; Wastavino et al. 2004; Segura and Escobar-Mesa 2005; Attran 2006).

The first priority in this part of the investigation required gathering information about local living conditions. Chapter two described several domestic and peri-domestic environmental risk factors associated with triatomine infestations and the epidemiology of Chagas disease (Zeledon 1974; Gurtler et al. 1990, Gurtler 1998; Zledon and Rojas 2005). These include house-type construction materials, number of pets in the yard, number of pets in the house, the distance from the house to wooded areas, the presence of Saint shrines in the walls of houses, and the presence of wood piles next to houses. These traditional risk factors were combined with experiences gained from previous field-trips to the study communities in order to create an appropriate site-specific risk assessment tool (See Appendix A). The following sections develop the rationale for the collection of domicile information.

4.4.2.2.1 Building Materials

The house type surveys included materials used in the construction of the walls, roof, and floor. These characteristics are crucial to assess possible vector infestations because *Triatoma dimidiata*, the primary vector for the transmission of *T. cruzi*, is most often found in houses with specific characteristics, including dirt floors and wooden walls (Zeledon 1971). This building material information was included not only to examine commonalities between the Tuxtla communities, but also for comparison with other regions endemic to *Triatoma dimidiata*.

.4.4.2.2.2 Structural Gaps

The presence of holes in the structure of a domicile has also been documented as a risk factor to vector infestations (Segura and Escobar-Mesa 2005). In initial exploratory trips to the region personal observation found that most homes had unintended holes along the walls, between the floor and walls, and between the walls and roof. These characteristics can act as resting environments for the vector during the day. Therefore, also included in these house type surveys is information documenting the presence of visible openings in the walls, between the walls and floor, and between the walls and roof.

4.4.2.2.3 Window Screens

Window screens provide a barrier against many vectors, including *Triatoma dimidiata*, from entering a house through open windows, especially as lights may draw vectors toward or into the house (see chapter two). It was therefore necessary to document the presence of window screens (and their state of disrepair) so that the relationship between these barriers and vector presence could be explored. This information was again captured in the house-type survey.

4.4.2.2.4 Number of Domestic Animals Near the Home

In addition to the condition of the home, the number of animals in and around the yard was also recorded as this risk has been extensively documented as a primary cause of domestic infestations (Breceño-Leon 1990; Zeledon and Rojas 2005). Allowing animals to roam freely in and out of the home creates the peri-domestic conditions for the vector to find blood meals. Once near the home the vectors find refuge in the walls, floors, and ceilings of the home during the day, and during the night the vectors forage

for blood meals. *Triatoma dimidiata* feed on both the animals that drew them to the home and the humans that sleep unknowingly nearby.

4.4.2.2.5 Porch Gates

Relevant to the presence of animals around the home was the presence of a gate on the front porch. For these communities, gates either on the porch or in the front door could be used either to keep the animals out of the home or keep small children in the home. Irrespective of purpose, the gate might provide a further barrier to peri-domestic infestation.

4.4.2.2.6 Other Buildings

In many instances, one piece of property housed more than one building. These other buildings were sometimes sheds used for animals and farm equipment, while others housed different generations of family members. This information was deemed important because the more buildings in an area the more potential sources for the vector to establish a presence and then colonize the primary domicile.

4.4.2.2.7 The Kitchen Garden

It has been documented that the presence of vegetation close to the home may act as a gateway for domestic infestation (Breceño-Leon 1990). Prior to and during the scheduled interviews, garden information was recorded. These gardens, often referred to as kitchen gardens, were small beds found near the home where foodstuffs are grown.

4.4.2.3 Phase III: The Interviews

In order to identify the cultural factors of Chagas disease specific to Los Tuxtlas, it was important to conduct scheduled interviews with the community residents in order to capture their perceptions regarding place. Two scheduled interviews were conducted

through weeks 12 through 16 of the field trip (See Appendix B for interviews and chapter seven for more information)⁷. The intent was to include all of the 254 families who originally took specimen bottles, however only approximately 70 percent of this collection group participated in Phase III. The 30 percent that did not take part in Phase III were either not at home during any of the attempted times of interviewing or requested not to participate in this portion of the project. Each interview sheet was designed to preserve the participants' anonymity. Names were never recorded and instead the same numbering system was used as for the *Triatoma dimidiata* collections⁸

The first interview was created to extract local knowledge about Chagas disease, which helped to create the foundation for the *emic* perspective. This first contact was also used to determine family statistics. Each interview began with a series of questions concerning the basic demographics of the household including, size of the family and their respective genders. This would help in determining crude population statistics for our study area and possibly linking these to projected infection rates. The gender and number of persons present for the interview were also documented at the start of each interview.

The first interview included specific inquiries about each aspect of Chagas disease. This portion of the interview was initially to determine if the local population

⁷ Interviews were conducted, with the assistance of Mr. Velazco and an additional anthropologist fluent in Spanish, Ms. Samantha Euraque.

⁸The initial interview approach was to include one comprehensive interview with each household. However after a preliminary information gathering trip to the region and discussions with other scholars it was decided to break the original set of questions into a three part series. This interview structure is designed to gain trust, and allow for more revealing personal information to be truthfully answered, thus lending to a better understanding of the local Chagas landscape. I felt that separating the questions would allow me to gather more accurate information and create a more comfortable atmosphere for the participants. Once my team and I began the interviews we realized that three separate visits were not going to be acceptable for our interviewees. Many of our participants were too busy. Therefore, we combined the second and third series of questions into one interview in order to minimize our impact on the participants' lives. This decision also should help to gain future participation from the same households in similar projects.

had any previous knowledge about the disease. These questions were originally to be asked before any of the *Triatoma dimidiata* collections took place. As this project changed while in the field, Phase III was conducted after the *Triatoma dimidiata* collections. This consequently broadened the local populations Chagas knowledge networks to include the information distributed during Phase II of this project. Therefore, as we began the interviews we asked the person to specify if they had knowledge about Chagas disease prior to our arrival. If they did we documented where they learned about the disease.

The first series of questions in the Chagas disease interview related specifically to the knowledge about the vector *Triatoma dimidiata*. Included in this portion of the interview were questions that asked, for example, if they had ever heard of the *chinche*⁹ prior to our arrival. If they had, we then followed up with where they had heard about the *chinche*. We also asked if there were any other names for the *chinche* in their communities. We asked this question because other research projects have noted several alternative names for the *chinche* and we were interested in determining if any of these terms were used in this region (Ramsey 2003; Wastavino et al. 2004; Segura and Escobar-Mesa 2005). We then asked the participants to describe the *chinche* and its characteristics, (color, size, smell, etc.). Next, we asked if the participants had ever seen the *chinche* in their home. This was followed up with where in the home they had seen the *chinche*. The participants were also asked where they thought the *chinche* could be found (this questions received some interesting answers that will be discussed in chapter five). The final set of questions related to the vector, asked the participant to describe the

⁹ *Chinche*, as described in chapter two, is a local term for the vector *Triatoma dimidiata* and was used during the interviews instead of the scientific term.

types of places a *chinche* might live and what the *chinche* might feed on. These included: house types, plants, and the type of animals the participants thought might feed the *chinche*.

Once the initial vector questions were complete we continued the interview with questions concerning the participants' knowledge about the signs and symptoms of Chagas disease. We began this portion of the interview by asking if they had heard of the disease before we arrived. This was followed with a series of questions related to their knowledge about the specifics of Chagas disease, including if they knew how Chagas disease was transmitted by the *chinche*, and any other general information they could relate about the disease.

The final series of questions in the first interview were posed to determine possible Chagas infections in the community. It was assumed that many of the community residents would not know the visible symptoms of the disease so a series of questions were included to ask specifically about symptoms. For example, we asked if anyone in the family or community had a swollen eye for several months. This question received some interesting answers which will be discussed in chapter five. Next we asked if anyone in the family or in the community had been stricken with a swollen belly for long periods of time. This also received some interesting responses. Our final questions in this interview asked if any person in the family or in the community had not been unable to defecate for long periods of time. Each of the symptom questions were posed in order to acquire knowledge that may have been unknowingly held by the participants. Again, these questions provide the foundation in developing the *emic* perspective. These questions were also asked first as they were deemed to not be as

intrusive. The responses have revealed some interesting gender issues related to health in these communities, the results of which will again be discussed in chapter five¹⁰.

In the second interview we were concerned with identifying the families economic statuses based on their daily activities, identifying their perceptions of landscape change, and identifying the general life of the community. In addition to determining the family's means of making a living these questions also allow for an investigation into whether or not work activities bring the family into contact with the vector or if these activities were facilitating the vector into the home. This proved to be the most difficult information to acquire as many residents were not forthcoming about their economic status.

The first series of questions address the family's socio-economic status. Questions concerning food production and consumption, associated animals, household income, work related travel, and general demographic information about the family were included. These questions help place these families in the context of the project; whether Chagas disease in Mexico is truly a disease of the poor as it has been shown in other countries. These questions also help identify if there are any spatial patterns to the disease in association with travel and migration. Finding out where people travel to and, when applicable, where they have come from, could shed light on the distribution of knowledge about Chagas disease and possible sources for human infection that could be used in further studies.

¹⁰ On each printed interview sheet, we included cues to lead us to the next question we wanted to ask based on the information provided by the participant. For example, if the participant answered they had no previous knowledge about the chinche then we would skip the questions about the chinche and continue with those on Chagas disease specifically. These cues were mostly to help in the flow of the interview.

We also asked questions that address the time people have lived in the community and what, if any, changes have been made to the surrounding environment since they had become a resident. These questions were created to address landscape changes that might be associated with Chagas vector infestations. Additionally, we were interested in determining perceptions about these changes.

I must make one note here that excludes me from calling this research a traditional ethnography (Kottak 2001). I did not live in one specific community using the Malinowski method, and collect as much information about that community as possible. Instead, because we decided that I should collect information from six communities, I lived at the UNAM Biological Field Station, which provided a central location for the project. The communities assigned to the project are found in a 10km radius around the Station. Other ethnographic projects, most notably Margaret Mead's project in Samoa, have also involved the ethnographer living outside the communities for which she would study (Mead 1976).

4.4.3 The CODES-GIS

This project has also tested a new technology, now called CODES-GIS, or Chagas Online Data Entry System which is a Geographic Information System with a web-interface. The web mapping allows data to be uploaded from the field without GIS expertise or software. This technology, developed by the World Health Organization Collaboration Center for Remote Sensing and GIS for Public Health (WHOCC) located at Louisiana State University, was designed to promote the standardization of spatial data collection in remote field locations, while at the same time providing a visual (cartographic) means for an interaction between the field worker and the external

research center. Additionally, the technology allows for data to be archived remotely. This technology, which has subsequently been employed in other WHOCC projects, was specifically developed for this research project. With the help of Jason Blackburn, I was able to create large-scale maps of the six communities, with high enough resolution to identify individual houses. Using this web-based mapping technique we were able to look at the distribution of the collected insects and relevant house type information in (near) real-time. Data entered in the field was immediately visible on research computer generated maps at LSU, and vice versa, analyses conducted at LSU could also be viewed in the field. Technology such as this allows field researchers to immediately assess collected information and in the cases of disease outbreaks may help in the speedy containment of the problem (Figure 4.11-4.12).

Figure 4.11: Sample Page of Chagas Database

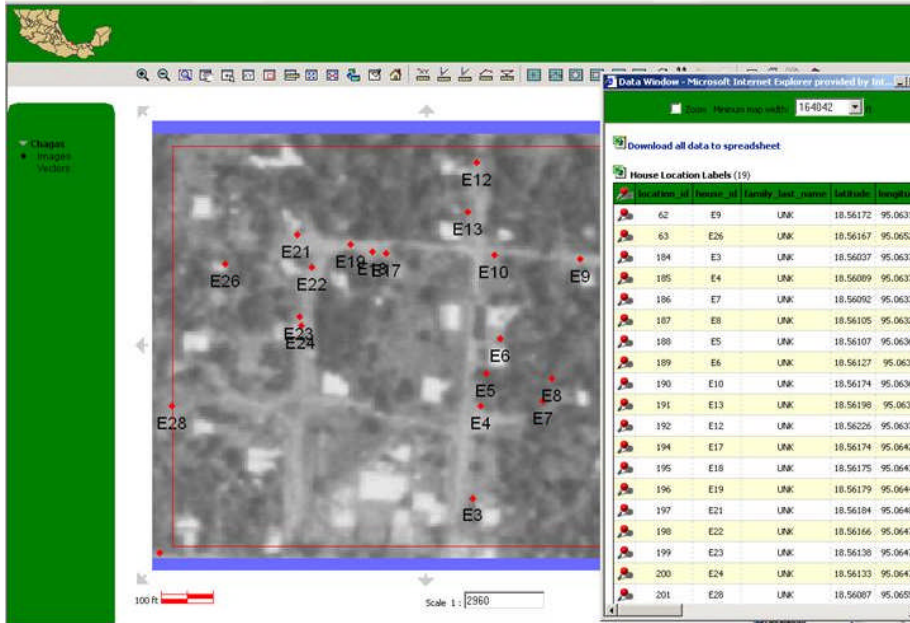


Figure 4.12: Resulting Maps from Uploaded Chagas Field Data

CHAPTER 5
IDENTIFYING THE VECTOR LANDSCAPE IN LOS TUXTLAS:
ANALYSIS OF THE HOUSE TYPE SURVEYS AND THE *TRITOMA*
***DIMIDIATA* COLLECTION DATA**

5.1 Introduction

This chapter will use data collected in Los Tuxtlas to develop the Chagas disease landscape. This landscape will be primarily constructed of risk factors, such as house type construction, as well as vector identification, and parasite recognition, in connection with human-vector contact in the six studied communities. These examined risk factors create a place-specific investigation which will contribute to the larger Chagas disease literature.

It is hypothesized that the risk factors associated with *Triatoma dimidiata* domestic infestations found in other locations will also be identified in Los Tuxtlas. These traditional risk factors, such as earthen floors and wooden homes, are examined in relation to the six studied communities. By identifying the community specific risk factors a better understanding of the local risk-environment can be used to accept or reject the hypothesis. In other words, are the risks faced by residents of the project communities the same or do they show local differences to other Chagas disease studies?

In addition, this chapter will also address the vector data collected during the 2005 field season. As shown in chapter two, *Triatoma dimidiata* is the dominant Chagas disease vector in this region. Therefore, documenting the vector collection data also contributes to identifying the risk landscape associated with Chagas disease in the study communities and by extension the larger Tuxtlas region.

Finally, it will be important to determine if the parasite *T. cruzi* is also found in this region. If it is determined that the landscape is conducive to domestic infestations,

and the vector *Triatoma dimidiata* has been found in the domestic environment, then finding the parasite *T. cruzi* will further show the risk for human contraction of Chagas disease. Although this study was not designed to examine human infections of Chagas disease, documenting the presence of the parasite *T. cruzi*, in the domestically collected *Triatoma dimidiata*, will add to the general risk from the disease in the region (Figure 5.1)

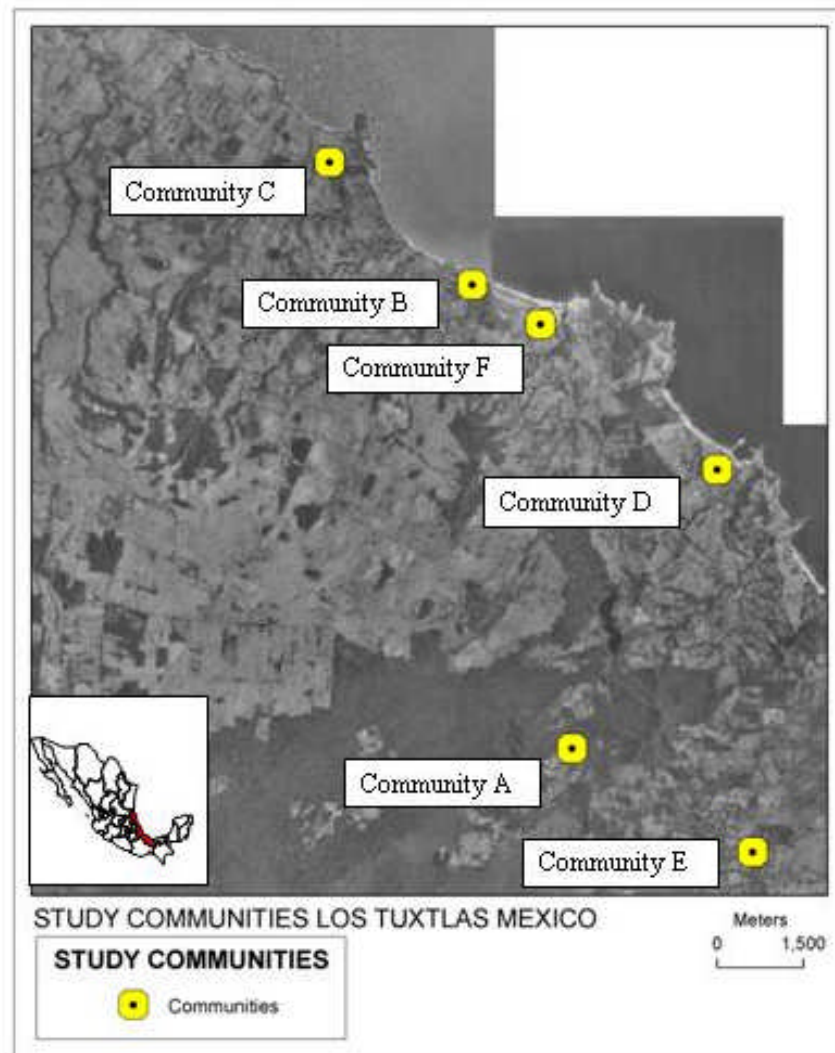


Figure 5.1: Study Communities in Los Tuxtlas, Mexico

5.2 The Survey Data

Human induced risk factors associated with domestic infestations of the Chagas disease vectors, and *Triatoma dimidiata*, are well described in the literature (Zeledon 1969; Wastavino 2004; Sarquis et al. 2006; Becerril-Flores et al. 2007). *Triatoma dimidiata* is most often found in wooden houses with dirt floors and homes where the house is raised off the ground but dirt is still exposed underneath (Zeledon 1969; Wastavino 2004; Sarquis et al. 2006; Becerril-Flores et al. 2007). This access to dirt is important as a trait of *Triatoma dimidiata* is the ability of the nymph to camouflage itself in such matter. Therefore, nymphs are most often found on the ground instead of in the walls or ceilings as is more common with other species of *Triatoma* (Zeledon 1974, 2001). The presence of animals in and near the home is associated with domestic and peri-domestic infestations. Consequently, the *house type surveys* captured both the characteristics of the home and the presence of animals in the yards.

At present, to this author's knowledge, no study has systematically addressed the house types in these six Los Tuxtlas communities. Therefore, it is important to document the condition of each house included in the study. From preliminary field trips to the region, observations about common house types were used to produce a list of the most common building materials used in house construction. The *house type survey*, based upon those different building materials, was developed from these initial notes and used in each community.

In this section each of the house type material choices used in the survey will be discussed. A brief description of each material will be given and its frequency of use in the study area. The additional information collected on the surveys will also be

discussed, including frequency of structural gaps, the presence or absences of window screens, the presence or absence of the porch gate, the presence or absence of a kitchen garden, and the types of animals seen most often in the communities. The survey section concludes with a discussion of the results from the *house type surveys* for each of the six communities separately. Again this information was gathered from February 2005 to June 2005. Two hundred and fifty-four residents agreed to participate in this portion of the study.

5.2.1 Structural Materials in the Study Region

The most common wall construction materials found in all six communities in Los Tuxtlas were: wood, cement, and exposed cinder blocks. Cement houses were initially assumed to be different from cinderblock houses, but upon closer examination appear to actually be the same. Similar to stucco construction, once the cinderblocks are in place and mortared together cement is then used as a topcoat over the cinderblocks. In most cases, once the cement coat is in place the walls are painted. As most of the interaction with local residents was conducted outside the home it is not known if every house with a cement coating also had a corresponding coating inside the home. Those few homes that were examined from the inside had coated interior walls. The distinction between cinderblock and cement homes is maintained because homes with exposed cinderblock pose a higher risk for infestation than those with a cement coating. It is noted in the literature that *Triatoma dimidiata* adults tend to hide during daylight hours in cracks in the walls (Minter 1978; Zeledon 1974, 2001; Wastavino 2004; Sarquis et al. 2006; Becerril-Flores et al. 2007). Therefore, if the cinderblocks are left uncoated, the possibility for hiding places increases. Other materials found in the six communities

were brick, a mixture of wood and *carton*, plastic tarp, and *lamina*. The most common wall-type throughout the six communities was wood. Cement walls were the next most common then exposed cement blocks. Only one home in any of the communities used palm poles (Table 5.1 and Figure 5.2).

Table 5.1: Most Common Wall Types

Wall Materials	Houses with Vector	Houses without Vector	Totals
Wood	16	94	110
Concrete	12	89	101
Other	0	44	44

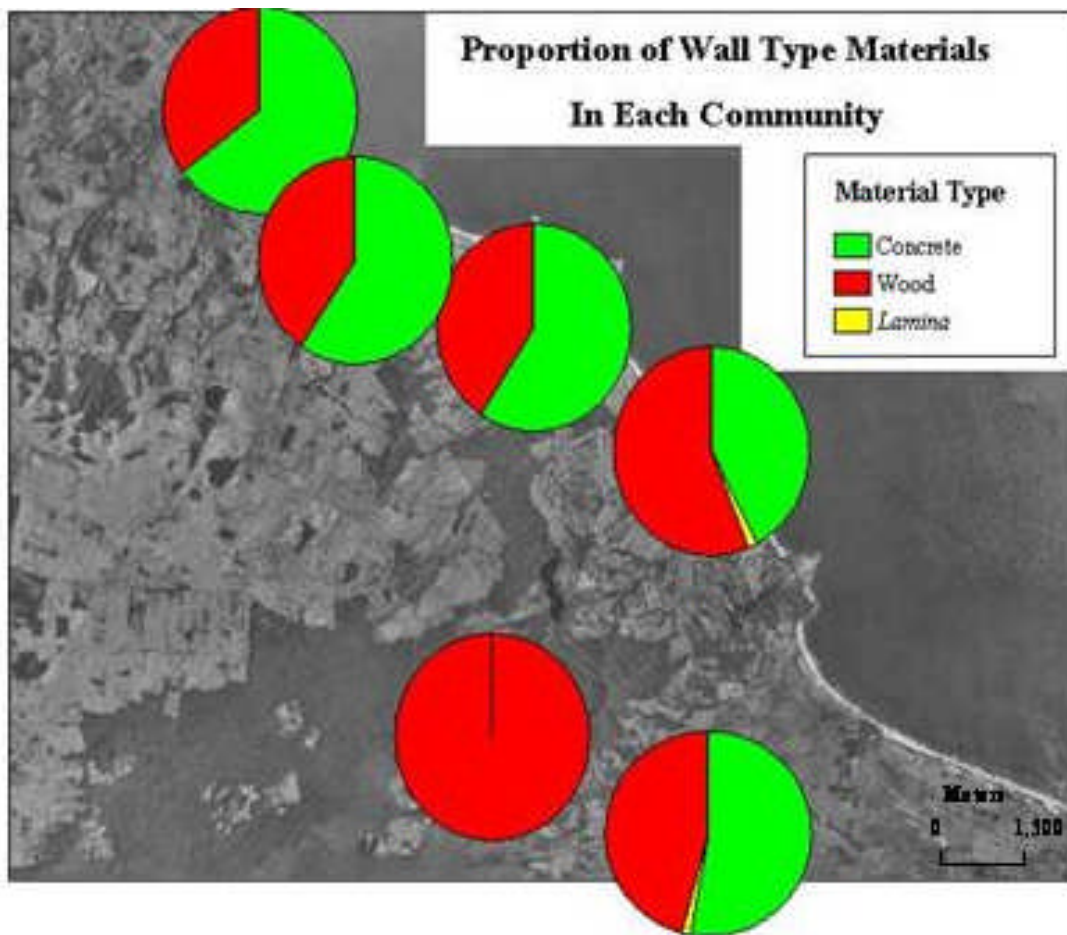


Figure 5.2: Proportion of Wall Type Material in Each Community

The choices for roofing materials included in the survey were *carton*, *asbesto*, *lamina*, and *palma*. *Carton* is a cardboard-like material. In the study area, *carton* is used without shingles and is also corrugated. *Lamina* is a type of corrugated zinc used as a roofing material. *Asbesto* is a general name used in this region to refer to a type of roofing material made to look like roofing-tile. *Asbesto* roofs are made with asbestos. *Palma* simply describes the use of palm fronds used as a simple means of roofing a structure. The most common material used throughout the six communities is *lamina*. *Asbesto* is the second most common material while *carton* is the third. *Palma* was seen only twice in the six communities. An additional material noted within the communities was cement. Several houses made of cinderblock also had cement roofs (Table 5.2 and Figure 5.3).

Within the six communities, two floor types dominated. These included cement and earthen floors. The earthen floors varied in the types of additive materials incorporated into them. In most cases, homes with earthen floors were simply walls built over the bare ground. Sometimes, though, a mixture of cement and dirt was used. In several other cases, it seemed that prior to the home being constructed dirt was piled as a type of foundation. The walls of the house were then placed on this raised area. The most common type of floor used in the six communities was cement. Earthen floors occurred most frequently with wooden walls (Table 5.3 and Figure 5.4).

Table 5.2: Roof Materials for Each Community

Roof Materials	Houses with Vectors	Houses without Vectors	Totals
Asbesto	5	61	66
Carton	3	10	13
Lamina	18	147	165
Cement	2	9	11

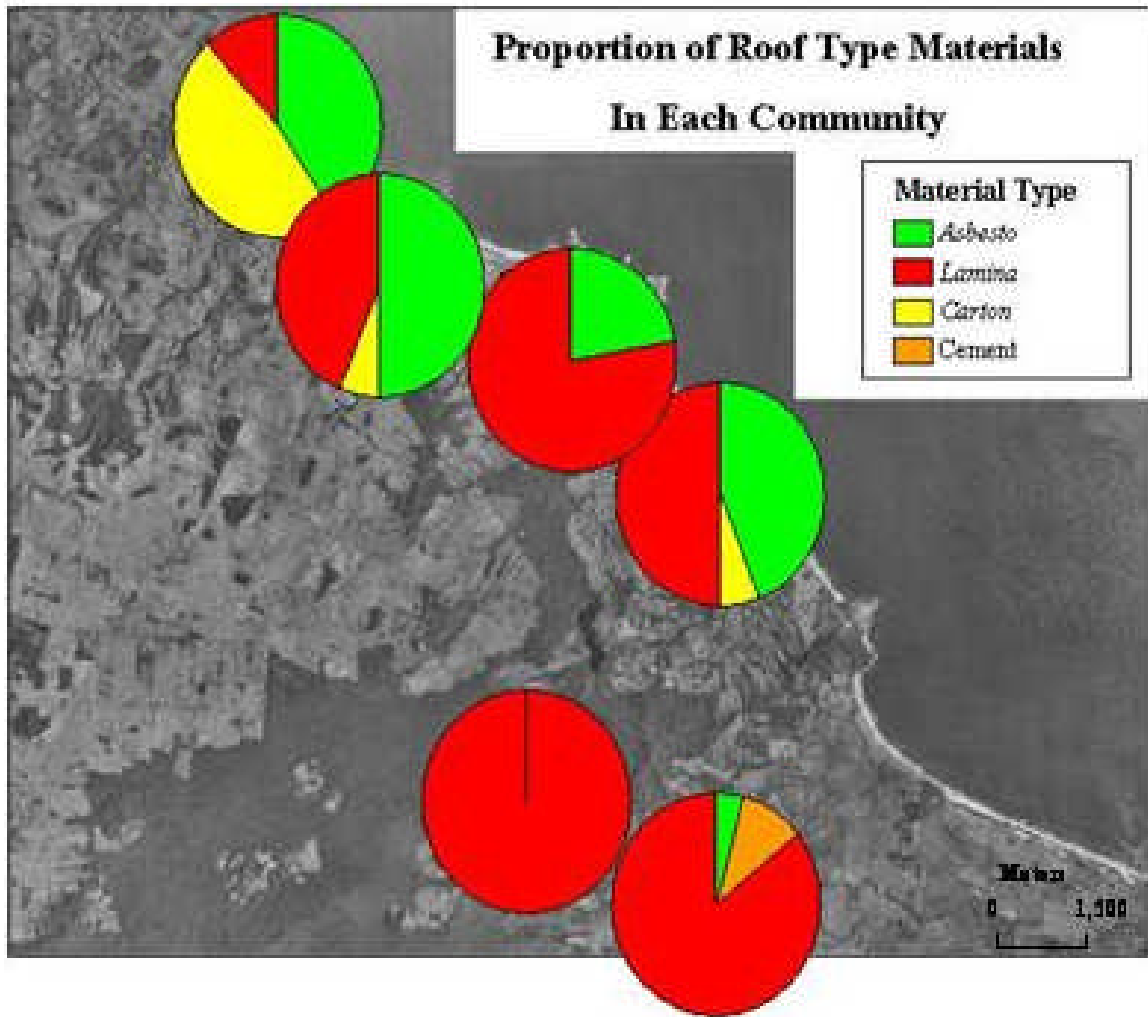


Figure 5.3: Proportion of Roof Type Materials in Each Community

Table 5.3: Floor Types for Each Community

Floor Material	Houses with Vector	Houses without Vector	Totals
Concrete	15	148	163
Earthen	13	79	92

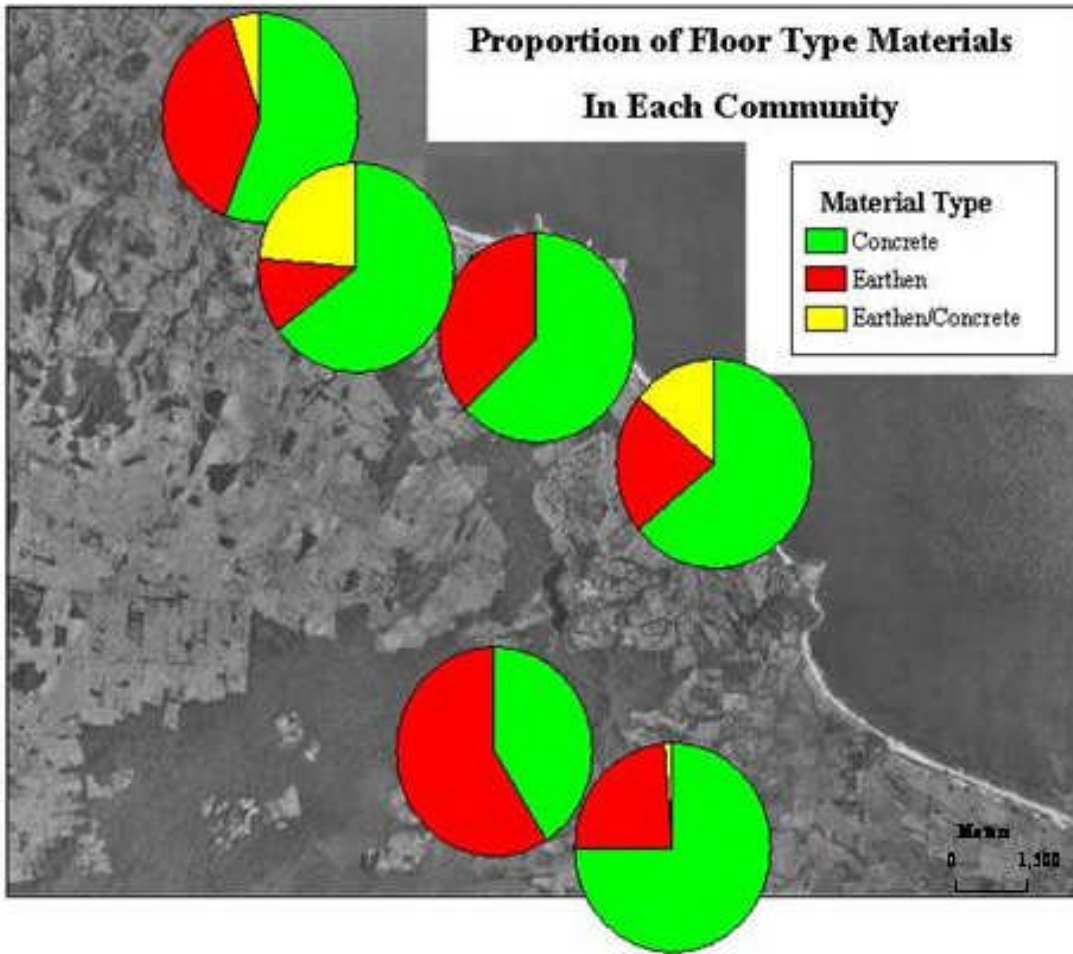


Figure 5.4: Proportion of Floor Type Materials in Each Community

The material used in the construction of the home has an important bearing on the presence or absence of openings in the structure. Openings in the structure have been documented as an important factor in the domestic cohabitation of *Triatoma dimidiata* (Laranja 1956; Koberle 1968; Zeledon 1974, 2001; Yamagata 2006). Again, holes found in the walls of a structure can conceal the vector during rest periods. Gaps found between the walls and roof have also been documented as an important hiding place for the *Triatoma dimidiata* (Laranja 1956; Koberle 1968; Briceno-Leon 1990, 1993; Segura

and Escobar-Mesa 2005). Gaps found between the floor and walls may also act as sites of penetration for the vector which has a tendency to crawl.

Wooden homes in the study communities contain the most structural gaps (Table 5.4, 5.5, 5.6). The construction techniques for the wooden home create these gaps as in most cases the walls are built using the bare ground as foundation and over time, as the earthen floors erode, new openings are exposed. The roof is attached to the walls using a framing mechanism which frequently leaves a substantial gap between the walls and roof. In nearly all of the wooden homes the boards used in construction were rarely placed flush against each other. Instead, the boards were either spaced out so that fewer boards were necessary for construction or the boards were not shored up so that they lay flush against the next board in the wall. Again, these gaps pose a potential risk since they provide adequate resting places for the vector during the day.

Table 5.4: Structural Gaps found between the Wall and Roof for all Communities

Gaps Between Wall and Roof	Houses with Vector	Houses without Vector	Totals
Yes	19	140	159
No	9	60	69

Table 5.5: Structural Gaps found between the Wall and Floor for all Communities

Gaps Between Wall and Floor	Houses with Vector	Houses without Vector	Totals
Yes	15	109	124
No	13	118	131

Table 5.6: Structural Gaps found in the Walls for all Communities

Gaps in the Walls	Houses with Vector	Houses without Vector	Totals
Yes	12	93	105
No	16	134	150

As previously stated, suitably functioning window screens also act as barriers between insects and the domicile. Not only did the survey include an accounting of the presence of the screens, but it also allowed for a description of the screens themselves, including the presence of holes. Additionally, the number of windows with screens and if the screens covered the whole window were also noted. Upon completion of the surveys, it became apparent that window screens are not common in these communities.

Although window screens were found most frequently in concrete houses, they were not frequent for either housing type (Table 5.7). Of the few homes that did possess screens, most had them on the living and sleeping area windows, but not for the kitchen. The presence of screens however, regardless of their state, can offer at least minimal protection from vector colonization. Therefore, the vast majority of homes in the study area have nothing to prevent *Triatoma dimidiata* and other insects from entering through the windows.

Table 5.7: House Types that Contained Window Screens

	Wood	Concrete	Other	With the Vector
With Window Screens	2	7	0	0
Without Window Screens	125	117	3	27

Again, as previously stated, the presence of a porch gate may act as a barrier to peri-domestic animal intrusion into the home, and against small children leaving the home. The presence of such a gate was not a common addition to many homes in the study site. Again this is worrying given how the free flow of animals throughout the home may facilitate *Triatoma dimidiata* infestation (Table 5.8).

Table 5.8: House Types that contained Porch Gates for all Communities

	Wood	Concrete	Other	With Vector
With Porch Gates	3	7	0	1
Without Porch Gates	124	117	3	26

The presence of ceilings in these homes was added to the surveys in order to fully document the characteristics of the domicile (discussed in chapter 3). However, it is apparent that ceilings are not a common feature shared by all of the communities in the study (Table 5.9). Although not mentioned in the literature as having a direct relationship to vector infestations, ceilings may act as additional hiding places for the vector, and thus were added to the surveys.

Table 5.9: House Types that were documented with Ceilings for all Communities

	Wood	Concrete	Other	With Vector
With a Ceiling	2	13	0	0
Without a Ceiling	125	111	3	27

Documenting the presence of a garden was often difficult. Many of the households that participated in the study never allowed the research team into their homes. It was hard to determine if the home had a garden if it was not located in plain sight from the front porch. Kitchen gardens have been documented in many rural communities throughout Latin America (West and Augelli 1980; Kottak 2001; Doolittle et al. 2002). Documenting these types of gardens in this region would expand this already important literature. It is also an aspect of the cultural landscape that may pose as a risk factor to domestic infestations of *Triatoma dimidiata*. Vegetation found close to the home has been identified as a potential pathway for the vector to enter the home ((Briceno-Leon 1990; Briceño-León 1993; Schmunis 1994; Gurtler et al. 1997; Zeledon

and Rojas 2006). Table 5.10 illustrates that kitchen gardens were found in approximately 40 percent of the homes surveyed.

Table 5.10: Participating Houses Documented with Gardens

	Number of Houses	With Vectors
With a Garden	101	10
Without a Garden	125	15
Unknown	28	2

The number and kinds of animals present in and around the home during the 2005 field season were varied. The fluidity of animal movement, however, from one yard to another, and consequently from one house to another presented a challenge in this investigation. It became increasingly difficult to document the number and kinds of animals present at any one time in a given yard. Frequently, the number and types of animals changed several times during the course of the initial survey, as well as during interview sessions. Several animals were frequently observed. Nearly all the homes in the survey possessed at least one dog. Barnyard fowl (chickens, ducks, and turkeys) were also a dominant feature in this landscape. Both dogs and barnyard fowl, in nearly all the homes surveyed, also had access to the home, and both sets of animals have been well documented in the Chagas literature as potential pathways for *Triatoma dimidiata* to enter and infest domestic spaces (Zeledon 1974; Briceno-Leon 1990, 1993; Schmunis 1994; Gurtler et al. 1997; Wastavino 2004; Sarquis et al. 2006; Becerril-Flores et al. 2007). Animals such as these provide blood meal sources when humans are not present and enable long-term home infestation. Another consideration in the documentation of domesticated animals, such as dogs and barnyard fowl is that they can not only facilitate

an increased risk in the transmission of Chagas disease, but they are also important in the transmission of other zoonotic diseases.

The identified risk factors documented in the house type surveys provide evidence of a widespread potential for exposure to the vector of Chagas disease. By documenting these cultural attributes, a better understanding of the current situation can be addressed by health professional before the disease becomes problematic in the population. The next section takes a closer look at each community to determine if one place lives with a greater threat to domestic infestations compared to the others based on the house type surveys.

5.2.2 Community Specific Domicile Data

Situated several miles up slope from the single road leading in and out of the area, Community A is the most remote of the six studied communities and is found closest to secondary forest growth. Community A is the most undeveloped and has been inhabited the shortest amount of time. During the 2005 field season, sixteen homes were documented in the community. All of the sixteen homes were made of wood (Table 5.11 and Figure 5.5). Dominant roofing material, found on fourteen of the sixteen buildings, was *lamina* (Figure 5.6). Of the two buildings that did not follow this pattern, one had a combination of *lamina* and *carton* and the other had only *carton*. There was a nearly even distribution of flooring materials with slightly more earthen floors than concrete (Table 5.11 and Figure 5.7). None of the observed houses possessed window screens or porch gates. Although there seemed to be gardens scattered throughout the community few were located near the homes. Indeed, only three gardens were observed to be in

direct contact with a home. Those houses that did not include a garden are noted in Table 5.11. Only one home possessed a ceiling in Community A.

Table 5.11: House Type Survey Data from Community A

House Type	Roof Types	Floor Type	Window Screens	Porch Gate	Garden	Ceiling
16 Wood	15 Lamina	7 concrete	0 With	0 With	3 with	1 with
0 Concrete	1 Carton	9 Earthen	16 Without	16 Without	13 not near home	15 without

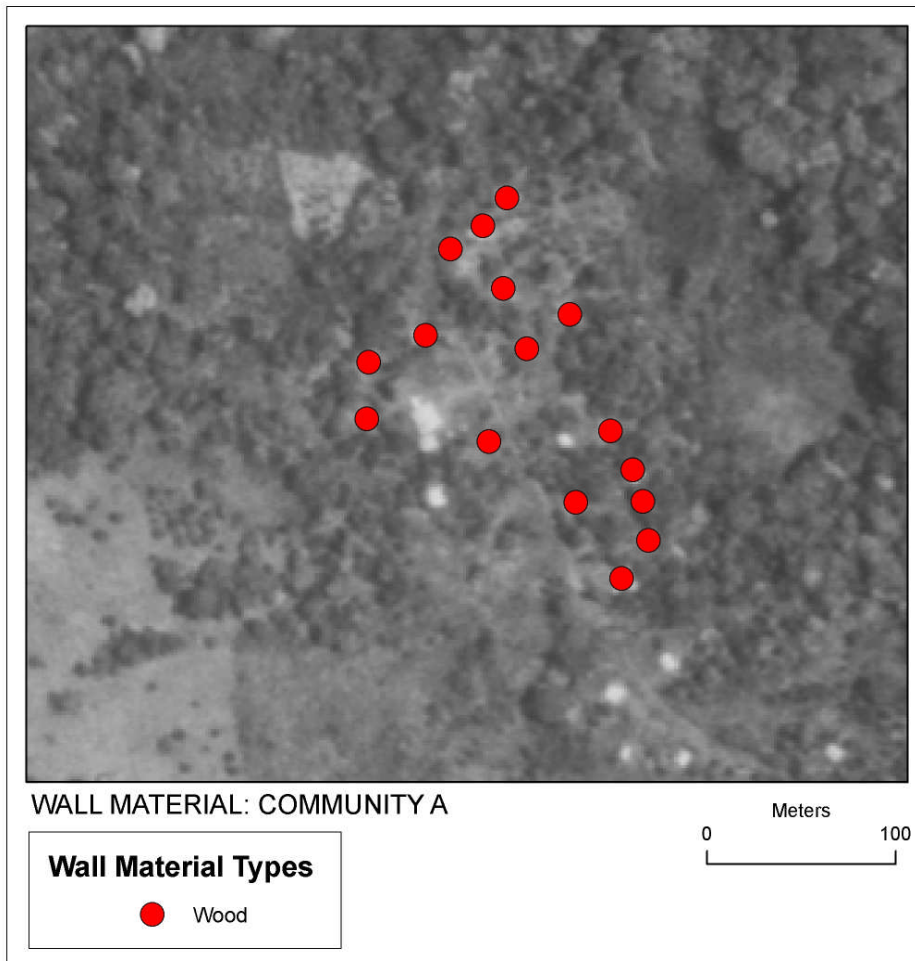


Figure 5.5: Wall Type Survey Data from Community A

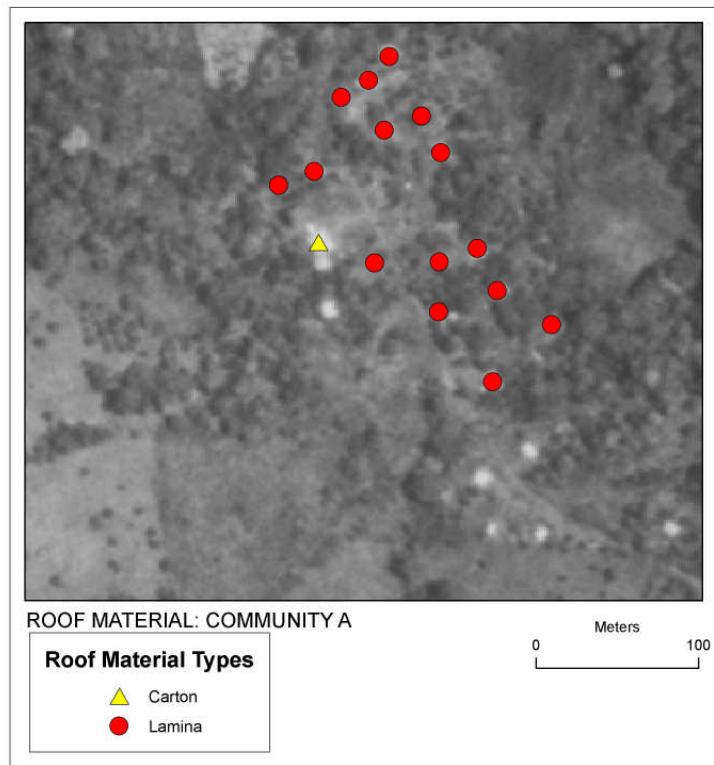


Figure 5.6: Roof Type Survey Data from Community A

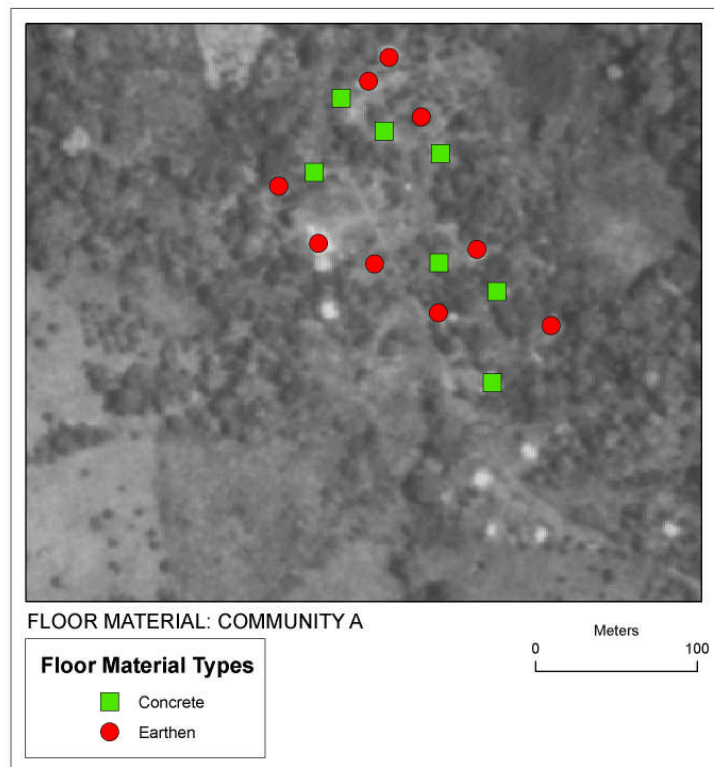


Figure 5.7: Floor Type Survey Data from Community A

Community B is also small with only 32 homes (seventeen of which agreed to participate in this study). Of the 17 homes which agreed to participate, 10 were of concrete construction (Table 5.12 and Figure 5.8). One home included a mixture of concrete and exposed cinderblock, while another included concrete, exposed cinderblock, and wood. Two other houses contained wood and concrete mixtures in their construction. The remaining three homes were built from wood. Roofing materials used in Community B are more varied than those found in Community A (Figure 5.9). Five homes used only *asbesto*. One home used a combination of *asbesto* and *lamina* while another combined *asbesto*, *lamina*, and *palma*. Additionally, one home used a combination of *asbesto* and *palma*. Five other homes used *lamina* alone, while two others used *lamina* in combination with another material. Finally, in Community B, one home was entirely cement, from floor to roof, while another used only *carton*. Flooring materials used in Community B did not vary from the standard materials observed in all six communities (Figure 5.10). Most homes possessed concrete floors while only two had entirely earthen floors. Only two homes made use of a porch gate, while five homes had observed ceilings. The kitchen garden was not common in Community B as Table 5.12 shows. Mosquito screens were found on none of the homes included in the study.

Table 5.12: House Type Survey Data from Community B

House Type	Roof Type	Floor Type	Window Screens	Porch Gate	Garden	Ceiling
11 concrete	7 Lamina	11 concrete	0 With	2 With	5 With	5 With
16 Wooden	1 Carton	2 Earthen	17 Without	15 Without	12 Without	12 Without
	8 Asbesto	4 Earthen and Concrete				

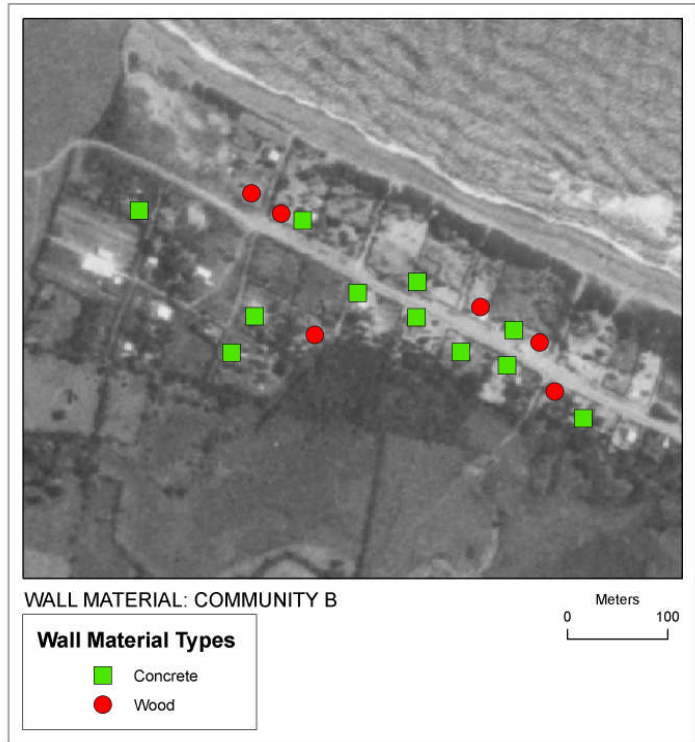


Figure 5.8: Wall Type Survey Data from Community B

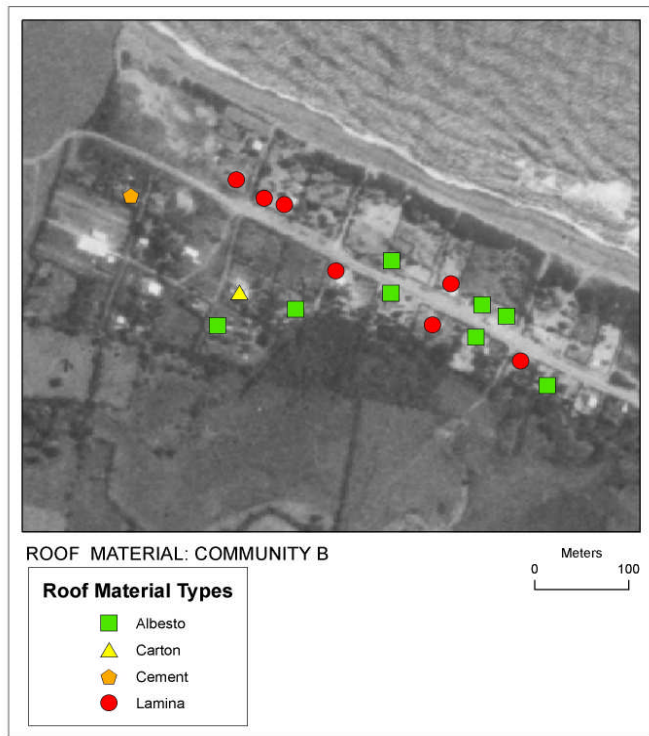


Figure 5.9: Roof Type Survey Data from Community B

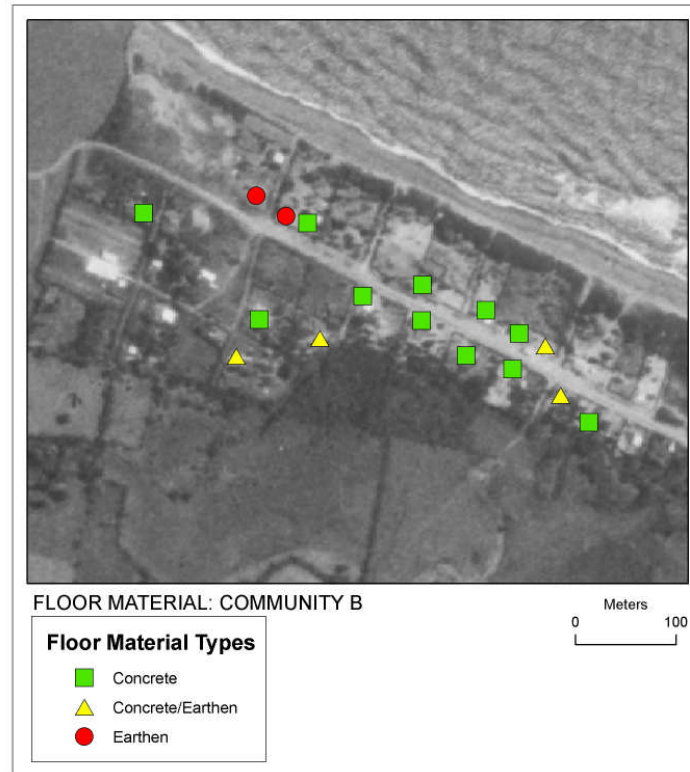


Figure 5.10: Floor Type Survey Data from Community B

Of the 72 observed homes in Community C, 59 actively participated in the study. Community C's landscape is dominated by the concrete home. Of the 59 families that participated, 37 possessed a variation of a concrete home (Table 5.13 and Figure 5.11). The remaining 22 homes were of wooden construction. Twenty-one homes have *asbesto* roofs, while 23 use *lamina* (Figure 5.12). Five other homes incorporated some combination of *lamina* and another material for their roofing needs. The remaining homes contain *carton* roofs. Twenty-three homes have entirely earthen floors, while three contain a combination of earth and concrete (Figure 5.13). The majority of homes have concrete floors. Only two porch gates were observed in Community C. Ceilings were similarly a sparse addition with only one observed during 2005. Of the 59 families who participated in this study only 17 homes could be classified as having a garden. As previously explained, because the research team was not given permission to explore the

property, it was difficult to determine if a garden existed. Of the 17 gardens found in this community, only eleven homes possessed a garden near the house. There were four homes in Community C that possessed window screens. These screens however, were in varying states of disrepair.

Table 5.13: House Type Survey Data from Community C

House Type	Roof Type	Floor Type	Window Screens	Porch Gate	Garden	Ceiling
35 concrete	7 Lamina	33 concrete	4 With	2 With	17 With	1 With
24 Wooden	28 Carton	23 Earthen	55 Without	57 Without	32 Without	58 Without
	24 Asbesto	3 Earthen and Concrete			10 Unknown	

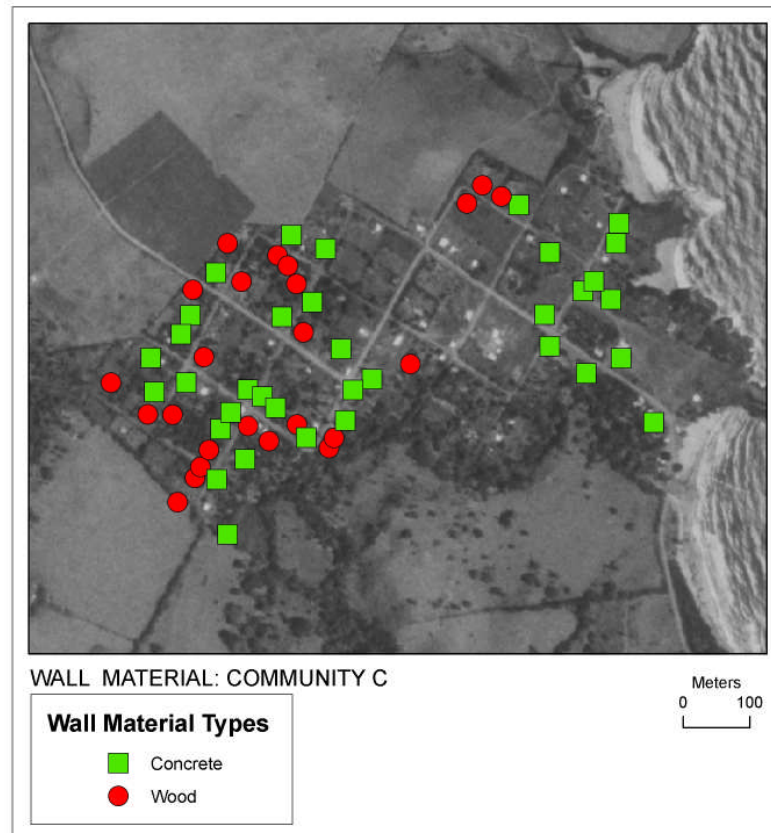


Figure 5.11: Wall Type Survey Data from Community C

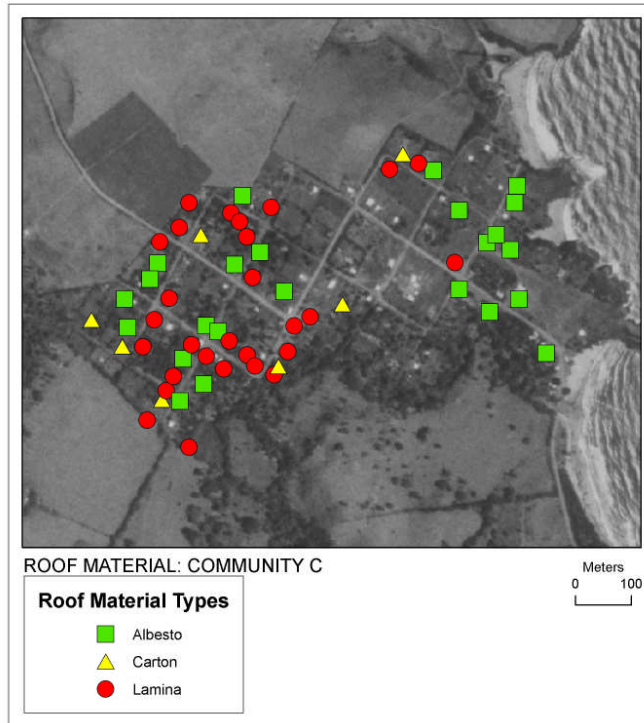


Figure 5.12: Roof Type Survey Data from Community C

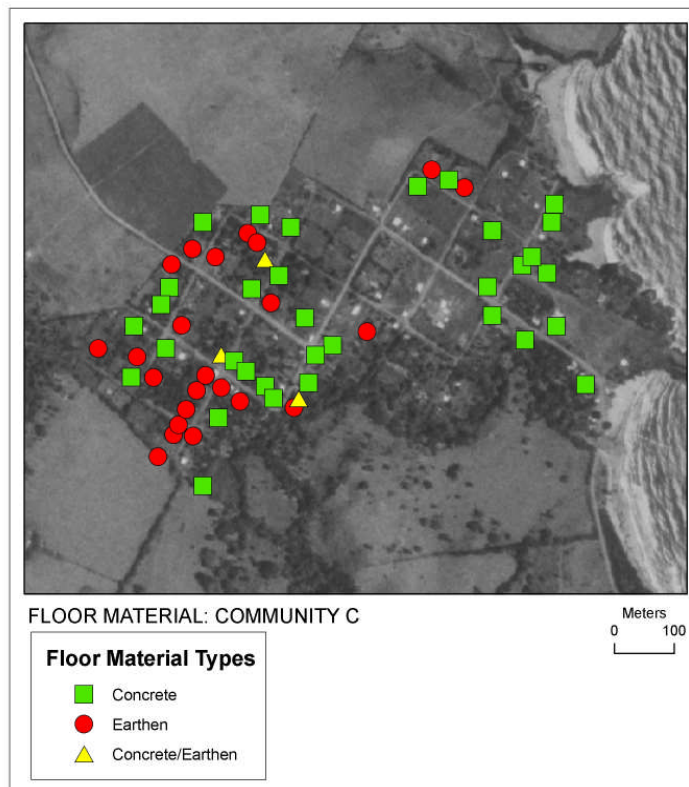


Figure 5.13: Floor Type Survey Data from Community C

Of the eighty homes in Community D, 64 agreed to participate in the study. There was a variety of materials used in construction in Community D (Table 5.14). Most homes however, were made of wood or concrete (Figure 5.14). Roofing materials were also varied (Figure 5.15). Of the 64 homes in Community D, 22 made use of *asbesto*. Three others used *asbesto* in combination with some other material. Only four homes used strictly *carton*. Two others used a combination of *carton* and *lamina*. Thirty-one homes used only *lamina*. The remaining two homes were completely constructed with cinderblock and concrete. Most floors found in this community were concrete (Table 5.14 and Figure 5.16). Only one home contained a porch gate. Ceilings were a sparse item in Community D, with only one observed. Gardens were present in 25 homes and only one domicile possessed a window screen.

Community E is the largest of the six communities in this study. According to the *comosario* 250 buildings can be found in this community. However, only 119 inhabited homes were documented during 2005. Some of the remaining buildings were uninhabited, which may explain the difference between the counts. Of these 119 homes, 71 actively participated in this study although, 109 were given collection jars during the initial walk-through. Most people who took a collection jar, but were not included in the final study were participating in the chili harvest taking place during the field season, therefore were not home during weekly bottle checks.

Thirty-seven of the 71 participating houses were constructed with a combination of cinderblock and concrete (Table 5.15 and Figure 5.17). One house was made of nothing but *lamina*. The remaining 33 were wooden or contained at least a portion of wood. The dominant flooring material used in Community E was concrete (Figure 5.19).

Surprisingly, considering the number of wooden homes, only 17 earthen floors were found. Interestingly, the dominant roofing material found in Community E was *lamina* (Figure 5.18). Only three documented homes made use of *asbesto*. There were no homes that used only *carton*, although two homes used *carton* in combination with *lamina*. The remaining seven homes were entirely concrete from floor to roof. Four homes in Community E had a porch gate. Seven homes in Community E contained ceilings, which is the most in any of the communities. Additionally, 40 kitchen gardens were also found in this community. Four homes in Community E contained window screens. The condition of these screens was similarly to those found in Community C; torn and in disrepair.

Table 5.14: House Type Survey Data from Community D

House Type	Roof Type	Floor Type	Window Screens	Porch Gate	Garden	Ceiling
26 concrete	33 Lamina	41 concrete	1 With	1 With	25 With	1 With
34 Wooden	4 Carton	14 Earthen	63 Without	63 Without	21 Without	63 Without
	25 Asbesto	9 Earthen and Concrete			18 Unknown	
	2 Cement					

Table 5.15: House Type Survey Data from Community E

House Type	Roof Type	Floor Type	Window Screens	Porch Gate	Garden	Ceiling
38 concrete	61 Lamina	53 concrete	4 With	4 With	40 With	7 With
33 Wooden	7 Cement	17 Earthen	67 Without	67 Without	31 Without	64 Without
1 Lamina	3 Asbesto	1 Earthen and Concrete				

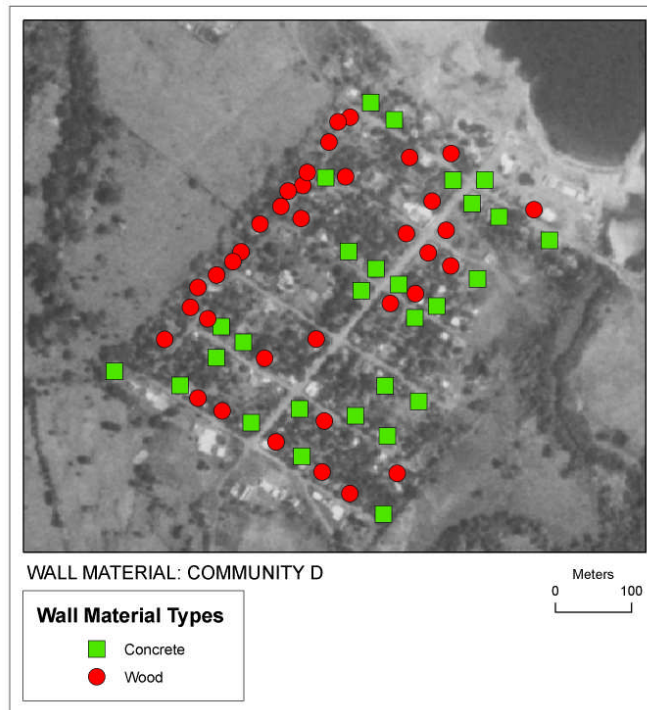


Figure 5.14: Wall Type Survey Data from Community D

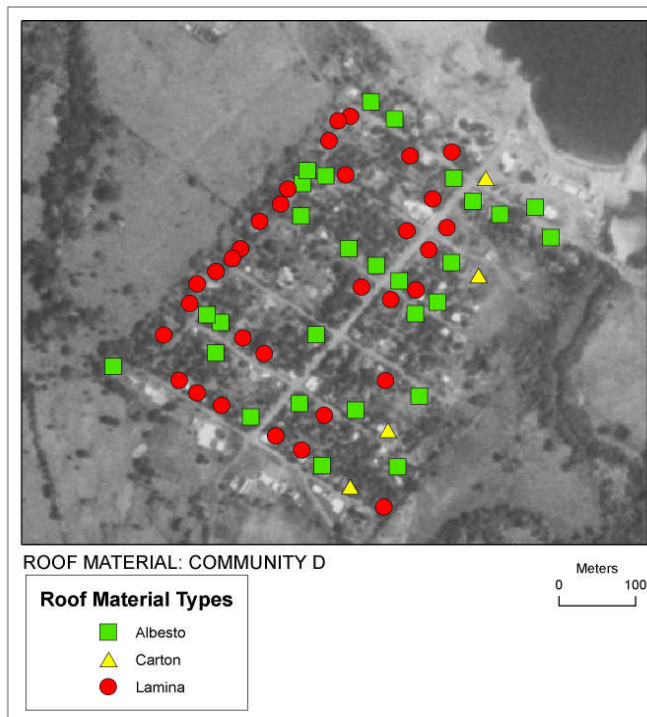


Figure 5.15: Roof Type Survey Data from Community D

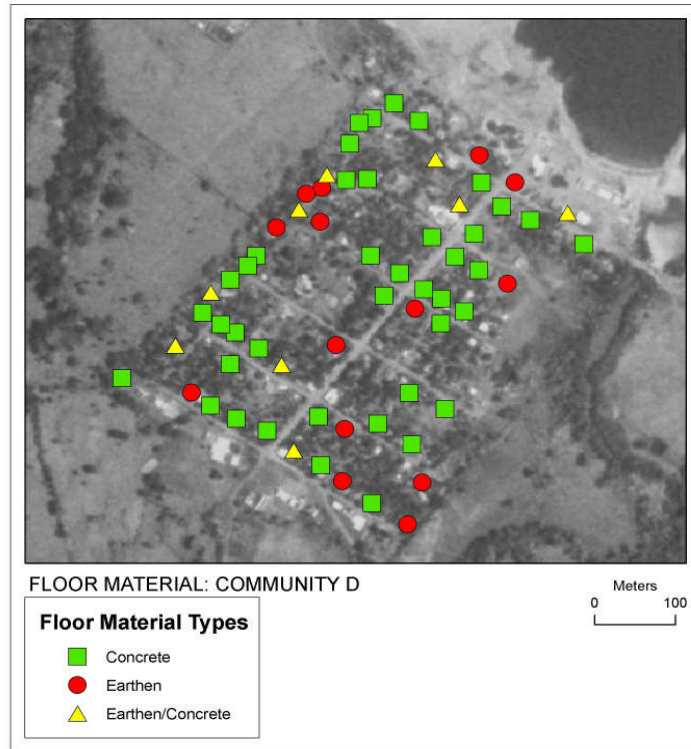


Figure 5.16: Floor Type Survey Data from Community D

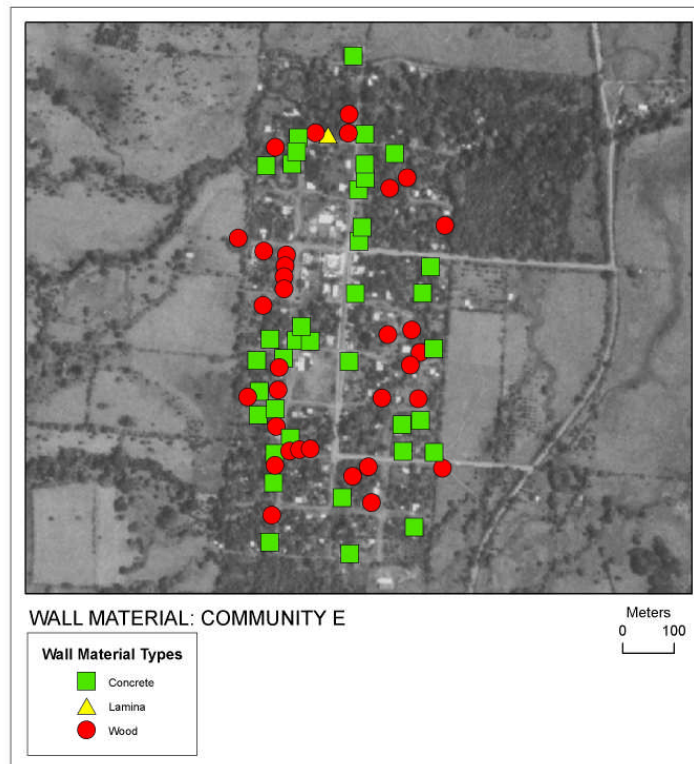


Figure 5.17: Wall Type Survey Data from Community E

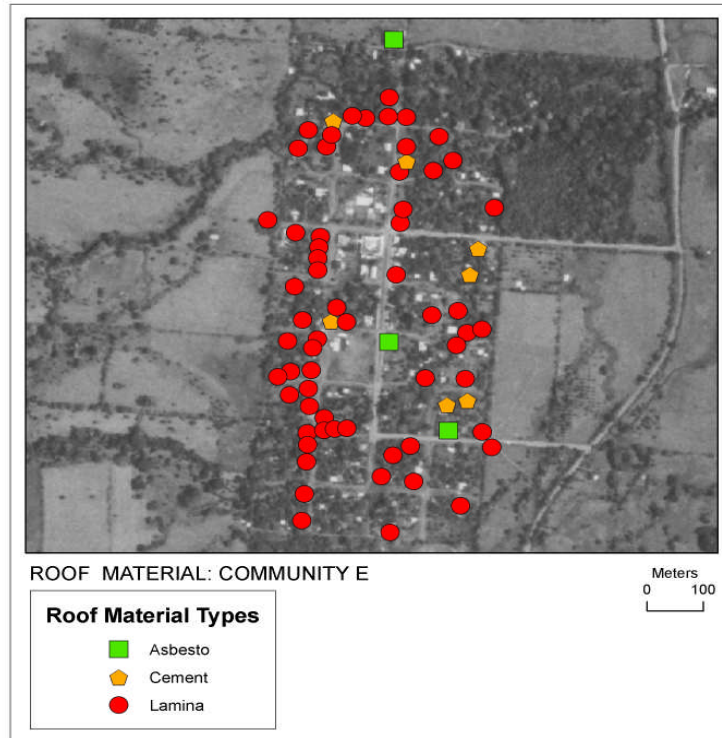


Figure 5.18: Roof Type Survey Data from Community E

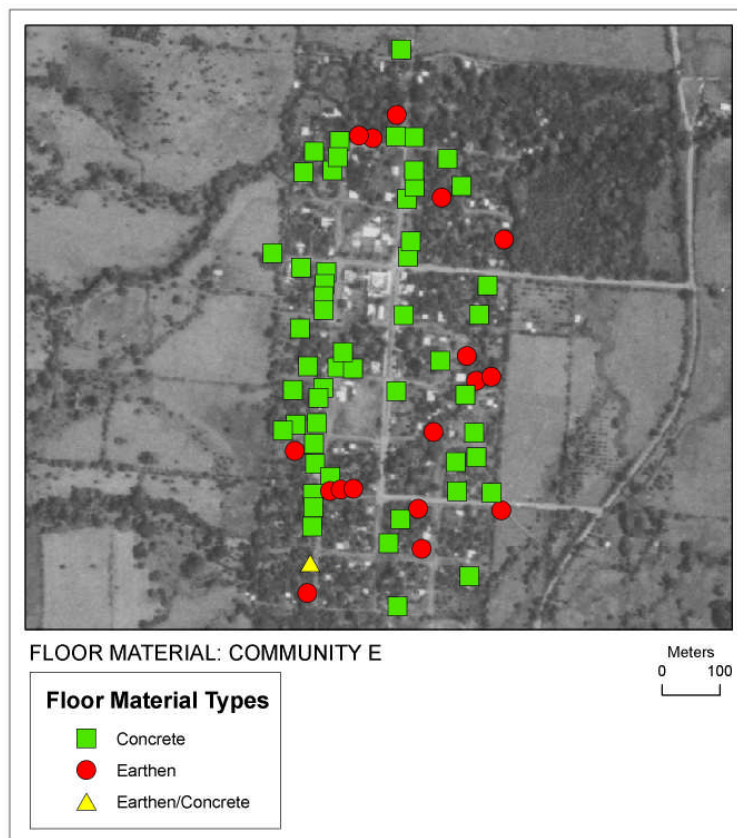


Figure 5.19: Floor Type Survey Data from Community E

Twenty-seven of the 29 homes in community F participated in the project. Of these 27 houses, 16 were constructed with cinderblocks and concrete (Table 5.16 and Figure 5.20). The remaining eleven homes were wooden. Six homes, including one wooden home, used *asbesto* as the roofing material (Figure 5.21). Eighteen homes made use of *lamina* while the remaining three used a combination of *lamina* and *carton*. Ten homes had earthen floors while the remaining used concrete (Figure 5.22). There were no recorded window screens or ceilings in Community F, and only one home had a porch gate. Eleven homes were documented with kitchen gardens during the 2005 field season.

In the next section the Chagas landscape will be further developed with a discussion of the results for Phase II. This discussion includes a visual representation of the collected vectors using a GIS created for the study area. The GIS contains the information collected in the house type surveys and any relevant vector data collected from the participating households.

5.3 Geographic Results from the Collection of *Triatoma dimidiata*

Phase II began on March 1, 2005 in Community F. Specimen cups for the collection of *Triatoma dimidiata* were distributed to 27 households during the initial visit. Again, each family agreeing to participate was given one specimen cup, a pair of plastic gloves, and a picture to help identify the vector *Triatoma dimidiata*. On March 2, 2005 specimen cups were distributed in Community A¹¹. On the sixth of March specimen cups were distributed to Communities B and C. Nearly fifty specimen cups were distributed to

¹¹ Because of Mr. Velazco's work schedule and his religious affiliation we were not able to make the next round of distributions until the sixth of that month.

these two communities. On March 7, 2005 specimen cups were distributed in Community D and the following day to Community E¹².

Table 5.16: House Type Survey Data from Community F

House Type	Roof Type	Floor Type	Window Screens	Porch Gate	Garden	Ceiling
15 concrete	21 Lamina	17 Concrete	0 With	1 With	11 With	0 With
11 Wooden	6 Asbesto	10 Earthen	27 Without	26 Without	16 Without	27 Without

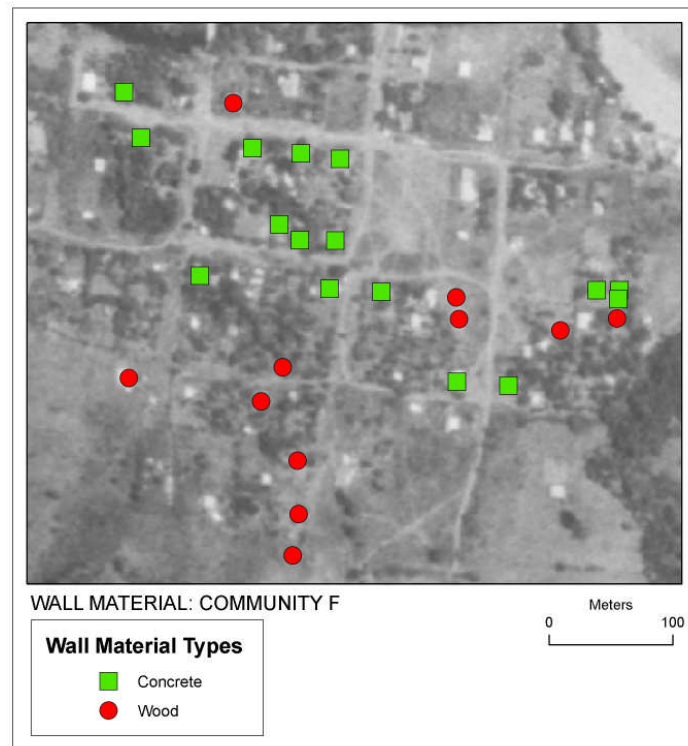


Figure 5.20: Wall Type Survey Data from Community F

¹² After our first visit to Community F we were stopped by two participants on the road to Community C. They suggested we give a local Rancher a specimen cup as well, as this family complained of a, “chinche problem” (Personal communication 2005). Therefore on March 11, 2005 Mr. Velazco and I spoke with them and then gave the ranch owner a bottle after he and his family agreed to participate in the project.

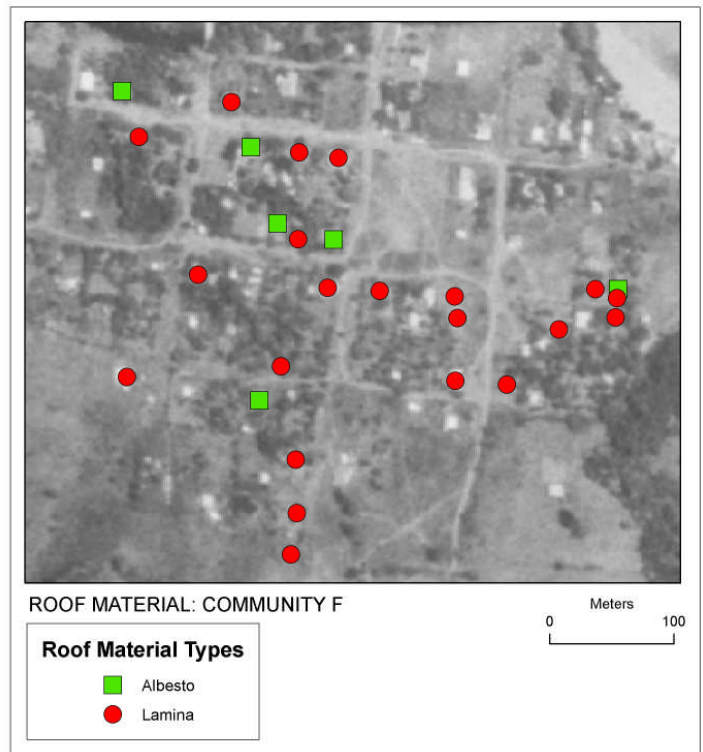


Figure 5.21: Roof Type Survey Data from Community F

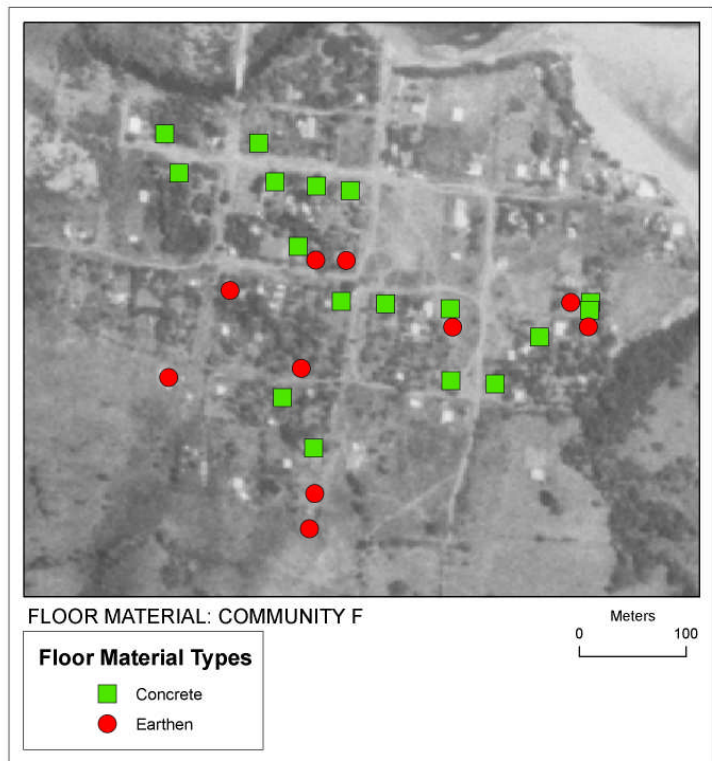


Figure 5.22: Floor Type Survey Data from Community F

After the first wave of distributions, the research team visited each participating home in each community weekly until June 5 2005¹³. During this sixteen-week period 65 insects were collected of which 58 have been positively identified as the vector *Triatoma dimidiata* (See Appendix C for Participant Specific Collection Data; see Appendix D for vector photographs).

Within ten days of the initial distribution period the first group of *Triatoma dimidiatas* was collected. Upon receipt of the insects, new specimen cups were distributed to the participants. The collected insects were processed at the Field Station, which included identification and preparation for transfer to Dr. Dorn (see chapter three). The sex or stage of development of each insect was identified in the field, and then reaffirmed by Dr. Dorn and her team at Loyola University.

The non-adult *Triatoma dimidiatas* were assigned instar ratings from one to five. This development scale was taken from entomological reference materials given to the team by Dr. Dorn (Lent and Wygodzinsky 1979). The instar ratings were simply a way to gage the development stage nymphs were in after being collected. In many cases it was difficult to determine the exact stage of instar development. Therefore, a range of two numbers was assigned to the collected specimens, and these results are summarized in Appendix C. Unfortunately, all of the collected insects were lost during Hurricane Katrina as Dr. Dorn's facilities were completely flooded so true instar identification is unavailable.

¹³ In the course of these weekly visits Mr. Valesco and I would walk from home to home inquiring about the *Triatoma dimidiata*. These visits not only allowed us to check the status of the vector collections, but they also allowed the community to become familiar with me and this project. The weekly visit provided insight for us into the daily life of the participants, as well. For example, each community had a certain day of the week they would burn their leaves as instructed by the local health authorities. This action was an attempt to discourage the resting habitat of the vector for dengue fever, *Aedes aegypti*. By burning the leaves and other ground cover the possibilities for daily resting places for this mosquito was diminished.

Only three vectors were collected from Community A. The first *Triatoma dimidiata* from Community A were collected on April 10 from houses A13 and A15 (Figure 5.23). These two vectors were documented as domestic, because they were found inside the participant's homes. The last vector collected from this community was recovered on May 9, from house A2. This *Triatoma dimidiata* was also documented as domestic (see Appendix C). Interestingly, it was expected that we would receive more domestic vectors from this community as it was documented as possessing the most risk factors. However, Community A produced nearly the smallest proportion of collected *Triatoma dimidiata*. Several reasons may help to explain these unexpected results and will be discussed in the next section.

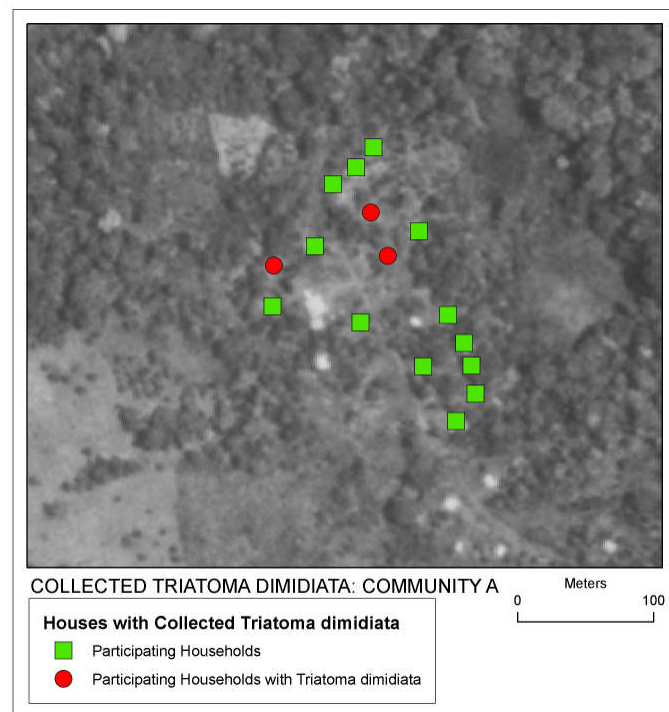


Figure 5.23: Household Representations of Collected Vector Data from Community A

Few *Triatoma dimidiata*s were also received from Community B. Four specimens were collected, but only three were identified as *Triatoma dimidiata* (Figure

5.24). The first two insects were collected from Community B on April 4, however, only one was a *Triatoma dimidiata*. The next specimen collected from Community B was received on May 5. This specimen came from house B6 and was found in the home. The last *Triatoma dimidiata* from Community B was collected from B32 on May 31. Interestingly, this home was not included in the original study of Community B as because of its location away from the primary settlement, the research team did not know the house existed. The owner of the house heard about the study and brought the *Triatoma dimidiata* to another member of the community to pass on. Once this specimen had been received, contact was made with the resident and she informed us she had found the *Triatoma dimidiata* in the home.

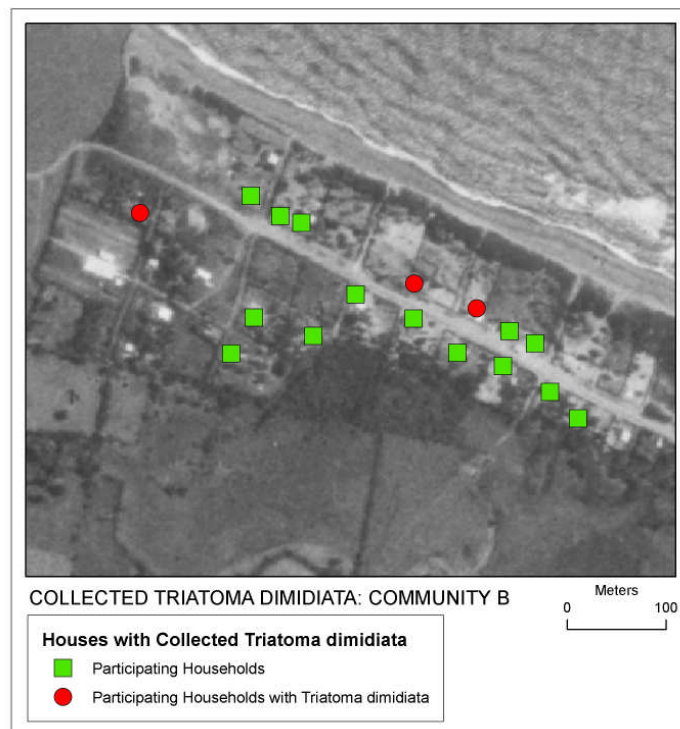


Figure 5.24: Household Representations of Collected Vector Data from Community B

The greatest numbers of *Triatoma dimidiata* were collected from Community C (Figure 5.25). A total of twenty-three specimens were gathered from this community

however, only twenty-two of these have been identified as *Triatoma dimidiata*. The first collected vectors were received on March 13 from two participants in Community C. As one can see from Appendix C and Figure 4.13, these vectors were collected from houses C15 and C30. We received an additional vector from C15 and C30 on April 4. On March 22 we collected one vector from C26. An additional five *Triatoma dimidiatas* were collected from this location on April 20¹⁴. On April 4, we received one *Triatoma dimidiata* from C3 and four additional specimens from C35. The *Triatoma dimidiata* collected from C3 was domestic. However, the four collected from C35 were found in a nearby shed on the property. It is believed that a chicken coup was inside the shed. This may explain the high numbers of *Triatoma dimidiata* collected from this building as chicken coups have been previously noted as nests or hotspots for the bug (Zeledon and Rojas 2006). Several days later on April 10, one *Triatoma dimidiata* was received from C53, this would be the only vector collected from this site. On April 20 one vector was received from C31. The remaining vectors collected from Community C were gathered in May 2005. May 1 saw one *Triatoma dimidiata* from C22. On May 15 and May 21 an additional one vector was collected from C75 and C70 respectively. The final *Triatoma dimidiata* was collected from C75 on May 31.

¹⁴ The participant in this household was one of the more hesitant members of the study community. During the sixteen-week field season we were never allowed into the yard. However, by the end of the field season, participant C26 became one of the most helpful members of the study. He diligently collected *Triatoma dimidiata* from his home. All vectors collected at this home were domestic.

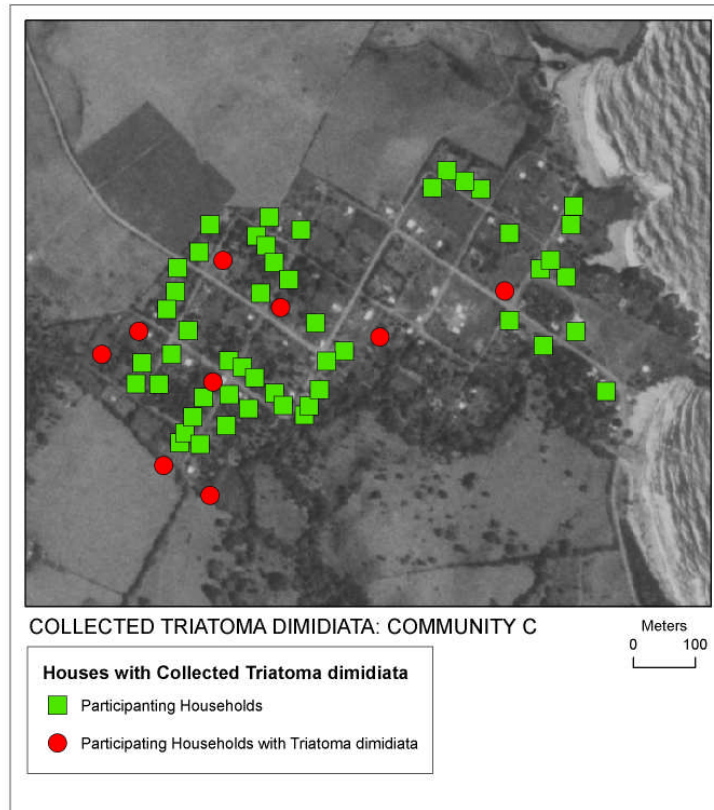


Figure 5.25: Household Representations of Collected Vector Data from Community C

Twenty insects were collected from Community D, although only 16 were *Triatoma dimidiata*. The first two *Triatoma dimidiatas* collected from Community D were from house D9 on March 20, 2005 (Figure 5.26; see Appendix C). An additional three vectors were collected from this residence on April 19 and May 31. Upon initial receipt of the insects the participant noted that the *Triatoma dimidiatas* were found inside the home. During later visits however, he explained that they were found outside the home. The reasons behind this change are unclear, although it is speculated that this change may have to do with the stigma associated with Chagas disease which will be discussed in chapter five.

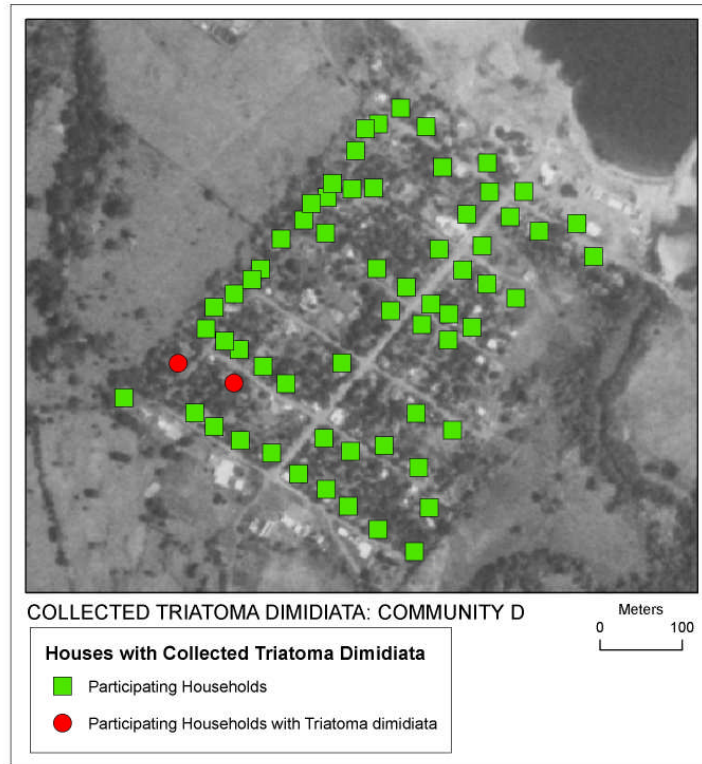


Figure 5.26: Household Representations of Collected Vector Data from Community D

House number D7 contributed the most specimens of all the homes included in this study. Eleven *Triatoma dimidiatas*, in total, were collected from this house on April 21 and May 17. When discussing the number of *Triatoma dimidiata* collected here the resident explained that there was a chicken coup behind the home, which is where they suspected the “*chinchés*” were coming from (Personal Communication 2005).

Fortunately, the family slept under mosquito nets so there were no reported human blood meals from this family. The remaining four insects collected from Community D were not *Triatoma dimidiata*. House numbers D47, D57, and D77 contributed several different species of insects found locally. Several of these resemble the *Triatoma dimidiata*, but can not transmit the parasite *Trypanosoma cruzi*.

A total of 10 *Triatoma dimidiatas* were collected from Community E (Figure 5.27). The first vectors were collected on March 15 from house numbers E26 and E9. Three other *Triatoma dimidiatas* were submitted by E9 during the study period (see Appendix C). In addition to these insects, one was collected from E23 on April 3 and another from E71 on May 2. The remaining three insects were collected from E12, E122, and E13 during May. All of the collected *Triatoma dimidiatas* from Community E were found in domestic environments.

Three insects were collected from Community F during the study period (Figure 5.28). Of these three however, only two were positively identified as *Triatoma dimidiata*. The first insect was received from F27 on March 29. This has been identified as a *Triatoma dimidiata*. The second insect from this community was collected on May 4 by house F8 and was also a *Triatoma dimidiata*. The final insect collected from Community F was received from house number F14 on May 29. This was not a *Triatoma dimidiata*.

Finally, two insects were collected from the Field Station during the 2005 field season. Both were identified as *Triatoma dimidiata*. These vectors were collected in May of 2005 by two other researchers residing at the field station, and were found beneath the mattress of the bed in which the researchers slept. These insects were dead upon receipt and looked to have been so for a long time. The *Triatoma dimidiata* were kept however, and tested for *T. cruzi*¹⁵.

¹⁵ It should be noted here that we never received any vectors from the ranch included in the study. It is believed that the family never felt comfortable with the project as we were not able to spend the same amount of time with this family as with the other families in the study. Most days when Mr. Velazco and I would try and visit the home no one would be home. The ranch did however contain the previously discussed risk factors such as, a wooden home and earthen floors that have been identified in this study.

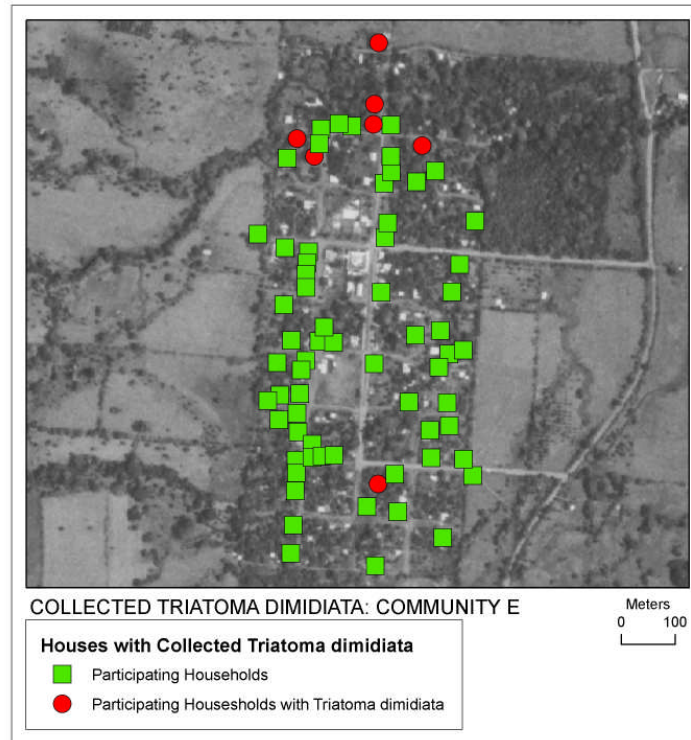


Figure 5.27: Household Representations of Collected Vector Data from Community E

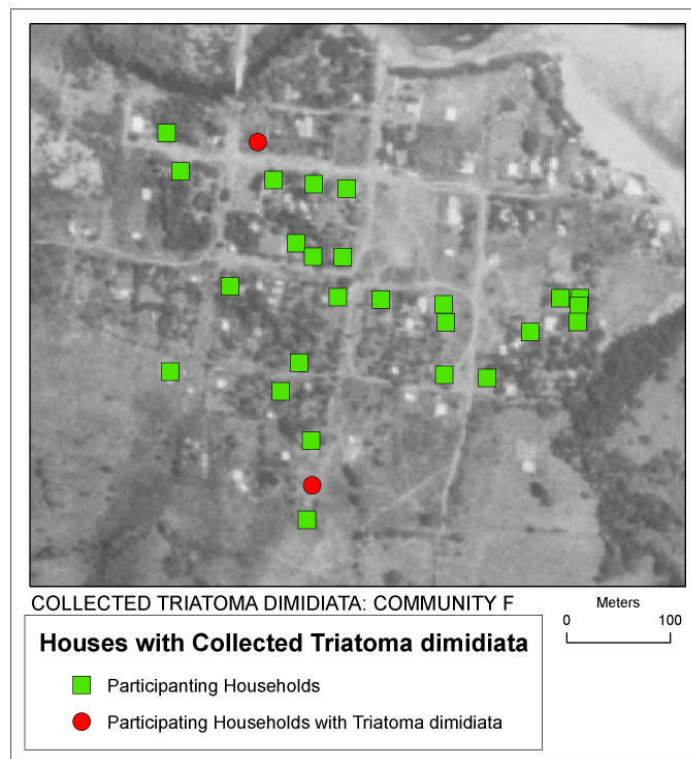


Figure 5.28: Household Representations of Collected Vector Data from Community F

5.3.1 *Triatoma dimidiata* Collection Indices

Identifying the frequency or probability of Chagas disease among the inhabitants of the six communities was not included in the original design of this study because data are unavailable. Instead, using the Entomological indexes defined by the World Health Organization, important indicators used to determine the percentage of possible human-vector contact in the six communities were calculated (Silveira et al. 1984; Aries et al. 1999; Dumonteil et al. 2002). These indicators help to present the potential risks the populations of this study area have for the contraction of Chagas disease. Upon further examination of these data it became clear that the numbers of *Triatoma dimidiata* collected for use in the human-vector contact calculations in this study were relatively low in relationship to other studies performed in similar environments. Therefore it is important in this section to first discuss the indexes used to calculate possible human risk and then to discuss concerns about the small number of vectors collected.

The indexes used in this analysis include: the Dispersion Index (percentage of *Triatoma dimidiata* positive communities), the Infestation Index (the percentage of *Triatoma dimidiata* positive habitations), the Infection Index (the percentage of *Tripanosoma cruzi* infected *Triatoma dimidiata*), the Colonization Index (the percentage of *Triatoma dimidiata* larvae positive homes), and the Density Index (the percentage of *Triatoma dimidiata* collected throughout the communities). Table 5.17 summarizes the indicator results. In the calculations for the number of *Triatoma dimidiata* positive habitations, house number C35 was excluded as these *Triatoma dimidiata* were collected from a peri-domestic environment. The four *Triatoma dimidiata* collected from this site were also excluded from all other calculations except for the Total Infection Index. The

Total Infection Index calculated the percentage of total *Triatoma dimidiata* collected which tested positive for *Trypanosoma cruzi*, thus it was necessary to include the four *Triatoma dimidiata* from house C35.

Table 5.17: *Triatoma dimidiata* Indices for the Six Studied Communities

	Dispersion Index	Infestation Index	Infection Index	Colonization Index	Density Index
Community A	-	19*	-	67*	19*
Community B	-	17*	33*	-	17*
Community C	-	15*	14*	33*	31*
Community D	-	3*	-	100*	25*
Community E	-	10*	10*	43*	14*
Community F	-	7*	-	-	7*
Station	-	50*	-	-	100*
Total	100*	11*	9*	37*	21*

* all numbers shown in percentages

Several of the results in Table 5.17 seem to be deceptive in relation to their represented populations. For example, the colonization index for Community D is 100 percent. The colonization index is calculated by dividing the number of houses with *Triatoma dimidiata* nymphs by the total number of *Triatoma dimidiata* positive houses in that community. Sixteen *Triatoma dimidiata* were collected from Community D, but from only two homes. Therefore, the 100 percent colonization rate is representative of only two homes and not the entire community. Table 5.17, must be interpreted with caution and particular attention paid to the number of *Triatoma dimidiata* collected and the number of homes they were collected from. The number and distribution of these collected *Triatoma dimidiata* are relatively low in comparison to other studies in similar *Triatoma dimidiata* dominant regions (Dumonteil et al. 2002; Wastavono et al. 2004; Segura and Escobar-Mesa 2004; Zeledon and Rojas 2006).

Although this study did not collect significantly high numbers of *Triatoma dimidiata*, nevertheless the vector was collected from domestic habitats indicating that

the potential for Chagas disease infection exists. One key element in this study was to determine the potential risks for human infections in these six communities. Therefore, the vector collection data adds weight that Chagas disease may be a significant health risk in the study area.

5.4 Diagnosis of *Trypanosoma cruzi* infections in the Collected *Triatoma dimidiata*

In order to determine the presence of Chagas diseases in the study area, the collected *Triatoma dimidiata* were tested for the presence of *Trypanosome cruzi* DNA. The sampling protocol used in this investigation was created by Dr. Patricia Dorn (see chapter four) and the polymerase chain reaction (PCR) amplification of *Trypanosome cruzi* DNA was used to perform this portion of the study. PCR is a technique for enzymatically replicating DNA without the presence of a living organism. The results of these tests and their significance to the larger study are discussed below.

A small amount of DNA from the gut of the collected *Triatoma dimidiata* was captured on filter papers and carried to Dr. Dorn upon arrival in Louisiana after the close of the 2005 field season. From this DNA, Dr. Dorn performed PCR kinetoplast amplification to detect the presence of *Trypanosoma cruzi* (for detailed explanation of this process see Dorn et al. 1997). Positive and negative controls were used for each PCR.

Extreme care was taken to ensure no cross-contamination occurred in the sampled gut contents in the field or lab. While in the field, before each *Triatoma dimidiata* was sampled all instruments and surface areas were cleaned with a 100 percent bleach solution and then with a ten percent ethyl alcohol solution. Surgical gloves were changed between each *Triatoma dimidiata* sampled. The PCR analysis performed in Louisiana

took place in a sterile lab environment with separate conditions for preparations and analysis of *Trypanosoma cruzi* controls and collected DNA.

From the collected *Triatoma dimidiata* gut contents, five positive *Trypanosoma cruzi* results were obtained (Table 5.18 and Figures 5.29-5.31). Table 5.17 displays a nine percent infection index from this study. Although these numbers are low in comparison to other studies carried out in similar *Triatoma dimidiata* regions (where infection indices can reach as high as ninety percent), they do indicate the presence of the parasite *T. cruzi* in the study area (Dumontiel et al. 2002; Wastavono et al. 2004; Segura and Escobar-Mesa 2004; Lopez-Cardenas. 2005; Zeledon and Rojas 2006). This identification successfully fulfills the project objective to determine if Chagas disease could be a major health risk in the region. Following this positive parasite detection further investigation is needed in order to determine the exact nature of the human risk.

Table 5.18: *T. cruzi* Results from the 2005 Collected Vector Data

House ID	Collection date	Sex	Ecotope	<i>T. cruzi</i> Results
C26.06	4/20/2005	Female	Domestic	Positive
E71.01	5/2/2005	Female	Domestic	Positive
B6.01	5/8/2005	Female	Domestic	Positive
C75.01	5/15/2005	Male	Domestic	Positive
C70.01	5/21/2005	Female	Domestic	Positive

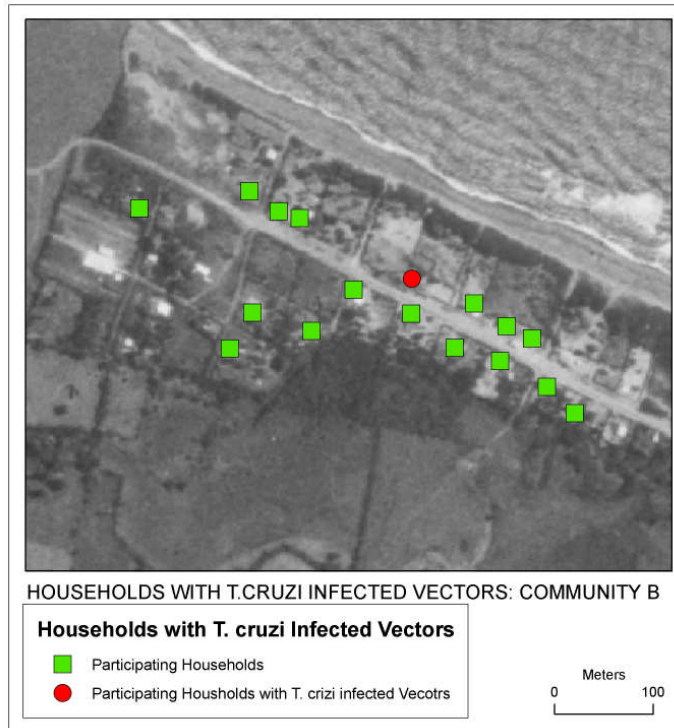


Figure 5.29: Household Representations of *T. cruzi* Results from the 2005 Collected Vector Data (Community B)

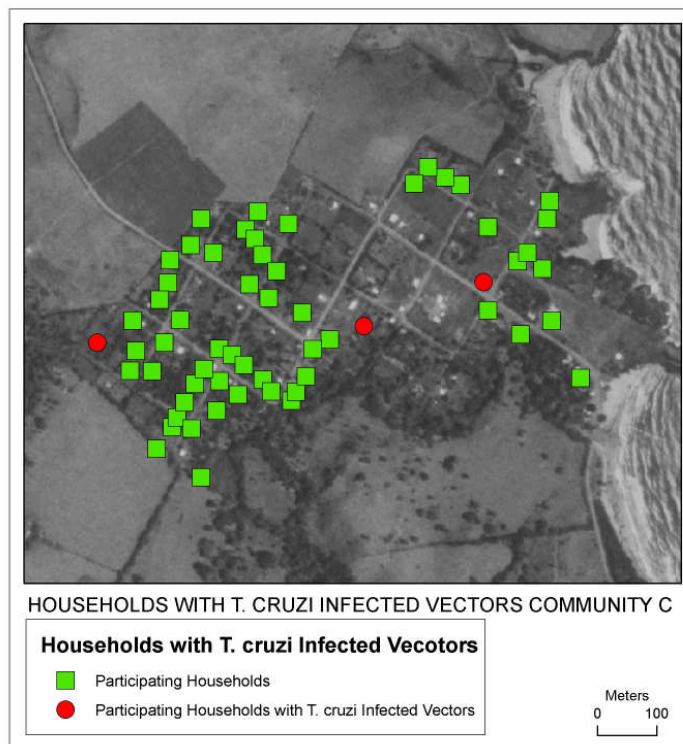


Figure 5.30: Household Representations of *T. cruzi* Results from the 2005 Collected Vector Data (Community C)

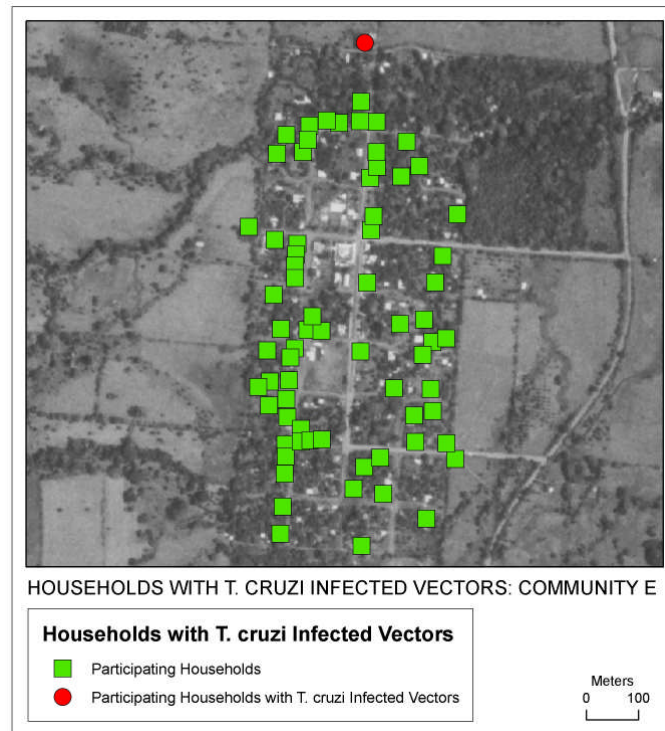


Figure 5.31: Household Representations of *T. cruzi* Results from the 2005 Collected Vector Data (Community E)

5.5 Identifying Correlations between House Type Surveys and Collected Vectors

The combination of information in the house-type surveys and the vector collection allowed for an opportunity to test for statistically significant correlations between pairs of possibly related variables. In order to accomplish this test of significance the chi-squared (χ^2) statistic is used. P-values < 0.05 were considered to be statistically significant. The Georgetown Chi Square Tutorial was used to perform the chi-square tests (Ball 2003). The results of these statistical tests are used to determine if any pattern exists in the data that may be similar to other studies of this nature (Wastavono et al. 2004; Segura and Escobar-Mesa 2004; Lopez-Cardenas. 2005; Zeledon and Rojas 2006). For example, wooden houses with dirt floors have been found to have a significant correlation to the presence of *Triatoma dimidiata* (Segura and Escobar-Mesa

2004). Additionally, homes with palm roofs and mud walls also have been found to contain, on average, more *Triatoma dimidiata* than other house types (Zeledon and Rojas 2006). Similar or different results to the previous studies will be telling in terms of the general geography of Chagas disease and *Triatoma dimidiata* data.

Chi-squared is a non-parametric test of statistical significance also known as crossbreak analysis (McGrew and Monroe 2000). This type of bivariate tabular analysis provides a rough estimate of confidence that accepts weaker data, which is why it was chosen for this study. Bivariate tabular analysis is used when one is trying to determine if any relationships exist between dependent and independent variables (McGrew and Monroe 2000). In this case the potential relationship between the independent variables of house type construction and the dependent variables of houses with *Triatoma dimidiata* was tested. Additionally houses which possess gaps (either in between the walls and floor, walls and ceiling, or in the walls themselves) are examined to determine if this aspect of construction makes any significant difference in the presence of *Triatoma dimidiata*. This study also employs chi-squared to determine if any significant relationship exists in the *house type survey* data between the six communities.

It was hypothesized that a relationship would exist between house construction-type and the presence of the vector *Triatoma dimidiata*. The chi-square value for house type materials was 0.32. The chi-square value for roof type materials was 2.50. The chi-square value for floor type materials was 1.46. For significance at the .05 level, chi-square values in all of the above should be greater than or equal to 3.84. Therefore the relationship is not significant. According to the results of the chi-square analysis, the

hypothesis was rejected and there is no statistically significant relationship in bug abundance according to type of construction materials (Tables 5.19-5.21).

Table 5.19: House Type Wall Material
(Chi-Squared including the Station)

	With Vector	Without Vector	Total
Wood	16	94	110
Concrete	12	89	101
Total	28	183	211

Table 5.20: House Type Roof Material
(Chi-Squared including the Station)

	With Vector	Without Vector	Total
Asbestos	5	66	71
Carton	3	13	16
Lamina	18	165	183
Cement	2	11	13
Total	28	255	283

Table 5.21: House Type Floor Material
(Chi-Squared including the Station)

	With Vector	Without Vector	Total
Concrete	15	148	163
Earthen	13	79	92
Total	28	227	255

A second hypothesis expected that a relationship would exist between the presence of gaps and the presence of *Triatoma dimidiata*. The chi-square value for the presence of gaps between the walls and roof was 0.053 (Table 5.22). The chi-square value for the presence of gaps between the walls and floor was 0.30 (Table 5.23). The chi-square value for the presence of gaps found in the walls 0.037 (Table 5.24). For significance at the .05 level, chi-square should be greater than or equal to 3.84. Thus, no significant relationship exists between the number of bugs collected and the presence of

gaps in the structure. The above results, however, differ from other Chagas disease studies in similar geographical regions. I believe this is directly linked to the number of vectors collected and the collection techniques used in this study. These ideas will be discussed further below.

Table 5.22: Structural Gaps Found between the Wall and Roof (Chi-Squared including the Station)

	With Vector	Without Vector	Total
Gaps	19	140	159
No Gaps	9	60	69
Total	28	200	228

Table 5.23: Structural Gaps Found between the Wall and Floor (Chi-Squared including the Station)

	With Vector	Without Vector	Total
Gaps	15	109	124
No Gaps	13	118	131
Total	28	227	255

Table 5.24: Structural Gaps Found in the Walls (Chi-Squared including the Station)

	With Vector	Without Vector	Total
Gaps	12	93	105
No Gaps	16	134	150
Total	28	227	255

A third hypothesis expected that the structural materials used between each community were not proportionally similar. In order to determine these relationships chi-square tests were run on wall type materials, roof type materials, and floor type materials. The chi-square value for wall type construction materials (concrete and wooden) between all six participating communities was 20.72 (Table 5.25). For significance at the .05 level, chi-square should be greater than or equal to 11.07. Thus the distribution is significant leading to the claim that the six communities are not using the same portion of

materials in wall type construction. The second cross-community relationship calculated using chi-square considered roof type materials. The chi-squared value for this relationship was 114.89 (Table 5.26). For significance at the .05 level, chi-square should be greater than or equal to 18.89. Again, the distribution is significant. The final chi-square test performed on the cross-community house type data considered the floor materials used within each community. The chi-square value for floor materials was 11.46 (Table 5.27). For significance at the .05 level, chi-square should be greater than or equal to 11.07. This distribution is also significant. Thus, there does seem to be a significant relationship between the number and kinds of materials participants were using in relation to the community in which they lived.

Table 5.25: Chi-Squared Interpretation between Communities in relation to Wall Material

Community	Concrete	Wooden	Total
A	0	16	16
B	11	16	27
C	35	24	59
D	26	34	60
E	38	33	71
F	15	11	26
Total	125	134	259

Table 5.26: Chi-Squared Interpretation between Communities in relation to Roof Material

Community	Lamina	Carton	Asbesto	Total
A	15	1	0	16
B	7	1	8	16
C	7	28	24	59
D	33	4	25	62
E	61	7	3	71
F	21	0	6	27
Total	144	41	66	251

Table 5.27: Chi-Squared Interpretation between Communities in relation to Floor Material

Community	Cement	Earthen	Total
A	7	9	16
B	11	2	13
C	33	23	56
D	41	14	55
E	53	17	70
F	17	10	27
Total	162	75	237

5.6 Discussion

5.6.1 Observed House Type Discussion

It was expected that the dominant house type found in this region would be the wooden house with earthen floor, however this proved not to be the case. Although the dominant wall material was wood, the dominant floor material was concrete. This pattern may represent a cultural attitude noted in the study communities which encouraged the use of concrete floors. It would seem that, the more monetarily stable the family, the more likely they possessed a concrete floor (Personal Communication 2005).

The presence of domesticated animals in and around the home has been well documented in the literature as attributing to domestic infestations of Chagas disease vectors (Briceno-Leon 1990; Briceño-León 1993; Schmunis 1994; Gurtler et al. 1997). As mentioned above, while in the field, it became increasingly difficult to document the number of animals in a participant's yard at any one time because of the fluidity of the animal's movement between residences. Although counting the numbers of animals was troublesome, documenting their presence in the communities as a whole was not. As discussed in the literature, simply having domesticated animals near the home can increase the probability for domestic infestations (Briceno-Leon 1990; Briceño-León

1993; Schmunis 1994; Gurtler et al. 1997; Zeledon and Rojas 2006). Therefore, the presence of these animals adds an additional layer to the Chagas disease landscape in the study area.

In addition to attributing to Chagas disease transmission, the cultural risks recorded in the house type surveys may also increase exposure likelihood to other diseases. For example, the use of roofing material made from asbestos, a known carcinogen, is an important issue which should be addressed in further research. In addition, the presence of animals in and around the home, can potentially introduce a risk of transmission of other zoonotic diseases such as rabies. These risk factors, which to this point have not been addressed in the literature, should be considered in further research of holistic studies of health.

5.6.2 Observed *Triatoma dimidiata* Collections Discussion

The literature suggests that *Triatoma dimidiata* tend to infest wooden houses with dirt floors more frequently than other homes (Zeledon 1974; Zeledon 2001; Wastavino 2004; Sarquis et al. 2006; Becerril-Flores et al. 2007). Additionally, the free-moving domestic animals increase the risk of infestation. It was hypothesized more *Triatoma dimidiata* would be collected from communities with these dominant features. Of the six communities, Community A possesses the greatest number of risk factors. Community A is the nearest to secondary tropical forests, the dominant house type is wood and the dominant flooring material is earthen. Additionally the free-movement of animals was witnessed on every visitation. Thus, it was anticipated that the greatest number of *Triatoma dimidiata* were expected to come from the domestic habitant in this

community. These results however, were not realized and only 18 percent of the collected vectors came from Community A (see chapter seven for further explanation).

Instead, the greatest numbers of *Triatoma dimidiata* were collected from Community C. Thirty-two percent of the total vectors collected from all the communities came from nine homes in Community C. Concrete homes with concrete floors were found more often in this community than wood homes with earthen floors. Community C is not located near any secondary forest growth and has been populated for at least seventy years. It is speculated that participants in Community C collected the most *Triatoma dimidiata* because prior to our arrival one community member found and was bitten by a *Triatoma dimidiata* (Personal Communication 2005). The family reported the incident to the local health authorities who quickly took action. The family was tested for *T. cruzi* and the home was sprayed using pyrethroid based insecticides. This incident, it is believed, caused community members to be more aware of the insect and therefore more willing to collect the *Triatoma dimidiata*¹⁶.

Several non-risk-based or non-biological factors may have affected the collection of *Triatoma dimidiata* in this study. The first of these factors depends heavily on the use of the voluntary collection method. Using this type of collection method requires untrained participants to be responsible for all entomological collections. These participants were never taught how to find the resting *Triatoma dimidiata* or how to collect insects during their feeding periods, both of which require specific techniques.

¹⁶During the course of the fieldwork, health officials were completing the first round of household fumigations. In approximately six months a second round of fumigations were to be carried out. It seemed, however, not every home in the community was being fumigated and not every family knew about the collected *Triatoma dimidiata* or the fumigation strategies. There seemed to be no pattern to homes that were fumigated and those that were not, but rather it seemed fumigators simply skipped homes if people were not home and did not try and return.

The lack of trained personal to collect specimens necessitated the use of the voluntary collection method instead of a more thorough self-collection method or use of Gomez-Nuñez boxes.

A second reason for the small number of collected *Triatoma dimidiata* may relate to the discussion found in chapter six. The majority of the participants knew nothing of Chagas disease prior to the field team's arrival. Local attitudes suggest that if residents are not continually made aware of a disease then it is not important. Unlike dengue fever and malaria, which local populations are constantly reminded about by bulletins and flyers, Chagas disease has never received the same kind of publicity. Therefore, it seems safe to assume that many people in the study decided the disease was not something to worry about, no matter what the "guera"¹⁷ said. Therefore looking for *chinchés* was unimportant.

Third, because I am an Anglo-American female, whose first language is not Spanish, acceptance by this Mexican population was problematic. This may also have affected the number of participants at the beginning of the project as well. Community A was described as untrusting of local outsiders or people who did not live and grow up in their community (Personal Communication 2005) (see chapter seven). If this is so, being a foreigner would have posed an additional barrier. Although Mr. Valesco's presence did help, he could not fully bridge the Anglo-Hispanic gap in Los Tuxtlas.

Although no significant relationships between house type construction materials and the presence of the vector or structural gaps and presence of the vector were found in the data collected in this study it must be reemphasized that materials found in this region have been shown to have significant relationships in other *Triatoma dimidiata* regions

¹⁷ This is a term used to refer to blonds in this region and was used to refer to me quite often.

(Wastavono et al. 2004; Segura and Escobar-Mesa 2004; Lopez-Cardenas. 2005; Zeledon and Rojas 2006). The primary reason for this inconsistency is directly linked to the small number of collected vectors. Although the results of the chi-squared analysis seem to indicate concrete floors and wooden floors may have similar significance rates in this region it must be noted that this is not an accurate representation. Instead it highlights the need for alternative collection techniques discussed above. These alternative techniques did not rely on untrained personnel for collection and as shown in other studies yield very different results (Wastavono et al. 2004; Segura and Escobar-Mesa 2004; Lopez-Cardenas. 2005; Zeledon and Rojas 2006). Documenting, however, these patterns in both construction materials and vector presence contributes to a better understanding of the potential risk of Chagas disease to these communities and exemplifies the need for further research using alternative strategies (see chapter eight).

The house type surveys, *Triatoma dimidiata* collections, PCR analyses, and chi-squared tests work together to create several interacting layers in the Chagas disease landscape of Los Tuxtlas. By examining these place-specific attributes of the Chagas landscape we were able to determine that risks frequently found in the literature are also present in this study area. As mentioned by Silveira et al. (1984), although it is nearly impossible to determine the exact probability or frequency of human-vector contact, determining and reducing the risk factors associated with this contact may help in preventing its occurrence. The final factor in developing the Chagas disease landscape for these project communities is assessing local understanding about the disease itself. This will be addressed in chapter six.

CHAPTER 6
CHINCHES, CHAGAS, AND CULTURE:
ANTHROPOCENTRIC INVESTIGATION OF DISEASE
KNOWLEDGE AND PLACE

6.1 Introduction

In order to identify the cultural factors of Chagas disease specific to Los Tuxtlas two scheduled interviews were conducted with the participants in the six study communities (Figure 6.1). These interviews intended to capture local knowledge, local knowledge networks, and ideas concerning disease in place. The intent of this third phase was to include all the participants who took specimen bottles during Phase II, however, as previously described, only about 70 percent of the original collection group participated in Phase III. The information contained in the interviews provides additional layers to our understanding of the Chagas disease landscape.¹⁸

Following the completion of the interviews, the information was coded based on criteria deemed crucial to meeting the goals of this project (Ryan and Bernard 2000; Gatrell 2002). Criteria such as, correct descriptions of the vector and disease as well as descriptions of environmental changes were documented in order to determine if participants consistently expressed these ideas across the six communities. Similarities and differences within and between communities were documented in order to identify potential regional patterns of knowledge compared to more localized forms of disease understanding. Documenting community specific data can also contribute to developing community-specific localized education programs.

¹⁸ As discussed in chapter four and in chapter seven, I conducted these interviews with Ms. S. Euraque and Mr. D. Velazco.

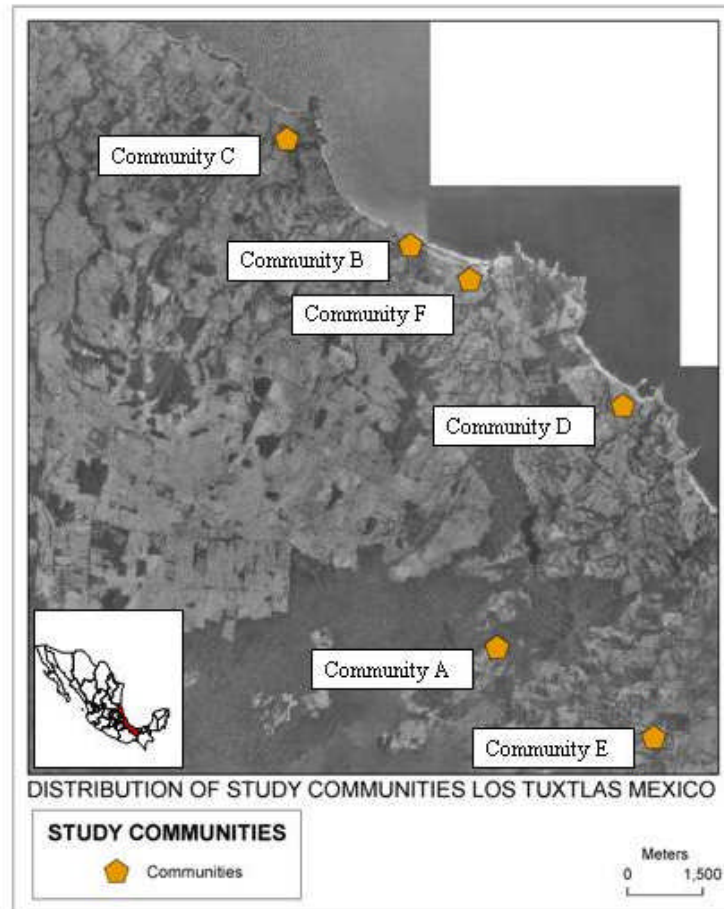


Figure 6.1: Distribution of Study Communities in Los Tuxtlas, Mexico

6.2 Results from the Chagas Disease Interviews

One of the primary goals of this project was to determine the extent of local knowledge about Chagas disease including; the vector *Triatoma dimidiata*, the vector's environment, and knowledge about symptoms of the disease. Although an open-ended interview can obtain greater amounts of personal information, this type of interview was unrealistic considering the number of families included in the research. In total 207 Chagas disease interviews were conducted throughout the six communities. The 45 participants included in Phase I but subsequently omitted from Phase III were either because they were not home during the scheduled time frame of the interview or asked not to participate in this phase of the project. Of the 207 interviews conducted, 141 were

conducted with women, 26 with men, and 40 with both men and women present (Table 6.1 and Figure 6.2).

Table 6.1: Gender of Interview Participants

Gender	Male	Female	Both Male and Female
Number of Interview Participants	26	141	40

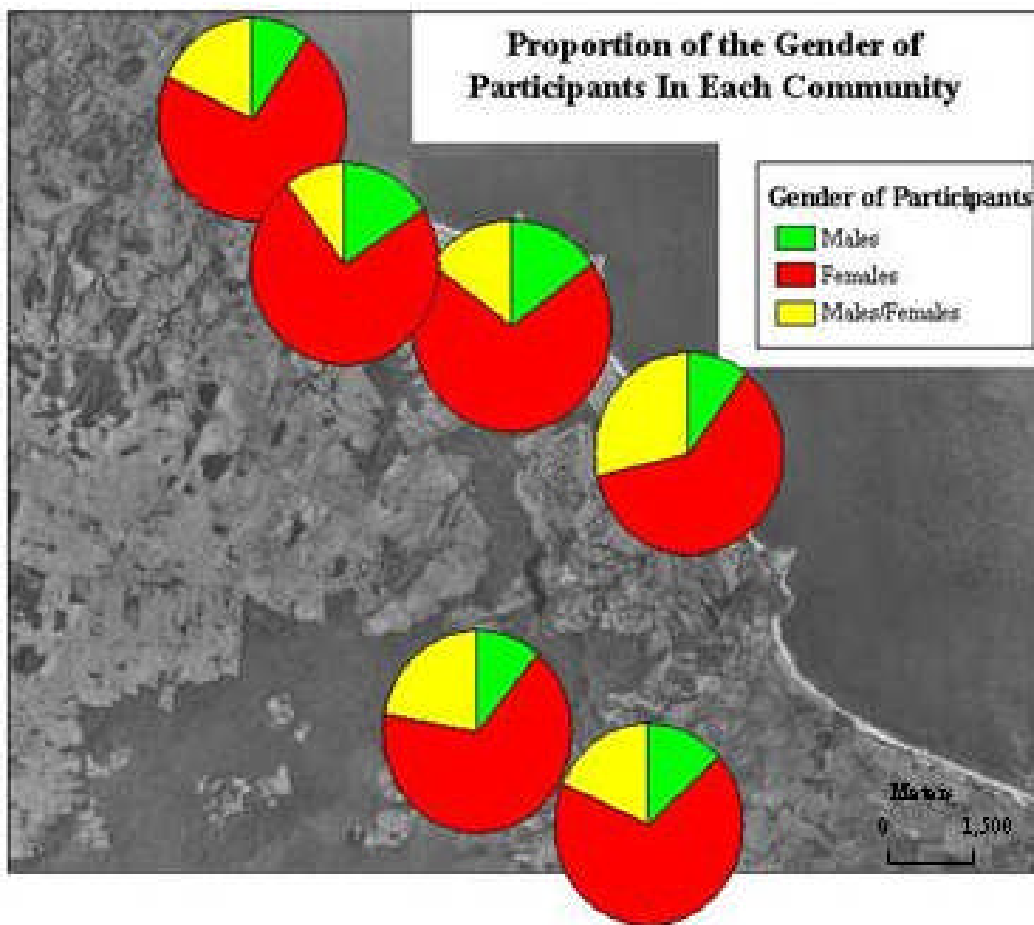


Figure 6.2: Gender of Participants who participated in Chagas Disease Interviews

The Chagas disease interview included 17 questions (see chapter four). Each question was designed to capture the interviewee's knowledge, about different aspects of

Chagas disease¹⁹. The goal of this interview was to determine the amount of accurate information local residents possessed about the disease and to determine if any patterns existed in the collected data with regards to gender.

The first series of questions concerned the vector, *Triatoma dimidiata*. One hundred and twenty-seven participants acknowledged they knew about the *chinche* (Table 6.2). Of these 127 only 72 could accurately describe the insect (including descriptors such as color, size, and shape) (Table 6.3 and Figure 6.3). An additional 17 people who said they did not know the *chinche* correctly describe the insect when asked. Nearly all of these participants were unable to tell us where they heard about the insect. Only two participants explained they had heard of the *chinche* in the *Oportunidades* (see 6.3.3). Several others explained that the local medical doctor at the clinic in Community D told them about the *chinche*. We also noted that many people who could describe the *chinche* also associated the insect with a “bad smell” (this will be addressed later).

6.2: Participants who initially acknowledged knowing the *chinche*

Gender	Male	Female	Both Male and Female
Acknowledged Vector	15	85	27
Could not know Vector	11	56	13

6.3: Participants who could actually describe the *chinche*

Gender	Male	Female	Both Male and Female
Could describe Vector Correctly	9	77	12
Could not describe Vector	21	64	28

¹⁹ During the course of the interviews we noted that some participants stated they did not know about the vector or disease but were actually able to describe them correctly.

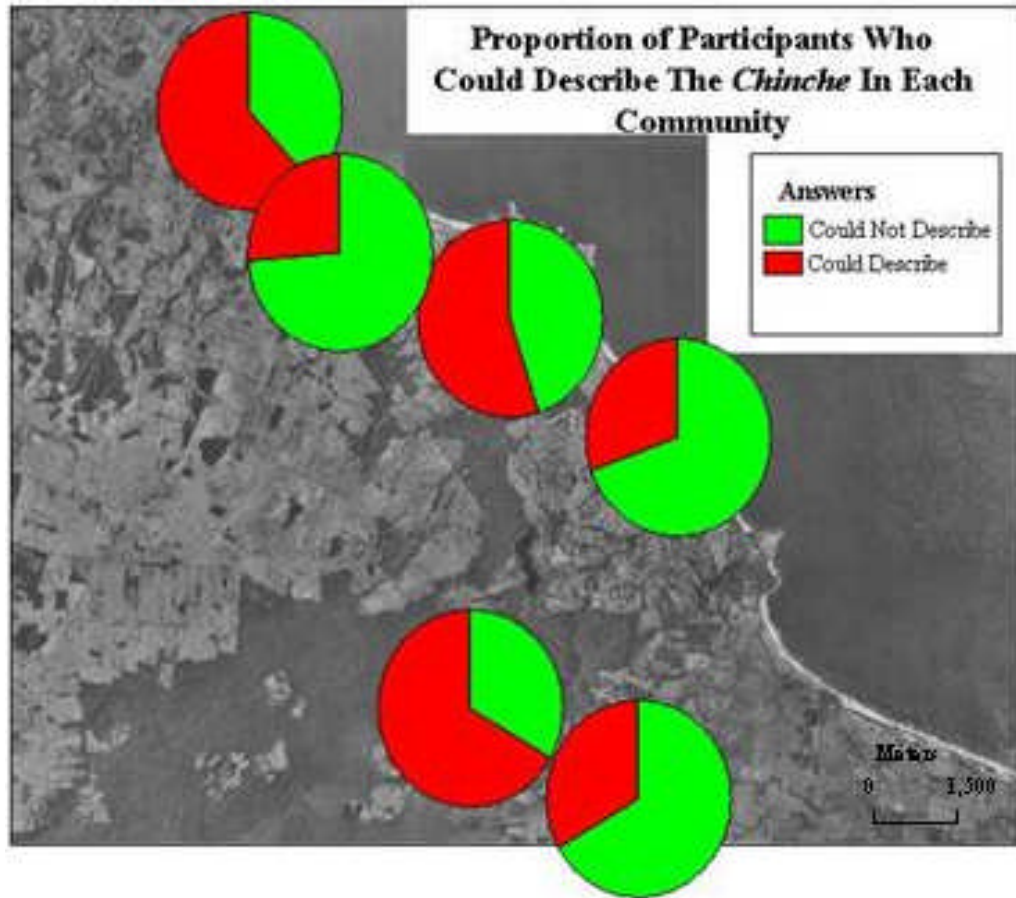


Figure 6.3: Cross-Community Comparison of Participants who accurately describe *Triatoma dimidiata*

According to the Chagas disease literature, residents in other regions of Mexico refer to the *chinche* by several different names (Ramsey 2003; Wastavino et al. 2004; Segura and Escobar-Mesa 2005). Therefore, we were also interested in determining if these alternative names occurred in Los Tuxtlas. Participants provided three additional names for this vector including, *talaje*, *chinchon*, and *Chagas*. *Talaje* and *chinchon* have also been found in other regions in Mexico (Guzmon-Brancho 2001; Ramsey 2003; Wastavino et al. 2004; Segura and Escobar-Mesa 2005). *Chagas*, however, to the author's knowledge, has not been used in other regions of Mexico, making this a region specific classification.

Although one objective of this research was to collect insects from each house, it was also important to determine if participants had seen the *chinche* prior to this investigation. Fifty-three participants acknowledged they had seen the vector in their home prior to our arrival (Table 6.4). Of the 53 participants who had seen the vector in their home, only 32 gave correct descriptions of the *chinche*. Most of the participants who acknowledged that the *chinche* had been found in their home located it in or near the bed. Generally, most participants (both those that could and those that could not describe the *chinche*) agreed that *chinchés* would be most often found in or near the bed. Other important places to find *chinchés* described by the participants included wood, firewood piles, the forest, and dirty houses.

6.4: Participants who acknowledged finding the vector in their home

Gender	Male	Female	Both Male and Female
Found Vector in Home	8	30	13
No Vector found in Home	18	111	27

We also asked each participant what kinds of homes, if any, would most likely harbor the *chinche*. Of the 166 participants who answered this question 106 pointed to the wooden home as being the most likely place someone would find a *chinche*. The next type of home associated with the *chinche* was the dirty home²⁰. The idea that the dirty home could harbor the *chinche* was a reoccurring pattern and may have affected other aspects of this project which will be discussed later in this chapter.

In trying to gain the clearest picture of the participants' knowledge about Chagas disease and its manifestations in this place we also included questions concerning the types of plants and animals (if any) people associated with the disease. Twenty different

²⁰ The word dirty or *susio* used by participants in their responses has to do with excessive clutter in the home and not usually unsanitary conditions.

kinds of plants were described as being associated with Chagas disease, though the most regularly described plant type was wild grasses. Participants also noted beans, corn, plantains, and tomatoes as key plants associated with Chagas disease. Several participants suggested that their kitchen gardens may also attract the *chinche* to the home as well. Ten different types of specific animals were associated with Chagas disease by participants. The most common of these were snakes, bats, cows, and dogs.

The final series of questions included in the Chagas disease interview focused specifically upon trying to determine local knowledge about the disease itself. Of the 207 people who participated in this interview, 91 acknowledged they knew about or had previously heard about Chagas disease (Table 6.5). Of these 91, only 50 could describe something about the disease correctly, such as, how it is transmitted, its symptoms, or any outcomes of the disease to the human body (Table 6.6 and Figure 6.4). An additional 16 participants, who said they did not know about the disease, were able to describe its symptoms correctly. Only 14 people claimed to know someone with Chagas disease, including the man living at C20, who explained that his wife died of the disease²¹.

Table 6.5: Participants who claimed to know about Chagas Disease

Gender	Male	Female	Both Male and Female
Said They knew the Disease	7	67	17
Did not know the Disease	19	74	23

Table 6.6: Participants who could describe Chagas Disease

Gender	Male	Female	Both Male and Female
Could describe the Disease	5	51	10
Could not describe the Disease	21	90	30

²¹ We were unable to verify this fact.

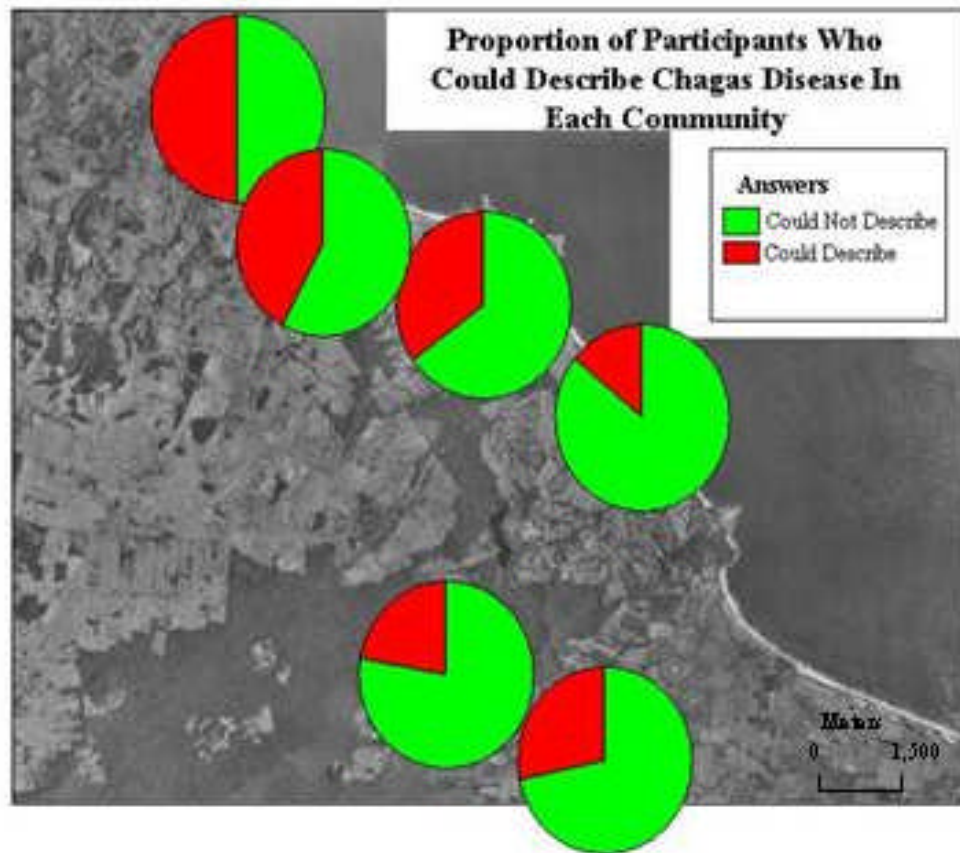


Figure 6.4: Cross-Community Comparison of Participants who could accurately describe Chagas Disease

Including C20, no participants knew anyone in their family or in their respective communities with any of the symptoms of the disease. C20, when asked if he had seen any of the symptoms, answered no. This is possible as his wife may have died from Chagastic cardiopathy, which would have no visible symptoms. We asked specifically about the most visible signs of Chagas disease such as the swollen eye and swollen belly. These symptoms had to be described in detail, as many people answered yes mistakenly, taking the symptoms of other disease for Chagas disease (this will be discussed later).

In summary, only 42 participants could describe the *chinche*, describe the symptoms of Chagas disease, and link the *chinche* with the disease in humans. Three of

these people were men, 32 were women, and seven were both men and women who were interviewed together (Table 6.7 and Figure 6.5). The majority of these 42 participants, who could describe the disease in detail, lived in Community C (Table 6.8).

Table 6.7: Participants who were able to link the *Triatoma dimidiata* with Chagas Disease

Gender	Male	Female	Both Male and Female
Linked the chinche with Chagas Disease	3	32	7
Could not link the Chinche with Chagas Disease	23	109	33

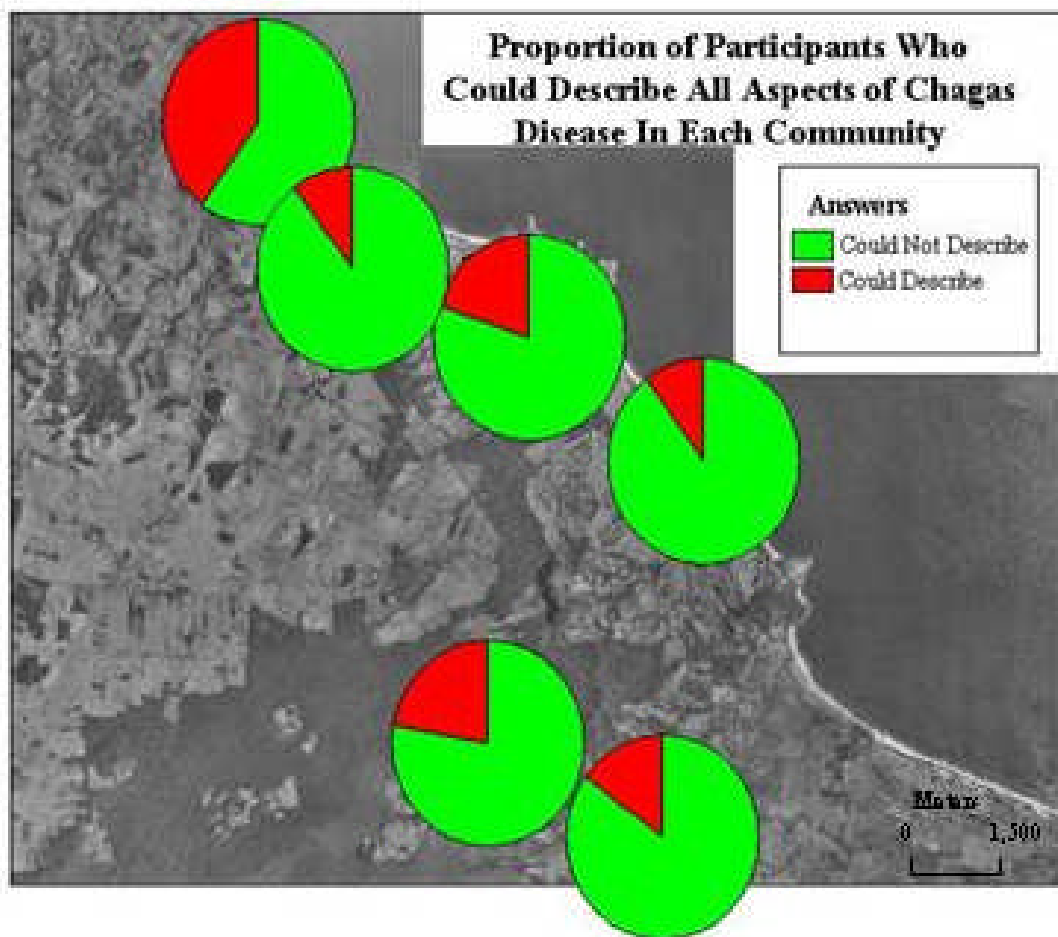


Figure 6.5: Cross-Community Comparison of Participants who could link *Triatoma dimidiata* with Chagas Disease

Table 6.8: Cross-Community Comparison of Participants who could link *Triatoma dimidiata* with Chagas Disease

Community	A	B	C	D	E	F
Linked the chinche with Chagas Disease	2	2	20	5	9	4
Could not link the Chinche with Chagas Disease	7	17	30	44	51	16

6.2.1 Chagas Disease Interview Results from the Participants who Collected *Triatoma dimidiata*

Of the 29 different locations where the vector *Triatoma dimidiata* was collected, 22 of those households agreed to participate in Phase III of this investigation. The two researchers staying at the Field Station were among those excluded from this portion of the project. These researchers were not local and this project was primarily interested in gathering local knowledge, thus they were disqualified from this portion of the study.

The remaining participants who did not participate in Phase III were not home during the scheduled interview time. Thirteen of the 22 participants were women, four were men, and five were a combination of men and women present during the interview.

Twenty-one of the 22 participants acknowledged they knew about the *chinche* prior to our investigation. Five participants were also familiar with the vector by its other names. Eleven of the participants correctly described the *chinche*. Five individuals said they had never found the *chinche* in their home prior to our arrival. All but one of the participating houses found the *chinch*es in the home. Additionally, nearly all of these participants believed the most likely place a person might find this vector was in a wooden home. Plantains were the only specific plants expressed by these participants as being linked to *chinch*es, although one male participant did mention forests in general.

Eleven participants said they had heard of Chagas disease prior to our visit. Of these eleven, only seven could describe any kind of detail about the disease. Three people who said they did not know about Chagas disease could describe some of its symptoms. Three people admitted to knowing someone or about someone with Chagas disease, although no one had seen any of the symptoms in their families or amongst the local population.

6.2.2 Results and Chi-Squared Analysis of Cross-Community Data

It is important to now look at the collected Chagas disease interview data across the communities and, using chi-square, determine if there exists any significant difference in participant answers. As one can see from Table 6.9, 100 percent of the Phase II participants from Community B also participated in the Chagas disease interview. However, as one can see from Table 6.10 Community C participants were more likely to be able to describe each of the Chagas disease elements in this interview. With these observed differences it will be important to determine if any significant relationships exist within this data set.

Table 6.9: Participants in Chagas Disease Interview by Community

Community	A	B	C	D	E	F
Number of Participants	9	19*	50	49	60	20
Percent of Total Participants in Phase II	56	100	85	77	85	74

*During the Interview Session 2 family members from B8 and B32 gave interviews and were counted separately

Table 6.10: Cross-Community Comparison of Chagas Disease Interview Data

Community	A	B	C	D	E	F
Acknowledged Vector	5	15	39	20	33	15
Did not know Vector	4	4	11	29	27	5
Could describe Vector Correctly	6	5	31	15	20	11
Could not describe Vector	3	14	19	34	40	9
Said They knew the Disease	3	10	31	18	15	12
Did not know the Disease	6	9	19	31	45	8
Could describe the Disease	2	8	25	7	17	7
Could not describe the Disease	7	11	25	42	43	13
Linked the chinche with Chagas Disease	2	2	20	5	9	4
Could not like the Chinche with Chagas Disease	7	17	30	44	51	16
Total Participants	9	19	50	49	60	20

Again, using chi-square, it was important to determine if there was any significance between what each community knew about the vector and the disease. The hypothesis for this portion of the study expected that the Chagas disease interview data between each community were not proportionally similar. In order to determine these relationships a chi-square test was run on; participants who could and those that could not describe the *chinche*, on participants who could and those that could not describe Chagas disease, and on those that could and could not link the vector with the disease.

The chi-squared value for participants who could describe the *chinche* in relation to those that could not describe the *chinche* between all six participating communities was 18.14 (Table 6.11). For significance at the .05 level, chi-square should be greater

than or equal to 11.07. Thus the relationship is significant lending to the claim that the six communities are not describing the *chinche* similarly.

Table: 6.11: Chi-Squared Cross-Community Comparison of Interview Results for those Participants who could describe the *Chinche* accurately

Community	Could Describe <i>Chinche</i>	Could Not Describe <i>Chinche</i>	Total
A	6	3	9
B	5	14	19
C	31	19	50
D	15	34	49
E	20	40	60
F	11	9	20
Total	88	119	207

The second cross-community relationship calculated using chi-square considered participants who could and those that could not describe Chagas disease. The chi-square value for this relationship was 16.28 (Table 6.12). Again, the relationship is significant and we can assume that participants are able to describe Chagas disease differently among the six communities.

Table: 6.12: Chi-Squared Cross-Community Comparison of Interview Results for those Participants who could describe Chagas Disease accurately

Community	Could Describe Chagas Disease	Could Not Describe Chagas Disease	Total
A	2	7	9
B	8	11	19
C	25	25	50
D	7	42	49
E	17	43	60
F	7	13	20
Total	66	141	207

The final chi-square test performed on the cross-community Chagas disease interview data looked at those participants who could and could not link the vector with the disease within each community. The chi-squared value for this data was 17.27 (Table 6.13). This relationship is also significant. Thus, there does seem to be a geographical variation in the kinds of knowledge participants have in relation to these three aspects of Chagas disease.

Table: 6.13: Chi-Squared Cross-Community Comparison of Interview Results for those Participants who could link the vector with Chagas Disease accurately

Community	Could Link the Vector with Chagas Disease	Could Not Link the Vector with Chagas Disease	Total
A	2	7	9
B	2	17	19
C	20	30	50
D	5	44	49
E	9	51	60
F	4	16	20
Total	42	165	207

6.3 Discussion of Disease Knowledge and Place

The interview results supported the initial hypothesis that where *Triatoma dimidiata* were found in the domestic habitat, so the local population would be able to describe the insect. Fifty-seven percent of those participants interviewed knew something about the vector *Triatoma dimidiata* indicating a strong local knowledge about the vector. When extrapolated across the six communities these results indicate that a little more than half the population has some information about this vector.

The results do not support the second hypothesis, that knowledge of the vector, *Triatoma dimidiata*, also indicates knowledge of Chagas disease. Forty-four percent of

those interviewed acknowledged they knew something about Chagas disease. Of this 44 percent only half actually gave accurate information about Chagas disease. Those that could describe the linkage correctly described it as related to the bite and the feces of the insect. It would seem that although the population knows something about the vector, making the connection between the vector and the disease is not likely. In fact, only 12 percent of the men, 23 percent of the women, and 18 percent of men and women interviewed together could actually describe this link.

Of those participants who could describe the link between the *chinche* and the disease, 48 percent lived in Community C (Table 6.14). It was expected that the communities which contained health clinics would have more information about Chagas disease than those without clinics. The interview results did not support this hypothesis. In fact, the two communities with clinics, Community D and Community E, had only 12 and 21 percent of the people, respectively, who connected the *chinche* with Chagas disease. Community C's high percentage of knowledge holders is possibly related to the incident discussed in chapter five (a community resident being bitten and contacting local health authorities) and the subsequent mitigation. Most of the people who knew about the disease learned the information from the health officials and the pest control men who were conducting the fumigation project taking place during the fieldwork of this research.

Table 6.14: Percentage of Participants who were able to describe the link between the vector and Chagas Disease by Community

Community	A	B	C	D	E	F
Percent of Participants who could describe link accurately	16	12	34	8	13	15

Again, 91 participants answered that they knew something about Chagas disease, while only 50 of these participants could actually describe the disease in any manner. Of the incorrect responses, several were descriptions of the symptoms of other more common diseases, such as malaria, dengue fever, and gastrointestinal disorders associated with amebic dysentery. It should be again mentioned that Chagas disease has only recently been included in the *Oportunidades* discussions (will be addressed later) by the local doctor. This may be one of the main reasons for its relative obscurity in these communities. Therefore, it is safe to assume, that although the risk factors are present in these communities, little is actually known about Chagas disease itself.

Included in the information gathered in these Chagas disease interviews were local perceptions of the disease and these perceptions may have affected the numbers and the documented location of the *Triatoma dimidiata* collected. For example, many of the interviewees described the kinds of places one could find the vector and, thus the disease, were in dirty houses²².

The idea connecting Chagas disease with uncleanness may have originated with the *Oportunidades* discussions. Females who described these discussions to us explained that the local health official advised that in order to keep the *chinche* out of the home a person must remove the clutter on the floor especially under the bed. It seems to be a local custom to keep boxes of clothes and other material under the beds, which is also discussed in the literature for other Chagas disease studies (Schettino et al. 1988; Dumonteil 1999; Guzman-Brancho 2001; Ramsey 2003; Wastavino et al. 2004; Segura and Escobar-Mesa 2005). Removing these boxes eliminates potential daytime hiding

²² The idea that vectors are linked to cluttered homes, I believe, may have played a role in participant D9 changing his mind about where he found his collected specimens.

places for the vector. In reality, this custom has nothing to do with being clean, instead, it is likely that health officials describe the act as dirty in order to gain greater compliance with the suggestion.

The evidence from the interviews in this study identified the wooden house most often associated with the *chinche* and Chagas disease. This house type is also discussed in the literature related to domestic infestations of *Triatoma dimidiata* (Dumonteil 1999; Guzman-Brancho 2001; Segura and Escobar-Mesa 2005). Although 58 percent of the vectors collected in this project were from wooden houses, the remaining 42 percent of the homes were concrete creating no significant relationship in this region with wooden houses *per se*. One would expect that because many of the participants pointed to wooden houses as harboring *chinchés*, a significantly greater number of vectors would have been collected from these types of homes. Additionally, only one person suggested that the *chinche* would be found in a concrete home yet 42 percent of the collected vectors were retrieved from this type of house. The lack of specimens from wooden homes may be a result of people living in wooden homes taking specimen bottles and later deciding not to participate. Therefore the lack of significant evidence may be more related to personal choice rather than the vector's absence from these homes.

In addition, it is possible that those people who pointed to the wooden house as being the most likely place one would find the *chinche* may have been referring to the other insects described by this name (Figure 6.6). Similarly, the most described place in the house where a *chinche* might be found was in or near the bed. Although this is an important hiding place for the *chinche*, many other insects possibly misidentified as *Triatoma dimidiata*, such as bed bugs and ticks, can also be found in this area of the

home, possibly explaining why so many participants suggested this location. A reoccurring pattern also emerged concerning a foul smell emitted by the insect, which appear in many participants descriptions of the *chinche*. According to local biologists, the insect represented in Figure 6.6 does tend to have an odor when killed. Many people were likely confusing this harmless insect with the *Triatoma dimidiata*, as the *Triatoma dimidiata* does not give off any kind of smell when killed.



Figure 6.6: Non-*Chinche* (left) with *Chinche* (right)
Collected during Field Season

In discussing local perceptions of the *chinche* and Chagas disease related to place, many of the interview participants associated the *chinche* with certain kinds of animals that are not mentioned in the Chagas disease literature. Participants seemed to be relating this disease with dangerous unclean animals, such snakes and bats. These constructed relationships possibly express underling perceptions about the *chinche* and Chagas disease such as, *chinchés* often being attributed to dirty homes. This pattern is likely reflected in the kinds of animals described as attracting the *chinche*. Bats and snakes are not household animals and are often described as dangerous and dirty, therefore associating the *chinche* with non-domestic animals may, in the mind of the participant, remove them from being able to acquire the disease. Additionally, only a few people

associated the *chinche* with household animals, such as the dog or cat. Again, this may reflect an unwillingness to associate oneself with the *chinche*.

6.3.1 Gendered Knowledge (Qualitative Perspective)

The discussion of gender in relation to disease and health has not been a key component in medical geography (Pearson 1989; Gesler and Kearns 2002; Panelli and Gallagher 2003). According to Parr (2004: 250) until recently, “medical geography has been considered genderless and colorblind.” Although recently the discipline has seen contributions to this topic (Dyck et al. 2001; Moss and Dyck, 2002; Allsion and Harpham 2002; Parr 2004), Parr (2004) calls for more emphasis on the discussion of how gender, culture, and social class, interact to create specific geographies of health. The gender information collected in this research therefore contributes to this neglected aspect of the discipline.

Works in medical and health geographies that have focused on or discussed gender issues in health, have primarily been concerned with how gender affects health status (Pearson 1989; Craddock 2001; Gesler and Kearns 2002; Parr 2002; Panelli and Gallagher 2003; Parr 2004). For example Craddock (2001: 42-43), offers a critical explanation of the HIV/AIDS issue in Africa, explaining that high rates of infection have little to do with risk behaviors, but rather are “embedded in social economies of impoverishment and gender inequality.” Using Craddock’s (2001) perspective, Chagas disease is not a gendered disease in its transmission because of the nocturnal nature of the vector. Both men and women sleep at night and are equally susceptible to infection. Whether or not equal access to health care based on gender once a person has contracted the parasite is beyond the scope of this project.

Although medical and health geographers have begun to discuss gender issues in relation to health and health care little has been written about the difference in disease knowledge in relation to gender. For example, do men and women associate different things with Chagas disease, view the disease in different ways, or generally have different levels of knowledge concerning the disease? The interview results indicate that knowledge about Chagas disease and the vector *Triatoma dimidiata* is gendered in the study areas. The way in which men and women described the vector and disease, for example, was different. Men tended to describe the vector as being a problem outside the home while women more often described the problem in the home. Specifically, when considering the question of where someone would expect to find the *chinche*, men more often answered “in the forest” or in “wood piles,” while women tended to respond “in the bed” or “in the walls”(Personal Communication 2005). This may be related to the division of labor among these participants. Often in these communities, the team noted that men worked outside the home while women worked in or near the home. Therefore, these differing explanations based on gendered can be partly explained as a reflection of the cultural division of labor. Similarly, only 12 percent of the men interviewed could accurately describe Chagas disease while 23 percent of women interviewed made the connection between the vector and the disease.

In addition to the gender division of labor, some of these gendered differences can also be attributed to the *Oportunidades*. Although only a few women admitted participating in this program, it was discovered that many more women were participating than were telling then team. In discussions with the local doctor, Dr. Walter Rojas Saiz, many of the local women participating in this study actively participated in

the *Oportunidades*. It is unclear why participants would not divulge this information as there seemed to be no stigma associated with the meetings.

Of course the number of men interviewed needs to be readdressed in future studies however, it was unrealistic for this project to try and coordinate speaking specifically with men. Because most of our interviews were conducted during the day (discussed in chapter seven) men were not often found in the home. Additionally, it was not until reflecting on the data that any patterns emerged in relation to gender, thus addressing the gender problem in the field was unrealistic. Suggestions for dealing with this issue will be discussed further in the conclusions.

6.3.2 Correlations with Gender (Quantitative Perspective)

In order to evaluate potential statistical relationships between gendered knowledge and Chagas disease, the interviews were reexamined using a chi-square test. This approach incorporates mixed methods in order to gain a broader understanding of the questions asked of participants. Additionally, including statistical analysis allows this work to reach a wider audience.

First, looking at the Chagas disease knowledge data, it was interesting to determine if any gender relationship existed between interviewees that said they knew about the disease (Table 6.15). The results of the chi squared test was 3.77, the relationship not being significant.

Table 6.15: Chi-Squared Results of Participants sorted by Gender who acknowledged they knew about Chagas Disease

	Answered Yes	Answered No	Total
Males	7	19	26
Females	67	74	141
Totals	74	93	167

Secondly, it was important to determine if any significant gender difference existed between participants who actually linked the *chinche* and Chagas disease (Table 6.16). The results of the chi-squared test were 1.65, again the result not being significant.

Table 6.16: Chi-Squared Results of Participants sorted by Gender who could correctly describe all Aspects of Chagas Disease

	Made Connection	Did not Make Connection	Total
Males	3	23	26
Females	32	109	141
Totals	35	132	167

It was also important to determine if any relationship existed amongst males and females in relation to their knowledge and accuracy about the *chinche* (Table 6.17 and Table 6.18). Again, using the chi-squared test for significance, the results from the test in relation to those that said they new about the *chinche* were .06 and those that actually could describe the *chinche* correctly were 1.63. Neither result was significant.

Table 6.17: Chi-Squared Results of Participants sorted by Gender who Acknowledged Knowing the *Chinche*

	Had Knowledge of Chinche	Did not have knowledge of Chinces	Total
Males	15	11	26
Females	85	56	141
Totals	100	67	167

Table 6.18: Chi-Squared Results of Participants sorted by Gender who could correctly describe the *Chinche*

	Could Describe Chinche	Could not Describe Chinche	Total
Males	9	17	26
Females	68	73	141
Total	77	90	167

6.3.3 Oportunidades

It is important to include a discussion of the *Oportunidades* as this program forms an important network between health officials and local populations, specifically women. This may also help to explain why differences exist in the way men and women talk about and relate to Chagas disease in this region.

Originally named *Progres*a, the *Oportunidades* program was developed in 1997. It has become the primary “anti-poverty” program in Mexico (Bulletin WHO 2006: 589). It was designed to increase the “human capital” of poor families in both rural and urban environments (World Bank 2003: Shanghai Poverty Conference 2006). Improvements in education, health, and nutrition, the Mexican government believes, will lead to long-term reduction of poverty for these families (World Bank 2003). This program also intends to alleviate current poverty by providing cash incentives distributed to residents who participate in education and health programs (World Bank 2003).

Important to the current study are the health care initiatives incorporated into this larger program. This component provides basic health care to all members of the family (World Bank 2003), the emphasis being on disease prevention. Providing monthly health lectures allows local health officials to interact with the populations and discuss important diseases that impact that specific area. According to the local doctor, Chagas disease has only recently been added to the discussion agenda. As mentioned above, he also concluded that most of the participants in his discussion groups are women. Thus, the results of the interviews, which found a greater percentage of women than men who connected the *chinche* with Chagas disease, are likely to have been impacted by these

discussions. Therefore the *Oportunidades* program has had an important impact on the Chagas disease knowledge in the study area.

6.4 Results from the Participant Socioeconomics and Landscape Change Interviews

The second interview targeted gaining a better understanding of the local population and, most importantly, to determine if the daily lives of the participants were putting them at risk for Chagas disease. One hundred and sixty-two interviews were carried out for this portion of Phase III. All participants who completed the first interview were initially included in the participant socioeconomics and landscape change interview, however, not all the 207 participants in the Chagas disease interview were able to complete the second survey.

The latter interview included two lines of questioning. First, in order to better understand agricultural pathways and connections between these communities and the larger towns of the region, participants were asked about their crops, livestock, and the resulting income from these activities. The goal behind this portion of the interview was to determine if the participants saw the *chinche* in their daily activities, particularly when working with cattle. In addition if these participants traveled to market, it was important to determine if they encountered the vector there as well.

It was expected that most of the participants would either farm or keep domestic cattle as a means of subsistence. Therefore, it was of interest to see if those who tended cattle interacted with the *chinche* in their daily activities. Additionally, if any participants spent time away from their communities, because of selling their produce, did they see the *chinche* in these places? The rationale for including experiences from either end of this agricultural pathway was to see if possible corridors existed for the vector, either into

or away from the communities. The second set of questions in the participant socioeconomics and landscape change interview sought to identify elements of landscape change, especially vegetation change that might have increased the potential contact between the residents and *Triatoma dimidiata*.

The first questions in this interview specified the kinds of farming activities (if any) participants were involved with, and the location of these activities. Of the 162 participants, 85 acknowledged they farmed. Dominant crops included corn, watermelon, and chili. All 85 of the participants carried out these activities in a *parcela*²³ away from the home.

Seventy-one of the 85 participants who stated they farm also raised cattle. Two others acknowledged that they worked with cattle but for other people. Of these 71 participants, 48 owned their cattle outright, while five were part owners of the cattle they raised. Eleven participants who stated that they had cows, admitted they did not own them (this conundrum will be addressed later). Other subsistence animals in these communities included pigs and chickens. Of the 162 participants in this portion of Phase III, 63 admitted owning pigs in their yards at the time of the interview. One person said they had recently owned a pig but that it had been killed and eaten, while another said their pig had died of a disease. Another participant stated having a pig at their ranch. From general observations, it seemed as though almost every family in the study communities had chickens in their yard during the 2005 field season. Chickens appeared to be the dominant barnyard fowl present in this landscape. Of the 162 interviewed participants, 130 acknowledged they owned chickens.

²³ *Parcelas* are intensive farmed land either owned or rented usually relatively near the person's community. These plots are much larger and can hold more crops than any household plot. Wood for household kitchen use is also often gathered in these plots.

As well as documenting the types of crops people grow, questions were asked about whether these products created monetary income for the family. One hundred and three families reported selling, at some point and in varying capacities, their produce. The dominant products sold included chicken, corn, watermelon, and milk. Participants most often sold these items from their homes. Only a few of the participants said they sold their products in other communities such as, Montepio, Catemaco, or San Andres Tuxtlas. Most of the participants who sold their milk did so to a milk vendor from San Andres Tuxtlas who would visit the communities weekly. No participants spent significant time away from their communities selling their products. In fact, no one reported spending the night away from their homes for the purpose of selling produce.

Of the participants who spent time in other towns or at their *parcelas*, seven male participants and one female acknowledged noticing *chinchés*. The male participants admitted finding these insects in the vegetation. The one female participant who admitted seeing the *chinche* simply said she saw it at the farm and was not more specific.

The Chagas disease literature often describes the presence of animals as creating the corridor for many Chagas disease vectors into domicile and peri-domicile environments (Zeledon 1971; Haddock 1979; Breceno-Leon 1990; Zeledon and Rojas 2005), especially as animals act as a constant blood meal source. Therefore, documenting participants who acknowledged owning or working on ranches was included because this type of environment seems likely to attract high numbers of vectors. Of the 162 participants of the socioeconomic and landscape change interview, only 13 admitted to working on, visiting, or living at (prior to this interview) a ranch. Of these 13

participants only three acknowledged seeing *chinch*es during the time they spent on the ranches.

The second part of the participant socioeconomics and landscape change interview sought to identify information about the communities themselves and how they have changed. The influence of vegetation change has been documented in the literature as promoting the presence of many Chagas disease vectors into human habitation. To accomplish this task, a series of questions were posed that attempted to define how long they had lived in the community in order to determine their perspectives about landscape changes, and then the types of changes they had observed. The information gathered in relation to people's histories was also linked to possible disease knowledge networks.

Fifty-nine of the 162 participants were born in their respective communities. The length of time residing in their community varied from one to 50 years among the remaining participants. Most participants moved from other local communities to their current place of residence.

In trying to link possible outside Chagas disease knowledge networks, an additional question was posed to those participants who had moved from other locations. Of the 42 participants who originally gave accurate knowledge about Chagas disease and its vector only 24 also participated in the participant socioeconomics and landscape change interview. Of these 24 participants, 19 were originally from other communities. When asked if they had seen the *chinche* in these other communities, all replied no, suggesting that Chagas disease is not a well known disease in the region.

Once a general timeline was established in reference to how long participants had been residing in each community, questions concerning landscape changes could be

better qualified. Those participants who had lived in the community for only a short period of time had little to say about the landscape of the community, and more to say about the main road which was being paved during the 2005 field season. Interviewees in all six communities expressed this particular landscape observation. Nearly all the other participants who had resided an average of 20 years in each of the six communities gave similar descriptions of landscape changes. The change they mentioned most often concerned vegetation loss.

Monte, a Spanish word for grass-like vegetation, was used in almost all of the landscape descriptions collected for this question. Most of the vegetation loss described did not concern the large forests, but rather the loss of the extensive grasses. Although much research has been conducted on the loss of local fragmented forests (See edited volumes Sorinno, Dizzo, and Vogt 1997 and Guevara, Laborde, and Sanchez-Rios 2004 for most recent descriptions), few participants described this particular problem. Instead, participants described the building of houses, the introduction of electricity and water, and the loss of the *monte*, as the most significant changes in their communities. For example, F28 who has lived in the community for about 23 years described the area as previously having an, “overgrowth of grasses” (Personal Communication 2005).

In addition to the loss of vegetation, a significant number of participants commented upon the loss of non-domesticated animals. Creatures such as armadillos, opossums, raccoons, wild pigs, and iguanas were most frequently remembered. D26 explained that when he and his wife moved to Community D over 40 years ago there were more, “raccoons, armadillos, and wild pigs and now there are just more people” (Personal Communication 2005).

A third landscape change often mentioned involved the materials used in house construction. Most long-time residents describe the transition from cane, *carton*, and palm houses to wood and then concrete homes. When participant C35 and his wife moved to the community over 40 years previously, they remembered that there were only houses with cane walls and palm roofs (Personal Communication 2005). As more people moved into the community, C35 remarked that people built more wooden houses, and only recently have people begun to use concrete (Personal Communication 2005).

6.5 Discussion

For the reasons described in chapter four, these participant socioeconomics and landscape change interview were significantly more difficult to conduct than the Chagas disease interviews. Coupled with the fact that this interview stage was conducted after the Chagas disease interviews and interviewees were likely tired of being asked questions, and that the participant socioeconomics and landscape change interview asked more personal questions, responses seemed to be more guarded. For example, many of the people who were involved in cattle husbandry would not tell the research team if they also owned the cattle. Also, many of the participants who acknowledged that they owned cattle were unwilling to disclose how many they owned. Several times it appeared that participants hesitated before answering this question. Others simply stated that they did not know how many cattle they owned or would say that they would rather not reveal that information. This hesitancy may stem from being interviewed by outsiders, and the personal nature of the questions. Alternatively, it may be related to a cultural phenomenon. One person explained that the tentativeness of participants may stem from the custom of having to pay taxes on the size of one's herd (Personal Communication

2005). Apparently many cattle owners only declare a small portion of their herds to government officials to lessen their tax burden. It is unclear the exact reasoning behind the cautiousness of participants, however, it nevertheless affected the outcome of these interviews.

The presence of chickens in nearly every household brings another important point to light. As was discussed above, many participants acknowledged they often sold their chicken products. The selling of chicken parts, including meat and eggs, appeared to comprise a significant portion of participants income. This may stem from the fact that chickens in this area seem to be one of the more low-maintenance barnyard animals in terms of daily needs, and chickens tend to produce products that can be sold almost daily. Additionally, once the chicken is no longer producing eggs they can then be used as food to be eaten by the family or sold for profit. Although chickens play an important role in the daily income of many participants' households, many of these families do not seem to worry about the fluidity of their chickens' movements. As mentioned in chapter five, barnyard animals move almost constantly from one yard to another and households seem not to pay attention to these movements. Therefore, determining how many chickens one household owned was difficult and many participants claimed not to know themselves.

Again, one of the purposes behind this interview was to determine behaviors that exposed individuals to a risk for Chagas disease. Question eight in the participant socioeconomics and landscape change interview discussed above, noted several male participants who claimed to have seen the *chinche* while working on their *parcelas* or ranches. However, none of these participants admitted spending nights at these places, thus it is highly unlikely that these people were actually observing *Triatoma dimidiata*

and probably were identifying another insect also called *chinche*. Linking this question back to the Chagas disease interview, the likelihood of men describing the presence of the *chinche* away from the home (in places like the forest or the grasses) may also be linked to differences in the kind of work men participate in. This would explain why women tend to describe the *chinche* in the home while men refer to the vector being outside the home.

6.5.1 Influences of Vegetation Changes on Transmission

Finally, the influence of vegetation changes on disease transmission is well documented in the literature (Zeledon 1971; Haddock 1979; Breceno-Leon 1990). For example the clearing of vegetation in Malaysia and Africa for the purpose of farming is associated with malaria (Livingstone 1958; Wiesenfeld 1967; Roudy 1990). Similarly, the clearing and use of native tropical trees as housing materials in Chagas disease prone areas is associated with human infections in many areas (Zeledon 1971; Haddock 1979). Including perceptions about landscape changes in the study communities helps to identify whether or not these changes influence Chagas disease risk.

The long-time residents of these six communities describe significant vegetation change during the last half-century. In addition to the interview material several publications discuss the drastic deforestation that has occurred in this region extending back to the colonial period (See edited volumes Sorinno, Dizzo, and Vogt 1997 and Guevara, Laborde, and Sanchez-Rios 2004 for most recent descriptions). These changes first occurred because of cattle ranching and may explain why residents described previous landscapes as being covered in overgrown grasses instead of large trees. The Spanish removed forests to create space for cattle ranches during the colonial period, then

once the Spanish abandoned their cattle production in the Americas, parts of the Tuxtla region were left fallow for several generations before new inhabitants moved into the region (Laborde 2004). Most of the large tropical trees had been removed prior to modern-day settlements, explaining why few residents describe the removal of large amounts of forest. This means, however, that the habitat of the *Triatoma dimidiata* had been altered before the current communities developed. It would be interesting to further consider how this ecological change in post-colonial time may have laid the foundations of a Chagas disease presence which are only recently being realized. Questions would include; has the risk been there for decades or longer, or has more recent human activity provided a necessary and previously missing component?

6.6 Collaboration with Dr. Rojas Saiz

During the course of the 2005 field season, Bióloga Coates (a resident research at the Field Station) suggested I make contact with a doctor located at the clinic in Community D. She explained that Dr. Rojas Saiz was interested in collaborating on this Chagas disease project. The doctor had heard of the project through local community members and through Bióloga Coates.

Unfortunately we did not meet in person until my return trip in August 2005. During this trip we shared collected information about our experiences with Chagas disease in the region. I gave Dr. Rojas Saiz all of the *Triatoma dimidiata* collection information including the *T. cruzi* results. Using our information as a base, he organized an important study which specifically looked for *T. cruzi* in the local human population. In order to complete this task, Dr. Rojas Saiz asked local residents if they wished to be

tested for the parasite. He focused his efforts in four of the six communities outlined in this dissertation (Community B,C, D, E).

6.6.1 Results

His first objective was to acquire blood samples from the five households which had produced *T. cruzi* positive *Triatoma dimidiata* in my project (Rojas Saiz unpublished report 2006). During my trip in August 2005 Dr. Rojas Saiz accompanied me to these positive households and together we informed the participants of the results. Dr. Rojas Saiz then asked if the residents wished to participate in the free blood screening. Four of the five families agreed to participate. B6 could not be located during the course of Dr. Rojas Saiz's investigation. In addition to these four households 22 other households from four of the original study communities volunteered to participate in Dr. Rojas Saiz's study (See Appendix E) (Rojas Saiz unpublished report 2006).

The collected blood was submitted to three separate types of *T. cruzi* tests by epidemiologist at the Central de Salud of San Andres (Rojas Saiz unpublished report 2006)²⁴. In order for a person to be considered *T. cruzi* positive their blood samples would have had to have tested positive for two of these tests. Nine participants tested positive for one of the tests but none of the participants tested positive for all two or more tests (See Appendix E) (Rojas Saiz unpublished report 2006). Therefore, Dr. Rojas Saiz suggests no participant in this sample could have Chagas disease. However, he strongly urged the expansion and continuation of this project in the future (Rojas Saiz unpublished report 2006).

Form the collection data discussed in chapter five we now know the vector is present in these community's domiciles, as is the parasite. Although no human infections

²⁴ Actual tests were not specified in Dr. Rojas Saiz's report

were discovered the need for further research is imperative as all six of the study communities display a potential landscape of risk. Both the actual physical elements of these participants' landscapes (such as house type and vegetation cover) and also the local knowledge landscape increases the inhabitants' chance for contracting Chagas disease. What the inhabitant does not know about Chagas disease may be detrimental to their lives. As was discussed above, few participants could actually link the disease with its vector. Thus, education and eradication programs must address this issue and these will be discussed in the conclusion.

CHAPTER 7 REFLECTIONS FROM THE FIELD

7.1 Introduction

In this chapter I will describe some of my field experiences while collecting data for this dissertation. These reflections add a personal element to the Chagas landscape developed in this project. The day-to-day experiences I collected will add to the overall goal of this work; creating a layer of human interaction that may help to highlight and exemplify the kind of mixed methods with which this dissertation is infused. This chapter may also provide future researchers with an insight into what might be expected while conducting similar fieldwork.

I will begin this section by describing the initial drive from Baton Rouge, Louisiana to Mexico City then to the UNAM Biological Field Station. This will be followed with a description of the Field Station. I will then reflect on the first critical days spent making contact with local residents and laying the foundations for this project. In addition I will describe impressions and experiences I had during initial visits to each community. I will also discuss experiences I had during our weekly visits to each community and while collecting the interview materials. As this dissertation is not an ethnography, per se, of these communities, I have chosen only a few observations which I feel best reflect my time spent in the field. These reflections may shed light on barriers that may have hindered our collecting vectors and similarly influenced the content contained in the interviews. These experiences also reflect how accepting and tolerant some participants were by allowing us to interrupt their days for a chat on the porch.

7.2 The Long Ride In

I left Baton Rouge, Louisiana on February 19, 2005 at about nine in the morning. I was traveling with a Mexican companion flown to Baton Rouge a few days before to accompany me on this trip. Our goal for the day was to reach the border town of McAllen, Texas. It was expected this portion of the trip would take approximately twelve hours. During the long drive my companion and I discussed the project and its goals. He advised me about the region and what I should expect during this long field season. I was grateful for the information.

We arrived in McAllen at nine in the evening and checked into the first hotel we were able to find. I had driven the entire trip and was exhausted. Fortunately our suitcases were at an accessible point in the truck so we were quickly able to unload. We left the rest of the gear in the truck and hoped no one would break in and steal the materials.

We left the next morning before sunrise so that we could get ahead of the daily border traffic. In order to bring an American car into Mexico one must register it at a Mexican registration station. We had chosen to cross the border into Reynosa the Mexican town opposite McAllen as it was suggested as being an easier border crossing than the Brownsville crossing just west of McAllen. It took us several minutes to find this station but once we did it was a quick process. We paid a fee and were issued Mexican papers that made the car legal to drive in the country. We then began a two day drive to Mexico City via Highway 40 and 57.

My companion was uncomfortable driving the highways at night and suggested we stop in San Juan del Rio northwest of Mexico City. We spent the night of February

20, 2005, in this small community. The hotel we chose had the feel of an old Spanish mission, with huge wooden gates and rooms with low door frames.

In trying to miss the morning rush-hour traffic in Mexico City we left San Juan del Rio at about ten in the morning. This would place us in Mexico City sometime around noon. I was terrified to drive into the city. I had been told many stories about the dangers of driving in Mexico City, from the taxicabs to the carjackings. My knuckles were white as we reached the first suburb. Eight lanes of traffic confronted us as we slowly entered the city from the north. We drove first to the home of my companion so that he could unload his luggage and then we proceeded to the hotel I would be staying in until we were ready to leave for the Field Station. Needless to say I did not drive in the city again until we left a week later. My companion was going to escort me to the station and make sure I was settled in but first had to attend a conference in Mexico City. This is why there was a week's delay in reaching the field site.

We left Mexico City on February 26 for Catemaco. It was decided we would spend one night in Catemaco prior to reaching the Field Station in order to gather last minute supplies. We arrived in Catemaco in the afternoon which gave us time to have a meal and take care of last minute shopping. We left the next day just before noon.

It took about an hour to make the thirty-five kilometer drive to the station. The portion of the road from Catemaco to the Field Station had yet to be paved and was still extremely difficult to pass in certain places (Figure 7.1). To make matters worse, the dump trucks and other heavy machinery used in paving the other end of this road had been driving back and forth across the unfinished portion from Catemaco to the Station. This created large ruts and exposed more rocks that made the drive even more difficult.

This portion of the road was not completed until after I had returned in June ending my field season (Figure 7.2). Today there is a two lane paved road extending from the main highway in the north (which connects Los Tuxtlas with Veracruz in the north and Acayucan in the south) to Catemaco in the south, creating an almost oxbow pattern. Upon reaching the station I parked the truck at the bottom of the hill in which the dormitories are built in order to check in with the Station manager. Once this was complete we drove up the steep driveway to the parking area available for residents and visitors of the station and began to unload.

7.3 The Field Station

The UNAM Biological Field Station is a 700 hectare parcel nestled into 14000 hectares of tropical rainforest. Today it is incorporated into the larger Los Tuxtlas Biosphere Reserve created to preserve the remaining tropical rainforest in this region. In order to maintain the integrity of the rainforest very little natural vegetation was removed when the Field Station was built in 1967. The Field Station in its infancy housed one building which acted as both researcher housing and lab space.

Today the facilities at the Field Station have improved immensely. There are two dormitories, one for students and the other for professors and researchers staying for long periods of time. The dormitory for students has two floors with a shared bathroom on each floor, men on the bottom floor and women on the top. The faculty dormitory also has two floors but each room is equipped with its own bathroom. There is 24-hour electricity, flush toilets, hot and cold running water and 24 hour security. In addition, there are two fully equipped labs, an air conditioned library, a classroom, a medical clinic

(which never opened), a cafeteria, a main office with telephone, fax machine and internet, and several other buildings adjacent to the main station including a botanical garden.



Figure 7.1: Main access road into region prior to paving



Figure 7.2: Main access road into region after paving

For this trip, as I would be staying for an extended period of time, I was given a room in the faculty dormitory. This provided me with a private bathroom, sleeping area, and office area with a desk (Figure 7.3 and 7.4). I chose to sleep in a mosquito tent as my window screens were not intact.

I was also given laboratory space in the unused medical building located just beyond the main entrance. This building contained three separate rooms. As it was originally meant to act as a medical clinic, on each side of the main room were separate exam rooms. I was given one of these exam rooms to use during my stay. This space included several desks and tables as well as a fully functional bathroom and internet connection. It is in this space that I conducted most of my work when not in the field. As discussed in chapter five, all of the vector dissections were conducted in this room. All of the laboratory equipment and stored insects were also housed in this room. I am grateful to Dr. Martin Ricker (head of the UNAM Field Station during my field season) for providing me with this space during my time at the Field Station.



Figure 7.3: Sleeping area in room



Figure 7.4: Office area in room

During my five-month stay at the Field Station I was fortunate enough to have considerable contact with other researchers. Students and professors from all over the world were also using the station facilities. At night we would all gather in the cafeteria and discuss our daily findings. No one researcher was working on the same project so it gave us time to decompress and listen and give fresh perspective on other topics. Compared with other field experiences where I was isolated in a small village or town with little contact with people who were able to speak English, the Field Station offered not only comfortable accommodations but a welcomed daily interaction with other researchers.

7.4 First Days in the Field

During the primary field season in February 2005, my first agenda was to acquire the help of a local community member to serve as liaison and guide for the remainder of the study period in Los Tuxtlas. This was my second trip to the region, and I was familiar with a few local residents. It had been previously discussed on the first visit to the area that I would try and acquire the help of a local *Comisario* named Domingo Velazco. *Comisarios* in these communities act as the collective voice for the community. I would associate them with a town council president. They are chosen by community members for a certain period of time to act as the spokesperson to outsiders. Mr. Velazco lives in a local community and is employed by the Field Station. He is well connected and respected in the area as being a fair and reliable man. Without Mr. Velazco's help this project would not have been possible. He played an important role in introductions and participation of local residents. He also helped in the acquisition of vectors and interviews. I believe obtaining the permission of the *Comisario* was important to Mr.

Velazco because of his status as a *Comisario*. Obtaining the permission of these men seemed important to Mr. Velazco, thus I felt, important to the success of the project. He indicated that talking with these men would make gaining the trust of the local population easier as, often these men represent the collective voice of the community on important affairs.

Although I was told this area receives foreign tourist travel, I could not help feel as though I was on display. Barely a step could be taken without someone taking a second look at me. This is not an uncommon occurrence in many of the cities I have traveled to in Latin America but I cannot seem to get use to the constant staring. It can be uncomfortable at times especially when men stare and make comments. If you react to these comments it makes the harassment worse. It was helpful being escorted by Mr. Velazco as, although the staring never stopped, the comments were kept to a minimum and were usually more curious than anything more sinister.

7.5 Community Reflections

7.5.1 Community A

Community A, as discussed in chapter four, was the most remote of the six communities. It is located upslope in a virtually undeveloped portion of the Tuxtla region (see Figure 5.5). The homes are laid out along parallel parcels to the main path into the community. The community is surrounded by secondary forest, with a few cow pastures which crisscross most of the region. It is the only community included in this study found in this type of environment. The only route accessible by car, which we used each week to check the *chinche* collections, was accessed through Community E. The access road is dirt in some points and lose gravel and rock in others. This road is only

wide enough for one car (Figure 7.5). At some points in the study period the road was only accessible with a four-wheel drive vehicle. For example, after a night of rain the portion of the road made of gravel would become to lose for a vehicle to find traction. At these spots the incline in the road was also very steep, thus requiring four-wheel drive. In several places along this road we were required to make stream crossings. Again, after heavy rains these streams could swell making it impossible to gain access to the community.



Figure 7.5: Access path to Community A

Community A was the first community in which Mr. Velazco and I visited during the 2005 field season. Upon arrival in Community A I noted the rustic homes made primarily of wood. As noted in chapter five, most homes in this community had dirt floors. Again, Community A is the smallest of the six study communities. There are no paved roads in this area. Within Community A, aside from the dirt road connecting

Community A with Community E, only dirt footpaths could be found. Along the back of the community, where the car path ended, one stream was noted. Along with the natural tropical vegetation found in this community, many fruit trees were also a prevalent part of the landscape. As noted in chapter five, many chickens, turkeys, and dogs could be seen wondering the community. The most prevalent means of travel in this community seemed to be the horse, although there were a few trucks scattered throughout the community. When we would see community members in Community E they were usually on foot. It was primarily because of these living conditions that this community was included in the study.

During my first visit to Community A, Mr. Velazco and I spoke with the *Comisario* in order to gain his acceptance of the project. After speaking with this man we walked the community. This initial walkthrough gave us the opportunity to introduce myself and the project to the community members. We did not distribute specimen cups during this visit. As we were walking, Mr. Velazco informed me that he knew several of the members of this community. One family in particular seemed to know Mr. Velazco very well. This familiarity may have caused tension with this community which ultimately created discomfort for Ms. Euraque and me towards the end of the project. It was suggested to us by a local informant that the family in Community A may have felt resentment because the community in which Mr. Velazco lived has more people employed by the UNAM Biological Field Station. I believe this may have caused jealousy among the community residents and created problems for this study.

7.5.2 Community B

Community B, as discussed in chapter 4, is also a small location. It can be found on both sides of the main paved road through the region (see Figure 5.8). A portion of the community extends onto the beach, while on the opposing side of the main road Community B has now expanded into the nearby hills. Most of the homes in Community B can be found along either side of the main highway. The homes that extend beyond the highway to the west do not seem to follow any pattern.

Unlike Community A, the vegetation found in Community B has been recently planted by its residents. There seems to be no secondary forest and instead one might find fruit trees and various species of shade trees common in this region as well as cow pastures. Prior to the 2005 field season the main road through this community was dirt. However in 2004 the road was paved and now extends in a kind of oxbow pattern from Catemaco to the main highway connecting Los Tuxtlas with Veracruz in the north and Acayucan in the south. Community B is located along this road between Community C and Community F. Within the community one can find only dirt footpaths.

According to local residents, Community B began as an extension of another community in the area that was not included in this study. However, most residents living in Community B did not move from the neighboring community. It is unclear why Community B is seen as an extension of this neighboring community. One may speculate that because this neighboring community is immersed in the tourism industry, Community B may be associating itself with this community in hopes that it may also benefit. There are no hotels or rental properties in Community B unlike the neighboring community but again Community B has direct access to the beach and to local waterfalls.

These waterfalls are located in the hills behind Community B. The waterfalls may present Community B with a potential to attract tourists.

Again, once Mr. Velazco and I spoke with the local *Comisario* we walked the community asking local residents if they wanted to participate in the project. In Community B, unlike in Community A, once residents agreed to participate we gave them specimen cups and gloves immediately. Mr. Velazco and I agreed this was best as we were not able to speak with this community until the end of the first week in the field. I did not feel it was best to lose any more collection time in order to maximize this field season.

After our first trip to Community B Mr. Velazco asked a local family who had a driveway of sorts, if we could park our truck on their property during our weekly visits. It was dangerous to leave the truck parked on the highway because of speeding trucks. The local family agreed. Each week after we walked the community I bought something to drink from the family's store. I felt this showed the family and community that I was interested in putting capital back into their community. I wanted them to know I was not just there to take from them.

7.5.3 Community C

Community C, as discussed in chapter 4, is one of the larger study communities. Located at the northeastern most point in the study region, Community C, like Community B, spans across the main road which connects Los Tuxtlas with Veracruz and Acayucan (see Figure 5.11). In 1999 when the aerial photos used in this study were taken the road did not bisect the community as it does today. Instead, as one can see in figure 5.11 the road followed the coast more closely.

Additionally, like Community B, vegetation in Community C is relatively new with little secondary forest growth. Community C is also flanked on its eastern border by the Gulf of Mexico and its western border by cow pastures and fields. North and south of Community C are watermelon and cornfields. Within Community C, unlike the above two communities, there are dirt roads wide enough for a car to pass. There are also dirt footpaths in some of the less accessible portions of the community.

Community C is laid out in a fairly traditional Latin American pattern (West and Agugelli 1980). Essentially rectangular in construction, the streets are laid out in intersecting straight lines. Although there is no central plaza the intersecting streets mimic Spanish colonial design. There is a large soccer field which dominates the eastern portion of the community. Community C also includes a kindergarten and primary school. In addition, there are several coves and inlets that provide fishermen and tourists safe points to access the Gulf of Mexico.

Residents in Community C not only subsist on farming, but fishing and tourism also play a part in daily economic activities. As mentioned above, Community C is located in an area where several coves and inlets can be found. These provide fishermen safe places to moor boats and tourists with semi-private beaches to enjoy the Easter holiday. Unlike the beaches found in Community D or Community B, the beaches along the coastal area of Community C are strewn with palms and other shade trees providing potential relief from the sun. The protected nature of the coves also provide relief from dangerous currents found along these coastlines.

Our first visit to Community C occurred on the same day as Community B. This visitation pattern would continue throughout the study period. Community B was located

on the road to Community C, therefore it made sense to cover the two communities in one day. Geographic location played an important role in weekly visitation schedules which will be discussed further below. During our first visit to Community C we talked with the *Comisario*, gained his permission to work in the community, then continued to talk with local residents. As with Community B, Mr. Velazco and I talked with local residents and distributed specimen cups during this visit. Community C was the first community in which we were unable to distribute specimen cups to the entire community. As discussed in chapter 4, because the second shipment of specimen cups did not arrive until May, by the time we reached Community C we were nearly out of cups.

Community C seemed to be the friendliest and most accepting of the six communities, possibly, because residents of Community C have experience dealing with outsiders through their tourism industry. In addition, aside from the time Ms. Euraque and I spent with a colleague in Community D, we spent some of our free time in Community C enjoying the protected beaches. This may also have played a role in the Community's openness with the team.

7.5.4 Community D

Located several kilometers off the main road Community D seems to emerge out of the Gulf of Mexico. As discussed in chapter four, Community D is also one of the larger communities (see Figure 5.14). There is no secondary forest left within the community. Along its perimeter one can find only pastures and fields. There is a small section of forest to the north and south of the community which houses important local wildlife.

Community D, much like Community C is laid out in a traditional Latin American pattern (West and Agugelli 1980). Essentially rectangular in construction, the streets are laid out in intersecting straight lines. Community D, however, does possess a central plaza mimicking Spanish colonial design. The roads in Community D are accessible by car, in many places wide enough for two cars to pass. There is also a primary school located in Community D.

Known in the region as a fishing community, as a supplement to daily farming activities, several local residents also take part in the fishing industry. In addition, Community D also caters to the Easter tourists who come to the region for the beaches. Several of the local stores double as bars during this season. During the week prior to Easter many tourists could be seen sitting at tables around the outside of these stores enjoying cool drinks and snacks.

Community D was one of the last communities visited during the first critical week in the field. Again, Mr. Velazco and I spoke with the local *Comisario* concerning the project and then proceeded to talk with local residents. As with Community C, we distributed specimen cups during this visit. We did have one resident return his specimen cup during the next visit and inform us he no longer wished to participate. It is unclear why this resident chose to return the cup, however, other local residents described him as being very suspicious of everyone. Again, as with Community C, we were only able to distribute specimen cups to half the community as we were slowly running out of materials.

7.5.5 Community E

Community E is also located along the main road but is situated closest to the town of Catemaco. As discussed in chapter four, Community E is the largest of the study communities. There is little secondary forest left within the community. Along its perimeter one can find only pastures and fields. Chili is the dominant crop grown in large fields surrounding Community E. Unlike Communities B, C, D, and F, Community E has no direct access to the Gulf of Mexico. Thus tourism and fishing are not included in daily subsistence patterns. Instead, it seemed that a large number of residents could be found working the chili fields. Landholding families who live in the large towns in the region own these large chili fields. Most local residents do not own large plots of land and instead either work for these landholders or farm smaller *parcelas*.

There are two entrances from the main road into Community E. One entrance crosses a large stream which now has a concrete bridge across it for safer access. The main entrances are paved though once in the community the roads revert to dirt and rock. Much like Community D, Community E also has a central plaza. However, the plaza in Community E includes a church and school. Streets diverge from this central plaza in a rectangular fashion in the colonial Spanish style (see Figure 5.17).

Community E was the final community visited during the first week of specimen cup distribution. Again, the primary objective on this day was to speak with the *Comisario* and gain permission to work in the community. We achieved this quickly as this was one of the locations visited on my first trip to the region the previous year. The *Comisario* remembered me and was excited we were going ahead with the project. Because this was the last and largest community included in this study only a portion of

the local households received specimen cups. However, nearly every home we visited took a cup and agreed to participate in the project. It remains to be seen if these families actually complied with the request as very few vectors were collected in this large community.

I believe, because Community E was so large, the personal interaction we were able to achieve with the other communities was not realized here. Although we did visit Community E each week, we often were unable to stop and talk with residents for long periods as unlike the other communities it usually took several hours to walk this site. Again, each day there was only limited time to spend in each location as Mr. Velazco was adamant about being home before dark.

7.5.6 Community F

Community F is, like Communities B and C, located on either side of the main road (see Figure 5.20). This site also has direct access to both the Gulf of Mexico and a protected river which it shares with another community not included in this study (Figure 7.6). Much like the above sites, Community F also has little forest left and instead many families have planted fruit and shade trees.

Located in this community is a primary school and soccer field. The soccer field is located next to the main road. One can find people playing on this field on most any day. This location seems to be the central point for the local soccer teams to meet and play. Although each community in this study (except for Community A) has their own field, the field in Community F seemed to be the most often used. On several occasions large crowds could be found gathered cheering their respective teams.

Similar to Community B, Community F considers itself to be an annex of another community linked to the Easter tourism industry. Community F boasts several stores which also double as bars. There is also a campsite associated with this community located on the beach.

Community F was the second community visited during the first week of specimen cup distribution. Again, the primary objective on this day was to speak with the *Comisario* and gain permission to work in the community. As with Community E, we distributed specimen cups during this visit. Although we had enough cups at this point to distribute to the entire community it seemed few residents were home during this visit. Those that were took cups and agreed to participate.



Figure 7.6: River mouth between Community F (on the left) and its neighboring Community (to the right)

7.6 Observations from Weekly Visits

As mentioned above, geography played an important role in weekly community visits. Each week Mr. Velazco and I followed nearly the same visitation pattern. On days we visited Community E, we would also visit Community A, as Community A is located up the mountain from Community E. Similarly, on days we would visit Community C we would also visit Community B as Community B was located on the road to Community C. Although Community D and F were also on this road these two communities would be visited separately from Community C and B. This was partly because Community D and Community C were rather spread out and would take several hours to walk through. Therefore the two smaller communities, F and B, were placed with the two larger communities C and D, insuring we returned before dark. One must also remember Mr. Velazco was only able to help after he finished his daily work for the station and was never available on Saturday's due to his religious affiliation. This left us usually four days during the week to reach each community. A typical day of community visits would begin at about three in the afternoon. This was usually when Mr. Velazco would finish with his duties with the station. After visiting usually two communities we would return home at about seven in the evening.

7.6.1 Community A

As discussed in chapter six, the fact that I am a nonhispanic female caused problems in this community. This fact was evident on our second visit to this community when several families gathered and began asking me questions. When I was unable to answer or unable to understand what they were asking me they would all laugh and make comments about the "guera." Although these comments may have been harmless, they

nevertheless created a barrier for me and this project. As mentioned in chapter 4, its remote location and the isolation in which many of these families live may also have affected our acceptance with local residents.

7.6.2 Community B

During the course of our weekly visits to Community B we had discussions with several of the older residents. These weekly discussions gave the team insight into daily activities of these residents. We spoke most often and at length with two households, B20 and B23.

The couple who lived in B20 invited us on several occasions (besides during the scheduled interviews) to sit on their porch and discuss topics ranging from Chagas disease, to their family's history in the region. One afternoon Mr. Velazco, Ms. Euraque, and I sat with this couple for an hour eating coconut and listening to stories about their children. Although we had come to conduct the Chagas disease interview we were fortunate enough to be trusted with family history. These moments, although rare, were important in helping to develop theories about the region and its people.

In addition to the couple in B20, B23 also allowed us to sit with them outside under their shade trees on a few occasions. I noticed during these visits that this family had several parrots that were nesting in the trees next to the family home. The birds had little strings tied to their legs that were also tied to the trees. This leads one to believe that, unlike in the United States, these birds had not had their wings clipped to keep them from flying away. These strings acted like leashes to keep the birds in the trees.

During our weekly visits to Community B we were also introduced to a local resident who could speak English. This was an unusual surprise as we had found no

other residents who were able to communicate in this way. It seems that this man had worked for most of his life on merchant ships out of Veracruz. These ships traveled primarily to the United States. He explained that it was on these ships were he learned English. He was also one of the few participants that were able to describe, in detail, Chagas disease, although he never really explained where he had learned of the disease. Most days we would find him working on his house or atop his white horse sauntering down the road.

7.6.3 Community C

As mentioned above, Community C seemed to be the friendliest of the six study sites. On several occasions we were asked by different households to sit and talk. Two households in particular invited us to talk on several occasions, C36 and C62.

The older couple who lived in C36 invited us on several occasions (besides during the scheduled interviews) to sit in their yard and discuss topics ranging from their family's history in the region to our feelings about Mexico. In addition to the talks we had with the family in C36, Ms. Euraque and I also spent time with the family living in C62. Our first afternoon with this family included both members of the household, Ms. Euraque and I and their family parrot. I mention this animal as it became the topic of conversation during this visit. Ms. Euraque was seated on a bench on one side of the living room while I was seated on the other. The lady of the house was seated between us at a table. At the beginning of the conversation it was only the three of us in the room. A few minutes into the conversation her husband entered the room followed by their parrot. The husband sat down on the bench next to the one I was occupying followed by the parrot. We continued to talk and I noticed that the parrot was slowly coming closer

and closer to me. Finally it attacked and I had to jump off the bench. The entire room erupted in laughter. I had no idea what I had done to this parrot. The husband and wife explained that the parrot was extremely protective of the husband and would not allow anyone to come close to him. Evidently, because I was sitting on the bench next to the husband the parrot felt I was a threat to its master and decided I needed to be eliminated, a field hazard I had never been confronted with before. During this visit, the lady of the house offered to let us park our truck in their yard if we ever felt like swimming in the cove located just a few meters away from their yard. For the next few weeks when we had free time we accepted their gracious offer.

7.6.4 Community D

The research team and I were never asked to sit and talk with households as in Community B or C. Community D, however, had some interesting examples of chicken coops that were an important element in the description of the Chagas landscape. Our weekly visit allowed me to document several different types of chicken coops used in this region providing examples that were found in nearly all the study communities.

The first type of chicken coop noted in Community D consisted simply of fishing net wrapped around wooden stakes. This creation seemed to be used to corral the baby chickens which had just hatched. Most of these coops could be found near the home. Another type of coop found in Community D and then noted in several other communities used the same materials, fishing net and wooden stakes, but on a much grander scale. With this type of coop both hens and chicks were corralled together. These coops were usually found along an outer wall of the home. Contained in this type of coop were several hundred chicks with several hens. The final type of chicken coop

noted in Community D (also found in other communities as well) seemed to be a more stable coop made of wood, tin, and chicken wire. This type of coop was noted at D7. It was located just outside the back entrance to the home. This resembled a more traditional coop where hens were given separate spaces to roost and chicks were kept near the coop using a chicken wire fence.

7.6.5 Community E

As mentioned above it was difficult to make the personal connections with families in Community E because of the sheer size of the community. We did however, have an opportunity to talk with one family extensively about their experience with Chagas disease. It seemed that one of the children in this household had been bitten by a *chinche* and the mother recognized the bite from the monthly *Oportunidades* lectures. The family explained that when the mother realized the daughter may have been bitten by one of the “Chagas” insects they took her to the local hospital immediately. Doctors drew blood and then sent the family home. It seems, however, the family never heard anything from the hospital. They assumed since the doctors never visited them the daughter must have been negative for the disease.

During the course of our investigation in Community E we were also mistakenly identified with local government officials. One afternoon while walking the community during the interview portion of the project we came upon a house that had not been included in the original study but did seem to have residents home that day. We approached the door and said hello several times. As we said hello all noise from the houses stopped. Several children finally came to the door and told us their mother was not home. As we walked away we saw her behind the home. It seems, the neighbor

informed us, that the mother had been visited by some government officials several days prior about something and did not want to deal with these people again. She assumed we were with this organization because she'd seen us talking with other families. It seems on several occasions, in several communities, we were mistaken for health workers or associated with the local government by people who were not home during the initial visits in March. I am sure this caused some of the problems with collections as people were unsure of exactly who we were and probably did not fully trust the project.

7.6.6 Community F

During one weekly visit to Community F we were asked to sit with one family and talk for a few minutes. While we were sitting several of the household children brought insects for me to examine. I, not being an entomologist, was unable to identify them, but reassured the children they were not *chinchas*. The children then informed us that they had taped the photo of the *chinchas* we had given them to the wall just inside their door. They said they did this so that they would always be able to compare insects they found to the photos. Although this household never gave us *chinchas* they did seem to want to actively participate in the project.

7.7 Car Troubles

One of the drawbacks of working in multiple communities during this project and any project of this type was the need to have transportation. Because of the distance between Community E and Community C, the two farthest communities from the Field Station, walking was not an option. In addition, the few times Mr. Velazco and I were forced to walk, Mr. Velazco was adamant about carrying a machete. I never asked why, I just assumed that it had something to do with local gossip about released criminals who

were living in the area. Although there were taxis that passed through this area, they were considered to be unreliable. Thus having a vehicle that worked was imperative to the success of the project. Several times during the 2005 field season however, my 1990 Jeep Cherokee had to be repaired. Between the rough roads and the age of the truck, parts kept breaking.

My first experience with car trouble was during the week when Jason Blackburn (another WHOCC student) was visiting. Jason had been sent down two weeks after I arrived to give me a crash course in the CODES-GIS and to explain the protocol for sampling the vectors (see chapter four for details). While he was visiting the power steering hose sprang a leak, fortunately, however, the construction crews who were paving the road passed by the Field Station on a regular basis. They saw us having trouble with the truck and asked if they could help. Jason and I explained the situation and they promised to bring some “fluid” by before they left for the evening. Jason and I sat on the fence post in front of the Station for several hours waiting for the “fluid.” At about nine in the evening the last dump truck rolled by with the “fluid.” This allowed us to get the truck down to San Andres in order to have the hose replaced. Along with the power steering hose, I also had to replace the alternator, starter, and have a leak plugged in the transmission fluid line. Each of these problems cost days in the field.

At the time of these breakdowns I felt great frustration and disappointment as I felt these delays threatened the project. Upon reflection, however, these bumps in the road allowed me time to explore other aspects of local culture and forced me to learn a new vocabulary dealing specifically with automotive parts and service (a useful skill if

one is forced to drive a 15 year old truck in Latin America). The latter has proven to be helpful in other projects.

7.8 Conclusions

The reflections I have chosen to put to paper I hope give the reader an insight into the trials and experiences on what one might expect when conducting field research. I also hope these experiences show how important taking the time to make observations can be in understanding the outcome of a project. As academic researchers we must always be humble in our work and learn from the cultures into which we immerse ourselves. Let others teach us new ways to look at old ideas.

CHAPTER 8 CONCLUSIONS

8.1 Introduction

This dissertation sought to identify a Chagas disease landscape in the Los Tuxtlas region of Mexico using place specific characteristics created by both the human population and vector/parasite presence. This study contributes to the growing literature describing the human environment of Chagas disease with the ultimate goal of preventing the infection. This has been achieved as although the parasite has been found in these communities, and although several other risk factors contribute to potential bug-human interaction, as of yet no known infection has occurred. Research such as this should be utilized to continue this mainly through educational strategies. Additionally, within medical geographic research, this dissertation contributes to the generally neglected aspect of gender and disease within the sub-discipline. This dissertation also adds to the growing medical and health geography literature which focus upon the importance of place and context in disease causation.

In identifying these local characteristics and attempting to link the study area to other Chagas endemic regions, new questions arose. Some of these questions are answered within this text. However, others will form the basis for a future research agenda focused upon education and eradication strategies for Chagas disease in the region. Additionally, while conducting this research, new connections surfaced between the ongoing Chagas disease concerns in Central and South America and its diffusion to places traditionally not at risk for human infections. This new development will briefly be addressed in addition to the conclusions drawn from the different chapters.

8.2 Summary of Conclusions

First, the analyses in chapters five and six identify that Chagas disease does pose an important health risk among the six study communities in Los Tuxtlas. Key human induced risk factors, such as house construction materials and domestic animal presence, were documented during this study. Specimens of *T. cruzi* infected *Triatoma dimidiata* were found in the domestic ecotope. Although the vector was collected from traditional risk environments (wooden homes with earthen floors), it was also collected from non-traditional house type environments (concrete homes with concrete floors). Although still more common in wooden houses, this tendency does not preclude concrete houses from domestic infestations of *Triatoma dimidiata*. This finding indicates a need to reassess our expectations of the (research reported) human environment variables associated with Chagas disease as it would be dangerous to rely solely on certain “risk” construction materials if this leads to complacency elsewhere.

In addition to documenting a Chagas disease risk landscape in the six study communities, this dissertation, using a mixed methods approach, also documented local knowledge about the vector and disease. The results indicate that although participants were more likely to describe the vector, few could actually identify the link between the vector and Chagas disease. This lack of knowledge may contribute to future infections, as local populations are not adequately educated with regard to the transmission cycle of this disease.

Through the collection of interview information an interesting gender issue appeared. Chagas disease, in general, and in this region more specifically, does not have a gendered pattern to infection. Both men and women are equally susceptible to infection, as the vectors of this disease are nocturnal and have an equal opportunity to bite sleeping victims. Some interesting findings related to gender, however, showed that women are able to describe the vector and link this insect to the disease more frequently than men. Although this information does not contribute to the literature in terms of the gendering of disease transmission, it instead creates a new avenue for exploration into gendered disease knowledge.

One limitation in drawing any gendered conclusion from the findings of this study is the limited number of male interview participants. This was most likely a function of the time of day during which most interviews took place. Those interviews completed during lunch time hours or late in the afternoon often involved more male participants than those carried out in the morning or mid-day. Therefore, in future studies varying the time of day for interviews could help to incorporate more men into the study. Additionally, in future studies it is suggested that, when possible, participants should be interviewed separately so as not to involve cross-gender contamination in the data.

Although the chances of contracting Chagas disease has little to do with gender in this study, it can be said that poverty does play a role in the risk of Chagas disease transmission in Los Tuxtlas. According to the Mexican government, many of the participants in this study can be considered poor, subsisting on what can be produced and sold to their neighbors. Indeed, local residents also participate in the *Oportunidades* programs offered by the government. As discussed in chapter six, this extensive program

was designed by the Mexican government to alleviate poverty. Therefore, in order for the residents to be eligible to participate they must be considered poor by the government. Those that do save their money, often use these monetary funds to make household improvements, such as laying cement floors or converting a wooden house to a concrete house. Although in this study area participants produced vectors from houses with concrete floors, throughout the rest of the Chagas disease region, especially where the vector *Triatoma dimidiata* dominates, earthen floors produce the greatest risk for human contact with the vector and subsequently the parasite. Thus, being poor in these study communities contributes to the possibility of infection.

8.3 Future Projects and Recommendations

In no way should this research project be used as final evidence of Chagas disease in these communities. Instead, it should be used as a baseline for a further research and eradication approach in the six communities. Therefore, the following section discusses possible strategies for future projects in this region specifically related to eradication of the vector *Triatoma dimidiata* and education about Chagas disease. Using studies conducted by the WHO (1999) as well as other research projects (Ramsey et al. 2003; Wastevion et al. 2004), alternative or additional approaches are suggested to fill gaps in the original 2005 project.

8.3.1 Baseline Data Collection

The first necessary step towards furthering Chagas disease research in Los Tuxtlas is the collection of updated background population data for use in a GIS. The population of the region experiences frequent fluctuations, thus data collected in 2005 may no longer be accurate. These population data should include demographic variables including age

and gender to better divide the population into appropriate cohorts for analysis. This will allow for more thorough studies into human *T. cruzi* infections.

An important element missing from the current project was an extensive investigation into human infections within the six communities. Dr. Rojas Saiz did investigate further households (Rojas Saiz unpublished report 2006) though a much larger population must be included to gain a more accurate understanding of disease (or vector) distribution. This baseline acquisition may also help focus important education and eradication steps if one community has significantly higher infection rates compared to the others.

Both domestic and peri-domestic collections of the vector must be gathered in any future projects. Peri-domestic vector collections were omitted from this study as this project was specifically concerned with domestic infestations. However, in future projects, where time and the resources are available, collecting vector data from peri-domestic ecotopes must be evaluated in order to determine possible domestic corridors between domestic habitat and the vector's traditional environment. Additionally, the type of vector collection technique must be altered. Trained personnel should be used to collect vectors at timed intervals. This will eliminate problems encountered in this project, such as lack of participation and the education of local residents concerning the vector, which impacted the vector collection results. Local residents are not educated in entomology and should not be required to perform entomological tasks.

A monitoring system needs to be created to track changes in domestic infestations following improvements to the vector collection system. Suggested techniques include the use of a monthly calendar placed on the wall of the participating dwellings and

replaced at the end of each month. This calendar is then examined for the presence of vector feces using criteria set forth by Menezes et al. (1990; WHO 1999; Ramsey et al. 2003; Wastevion et al. 2004). In addition to the calendar method, voluntary collections by household members should also be encouraged.

Although not mentioned in the studied programs providing the basis for these recommendations (WHO 1999; Ramsey et al. 2003; Wastevion et al. 2004), local knowledge interviews should be a critical element in future studies. In order to create culture specific education strategies, researchers must first understand local knowledge about all aspects of the disease. Therefore, expanding the Chagas disease interview (discussed in chapter six) to include additional questions related to both vector and disease symptoms must be included. These local perceptions can then be used to develop culturally sensitive intervention strategies.

8.3.2 Intervention Strategies

Several intervention strategies have been discussed in other Chagas disease investigations. Some include only pesticide applications, while others involve both house improvements and pesticide applications (WHO 1999; Ramsey et al. 2003; Wastevion et al. 2004). As was shown in this investigation, simply relying on pesticide applications is not a realistic strategy for this region, and Community C provides a good example of this. Despite receiving pesticide applications for *Triatoma dimidiata* during the 2005 field season, live vectors were still collected from households. Instead, future projects should include pesticide applications when extreme domicile infestations are observed, but in addition education programs should be developed that thoroughly explain the disease to local communities. In creating local education programs the baseline Chagas disease

knowledge data can guide educators to more culturally sensitive and appropriate teaching techniques.

The *Oportunidades* meetings provide one existing avenue for this type of education initiative. However, present discussion tactics must be reevaluated. Instead of discussing multiple diseases during monthly meetings, I would suggest focusing on one disease and thoroughly explaining all aspects of that particular disease. This may eliminate confusion between multiple diseases, which was recorded during this study in the six communities. I also believe it is imperative that men also be included in these monthly meetings. This investigation suggests that men tend to know less about Chagas disease than compared to women. Therefore, the inclusion of men in the education process will aid the whole population since, as shown in this dissertation, Chagas disease is not a gendered infection.

The six communities that comprise this study area display a Chagas disease landscape. This landscape includes human induced risks factors (such as house type construction and domestic animal presence) and *T. cruzi* infected vector presence. Thus, human infections are possible in this region. Mitigation measures must be implemented now, in order to prevent future generations from contracting the disease in the region.

8.4 Significance to Non-traditional Chagas Disease Regions

During the course of this investigation it came to the author's attention that Chagas disease has now become a focus for the Food and Drug administration and the Center for Disease Control and Prevention in the United States. Chagas disease can be transmitted through contaminated blood and organs (chapter three). As the population of

immigrates from Chagas disease endemic countries increases in the United States the likelihood of infected blood and organs also increases.

In April 2001, doctors notified the CDC of an acute case of Chagas disease in an organ transplant patient from March of that year (CDC 2001). The patient returned to the hospital on April 23 because of a fever assumed to be associated with the transplant (CDC 2001). A blood smear taken from the patient returned a positive result for the parasite *T. cruzi*. Additionally, two other patients (who had received organs from the same donor as the April 23 case) were also diagnosed with acute Chagas disease (CDC 2001). The three cases were treated with parasite suppressive drugs for four months (CDC 2001). Only one of the three survived (CDC 2001). In 2005, doctors in Los Angeles County detected two more Chagas disease infections in organ transplant recipients (CDC 2006). Both of these patients died soon after the identification of the infection. In each of the five cases, doctors traced the infections back to three original donors (CDC 2001; CDC 2006). Two of these donors were from Central American countries and had immigrated to the United States, while one was born in the United States but had traveled extensively to Chagas disease endemic areas of Latin America (CDC 2001; CDC 2006)

According to the CDC in the 2006 article “Chagas Disease After Organ Transplantation—Los Angeles, CA, 2006”, blood and organ donors are not screened for Chagas disease, “unless there presents a suspicious history” (personal communication with transplant laboratory specialist December 2006). However, as of December 2006, the CDC had issued a statement on their website indicating the acceptance of a screening procedure permitted by the Food and Drug Administration for the presence of Chagas

disease in the United States blood and organ supply (CBCSF 2006; CDC, Division of Parasitic Disease 2006). Whether this procedure has now been implemented is unclear. In Dade County Florida, as of July 2006, the Community Blood Centers of South Florida, distribute Chagas disease pamphlets to blood donors giving pertinent information about the disease (Appendix F). This step seems essential in preventing the disease from gaining a foothold in the United States.

As Chagas disease has been detected in blood and organ supplies on a global scale it is no longer a disease limited by geography and poverty as the modes of infection have now expanded to include previously non-traditional risk communities. It is imperative that researchers in the United States establish research collaborations in Latin America as both societies now have a vested interest in understanding and preventing this disease.

REFERENCES

- Abad-Franch, F. et al. 2001. Biogeography of Triatominae (Hemiptera:Reduviidae) in Ecuador: Implications for the Design of Control Strategies. *Memorias do Instituto Oswaldo Cruz*,96(5): 611-620.
- Adler, S. 1959. Darwin's Illness. *Nature*, 18(4): 1102-1103.
- Alchon, S. 2003. *A Pest in the Land New World Epidemics in a Global Perspective*. Albuquerque: University of New Mexico Press.
- Alland, A. Jr. 1966. Medical Anthropology and the Study of Biological and Cultural Adaptations. *American Anthropologist*, New Series, 68(1): 40-51.
- Anderson, K. 1991. *Vancouver's Chinatown: Racial Discourses in Canada, 1875-1980*. Montreal: McGill Queens University Press.
- Andrews, G. 2004. (Re)thinking the dynamics between healthcare and place: therapeutic geographies in treatment and care practices. *Area*, 36(3): 307-318.
- Andrews, G. And Kearns, R. 2005. Everyday Health Histories and the Making of Place: The Case of an English Coastal Town. *Social Science and Medicine*, 60(12): 2697-2713.
- Andrle, R. 1964. *A Biogeographical Investigation of the Sierra de Tuxtla in Veracruz, Mexico*. Ph.D. dissertation, Department of Geog. and Anth., Louisiana State University.
- Arance, L. 1994. Mexico: Factores psicosociales de la enfermedad de Chagas en Jalisco. *FERMENTUM. Revista Venezolana de Sociologia Antropologia*, 3(8): 46-74.
- Arias, A.R., et al. 1988. Chagas' Disease in Paraguay. *XII International Congress for Tropical Medicine and Malaria*.
- Arnold, D.Y. 1992. La Casa de Adobes y piedras del Inka. In *Hacia un orden andino de las cosas*, ed. Dense Arnold, D. Junenez and Juan de Dios Yapita, 31-108. La Paz: Hisbol.
- Arnold, P. 1988. Ceramic Production and Consumption in the Sierra de los Tuxtlas, Veracruz, Mexico. *Latin American Institute Research Paper Series*, 21:1-67.
- Arnold, P. III. 1990. The Organization of Refuse Disposal and Ceramic Production within Contemporary Mexican Households. *American Anthropologists*, New Series, 92(4): 915-932.

- Arnold, P and Santley, R. 1993. Household Ceramic Production at Middle Classic Period Matacapan. In *Prehispanic Domestic Units in Western Mesoamerica: Studies of the Household, Compound, and Residence* ed. Santley and Hirth. FL: CRC Press.
- Arriaza, B. 1995. Chile's Chinchorro Mummies. *National Geographic* (March): 71-88.
- Atias, A. 1980. Enfermedad de Chagas digestiva en Chile, Experiencia de 20 anos. *Boletín Hospital Civil de San Juan de Dios* (Quito), 27:251-257.
- Aufderheide, A. et al. 2004. A 9,000 Year Record of Chagas' Disease. *Proceedings of the National Academy of Sciences of the United States of America*, 101(7): 2034-2039.
- Ault, S. et al. 1992. Technical Evaluation of USAID CCH-Chagas' Disease Control Project Bolivia—August 1992. In *Vector Biology and Control Project Report No. 82061*. Arlington: Vector Biology and Control Project.
- Azogue, E.; La Fuente, C; and Darras, C. 1981. Transmisión Congenita de la Enfermedad de Chagas en Santa Cruz Bolivia, I: *Epidemiologia. Boletín Informativo del CENETROP*, 7(1): 23-29.
- . 1985. Congenital Chagas' disease in Bolivia: Epidemiological Aspects and Pathological Findings. *Transactions of the Royal Society of Tropical medicine and Hygiene*, 79:178-180.
- Baer, H. et al. 2003. *Medical Anthropology and the World System*. Connecticut: Praeger Publishers.
- Bailey, C. et al. 2006. Different public health geographies of the 2001 foot and mouth disease epidemic: 'citizen' versus 'professional' epidemiology. *Health and Place* 12: 157-166.
- Ball, C. Web Chi Square Calculator. Georgetown University Linguistics. http://www.georgetown.edu/faculty/ballc/webtools/web_chi.html
- Barnabé, C. et al. 2001. Trypanosoma cruzi: A Considerable Phylogentic Divergence Indicates that the Agent of Chagas Disease is Indigenous to the Native Fauna of the United States. *Experimental Parasitology*, 99: 73-79.
- Barnett, J. 2000. Rationalizing Hospital Services: Reflections on Hospital Restructuring and its Impacts in New Zealand. *New Zealand Geographer*, 56: 5-21.
- Barrett, F. 1980. Medical Geography as a Foster Child. In *Conceptual and Methodological Issues in Medical Geograophy*, ed. M. Meade. Chapel Hill: University of North Carolina Press.

- Barrett, F. 1986. Medical Geography: Concepts and Definition. In *Medical Geography Progress and Prospects*, Michael Pacione, ed.. London: Croom Helm.
- Barret, T. et al. 1980. Epidemiological Aspects of three *Trypanosoma cruzi* Zymodemes in Bahia State, Brazil. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, 74(1):84-90.
- Barrow, C. 1988. The Impact of Hydroelectric Development on the Amazonian Environemnt: With Particular Reference to the Tucuruí Project. *Journal of Biogeography*, 15(1), *Biogeography and development in the Humid Tropics*: 67-78.
- Barrows, H. 1923. Geography as Human Ecology. *Annals of the Association of American Geographers*, 13: 1-14.
- Barr, S. et al. 1991. Clinical, Clinicopathologic, and Parasitologic Observations of Trypanosomiasis in Dogs Infected with North American *Trypanosoma cruzi* Isolates. *American Journal of Veterinary Research*, 52(6): 954-960.
- Barr, S. et al. 1991. The Lesions and Prevalence of *Trypanosoma cruzi* in Opossums and Armadillos from Southern Louisiana. *Journal of Parasitol*, 77(4): 624-627.
- Barrett, F. 1980. Medical Geography as a Foster Child. In *Conceptual and Methodological Issues in Medical Geography*, M. Meade ed.. Chapel Hill: University of North Carolina, Department of Geography.
- Bastien, J. 1987. Cross-Cultural Communication Between Doctors and Peasants in Bolivia. *Social Science and Medicine*, 24:1109-1118.
- 1998. *Kiss of Death: Chagas' Disease in the Americas*. Salt Lake City: The University of Utah Press.
- Baxter, J., Eyles, J., and Willms, D. 1992. The Hagersville tire fire: Interpreting risk through a qualitative research design. *Qualitative Health research* 2:208-237.
- Beard. C. et al. 2003. Chagas Disease in a Domestic Transmission Cycle in Southern Texas, USA. *Emerging Infectious Diseases*, 9(1): 103-105.
- Becerril-Flores, M. et al. 2007. Human infection and risk of transmission of Chagas disease in Hidalgo State, Mexico. *American Journal of Tropical Medicine and Hygiene*, 76(2): 318-323.
- Ben-Shlomo, Y, et al. 1996. Does Variation in the Socioeconomic Characteristics of an Area Affect Mortality? *British Medical Journal*, 312: 1013-14.

- Bennett, C. 1967. A Review of Ecological Research in Middle America. *Latin American Research Review*, 2(3): 3-27.
- Berkman, L. and Kawachi, I. 2000. A Historical Framework for Social Epidemiology. In L. Berkman and I. Kawachi ed. *Social Epidemiology*. New York: Oxford University Press.
- Berkman, L. 1980. Physical Health and the Social Environment: A Social Epidemiological Perspective. In *The Relevance of Social Science and Medicine*, L. Eisenberg and A. Kleinman. Dordrecht: Riedel.
- Bice, D. and Zeledon, R. 1970. Comparison of Infectivity of Strains of Trypanosome cruzi (Chagas, 1909). *The Journal of Parasitology*, 56(4):663-670.
- Bittencourt, A. 1976. Congenital Chagas Disease. *American Journal of Disease of Children*, 130:97-103.
- Bittencourt, A. et al. 1981. Pneumonitis in Congenital Chagas Disease. A study of Ten Cases. *American Journal of Tropical Medicine and Hygiene*, 30:38-42.
- Bittencourt, A. et al. 1988. Evaluation of Chagas' Disease Transmission Through Breast-Feeding. *Memorias do Instituto Oswaldo Cruz*, 83:37-39.
- Bolam, B., Murphy, S., and Gleeson, K. 2005. Place-identity and geographical inequalities in health: A qualitative study. *Psychology and Health*.
- Bos, R. 1988. The Importance of Peridomestic Environmental Management for the Control of the Vector of Chagas' Disease. *Revista Argentina de Microbiologia* (Buenos Aires), 50:56-62.
- Boyer, Bennett. 2007. Provided illustrations for 3.3 and 3.4.
- Brener, Z. 1994. The Pathogenesis of Chagas' Disease: An Overview of Current Theories. In *Chagas' Disease and the Nervous System*, Scientific Publication No. 547, 30-46. Washington, D.C.: Pan American Health Organization.
- Brénière, S. et al. 1989. Chagas's Disease in Bolivia: Clinical and Epidemiological Features and Zymodeme Variability of *Trypanosoma cruzi* strains Isolated from Patients. *American Journal of Tropical Medicine and Hygiene*, 41:521-529.
- Brenner, R. 1987. General Aspects of Reduviidae Biochemistry. In *Chagas' Disease Vectors V3, Biochemical Aspects and Control*, ed. Rodolfo Brenner and Angel de la Merced Stoka, 2-8. Boca Raton: CRC Press.
- Briceño-León, R. 1987. Housing for Control of Chagas' Disease in Venezuela. *Parasitology Today*, 3:384-387.

- . 1990. *La Casa Enferma: Sociología de la Enfermedad de Chagas*. Caraca: Fondo Editorial Acta Científica Venezolana Consorcio de Ediciones Carriles C.A.
- . 1993. Social Aspects of Chagas Disease. In *Knowledge, Power, and Practice: The Anthropology of Medicine and Everyday Life*. Ed. Shirley Lindenbaum and Margaret Lock. Berkeley: University of California Press.
- Brown, M. Knopp, L. and Morill, R. 2005. The culture Wars and Urban Electoral Politics: Sexuality, Race and Class in Tacoma, Washington. *Political Geography*, 24(3): 267-291.
- Bryan, R. et al. 1994. Community Participation in Vector Control: Lessons from Chagas' Disease. *American Journal of Tropical Medicine and Hygiene*, 50(6):61-71.
- Burgdorfer, W.; Lane, R.; and Barbour, A. 1985. The Western Black-legged Tick, *Ixodes pacifus*: A vector of *Borrelia burgdorferi*. *American Journal of Tropical Medicine and Hygiene*, 34: 925-930.
- Camara-Lopes, L. 1962. The Endemic South-American Megaesophagus. *Second World Congress of Gastroenterology* (Munich), 1:79-82.
- Carcavallo, R. 1999. Climatic Factors Related to Chagas Disease Transmission. *Memórias do Instituto Oswaldo Cruz*, 94(Supp.): 367-369.
- . 1987. The subfamily Triatominae (Hemiptera: Reduviidae): Systematic and some Ecological Factors. In *Chagas' Disease Vectors, Vol 1, Taxonomic, Ecological, and Epidemiological Aspects*, ed. R. Brenner and A. de la Merced Stoka, 1-18. Boca Raton: CRC Press:1-39.
- Carrasco, R et al. 1990. Prevalence of *Trypanosoma cruzi* infection in blood banks of seven Departments of Bolivia. *Memórias do Instituto Oswaldo Cruz*, 85:69-73.
- Cassel, J. et al. 1960. Epidemiologic Analysis of the Health Implications of Culture Change: A Conceptual Model. *Annals of the New York Academy of Science*, 84: 938-949.
- Cassel, J. 1964. Social Science Theory as a Source of Hypotheses in Epidemiological Research. *American Journal of Public Health*, 54: 1482-1488.
- CBCSF. 2006. Assassin Bugs and Chagas Disease: A New Public Health Challenge. *Newsletter*, 9: 1-2.

- Cecere, M.; Canale, D.; and Gurtler, R. 2003. Effects of refuge availability on the Population Dynamics of *Triatoma infestans* in Central Argentina. *Journal of Applied Ecology*, 40: 742-756.
- Cedillos, R. 1975. Chagas' Disease in El Salvador. *Bulletin, Pan American Health Organization*, 9(2):135-141.
- . 1987. Current Knowledge of the Epidemiology of Chagas' Disease in Central America and Panama. In *Chagas' Disease Vectors, vol. I*, ed. Rodolfo Brenner and Angel de la Merced Stoka, 41-45. Boca Raton: CRC Press.
- Center for Disease Control and Prevention. 2002. Chagas Disease after Organ Transplantation—United States, 2001. *MMWR*, 51: 210-212.
- . 2006. . Chagas Disease after Organ Transplantation—Los Angeles, California, 2006. *MMWR*, 55: 798-800.
- Chacko, E. 2005. Understanding the Geography of Pellagra in the United States: The role of social and place-based identities. *Gender Place and Culture*, 12(2): 197-212.
- Coe, M.. 2001. The Archeology of San Lorenzo Tenochtitlan. *In the Land of the Olmec, Vol. 1*. TX: University of Texas Press.
- Coe, M and Koontz, R. 2002. *Mexico*. New York: Thames and Hudson.
- Coimbra, C. 1988. Human Settlements, Demographic Patterns, and Epidemiology in Lowland Amazonia: The Case of Chagas Disease. *American Anthropologist*, 90(1): 82-97.
- Coimbra, C. et al. 1992. Seroepidemiological Survey for Chagas' Disease Among Xavante Indians of Central Brazil. *Annals of Tropical Medicine and Parasitology*, 86(5):567-568.
- Colson, A. and Selby, K. 1974. Medical Anthropology. *Annual Review of Anthropology*, 3: 245-262.
- Creswell, J. 2006. *Designing and Conducting Mixed Methods Research*. California: Sage Publications.
- Creswell, T. 1996. *In Place/Out of Place*. Minnesota: University of Minnesota Press.
- Croll, N and Cross, J. 1983. *Human Ecology and Infectious Diseases*. New York: Academic Press.

- Crosby, A. 1972. *The Columbian Exchange: Biological and Cultural Consequences of 1492*. Westport, CT: Greenwood.
- . 1976. Notes and Documents: Virgin Soil Epidemics as a Factor in the Aboriginal Depopulation in America. *William and Mary Quarterly*, 33(2):289-299.
- Curtis, A., Mills J.W., and M. Leitner (forthcoming) Katrina and Vulnerability: The Geography of Stress, *Journal of Health Care for the Poor and Underserved*
- Curtis, S. and Taket, A. 1996. *Health and Society: Changing Perspectives*. London: Holder Headline Group.
- Curtis, S. et al. 2003. Area Effects on Health variation over the life-course: Analysis of the Longitudinal Study sample in England using new Data on Area of Residence in Childhood. *Social Science and Medicine*, 58: 57-74.
- Da Silveira, G. 1976. Chagas' Disease of the Colon. *British Journal of Surgery*, 63:831-835.
- Dangana, L. and Tropp, C. 1995. Human Ecology and Environmental Ethics. In M. Atchia and S. Tropp, eds., *Environmental Management: Issues and Solutions*. Chichester: John Wiley and Sons: 19-29.
- Dear, M. and Wolch, J. 1987. *Landscapes of Despair: From Deinstitutionalization to Homelessness*. Princeton: Princeton University Press.
- Del Castillo, M et al. 1990. AIDS and Chagas' Disease with the Central Nervous System Tumor-like Lesion. *American Journal of Medicine*, 88:693-694.
- Department of Health and Social Security. 1980. *Inequalities in Health: Report of a Working Group Chaired by Sir Douglas Black*. DHSS:London.
- Dias, J. 1985. Aspectos Socioculturales y Económicos Relativos al Vector de la Enfermedad de Chagas. In *Factores Biológicos y Ecológicos en la Enfermedad de Chagas*, ed. R. Carcavallo. Buenos Aires: Servicio Nacional de Chagas.
- . 1987. Control of Chagas Disease in Brazil. *Parasitology Today*, 3(11):336-341.
- . Rural Resource Development and its Potential to Introduce Domestic Vectors into new Epidemiological Situations. *Revista Argentina de Microbiología*, 50:81-85.
- Dias, J. and Dias, R. 1982. Housing and the Control of Vectors of Human Chagas' Disease in the State of Minas Gerais, Brazil. *PAHO Bulletin*, 26:117-128.

- Dias, J. and Dias, R. 1982. Las Viviendas y la Lucha Contra los Vectores de la Enfermedad de Chagas en el Hombre, en el Estado de Minas Gerais, Brazil. *Boletín de la Oficina Sanitaria Panamericana*, 95(3): 453-465.
- Dias, J. and Brener, Z. 1984. Chagas' Disease and Blood Transfusion. *Memórias do Instituto Oswaldo Cruz*, 79(suppl.):139-147.
- Dirzo, R., Soriano, E, and Vogt, R. 1997. Introduccion General. in *Historia Natural de Los Tuxtlas*. Ed Soriano, E., Dirzo, R, and Vogt, R.
- Docampo, R. et al. 1988. Prevention of Chagas' Disease resulting from Blood Transfusion by Treatment of Blood: Toxicity and Mode of Action of Gentian Violet. *Biomedical Environmental Science*, I(4):406-413.
- Doolittle, W et al. 2002. Feeding a Growing Population on an Increasing Fragile Planet. in *Latin America in the 21st Century: Challenges and Solutions* ed. Knapp, G. Texas: University of Texas Press.
- Dorling, D. 2001. Anecdote is the Singular of Data. *Environment and Planning A*, 33: 1335-1369.
- Dorn, M. and Laws, G. 1994. Social Theory, Body Politics, and Medical Geography: Extending Kearns' Invitation. *The Professional Geographer*, 46:106-110.
- Dorn, P., Segean, S., and Guillot, M. 1997. Simplified Method for Preservation and Polymerase Chain Reaction-amplification of *Trypanosoma cruzi* DNA in Human Blood. *Memorias del Instituto Oswaldo Cruz*, 92(2): 253-255.
- Dorn, P., et al. 2007. Autochthonous Transmission of *Trypanosoma cruzi*, Louisiana. *Emerging Infectious Diseases*. 13,(4).
- Dorn, P., Monroy, C., and Curtis, A. 2007. *Triatoma dimidiata* (Latreille, 1811): A review of its diversity across its geographic range and the relationship among populations. *Infection Genetics and Evolution*, 7(2): 343-352.
- Dumonteil, E. 1999. Update on Chagas' disease in Mexico. *Salud Publica de Maxico*, 41(4): 332-337.
- Dumonteil, E., et al. 2002. Geographic Distribution of *Triatoma Dimidiata* and Transmission Dynamics of *Trypanosoma Cruzi* in the Yucatan Peninsula of México. *American Journal of Tropical Medicine and Hygiene*, 67(2): 176-183.
- Dumonteil, E. et al. 2006. Assesment of *Triatoma dimidiata* dispersal in the Yucatan peninsula of Mexico using morphometry and microsatellite markers. *American Journal of Tropical Medicine and Hygiene*, 75(5-Supp S): 116-116.

- Duncan, C. et al. 1998. Context, Composition, and Heterogeneity: Using Multilevel Models in Health Research. *Social Science and Medicine*, 46: 97-117.
- Dyck, I. 1992. Health and health care experience of the immigrant woman: Questions of Culture, context and gender. In *Community, Environment and Health in British Columbia*. ed. M.V. Hayes. L.T. Foster, and H.D. Foster, 231-256. Victoria: BC.
- . 1999. Using Qualitative Methods in Medical Geography: Deconstructive Moments in a Subdiscipline. *Professional Geographer*, 51(2): 243-253.
- Dyck, I et al. 2005. The home as a site for long-term care: meanings and management of bodies and space. *Health and Place*, 11(2): 173-185.
- Eisenberg, L. 1977. Disease and Illness: Distinctions between Professional and Popular Ideas Sickness. *Culture, Medicine, and Psychiatry*, 1: 9-23.
- Eldridge, B. and Edman, J. ed. 2004. *Medical Entomology A Textbook on Public Health and Veterinary Problems Caused by Arthropods*. MA: Kluwer Academic Publishers. pp. 57-63, 156, 165-167, 285-298.
- Ellaway, McIntyre, S. And Kearns, R. 2001. Perceptions of Place and Health in Socially Contrasting Neighborhoods. *Urban Studies*, 38: 2299-2316.
- Elliott, S. 1999. And the Question Shall Determine the Method. *Professional Geographer*, 51(2): 240-243.
- Enger, K., Ordonez, R., Wilson, M., and Ramsey, J. 2004. Evaluation of Risk Factors for Rural Infestation by *Triatoma pallidipennis* (Hemiptera: Triatominae), a Mexican vector of Chagas Disease. *Journal of Medical Entomology*, 41(4): p 760-767.
- Evans, R., Barer, M., and Marmor, T.R. 1994. *Why Are Some People Healthy and Others Not?: The Determinants of Health of Populations*. New York: Aldine de Gruyter.
- Eyles, J., and Smith, D. 1988. *Qualitative Methods in Human Geography*. Cambridge, U.K Polity Press.
- Eyles, J et al. 1993. Worrying about waste: Living close to waste disposal facilities in southern Ontario. *Social Science and Medicine*, 37(6):805-812.
- Fabrega, H. 1971. Medical Anthropology. *Biennial Review of Anthropology*, 7: 167-229.
- Farmer, P. 2001. *Infections and Inequalities*. Berkley: University of California Press.

- Feit, A; El-Sherif, N; and Korastoff, S. 1983. Chagas' Disease Masquerading as a Coronary Artery Disease. *Archives of Internal Medicine*, 142:144-145.
- Foege, W. 1988. Plagues: Perceptions of Risk and Social Responses. *Social Research*, 55(3):331-342.
- Fonaroff, L. 1968. Man and Malaria in Trinidad: Ecological Perspectives on a Changing Health Hazard. *Annals of the Association of American Geographers*, 58: 526-556.
- Forattini, O. 1972. Ecological Aspects of American Trypanosomiasis. *Revista de Saude Pública*, 6(2):183-187.
- Fornaciari, G. et al. 1992. Chagas' Disease in Peruvian Inca Mummy. *The Lancet*, 339:128-129.
- Franco, H. et al. 2000. *Mepraia spinolai* in the Southeastern Pacific Ocean Coast (Chile) – First Insular Record and Feeding pattern on the Pan de Azúcar Island. *Memorias do Instituto Oswaldo Cruz*, 95(2): 167-170.
- Gamboa, J. and Ríos, L. 1965. El Rancho Venezolanos, su Influencia en la Prevalencia Triatomina Doméstica. *Archivos Venezolanos de Medicina Tropical y Parasitología Médica*, 5:305-328.
- Garrett, L. 1994. *The Coming Plague: Newly Emerging Disease in a World Out of Balance*. New York: Farrar, Straus and Giroux.
- Gatrell, A. et al. 1996. Spatial Point Pattern Analysis and its Application in Geographical Epidemiology. *Transactions of the Institute of British Geographers, New Series*, 21(1): 256-274.
- Gatrell, A. 1997. Structures of Geographical and Social Space and Their Consequences for Human Health. *Geografiska Annaler, Series B Human Geography*, 79(3): 141-154.
- . 2002. *Geographies of Health*. Mass.: Blackwell Publishers.
- Geissert, D. 2004. La Geomorfología. in *Los Tuxtles: El Paisaje de la Sierra* ed. Guevara, S., Laborde, D. and Sanchez-Rios, G. Veracruz: Instituto de Ecología.
- Gesler, W. 1992. Therapeutic Landscapes: Medical Issues in Light of New Cultural Geography. *Social Science and Medicine*, 34: 735-46.
- Goldstein, J. 1989. Darwin, Chagas', Mind, and Body. *Perspectives in Biology and Medicine*, 32(4):586-600.

- Goman, M. 1992. Paleocological Evidence for Prehistoric Agriculture and Tropical Forest Clearance of the Sierra de Los Tuxtlas, Veracruz, Mexico. Masters of Arts in Geography. University of California, Berkeley.
- Gomez-Pompa, A. 1973. Ecology of the Vegetation of Veracruz. In *Vegetation and Vegetational History of Northern Latin America*, ed. Graham. Amsterdam: Elsevier Scientific.
- Gonçalves, T. et al. 1998. An Investigation on the Ecology of *Triatoma vitticeps* (Stal, 1859) and its Possible Role in the Transmission of *Trypanosoma cruzi*, in the Locality of Triunfo, Santa Maria Madalena Municipal District, State of Rio de Janeiro, Brazil. *Memorias do Instituto Oswaldo Cruz*, 93(6):711-717.
- Goodenough, W. 1963. *Cooperation in Change: An Anthropological Approach to Community Development*. New York: Russell Sage Foundation.
- Grant, I; Gold, J.; and Wittner, M. 1989. Transfusion-associated Acute Chagas Disease Acquired in the United States. *Annals of Internal Medicine*, 111: 849-851.
- Greene, et al 1989. Toward a Conceptual Framework for Mixed-Method Evaluation Designs. *Education Evaluation and Policy Analysis*, 11: 255-274.
- Gregory, D. 1978. *Ideology, Science, and Human Geography*. London: Hutchinson.
- Gürtler, R. et al. 1998. Influence of Humans and Domestic Animals on the Household Prevalence of *Trypanosoma Cruzi* in *Triatoma Infestans* Populations in Northwest Argentina. *American Journal of Tropical Medicine and Hygiene*, 58(6): 748-758.
- Gürtler, R. et al. 1997. Shifting Host Choices of the Vector of Chagas Disease, *Triatoma Infestans*, in Relation to the Availability of Host in Houses in North-West Argentina. *Journal of Applied Ecology*, 34(3): 699-715.
- Gürtler, R. et al. 1996. Host-Feeding Patterns of Domiciliary *Triatoma infestans* (Hemiptera: Reduviidae) in Northwest Argentina: Seasonal and Instar Variation. *Journal of Medical Entomology*, 33(1):15-26.
- Gürtler, R. et al. 1990. The Prevalence of *Trypanosoma cruzi* and the Demography of Dog Populations after Insecticidal Spraying of Houses: A Predictive Model. *Annals of Tropical Medicine and Parasitology*, 84:313-323.
- Gürtler, R. et al. 1991. Chagas Disease in North-west Argentina: Infected Dogs as a Risk Factor for the domestic transmission of *Trypanosoma cruzi*. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, 85: 741-745.

- Gutteridge, W. 1982. Chemotherapy of Chags' Disease. In Perspectives in Trypanosomiasis Research. Proceedings of the Twenty-first Trypanosomiasis Seminar, London 1981, ed. J. Backer. London: Research Studies Press.
- Guzmán-Bracho, C. 2001. Epidemiology of Chagas Disease in Mexico: An Update. *Trends in Parasitology*, 17(8): 372-376.
- Haddock, K. 1979. Disease and Development in the Tropics: A Review of Chagas' Disease. *Social Science and Medicine*, 13(D):53-60.
- Hagar, J. and Rahimtoola, S. 1991. Chagas' Disease in the United States. *New England Journal of Medicine*, 325:763-768.
- Hahn, R. 1995. *Sickness and Healing: An Anthropological Perspective*. An Arbor: University of Michigan Press.
- Halstead, S. 1980. Dengue Hemorrhagic Fever: A Public Health Problem and a Field of Research. *Bulletin of the World Health Organization*, 58: 1-21.
- Harvey, D. 1969. *Explanation in Geography*. London: Edward Arnold.
- Hawley, A. 1986. *Human Ecology: a Theoretical Essay*. Chicago: The University of Chicago Press.
- Hayes, M. Man, Disease, and Environmental Associations: From Medical Geography to Health Inequalities. *Progress in Human Geography*, 23(2): 2889-296.
- Headland, T. et al. 1990. *Emics and Etics: The Insider/Outsider Debate*. Frontiers of Anthropology Series, 7. Newbury Park and London: Sage.
- Heggebhougen, H. and Shore, L. 1986. Cultural Components of Behavioural Epidemiology: Implications for Primary Health Care. *Social Science and Medicine*, 22: 1235-1245.
- Herrer, A. and Christensen, H. 1976. Epidemiological Patterns of Cutaneous Leishmaniasis in Panama: II. Incidental Occurrence of Cases in Non-epidemic Settlements. *Annals of Tropical Medicine and Parasitology*, 70: 67-71.
- Herwaldt, B. 2000. Use of Polymerase Chain Reaction to Diagnose the Fifth Reported US Case of Autochthonous Transmission of *Trypanosoma cruzi*, in Tennessee, 1998. *The Journal of Infectious Diseases*, 181: 395-399.
- Heyneman, D. 1984. Development and Disease: A Dual Dilemma. *The Journal of Parasitology*, 70(1): 3-17.

- House, J. 2002. Understanding social factors and inequalities in health: 20th century progress and 21st century prospects. *Journal of Health and Social Behavior*, 43(2): 125-142.
- Howard, J and Rubio, M. 1968. Congenital Chagas Disease.1. Clinical and Epidemiological Study of Thirsy Cases. *Boletín Chileno de Parasitología*, 23:107-112.
- Inhorn, M. and Brown, P. 1990. The Anthropology of Infectious Disease. *Annual Review of Anthropology*, 19: 89-117.
- Jiménez, M., Llinas, J., and Palacios, C. 2003. Infection Rates in *Dipetalogaster maximus* (Reduviidae: Triatominae) by *Trypanosoma cruzi* in the Cape region, Baja California Sur, Mexico. *Journal of Medical Entomology* 40(1): p 18-21.
- Johnson, L. 1999. Analyzing Spatial and Temporal Phenomena using Geographical Information Systems: A Review of Ecological Applications. *Landscape Ecology*, 4(1): 31-43.
- Jomeen, J and Martin, CR 2005. A mixed-methods approach to understanding women's worries during early pregnancy. *Journal of Reproductive and Infant Psychology* 23(3): 276-277.
- Jones, K. and Moon, G. 1993. Medical Geography: Taking space seriously. *Progress in Human Geography* 17:515-524.
- Joseph, A. and Chalmers, A. 1996. Restructuring Long-term Care and the Geography of Ageing: A view from Rural New Zealand. *Social Science and Medicine*, 6: 887-896.
- Justeson and Kaufman. 1993. A decipherment of Epi-Olmec Hieroglyphic Writing. *Science*, 259: 1703-1711.
- Katz, M; Despommier, D.; and Gwadz, R. 1989. *Parasitic Diseases* 2nd ed. New York: Springer-Verlag New York Inc.
- Kean, B. 1977. Carlos Chagas and Chagas' Disease. *American Journal of Tropical Medicine and Hygiene*, 26(5):1084-1086.
- Kearns, R. 1993. Place and Health: Towards a reformed Medical Geography. *The Professional Geographer* 45:139-147.
- . 1994. Putting health and health care into place: An invitation accepted and declined. *The Professional Geographer* 46(1):111-115.

- . 1995. Medical geography: Making space for difference. *Progress in Human Geography* 19:249-257.
- . 1996. AIDS and medical geography: Embracing the other? *Progress in Human Geography* 20:123-131.
- . 1997. Narrative and metaphor in health geographies. *Progress in Human Geography* 21:269-277.
- Kearns, R., and Alun, J. 1993. Space in its place: Developing the link in medical geography. *Social Science and Medicine* 37:711-717.
- Kearns, R. and Moon, G. 2002. From Medical to Health Geography: novelty, Place and Theory after a Decade of Change. *Progress in Human Geography*, 26(5): 605-625.
- Kearns, R. and Joseph, A. 1993. Space in its Place-Developing the Link in Medical Geography. *Social Science and Medicine*, 37(6): 711-717.
- Killion, T. 1992. Residential Ethnoarchaeology and Ancient Site Structure: Contemporary Farming and Perhistoric Settlement Agriculture at Matacapan, Veracruz, Mexico. In *Gardens of Prehistory* ed. T. Killion. AL: University of Alabama Press.
- Kirchhoff, L. 1989. Trypanosoma cruzi a new Threat to our Blood Supply? *Annals of Internal Medicine*, 111:773-775.
- . 1990. Trypanosoma Species (American Trypanosomiasis, Chagas' Disease): Biology of Trypanosomes. In *Principles and Practices of Infectious Diseases*, ed. G. Mandell, R. Douglas, J. Bennett, 3rd ed., 2077-2084. New York: Churchill Livingstone.
- . 1993. American trypanosomiasis (Chagas' Disease)—A Tropical Disease now in the United States. *New England Journal of Medicine*, 329(9):639-643.
- Kirchhoff, L. and Neva, F. 1985. Chagas' Disease in Latin American Immigrants. *Journal of American Medical Association*, 234:3058-3060.
- Knight, C. 1971. The Ecology of African Sleeping Sickness. *Annals of the Association of American Geographers*, 61: 23-44.
- Köberle, F. 1968. Chagas' Disease and Chagas' Syndromes: The Pathology of American Trypanosomiasis. In *Advances in Parasitology*, vol. 6, ed. B. Dawes, 63-116. London: Academic Press.
- Kottak, C. 2005. *Assault on Paradise*. New York: McGraw-Hill Companies, Inc.

- Kramer, J. 1993. Bad Blood. *New Yorker* 33 (November 10):74-95.
- Laborde, D. 2004. Los Habitantes. in *Los Tuxtlas: El Paisaje de la Sierra* ed. Guevara, S., Laborde, D. and Sanchez-Rios, G. Veracruz: Instituto de Ecologia.
- Lainson, R. et al. 1979. Chagas' Disease in the Amazon Basin:1. Trypanosoma cruzi Infections in Sylvatic Mammals, Triatomine Bugs and Man in the State of Para, North East Brazil. *Transactions of the Royal Society of Tropical Medicine and Hygiene* 73:193-204.
- Lang, N. 1991. Stigma, self-esteem, and depression: Psycho-social responses to risk of AIDS. *Human Organization* 50:66-72.
- Laranja, F. et al. 1956. Chagas' Disease, a Clinical, Epidemiological and Pathologic Study. *Circulation*, 14:1035-1060.
- Leitner M, Curtis A. 2006. A first step towards a framework for presenting the location of confidential point data on maps - results of an empirical perceptual study. *International Journal of Geographical Information Science*, 20(7): 813-822.
- Lent, H. and Wygodzinsky. 1979. Revision of the Triatominae (Hemiptera, Reduviidae), and their Significance as Vectors of Chagas' Disease. *Bulletin of the Merican Museum of National History*, 163:123-520.
- Lewinsohn, R. 1979. Carlos Chagas (1879-1934):The Discovery of Trypanosoma cruzi and of American Trypanosomiasis (foot-notes to the history of Chagas's Disease). *Transactions of the Royal Society of Tropical Medicine and Hygiene*, 73(5):513-523.
- . 1981. Carlos Chagas and the Discovery of Chagas's Disease (American Trypanosomiasis). *Journal of Royal Society of Medicine*, 74:451-455.
- Lewis, S. 1995. A search for meaning: Making sense of depression. *Journal of Mental Health* 4:369-382.
- Lewis, N. D., and Mayer, J. 1988. Disease as natural hazard. *Progress in Human Geography* 12:15-33.
- Lilienfeld, A. 1976. *Foundations of Epidemiology*. New York: Oxford University Press.
- Lindenbaum, S. 1979. *Kuru Sorcery*. Boston: McGraw-Hill.
- Litva, A., and Eyles, J. 1994. Health or healthy: Why people are not sick in a southern Ontarian town. *Social Science and Medicine* 39(8):1083-1091.

- Lopez-Cardenas, J. et al. 2005. Fine-scale predictions of distributions of Chagas disease vectors in the state of Guanajuato, Mexico. *Journal of Medical Entomology*, 42(6): 1068-1081.
- Lunginaah, I et al. 2000. A Longitudinal Study of the Health Impacts of a Petroleum Refinery. *Social Science and Medicine*, 50: 1155-1166.
- MacCormack, C. 1985. Anthropology and the Control of Tropical Disease. *Anthropology Today*, 1(3): 14-16.
- MacDonald, J. and MacDonald, L. 1971. Jobs and Housing: Alternative Developments in the Venezuelan Guayana. *Journal of Interamerican Studies and World Affairs*, 13(3/4): 342-366.
- Marmot, M. 1981. Culture and Illness: Epidemiological Evidence. In *Foundations of Psychosomatics*, ed. M. Christie and P. Mellett. Chichester: Wiley.
- Markell and Voge 1986. *Medical Parasitology*. Philadelphia: Saunders.
- Marsden, P. 1983. The Transimission of Trypanosoma cruzi infection to Man and its Control. In *Human Ecology and Infectious Diseases*, ed. N. Croll and J. Cross, 253-289. New York: Academic Press.
- Marsden, P. and Pena, R. 1982. A "Vigilance Unit" for Households Subject to Triatomine Control. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, 76(6):790-792.
- Mattingly,, C. 2005. Toward a vulnerable ethics of research practice. *Health*, 9(4) 453-471.
- May, J. 1950. Medical Geography: Its Methods and Objectives. *Geographical Review*, 40: 9-41.
- May, J. M. 1954. Cultural aspects of tropical medicine. *American Journal of Tropical Medicine and hygiene* 3:422-430.
- Mayer, J.D. 1984. Medical geography: An emerging discipline. *Journal of the American Medical Association* 251:2680-2683.
- Mayer, J.D. 1982. Relations between two traditions of medical geography: Health systems planning and geographical epidemiology. *Progress in Human Geography* 6:216-230.
- Mayer, J., and Meade, M. A Reformed Medical Geography Reconsidered. *Professional Geographer*, 46(1):103-106, 1994.

- McGrew, J. and Monroe, C. 2000. *An Introduction to Statistical Problem solving in Geography* (2nd edition). Boston: McGraw Hill Press.
- McIntyre, S. et al. 1993. Area, class and Health: Should we be focusing on People or Places? *Journal of Social Policy*, 22: 213-234.
- McIntyre, S. 1997. The Black Report and Beyond. What are the issues? *Social Science and Medicine*, 44: 723-745.
- McIntyre, S. Ellaway, A., and Cummins, S. 2002. Place Effects on Health: How Can we Operationalis and Measure them? *Social Science and Medicine*, 55: 125-139.
- McIntyre, S., McKay, S., and Ellaway, A. 2004. Are Rich People more likely to be Ill? Lay Perceptions, by Social Class and Neighborhood, of Inequalities in Health. *Social Science and Medicine*, 60: 313-317.
- Mead, M. 1961. *Coming of Age in Samoa*. New York: William Morrow and Company, Inc.
- Meade, M. 1977. Medical geography as human ecology: The dimension of population movement. *Geographical Review* 67:379-393.
- . 1986. Geographic Analysis of Disease and Care. *Annual Review of Public Health*, 7: 313-335
- . 1990. Geography in Vietnam and Cambodia. *Professional Geographer*, 42(1): 109-113.
- . 1992. Medical geography: Backwards and forwards. Paper presented at the International Medical Geography Symposium, Charlotte, NC.
- . 1994. Geomedical Systems: Intervention and Control. *Professional Geographer*, 43(1): 136-136.
- Meade, M. and Earickson, R. 2000. *Medical Geography*. New York: The Guilford Press.
- Mello, D. and Borges, M. 1981. Initial Discovery of *Triatoma costalimai* naturally Infected with *Tripanosoma cruzi*: Study of the Biological Aspects of an Isolated Sample. *Memórias do Instituto Oswaldo Cruz*, 76(1):61-69.
- Miles, M, et al. 1981. Do Radically Dissimilar *Trypanosoma cruzi* strains (Zymodemes) cause Venezuelan and Brazilian forms of Chagas' Disease? *The Lancet* 63(2):1338-1340.

- Miles, M. et al. 1981. Chagas' Disease in the Amazon Basin II: The Distribution of *Trypanosoma cruzi* zymodemes I and 3 in Para State, North Brazil. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, 75: 667-674.
- Miles, M. et al. 1980. Further Enzymic Characters of *Trypanosoma cruzi* and their Evaluation for Strain Identification. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, 74(2):221-237.
- Miles, M. et al. 1977. The Identification by Isoenzyme Patterns of two Distinct Strain-groups of *Tripanosoma cruzi*, Circulating Independently in a Rural area of Brazil. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, 71(3):217-225.
- Miles, M. 1976. Human Behavior and the Propagation of Chagas' Disease. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, 50: 521-522.
- Minter, D. 1978. Triatomine bugs and the Household Ecology of Chagas' Disease. In *Medical Entomology Centenary Symposium, Proceedings*, 85-93. London: Royal Society of Tropical Medicine and Hygiene.
- Mitchell, R. et al. 1998. Health: Who you are or Where you Live? *ESRC Health Variations Newsletter*, 2: 4.5.
- Mitman, G. and Numbers, R. 2003. From Miasma to Asthma: The changing Fortunes of Medical Geography in America. *History and Philosophy of the Life Sciences*, 25(3): 391-412.
- Mohan, J. 2000a: Geography of Health and Health Care. In Johnston, R. et al. editors, *The Dictionary of Human Geography* (fourth edition), Oxford: Blackwell: 330-332.
- . 2000b: Medical Geography. In Johnston, R. et al. editors, *The Dictionary of Human Geography* (fourth edition), Oxford: Blackwell: 494-496.
- Moncayo, A. 2003. Chagas Disease: Current Epidemiological Trends after the Interruption of Vectorial and Transfusional Transmission in the Southern Cone Countries. *Memorias do Instituto Oswaldo Cruz*, 98(5): p 577-591.
- Montenegro, V. et al. 2002. Chagas Disease in Dogs from Endemic Areas of Coast Rica. *Memorias do Instituto Oswaldo Cruz*, 97(4): 491-494.
- Moon, G. Kearns, R, and Joseph, A. 2006. Selling the private asylum: therapeutic landscapes and the (re)valorization of confinement in the era of community care: *Transactions of the Institute of British Geographers*, 31(2): 131-149.

- Moraes-Souza, Helio. 1999. Chagas infection transmission control: situation of transfusional transmission in Brazil and other countries of Latin America. *Mem. Inst. Oswaldo Cruz*, 94 (suppl.1): 419-423.
- Morel CM, Lazdins J. 2003. Chagas disease. *Mat Rev Microbiol*, 1:14-15.
- Moya, P. 1977. *El Hijo de Madre Chagásica*. Ph. D. diss., Universidad Nacional de Córdoba (Córdoba, Argentina).
- . 1994. Chagas' Disease in Children: Neurological and Psychological Aspects. In *Chagas' Disease and the Nervous System*, 189-202. Washington, DC: Pan American Health Organization.
- Moya, P and Barousse, A. 1984. Enfermedad de Chagas Congénita. In *Enfermedad de Chagas. Apotes del Programa Nacional de Investigaciones en Enfermedades Endémicas 1979-1983*, 51-65. Buenos Aires: Ministerio de Educación y Justicia.
- Muñoz, S et al. 1994. Poblaciones de *Trypanosoma cruzi* Altamente Homogeneas en una Region de Baja Endemia Chagásica: Relevancia en la Patógena de la Enfermedad de Chagas. *Revista Médica de Chile*, 122:1231-1238.
- Nash, R. 1923. The Houses of Rural Brazil. *Geographical Review*, 13(3): 329-344.
- Nickerson, P., et al. 1994. Transfusion-associated *Trypanosoma cruzi* Infection in a Non-endemic Area. *Annals of Internal Medicine*, 111: 851-853.
- Nogueira, D. 1977. The Transamazonian Route and the Health of its Workers: A Challenge. *Journal of Occupational Medicine*, 19: 487-489.
- Norma Oficial Mexicana. 2001. Para la Vigilancia Epidemiológica, Prevención y Control de Enfermedades Transmitidas por Vector. In *Diario Oficial de la Federación (PROY_NOM_032_SSA2_2000)*:1-45
- O'Daly, J. and Rodríguez, M. 1987. Protein Nucleotide Contamination of Bovine Liver Catalase used in Culture Medium Explains Growth of *Trypanosoma cruzi*. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, 81: 1-2.
- Opie, A. 1992. Qualitative research, appropriation of the "Other" and empowerment. *Feminist Review* 40:51-69.
- Papanek, V. 1984. *Design for the Real World: Human Ecology and Social Change*, 2nd ed. London: Thames and Hudson.
- Parr, H. and Philo, C. 1995. Mapping 'mad' identities. In *Mapping the Subject*, ed. Steve Pile and Nigel Thrift, 199-225. London: Routledge.

- Parr, H. 1997. Mental health, public space, and the city: Questions of individuals and collective access. *Environment and Planning D: Society and Space*. 15:435-54.
- . 1998. Mental Health, Ethnography and the Body. *Area*, 30: 28-37.
- . 2002. New Body-Geographies: The Embodied Spaces of Health and Medical Information on the Internet. *Environment and Planning D-Society and Space*, 20(1): 73-95.
- . 2004. Medical Geography: Critical Medical and Health Geography? *Progress in Human Geography*, 20(2): 246-257.
- Patton, M. 1990. *Qualitative Evaluation and Research Methods*. California: Sage Publications.
- Pavlonc, L, et al. 1988. Field Research on an Epidemiological Surveillance Alternative of Chagas' Disease Transmission: The Primary Health Care Strategy in Rural Areas. *Revista Argentina de Microbiología* 20(supp.): 103-105.
- Pearlman, J. 1983. Chagas' Disease in Northern California: No Longer an Endemic Diagnosis. *American Journal of Medicine*, 75(6): 1057-1060.
- Pehrson, P.; Wahlgren, M.; and Bengtsson, E. 1982. Intracranial Calcifications Probably due to Congenital Chagas' Disease. *American Journal of Tropical Medicine and Hygiene*, 31: 449-451.
- Pereira Barreto, M. 1984. Characteristics of Urban Mortality from Chagas Disease in Brazil's Federal District. *Bulletin of Pan American Health Organization*, 18(1): 2-9.
- Peterson, A. et al. 2001. Effects of Global Climate Change on Geographical Distributions of Mexican Cracidae. *Ecological Modeling*, 144: 21-30.
- Peterson, A. et al. 2002. Ecologic Niche Modeling and Potential Reservoirs for Chagas Disease, Mexico. *Emerging Infectious Disease*, 8(7): 662-667.
- Petry, K. and Eisen, H. 1989. Chagas' Disease: A Model for the Study of Autoimmune Diseases. *Parasitology Today*, 5: 11-116.
- Pietrokovsky, S. et al. 1991. The Skunk *Conepatus chinga* as New Host of *Trypanosoma cruzi* in Argentina. *Journal of Parasitology*, 77(4): 643-645.
- Ruiz-Piña, H. and Cruz-Reyes, A. 2002. The Opossum *Didelphis virginiana* as a Synanthropic Reservoir of *Trypanosoma cruzi* in Dzidzilché. Yucatán, Mexico. *Memórias do Instituto Oswaldo Cruz*, 97: 1-8.

- Pinchin, R. et al. 1978. Slow Release Insecticides for Triatomine Control: Activity and Persistence. *Revista Brasileira Malariologia e Doenças Tropicales* (Rio de Janeiro), 30: 45-55.
- Pinchin, R. et al. 1978a. Slow Release Insecticides for Triatomine Control: Preliminary Field Trials. *Revista Brasileira Malariologia e Doenças Tropicales* (Rio de Janeiro), 30: 57-63.
- Pipkin, A. 1968. Domiciliary Reduviid Bugs and Epidemiology of Chagas' Disease in Panama (Hemiptera: Reduviidae: Triatominae). *Journal of Medical Entomology*, 5:107.
- . 1969. The Transmission of *Trypanosoma cruzi* by Arthropod Vectors: Anterior Versus Posterior Route Infection. *International Review of Tropical Medicine* (New York), 3: 1-47.
- Pless, M. et al. 1992. The Epidemiology of Chagas' Disease in a Hyperendemic Area of Cochabamba, Bolivia: A Clinical Study Including Electrocardiography, Seroreactivity to *Trypanosoma cruzi*, Xenodiagnosis, and Domiciliary Triatomine Distribution. *American Journal of Tropical Medicine and Hygiene*, 5: 539-546.
- Ponce, C. and Zeledón, R. 1973. La Enfermedad de Chagas en Honduras. *Boletín Oficina Sanitaria Panamericana*, 75(3): 239.
- Prata A. 1999. Evolution of the clinical and epidemiological knowledge about Chagas disease 90 years after its discovery. *Memorias do Instituto Oswaldo Cruz*, 94(Supp 1): 81-88.
- Prothero, R. 1961. Population Movements and Problems of Malaria Eradication in Africa. *Bulletin of the World Health Organization*, 24: 405-425.
- Prothero, R. and Davenport, J. 1986. The Geography of Health in South-east Mexico: A Research Study and Agenda. *Social Science and Medicine*, 22(12): 1321-1327.
- Rabinovitch, J. et al. 1979. Domiciliary Biting Frequency and Blood Ingestion of Chagas' Disease Vector *Rhodnius prolixus* Stahl (Hemiptera: Reduviidae) in Venezuela. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, 73(3): 273-283.
- Rabinovich, J. et al. 2001. Probability of *Trypanosoma Cruzi* Transmission by *Tritoma Infestans* (Hemiptera: Reduviidae) to the Opossum *Didelphis Albiventris* (Marsupiala: Didelphidae). *American Journal of Tropical Medicine and Hygiene*, 65(2): 125-130.
- Ramsey, J. et al. 2003. Efficacy of pyrethroid insecticides against domestic and peridomestic populations of *Triatoma pallidipennis* and *Triatoma barberi*

- (Reduviidae: Triatominae) vectors of Chagas' disease in Mexico. *Journal of Medical Entomology*, 40(6): 912-920.
- Ramsey, J. and Schofield, C. 2003. Control of Chagas Disease Vectors. *Salud Publica De Mexico*, 45(2): 123-128.
- Ramsey, J. 2005. unpublished manuscript.
- Rangel, H.; Gatica, R.; and Ramos, C. 1998. Detection of Antibodies Against *Trypanosoma cruzi* in Donors from a Blood Bank in Cuernavaca, Morelos, Mexico. *Archives of Medical Research*, 29(1): 79-82.
- Rangel-Flores, H. et al. 2001. Serologic and Parasitologic Demonstration of *Trypanosoma cruzi* Infections in an Urban Area of Central Mexico: Correlation with Electrocardiographic Alterations. *American Journal of Tropical Medicine and Hygiene*, 65(6): 887-895.
- Rassi, A. and Rezende, J. 1976. Prevention of Transmission of *T. cruzi* by Blood Transfusion. In *American Trpanosomiasis Research* vol. 318, 273-278. Washington: Pan American Health Organization.
- Recacoechea, M. 1979. A Study of 39 Cases of Acute Chagas Disease in Santa Cruz. *Boletin Chileno de Parasitología*, 34(3-4): 53-58.
- Ribeiro-dos-Santos, R. and Hudson, L. 1980. *Tripanosoma cruzi*: Binding of Parasite Antigens to Mammalian Cell Membranes. *Parasite Immunology*, 2: 1-10.
- Richardson, M. 2003. Lecture Notes (Place and Culture). Louisiana State University.
- Rojas de Arias A et al. [Chagas disease vector control through different intervention modalities in endemic localities of Paraguay]. *Bulletin of the World Health Organization*, 1999, 77(4).
- Rothhammer, F. et al. 1985. Chagas' Disease in Pre-Columbian South America. *American Journal of Physical Anthropology*, 68: 495-498.
- Roudy, R. 1980. The Influence of Vegetational Chages on Disease Patterns. . In *Conceptual and Methodological Issues in Medical Geograophy*, ed. M. Meade. Chapel Hill: University of North Carolina Press.
- . 1978. A Model for Combining Human Behavior and Disease Ecology to assess Disease Hazard in a Community; Rural Ethiopia as a Model. *Social Science and Medicine*, 12: 121-130.

- Ryan, G. and Bernard, R. 2000. Data Management and Analysis Methods. in *Handbook of Qualitative Methods* ed Denzin, N and Lincoln, Y. California: Sage Publications, Inc.
- Ryckman, R. 1986. Names of the Triatominae of North and Central America and the West Indies: Their Histories, Derivations, and Etymology (Hemiptera, Reduviidae, Triatominae). *Bulletin of the Society of Vector Ecologists*, 11: 209-220.
- Salvatella, R. 1986. Encuesta de Prevalencia Serológica de la Enfermedad de Chagas en Uruguay. *Revista Médica del Uruguay*, 2(2): 119-124.
- Santley, Arnold, and Pool. 1989. The Ceramic Production System at Matacapán, Veracruz, Mexico. *Journal of Field Archeology*, 16: 107-132.
- Santley, Ortiz, and Pool. 1987. Recent Archeological Research at Matacapán, Veracruz: A summary of the results of the 1982 to 1986 field seasons. *Mexicon*, IX: 41-48.
- Santley, R. 1992. A consideration of the Olmec Phenomenon in the Tuxtlas: Early Formative Settlement Pattern, Land Use, and Refuse Disposal at Matacapán, Veracruz, Mexico. In *Gardens of Prehistory* ed. T. Killion. AL: University of Alabama Press.
- Santley, R and Arnold, P. 1996. Prehispanic Settlement Patterns in the Tuxtla Mountains, Southern Veracruz, Mexico. *Journal of Field Archaeology*, 23(2): 225-249.
- Sarquis O. et al. 2006. Aspects of peridomestic ecotopes in rural areas of Northeastern Brazil associated to triatomine (Hemiptera, Reduviidae) infestation, vectors of Chagas disease. *Memorias do Instituto Oswaldo Cruz*, 101(2):143-147.
- Sauer, C. 1963. The Morphology of Landscape. In *Land and Life: Selections from the writings of Carol Ortwin Sauer*. Berkeley: University of California Press.
- Sawers, L. 2000. Income Distribution and Environmental Degradation in the Argentine Interior. *Latin American Research Review*, 35(2): 3-33.
- Schenone, H. et al. 1985. Enfermedad de Chagas en Chile. Sectores Rurales y Periurbanos del Área de Endemiositosis. Relaciones Entre Condiciones de la Vivienda, Infestación Triatomínea Domiciliaria e Infección por *Triposanosoma cruzi* del Vector, del Humano y de Mamíferos Domésticos, 1982-1985. *Boletín Chileno de Parasitología*, 40: 58-67.
- Scheper-Hughes, N. and Lock, M. 1987. The Mindful Body: A Prolegomenon to Future Work in Medical Anthropology. *Medical Anthropology Quarterly, New Series*, 1(1): 6-41.

- Schettino, P.; Arteaga, I.; and Berruela, T. 1988. Chagas' Disease in Mexico. *Parasitology Today*, 4(12): 348-352.
- Schiffler, R. J., et al. Indigenous Chagas' disease (American trypanosomiasis) in California. *JAMA*. 1984; 251:2983-2984.
- Schmuñis, G. 1985. Chagas' Disease and Blood Transfusions. *Progress in Clinical and Biological Research*, 182: 127-145.
- . 1991. Trypanosoma cruzi, the Etiologic Agent of Chagas' Disease: Status in the Blood Supply in Endemic and Nonendemic Countries. *Transfusion*, 31(6):547-557.
- . 1994. American Trypanosomiasis as a Public Health Problem. *In Chagas' Disease and the Nervous System*, ed. Pan American Health Organizations, 3-29. Washington, D.C.: Pan American Health Organizations.
- Schofield, C. 1978. A Comparison of Sampling Techniques for Domestic Populations of Triatominae. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, 72: 449-455.
- . 1979. The Behavior of Triatominae (Hemiptera: Reduviidae): A Review. *Bulletin of Entomology Research*, 69:363-379.
- . 1982. The Problem of Chagas's Disease Vector Control. In *Perspectives in Trypanosomiasis Research*, ed. J. Baker, 71-84. Chichester: Research Studies Press.
- . 1985. Control of Chagas' Disease Vectors. *British Medical Bulletin*, 4: 187-194.
- Schofield, C. and Marsden, P. 1982. The Effect of Wall Plaster on a Domestic Population of *Triatoma infestans*. *Pan American Health Organization*, 16(4): 356-360.
- Schofield, C.; Apt, W.; and Miles, A. 1982. The Ecology of Chagas' Disease in Chile. *Ecology of Disease*, 1(2-3): 117-129.
- Schofield, C. et al. 1990. The Role of House Design in Limiting Vector-borne Disease. In *Appropriate Technology in Vector Control*, ed. C. Curtis, 187-212. Boca Raton, FL: CRC Press.
- Segura, E. and Escobar-Mesa, A. 2005. Epidemiología de la enfermedad de Chagas en el estado de Veracruz. *Salud pública de México*, 47(3):201-208

- Sgambatti de A. et al. 1995. Evaluation of Risk Factors for House Infestation by *Triatoma infestans* in Brazil. *American Journal of Tropical Medicine and Hygiene*, 53(5): 443-447.
- Skelly A. et al. 2002. Sociospatial Knowledge Networks: Appraising Community as Place. *Research in Nursing and Health*, 25(2): 159-170.
- Skolnick, A. 1989. Does Influx from Endemic Areas Mean more Transfusion-associated Chagas' Disease? *Journal of American Medical Association*, 262: 1433.
- Silveira, A., et al. Risk Measure of Domestic Transmission of Chagas' Disease, Through a New Entomological Indicator. *Memorias del Instituto Oswaldo Cruz*, Rio de Janeiro, Suppl. Vol. 79 :113-115, 1984.
- Smith, S.J. and Easterlow, D. 2005. The Strange Geography of Health Inequalities. *Transactions of the Institute of British Geographers*, 30(2): 173-190.
- Smyth, F. 2005. Medical Geography: Therapeutic Places, Spaces and Networks. *Progress in Human Geography*, 29(4): 488-495.
- Smyth, F. and Thomas, R. 2005. 'Burning Issues': An Introduction to Selected Papers from the 10th International Symposium in Medical Geography, Manchester 2003. *Social Science and Medicine*, 60(12): 2657-2660.
- SOH/CCH (Secretariat of Health and Community and Child Health). 1994. Chagas' Disease in Bolivia. La Paz: USAID.
- Solari, A. et al. 1992. Characterization of Chilean, Bolivian, and Argentinian *Tripanosoma cruzi* Populations by Restriction Endonuclease and Isoenzyme Analysis. *Experimental Parasitology*, 75: 187-195.
- Sosa-Jurado, F., Mazariego-Aranda, M, etc. 2003. Eletrocardiographic Findings in Mexican Chagasic Living in High and Low Endemic Regions of *Trypanosoma cruzi* Infection. *Memorias do Instituto Oswaldo Cruz* 98(5): p 605-610.
- Soto, M. 2004. El Clima. in *Los Tuxtlas: El Paisaje de la Sierra* ed. Guevara, S., Laborde, D. and Sanchez-Rios, G. Veracruz: Instituto de Ecologia.
- Sousa, O. and Johnson, C. 1971. Frequency and Distribution of *Trypanosoma cruzi* and *Trypanosoma rangeli* in the Republic of Panama. *American Journal of Tropical Medicine and Hygiene*, 20(3): 405.
- Stark. 1978. An Ethnohistoric Model for Native Economy and Settlement Patterns in Southern Veracruz, Mexico. In *Prehistoric Coastal Adaptations: The Economy*

- and Ecology of Maritime Middle America*, ed. Stark and Voorhies. New York: Academic Press.
- Starr, M. et al. 1991. Chagas' Disease: Risk Factors for House Infestation by *Triatoma dimidiata*, the Major Vector of *Trypanosoma cruzi* in Costa Rica. *American Journal of Epidemiology*, 138:740-747.
- Steiner, D. and Nauser, M. 1993. *Human Ecology: Fragments of Anti-fragmentary Views of the World*. London: Routledge.
- Taieb, O. et al. 2005. Finding a meaning for illness: from medical anthropology to cultural epidemiology. *Medecine Et Maladies Infectieuses*, 35(4): 173-185.
- Tashakkori, A. and Teddlie, C. 1998. *Mixed Methodology: Combining Qualitative and Quantitative Approaches (Applied Social Research Methods)*. California: Sage Publications.
- Tashakkori, A. and Teddlie, C. 2007. *Foundations of Mixed Methods Research: Integrating Quantitative and Qualitative Techniques in the Social and Behavioral Sciences*. California: Sage Publications.
- Thompson, R. et al. 2002. Climatic and Demographic Determinants of American Visceral Leishmaniasis in Northeastern Brazil Using Remote Sensing Technology for Environmental Categorization of Rain and Region Influences on Leishmaniasis. *American Journal of Tropical Medicine and Hygiene*, 67(6): 648-655.
- Tobias, M and Searle, P. 2006. Does geography explain ethnic inequalities in health in New Zealand? *Australian and New Zealand Journal of Public Health*, 30(5): 457-460.
- Trostle, J. and Sommerfeld, J. 1996. Medical Anthropology and Epidemiology. *Annual Review of Anthropology*, 25: 253-274.
- Turner, J. 1969. Uncontrolled Urban Settlements: Problems and Solutions. In *The City in Developing Countries*, ed. G. Breese, 507-535. Englewood Cliffs, NJ: Prentice Hall.
- Valdivia, J. et al. 1977. *Usted y la Enfermedad de Chagas*. Santa Cruz: Ateneo de Medicina.
- Vidal-Acosta, V.; Ibáñez-Bernal, S.; and Martínez-Campos, C. 2000. Infección de Chinchas Triatominae con *Trypanosoma cruzi* Asociadas a la Vivienda Humana en México. *Salude Pública México*, 42(6): 496-503.

- Villarroel, F. et al. 1991. Enfermedad de Chagas en el Altiplano Chileno: Aspectos Epidemiológicos, Parasitológicos y Clínicos. *Boletín Chileno Parasitología*, 46: 61-69.
- Wakefield, S. and Elliott, S. 2000. Environmental Risk Perception and Well-Being: Effects on Landfill Siting in two Southern Ontario Communities. *Social Science and Medicine*, 50: 1139-1154.
- Wakefield, S. and McMullan, C. 2005. Healing in places of decline: (re)imagining everyday landscapes in Hamilton, Ontario. *Health and Place*, 11(4): 299-312.
- Walsh, J.; Molyneux, D.; and Birley, H. 1993. Deforestation: Effects on Vector-borne Disease. *Parasitology*, 106(Supp.): 55-75.
- Wastavino, G. et al. 2004. Insecticide and Community Interventions to Control Triatomadimidata in Localities of the State of Veracruz, Mexico. *Memorias do Instituto Oswaldo Cruz*, 99(4):433-437.
- Webb, D. 1985. Low Cost Housing and Parasite Vectors. *Parasitology Today* 1(2): 65-66.
- Weil, C. 1981. Health Problems Associated with Agricultural Colonization in Latin American. *Social Science and Medicine*, 15(D): 449-461.
- Weiss, M. 2001. Cultural Epidemiology: An Introduction and Overview. *Anthropology and Medicine*, 8(1): 2001.
- Wellmer, H. 1983. *Dengue Hemorrhagic Fever in Thailand*. New York: Springer-Verlag.
- Wellmer, H. and Jusatz, H. 1981. Geocological Analysis of the Spread of Tick-borne Encephalitis in Central Europe. *Social Science and Medicine*, 5D: 159-162.
- Wendel, S. and Diaz, J. 1992. Transfusion-transmitted Chagas' Disease. In *Chagas' Disease (American trypanosomiasis): Its Impact on Transfusion and Clinical Medicine*, ed. S. Wendel et al. Sao Paulo, Brazil: ISBT-Sociedade Brasileira de Hematologia e Hemoterapia.
- Wenke, R. 1984. *Patterns of Prehistory: Humankind's First Three Million Years*. New York: Oxford University Press.
- West, R. and Agugelli, J. 1980. *Middle America Its Lands and People*. New Jersey: Prentice Hall.
- White, N. F. 1981. Modern Health Concepts. In *The Health Conundrum*, ed. N. F. White, 5-18. Toronto: T.V. Ontario.

- Williams, A. editor. 1999. *Therapeutic Landscapes: The Dynamic Between Wellness and Place*. Lanham, MD: University Press of America.
- Winnie, B. and Knight, G. 1971. Human Trypanosomiasis: Unique to Africa? *Annals of the Association of American Geographers*, 61(4): 824-829.
- Wisnivesky-Colli, C. et al. 1982. Feeding pattern of *Triatoma Infestans*(Hemiptera: Reduviidae) in Relation to Transitions of American Trypanosomiasis in Argentina. *Journal of Medical Entomology*, 19(6): 645-654.
- Williams and Heizer. 1965. Source Rocks used in Olmec Monuments. In *Sources of Stones Used in Prehistoric Mesoamerican Sites. Contributions of the University of California Archeological Research Facility 1*: CA: University of California Press.
- Wood, S. 1951. Importance of Feeding and Defecation Times of Insect Vectors in Transmission of Chagas' Disease. *Journal of Economic Entomology*, 44: 52-54.
- Woodruff, A. 1965. Darwin's Health in Relation to his Voyage in South America. *British Medical Journal*, 1(1): 745-750.
- Woody, N. and Woody, H. 1955. American Trypanosomiasis (Chagas' Disease): First Indigenous Case in the United States.
- World Health Organization. 1957. *Measurements of Levels of Health: Report of the WHO Study Group*. Geneva: WHO.
- . 1985. Chagas' Disease in the Region of the Americas. *Weekly Epidemiological Record*, 60: 37.
- . 1990. Chagas Disease, Frequency and Geographical Distribution. *Weekly Epidemiological Records*, 65(34): 257-261.
- . 1991. *Chagas' disease. Report of a WHO Expert Committee.. WHO Technical Report Series 811*. Geneva.
- . 1991. Control of Chagas Disease. *WHO Technical Report Series 811*. Geneva.
- . 1994. *Workplan of the Task Force on Operational Research on Chagas Disease. Document TDR/INF/CHA/94.1*. Geneva.
- . 1996. *Chagas Disease: A Disease Whose Days are Numbered*. DCTD: Geneva.
- . 1996. Workplan of the Task Force on Operational Research on Chagas Disease. *TDRnews* (March).

- . 1999. Chagas Disease Vector Control Through Different Intervention Modalities in Endemic Localities of Paraguay. *Bulletin of the WHO*, 77(4): 331-339.
- Yaeger, R. 1971. Transmission of *Trypanosoma cruzi* Infection to Opossums via the Oral Route. *The Journal of Parasitology*, 57(6): 1375-1376.
- Yamagata, Y. and Nakagawa, J. 2006. Control of Chagas disease. *Advances in Parasitology*, 61: 129-165.
- Zarate, L. 1980. The Biology and Behavior of *Triatoma barberi*. 1. Blood Meal Source and Infection with *Tripanosoma cruzi*. *Journal of Medical Entomology*, 17(2): 103-116.
- . 1983. The Biology and Behavior of *Triatoma barberi* (Hemiptera: Reduviidae) in Mexico. III. Completion of the Life Cycle, Adult Longevity, and Egg Production under Optimal Feeding Conditions. *Journal of Medical Entomology*, 20(5): 485-497.
- Zárate, L and Tempelis, C. 1981. The Biology and Behavior of *Triatoma barberi* (Hemiptera: Reduviidae) in Mexico. II. Influence of a Single Versus a Double Feeding on the time that Blood Meal Antigens Remain Serologically Detectable. *Journal of Medical Entomology*, 18(2): 99-106.
- Zeledón, R. 1969. The Camouflage of *Triatoma dimidata* and the Epidemiology of Chagas Disease in Costa Rica. *Boletín Chileno de Parasitología*, 24(1): 106-108.
- . 1974. Epidemiology, Modes of Transmission and Reservoir Hosts of Chagas' Disease. In *Trypanosomiasis and Leishmaniasis with Special Reference to Chagas' Disease*. Ciba Foundation Symposium 20. Amsterdam, London, New York: Elsevier, Excerpta Medica, North Holland: Associated Scientific Publishers.
- . 1983. Vectores de la enfermedad de Chagas y sus características ecofisiológicas. *Interciencia* 8(6): 384-395.
- Zeledón, R. and Rabinovich, J. 1981. Chagas' Disease: An Ecological Appraisal with special Emphasis on its Insects Vectors. *Annual Review of Entomology*, 26: 101-133.
- Zeledón, R. et al. 1975. Epidemiological Pattern of Chagas' Disease in an Endemic Area of Costa Rica. *American Journal of Tropical Medicine and Hygiene*, 24(2): 214.

- Zeledón, R. and Vargas, L. 1984. The Role of Dirt Floors and of Firewood in Rural Dwellings in the Epidemiology of Chagas' Disease in Costa Rica. *American Journal of Tropical Medicine and Hygiene*, 33(2): 232-235.
- Zeledon, R.; Montenegro, V.; Zeledon, O. 2001. Evidence of Colonization of Man-Made Ecotopes by *Triatoma dimidiata* (Latreille, 1811) in Costa Rica. *Memorias do Instituto Oswaldo Cruz*, 96(5): 659-660.
- Zeledon, R. and Rojas, J. 2006. Environmental management for the control of *Triatoma dimidiata* (Latreille, 1811), (Hemiptera : Reduviidae) in Costa Rica: a pilot project. *Memorias do Instituto Oswaldo Cruz*, 101(4): 379-386.
- Zuna, H. et al. 1979. Infección Chagásica en Trabajadores Agrícolas Temporales y sus Familias, Proyecto Abapo-Izozog, Chaco Boliviano. *Boletín Informativo del CENETROP*, 5:16-29.

**APPENDIX A
HOUSE TYPE SURVEY**

Tipo de construcción:
(Type of Constuction)

Tipo de Casa Adobe_____	Madera_____	Cemento_____
(House Type) (Adobe)	(Wooden)	(Cement)
Bloques de cemento_____	Palos de caña_____	otro_____
(Cinder Block)	(Cane poles)	(Other)

Numero de edificios en la propiedad _____
(Number of buildings on the property)

Techo Asbesto_____	Lamina_____	Cartón_____	Palma_____
(Roof) (Asbestos)	(Metal)	(Carton)	(Palm fronds)
Otro_____			
(Other)			

Piso Piso de tierra_____	Piso de cemento_____	Otro_____
(Floor) (Earthen)	(Cement)	(Other)

Hoyos Techo y pared_____	piso y pared_____	pared_____
(Gaps) (Roof and Wall)	(floor and wall)	(wall)

Mosquiteros si_____	no_____	Hoyos si_____	no_____
(Window screens)		(Holes)	

Portón de corredor si_____ no_____

(Porch Gate)

Cielo Raso si_____ no_____

(Ceiling)

Jardín si_____ no_____

(Garden)

Numero de animales:
(Number of animals)

Gato _____
(Cat)

Perro _____
(Dog)

Gallina _____
(Chicken)

Gallo _____
(Rooster)

Pavo _____
(Turkey)

Puerco _____
(Pig)

Caballo _____
(Horse)

Burro _____
(Donkey)

Pájaro _____
(Birds)

Loro _____ jaula si _____ no _____
(Parrot) (in cage)

Otro _____
(Other)

**APPENDIX B
INTERVIEW QUESTIONS**

**Universidad Estatal de Louisiana
Estación de Biología Tropical Los Tuxtlas**

Encuesta

No. 1

1. Cuantas personas viven aquí en su casa?
(How many people live in your house?)

2. Cuantas personas que tienen menos de 18 viven en su casa?
(How many people are less than 18 in your house?)

Cuantas personas que tienen mas de 18 viven en su casa?
(How many people are over 18 in your house?)

3. Antes de haber hablado con nosotros conocía la “Chinche”? Si____No____(# 7)
(Before you talked with us did you know the chinche?)

4. La Chinche tiene otros nombres en esta comunidad?
(Does the chinche have other names in this community?)

5. Podría describirla? Si____ No____
(Can you describe the chinche?)

6. ¿Alguna vez ha visto la Chinche en su casa? Si____ No____
(Have you ever seen the chinche in your house?)

Si, si donde la ha visto?
(Where have you seen it?)

Si no donde piensa que se encuentran las chinches?
(Where do you think you could find the chinche?)

7. En que tipo de casa piensa usted que se encuentra la chinche?
(What kind of house do you think you would find the chinche?)

8. A que tipo de planta cree usted que esta atraída la chinche?
(What kind of plants do you think attract the chinche?)

9. Piensa usted que lo animales tienen algo que ver con la chinche?
(Do you think animals have anything to do with the chinche?)

10. ¿Alguna vez ha escuchado de la Enfermedad de Chagas (antes de haber hablado con nosotros)?
(Before you talked with us had you ever heard of Chagas disease?)
11. Sabe como se transmite el mal de chagas? (picada o del excremento)
(Do you know how the disease is transmitted?) (bites or feces)
12. Que mas sabe acerca de la enfermedad de chagas? (como se ve la picada de la chinche, síntomas, hay medicamentos o remedios caseros que ayudan con los síntomas de chagas)
(What else do you know about Chagas disease?) (The bite, the symptoms, any home remedies or medical cures?)
13. Conoce a alguien que sufre o que ha sufrido del mal de chagas?
(Do you know anyone with or who has suffered from Chagas disease?)
14. ¿Usted o alguien de su familia ha amanecido con un ojo muy hinchado?
(Have you or anyone in your family had a swollen eye?)
15. Conoce a alguien además de usted y su familia que ha amanecido con un ojo hinchado? (amistades u otros que conoce)
(Do you know anyone besides you and your family who has had a swollen eye?)
16. Usted o alguien de su familia ha tenido inflamación del estomago por no poder usar el baño?
(Have you or anyone in your family had an inflammation of the stomach because of being unable to use the bathroom?)
17. Conoce a alguien además de usted y su familia que ha tenido inflamación del estomago por no poder usar el baño?
(Do you know anyone else how has had an inflammation of the stomach because of being unable to use the bathroom?)

**Universidad Estatal de Louisiana
Estación de Biología Tropical Los Tuxtlas**

Encuesta

No. 2_____

1. ¿Usted siembra? Si_____ No_____
(Do you farm?)
2. ¿Usted es dueño de la parcela? Si_____ No_____
(Do you own a parcela?)
3. ¿Usted cría ganado? Si_____ No_____
Donde?
(Do you raise cows?)
(Where?)
4. ¿Usted es dueño de los animales? Si_____ No_____
(Are you the owner of the animals?)
5. ¿Usted cría cerdos? Si_____ No_____
Donde?
(Do you raise pigs?)
(Where?)
6. ¿Usted cría gallinas? Si_____ No_____
Donde?
(Do you raise chickens?)
(Where?)
7. ¿Usted vende algún producto de sus animales? Si respondió "SI", que productos vende?
(Do you sell your animals products?)
(What products do you sell?)
8. Donde vende sus productos de animales? En casa_____ cuidad_____
(Where do you sell your animal products?)
(Home or city?)
9. Si vende en la ciudad cada cuanto va a la ciudad y cuanto tiempo se queda?
(If you sell in the city how often do you go and for how long do you stay?)
10. Alguna vez ha visto la chinche en esa cuidad? Si_____ No_____
(Have you seen a chinche in that city?)

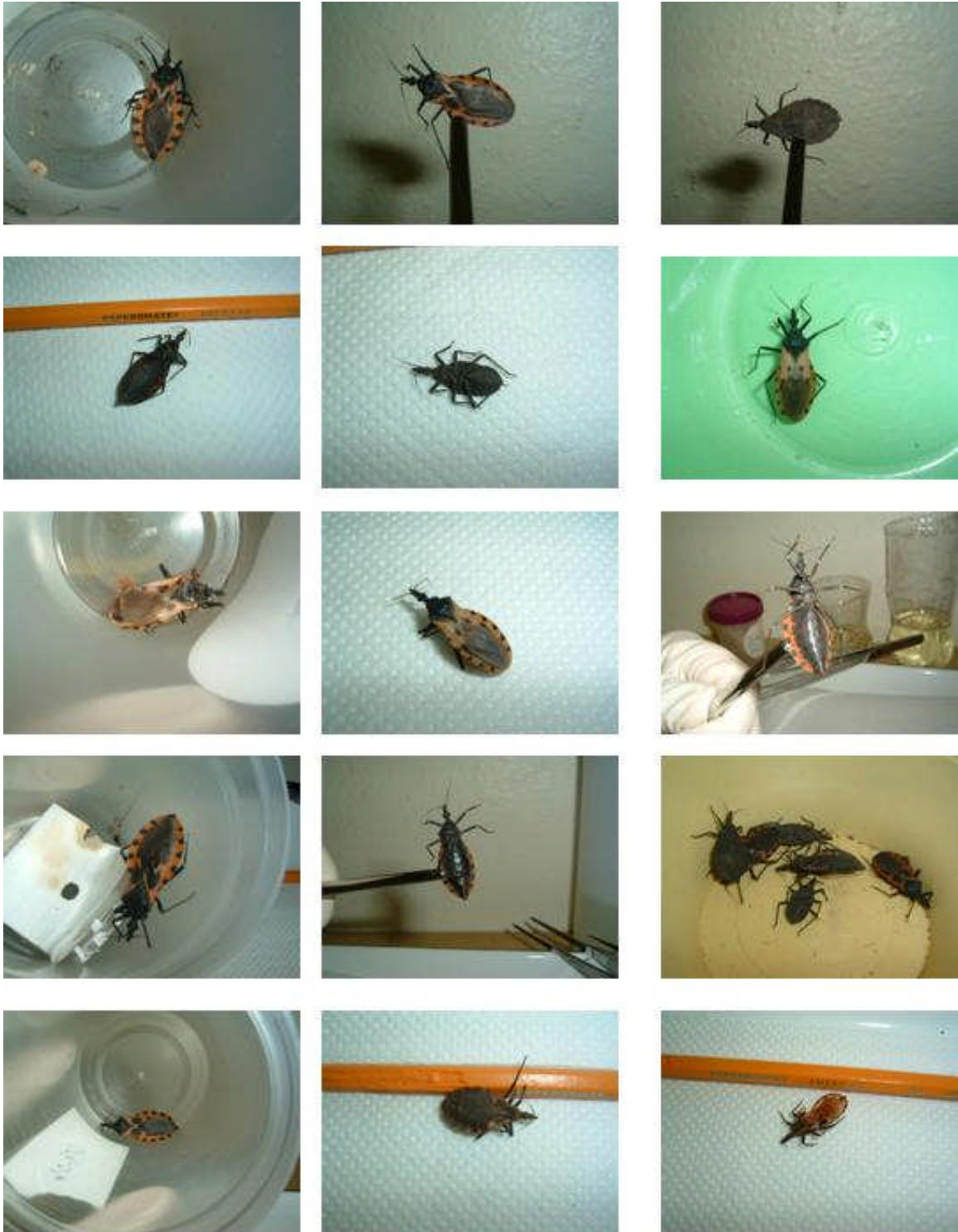
11. De donde trae su leña?
(Where do you gather firewood?)
12. Usted o alguien en su familia trabaja en un rancho? Si _____ No ____ Duerme
alli? Si _____ No _____
(Do you or anyone in the family work on a ranch?)
(Do you speep there?)
- Ha visto chinches en el rancho? Si _____ No _____
(Have you seen any chinchies in the ranch?)
13. ¿Cuánto tiempo ha vivido en esta comunidad?
(How long have you lived in this community?)
14. ¿Ha vivido en otro lado? Si _____ No _____
(Have you lived in any other place?)
15. ¿Cuánto tiempo estuvo en ese lugar?
(How long were you in that place?)
16. Como ha cambiado la comunidad desde que usted vive aquí?
(How has the community changed since you lived here?)

APPENDIX C
TRIATOMA DIMIDIATA COLLECTION INFORMATION

Insect	Collection date	Sex/Stage	Ecotope	Results
C15.01	3/13/2005	Instar 4or5	domestic	Negative
C30.01	3/13/2005	female	domestic	Negative
C30.02	3/13/2005	not t.dimidiata	domestic	Negative
E26.01	3/15/2005	Instar 4or5	domestic	Negative
E9.01	3/15/2005	Male	domestic	Negative
D9.01	3/20/2005	female	domestic(possibly pridomestic)	Negative
D9.02	3/20/2005	male	domestic(possibly pridomestic)	Negative
C26.01	3/22/2005	female	domestic	Negative
Sta1	3/23/2005	not t.dimidiata		Negative
sta2	3/23/2005	not t.dimidiata		Negative
Sta3	3/23/2005	not t.dimidiata		Negative
E9.02	3/24/2005	male	domestic	Negative
F27.01	3/29/2005	female	domestic	Negative
E23.01	4/3/2005	Instar 4or5	domestic	Negative
B5.01	4/4/2005	female	domestic	Negative
B5.02	4/4/2005	not t.dimidiata	domestic	Negative
C15.02	4/4/2005	male	domestic	Negative
C3.01	4/4/2005	Male	domestic	Negative
C30.03	4/4/2005	female	domestic	Negative
C35.01	4/4/2005	Instar 4or5	peridomestic	Negative
C35.02	4/4/2005	Instar 4or5	peridomestic	Negative
C35.03	4/4/2005	Instar 2or3	peridomestic	Negative
C35.04	4/4/2005	Instar 2or3	peridomestic	Negative
A13.01	4/10/2005	Instar 2or3	domestic	Negative
A15.01	4/10/2005	Instar 4or5	domestic	Negative
C53.01	4/10/2005	female	domestic	Negative
D9.03	4/19/2005	Instar 3 or 4	domestic (possibly peridomestic)	Negative
D9.04	4/19/2005	Instar 2or3	domestic (possibly peridomestic)	Negative
E9.03	4/19/2005	Male	domestic	Negative
C26.02	4/20/2005	male	domestic	Negative
C26.03	4/20/2005	female	domestic	Negative
C26.04	4/20/2005	Instar 4or5	domestic	Negative
C26.05	4/20/2005	Instar 4or5	domestic	Negative
C26.06	4/20/2005	female	domestic	Positive
C26.07	4/20/2005	Instar 4or5	domestic	Negative
C31.01	4/20/2005	Instar 4or5	domestic	Negative
D7.01	4/21/2005	Instar 4or5	domestic	Negative
D7.02	4/21/2005	female	domestic	Negative

D7.03	4/21/2005	female	domestic	Negative
D7.04	4/21/2005	female	domestic	Negative
D7.05	4/21/2005	female	domestic	Negative
C22.01	5/1/2005	Male	domestic	Negative
E71.01	5/2/2005	female	domestic	Positive
E9.03	5/2/2005	Male	domestic	Negative
F8.01	5/4/2005	female	domestic	Negative
B6.01	5/8/2005	male	domestic	Positive
A2.01	5/9/2005	female	domestic	Negative
E12.01	5/9/2005	female	domestic	Negative
C75.01	5/15/2005	Male	domestic	Positive
D7.06	5/17/2005	female	domestic	Negative
D7.07	5/17/2005	Instar 4or5	domestic	Negative
D7.08	5/17/2005	?	deomstic	Negative
D7.09	5/17/2005	Male	domestic	Negative
D7.10	5/17/2005	male	domestic	Negative
D7.11	5/17/2005	Male	domestic	Negative
C70.01	5/21/2005	female	domestic	Positive
E122.01	5/29/2005	female	domestic	Negative
E13.01	5/29/2005	Instar 4or5	domestic	Negative
F14.05	5/29/2005	not t.dimidiata	domestic	Negative
B32.01	5/31/2005	female	domestic	Negative
C75.02	5/31/2005	female	domestic	Negative
D57.01	5/31/2005	not t.dimidiata	domestic	Negative
D57.02	5/31/2005	not t.dimidiata	domestic	Negative
D77.01	5/31/2005	not t.dimidiata	domestic	Negative
D9.05	5/31/2005	Instar 1 or 2	domestic (possibly peridomestic)	Negative
D47.01	6/2/2005	not t.dimidiata	domestic	Negative
Sta 05		Male		Negative
Sta04		female		Negative

APPENDIX D
TRIATOMA DIMIDIATA PHOTOGRAPHS









APPENDIX E
RESULTS OF BLOOD COLLECTIONS

NO.	House ID	Results of the Human Blood Samples		
		Test 1	Test 2	Test 3
1	B2-01	Negative	Negative	Negative
2	B2-02	Negative	Negative	Negative
3	B5-01	Negative	Negative	Negative
4	B5-02	Negative	Negative	Negative
5	B33-01	Negative	Negative	Negative
6	B33-02	Negative	Negative	Negative
7	B33-03	Negative	Negative	Negative
8	B33-04	Positive	Negative	Negative
9	B33-05	Negative	Negative	Negative
10	B33-06	Negative	Negative	Negative
11	C03-01	Negative	Negative	Negative
12	C03-02	Negative	Negative	Negative
13	C03-03	Negative	Negative	Negative
14	C03-04	Negative	Negative	Negative
15	C03-05	Negative	Negative	Negative
16	C26-01	Negative	Negative	Negative
17	C30-01	Positive	Negative	Negative
18	C31-01	Negative	Negative	Negative
19	C31-02	Negative	Negative	Negative
20	C31-03	Negative	Negative	Negative
21	C31-04	Negative	Negative	Negative
22	C53-01	Negative	Negative	Negative
23	C70-01	Negative	Negative	Negative
24	C70-02	Negative	Negative	Negative
25	C70-03	Negative	Negative	Negative
26	C75-01	Negative	Negative	Negative
27	C75-02	Negative	Negative	Negative
28	D07-01	Negative	Negative	Negative
29	D07-02	Negative	Negative	Negative
30	D07-03	Negative	Negative	Negative
31	D09-01	Negative	Negative	Negative
32	D09-02	Negative	Negative	Negative
33	D19-01	Negative	Negative	Negative
34	D19-02	Negative	Negative	Negative
35	D21-01	Negative	Negative	Negative
36	D21-02	Negative	Negative	Negative
37	D21-03	Negative	Negative	Negative
38	D35-01	Negative	Negative	Negative
39	D47-01	Negative	Negative	Negative

40	D47-02	Negative	Negative	Negative
41	D47-03	Negative	Negative	Negative
42	D47-04	Positive	Negative	Negative
43	D65-01	Negative	Negative	Negative
44	D65-02	Positive	Negative	Negative
45	D77-01	Negative	Negative	Negative
46	D77-02	Negative	Negative	Negative
47	D77-03	Negative	Negative	Negative
48	D79-01	Negative	Negative	Negative
49	D80-01	Negative	Negative	Negative
50	D80-02	Negative	Negative	Negative
51	E09-01	Negative	Negative	Negative
52	E09-02	Negative	Negative	Negative
53	E12-01	Positive	Negative	Negative
54	E12-02	Negative	Negative	Negative
55	E12-03	Negative	Negative	Negative
56	E12-04	Negative	Negative	Negative
57	E12-05	Negative	Negative	Negative
58	E23-01	Negative	Negative	Negative
59	E23-02	Positive	Negative	Negative
60	E23-03	Positive	Negative	Negative
61	E23-04	Negative	Negative	Negative
62	E23-05	Positive	Negative	Negative
63	E71-01	Positive	Negative	Negative
64	E71-02	Negative	Negative	Negative
65	E122-01	Negative	Negative	Negative
66	E122-02	Negative	Negative	Negative
67	E122-03	Negative	Negative	Negative
68	E129-01	Negative	Negative	Negative

(Unpublished Results of Dr. W. Rojas Saiz 2006)

**APPENDIX F
CBCSF PAMPHLET**



Given to me by —> Roberto Lopez who received it when giving blood at a school sponsored Blood Drive.

The CBCSF Newsletter

Issue 9, July 2006

A Publication of Community Blood Centers of South Florida, Inc.

- Donor Centers**
- Call for Directions and Appointments! (Walk-ins Welcome)
- Boca Raton**
(561) 451-4389
 - Cooper City**
(954) 680-9410
 - Coral Springs**
(954) 752-6322
 - Hollywood**
(954) 986-6302
 - Homestead**
(305) 245-4757
 - Kendall**
(305) 270-6425
 - Key West**
(305) 294-7668
 - Lantana**
(561) 540-6620
 - Lauderhill**
(954) 777-2653
 - Miami**
(305) 667-6503
 - Miami Lakes**
(305) 362-9713
 - N. Fort Lauderdale**
(954) 491-9397
 - Palm Beach Gardens**
(561) 627-5165
 - Perrine**
(305) 256-1660
 - Pompano Beach**
(954) 782-2972
 - Sunrise**
(954) 747-3921

**ASSASSIN BUGS AND CHAGAS DISEASE
A New Public Health Challenge**

The recent deaths of organ transplant recipients in Los Angeles has once again focused the attention of physicians, blood centers, the Food and Drug Administration, and organ and transfusion recipients everywhere on Chagas Disease. It's been known for decades that Chagas Disease can be transmitted by transfusions as well as by bug bites, but only seven cases in 25 years are known to have occurred in the United States until now.

was studying the health status of workers building a railroad in northern Brazil. T. cruzi is a protozoan invader which colonizes soft tissue organs like the heart, lung, or liver and eventually causes congestive heart failure and death. The vector for T. cruzi is the Reduviid or "Kissing Bug," which is a close relative of Florida's Love Bug, an insect well known to anyone who has driven through central Florida in the spring or summer. How T. cruzi and the Reduviid bug work together to cause

The transplants took place in 2003 and were successful, but the recipients gradually became ill and died. The diagnosis of transplant-transmitted Chagas Disease is particularly disturbing as the donor was of Mexican origin and was likely infected before entering the U.S.

VECTOR, noun: An invertebrate, oftentimes an insect, capable of transmitting an infectious agent between vertebrates. The vector for malaria is a mosquito. The vector for Chagas Disease is the Reduviid or Love Bug.

Chagas Disease is one of the most fascinating stories in modern medicine.

The knowledge that Chagas Disease may have entered the United States blood supply is not welcome news. A screening test to eliminate infectious donated blood is well along in development, and Community Blood Centers will shortly be participating in the studies to determine the extent of the risk, if any, Chagas Disease poses to the safety of the blood supply.

Vectors and Pathogens

The vector of Chagas Disease is always a species of Triatomine insects of which 6 are known. The common names for these insects are Reduviid Bugs, but more famously they are known as Kissing Bugs or Love Bugs because of the tendency of the insect to bite people on the face around the eyes. The protozoan T. Cruzii lives in the digestive tract of the insects. When the insect bites a human it takes a blood meal swelling up to several times its original size. The insect then defecates and if the contaminated feces get into the wound or the victim's eyes, the protozoan enters the victim's body and infection is established.

Carlos Chagas was a parasitologist who in 1909 identified Trypanosoma cruzi as the causative agent of the disease which bears his name while he

(Continued on next page)

Coming in Aug 2006 - Coral Gables Branch!

VITA

Frances Heyward Currin Mujica was born April 13, 1977, in Anderson, South Carolina. She earned her Bachelor of Arts in geography and anthropology from the University of Memphis in December 1999. In December 2002 she completed her Master of Arts degree in geography at Louisiana State University. Frances will complete her Doctor of Philosophy in geography at Louisiana State University in August of 2007.