

Ecology and Persistence of Sylvatic Plague in Phillips County, Montana

By

Brian E. Holmes

B.S. University of Florida, 1999

Presented in partial fulfillment of the requirements for the degree of

Master of Science

The University of Montana

2003

Approved by:

---

Chairman, Board of Examiners

---

Dean, Graduate School

---

Date

Committee Chair: Dr. Kerry R. Foresman

Ecology and Persistence of Sylvatic Plague in Phillips County, Montana

### **Abstract**

Epizootic plague occurred among populations of black-tailed prairie dogs (*Cynomys ludovicianus*) in Phillips County, Montana from 1992 to 2001. During this time, some colonies were completely or nearly extirpated by the disease while others were apparently unaffected. I evaluated differences in small mammal and flea communities associated with prairie dog colonies with a history of plague, colonies with no history of plague, and “off-colony” sites where plague history was unknown. I also screened blood samples from small mammals for evidence of antibody to *Yersinia pestis*, the etiologic agent of plague, and screened fleas for the presence of *Y. pestis* and *Bartonella* spp. Small mammal species composition was essentially identical between colonies with and without a history of plague. Deer mice (*Peromyscus maniculatus*) were the most abundant small mammal found throughout the study area and occurred in higher numbers on prairie dog colonies with no history of plague than at colonies with a history of plague. Flea burdens on prairie dogs were higher at colonies with no history of plague and flea burdens on deer mice were higher on prairie dog colonies (regardless of plague history) than at off-colony sites. Coarse-scale habitat association was important in determining flea burdens on deer mice. No blood samples or fleas were positive for *Y. pestis* but a small number of fleas (1.4% of flea pools tested) taken from deer mice, coyotes (*Canis latrans*), and a black-tailed prairie dog were *Bartonella*-positive. It appears that *Y. pestis* infection is rare or absent in the small mammal populations sampled and that infection does not persist in small mammals at prairie dog colonies that have previously been affected by epizootics. There is no evidence that *Bartonella* spp. are pathogenic to wildlife, but *Bartonella* infection was found at several prairie dog colonies where there is currently a population of endangered black-footed ferrets (*Mustela nigripes*), warranting further investigation into the possible effects of this organism on ferrets and their main prey base, prairie dogs.

## ACKNOWLEDGEMENTS

I would like to thank the following people for their integral role in the design and execution of this research: my advisor Dr. Kerry Foresman, CMR biologist Randy Matchett, and Dr. Ken Gage of the CDC. These people dedicated a large amount of time to making this project happen and I would not have been able to proceed without them. Further thanks to my committee members: Dr. Scott Mills, Dr. Mary Poss, and Dr. Tom Schwan. Tom willingly took the time to teach me the art of identifying fleas.

I had exceptionally good help in the field from Tim Lawes, Dylan Mrkich, Mara Saccocia, Michelle Simms, Jilian Weiler, and Lourie Yelton who braved mud, wind, rain, lightning, WNV-carrying mosquitoes, and ornery small mammals. Jo Ann Dullum and Diedra Willingham also volunteered their time to help me in the field. In the lab I received significant help from Kelly Sheff and John Montenieri, both of the CDC Plague Section in Fort Collins, and field logistics were greatly aided by help from the staff of Sand Creek Field Station at CMR. Lastly, I'd like to acknowledge the support of my wife Heather who was often the first to hear my schemes and always gave me excellent feedback.

## TABLE OF CONTENTS

Abstract.....	ii
Acknowledgements.....	iii
Table of Contents.....	iv
List of Tables .....	v
List of Figures.....	v
List of Appendices .....	vi
Introduction.....	1
Chapter 1	
Abstract.....	5
Introduction.....	5
Methods.....	11
Results.....	19
Discussion.....	27
Chapter 2	
Abstract.....	36
Introduction.....	36
Methods.....	40
Reults .....	42
Discussion.....	45
Conclusions and Recommendations .....	50
Literature Cited.....	53
Appendices.....	62

## LIST OF TABLES

### Chapter 1

Table 1. Number and species of mammals captured .....	18
Table 2. Host-flea associations .....	21
Table 3. Number of hosts examined and aspects of flea burdens on small mammals.....	23
Table 4. Literature review of flea collections from prairie dogs .....	29

### Chapter 2

Table 1. Number and source of whole blood and serum samples collected in southern Phillips County, Montana .....	42
Table 2. <i>Bartonella</i> -positive flea pools taken from mammals.....	44

## LIST OF FIGURES

### Chapter 1

Figure 1. The study area: southern Phillips County, Montana .....	9
Figure 2. Locations of mammal trapping grids.....	10
Figure 3. Location of mammal trapping grids in relation to areas of forested cover .....	17
Figure 4. Mean minimum density of deer mice by year and site category .....	20
Figure 5. Frequency distribution of flea loads for black-tailed prairie dogs .....	24
Figure 6. Frequency distribution of flea loads for deer mice.....	24
Figure 7. Percent frequency distribution of flea loads on deer mice carrying at least one flea upon first capture.....	26

### Chapter 2

Figure 1. Location of <i>Bartonella</i> -positive flea samples.....	43
---	----

**LIST OF APPENDICES**

Appendix I. Scatterplot of total flea index for sympatric populations of deer mice and black-tailed prairie dogs; scatterplot of minimum population density vs. total flea index for deer mice ..... 62

Appendix II. Species composition of fleas collected from prairie dogs at colonies with and without a history of sylvatic plague ..... 64

Appendix III. Burrow sampling summary ..... 65

Appendix IV. Plots of prevalence and intensity of flea burdens on black-tailed prairie dogs and deer mice by site and age-sex class ..... 67

Appendix V. Logistic regression model summaries for prevalence of flea parasitism on black-tailed prairie dogs and deer mice ..... 71

Appendix VI. Prairie dog colonies included in survey for *Yersinia pestis* and *Bartonella* in southern Phillips County..... 72