

Presence and Effects of Lyme Disease in a Barrier Island Deer Population

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INTRODUCTION

As part of an investigation of the ecology of an unmanaged white-tailed deer (*Odocoileus virginianus*) population, the presence of *Borrelia burgdorferi* in ticks removed from deer and the serologic response of deer to the spirochete were examined. Further investigation was conducted to develop a standardized test for use in detecting *B. burgdorferi* antibodies in deer sera.

The study was conducted on Fire Island (lat. 40°41' N, long. 73°00' W), a 50-km barrier island parallel to the South Shore of Long Island, approximately 50 km east of New York City. Several levels of land use and management exist on the island, including federal, state and county parks, and private residential communities. Fire Island is a known endemic area for human Lyme disease.

METHODS

Ticks were collected from live and dead deer, triturated in phosphate-buffered saline (pH 7.4), and examined for spirochetes using dark-field microscopy.¹ Deer were either live-trapped using Clover traps or immobilized with a Capchur gun and darts® (Palmer Chemical and Equipment Co., Inc., Douglasville, GA) containing a mixture of xylazine hydrochloride (Rompun®; Haver Lockhart, Miles Laboratories, Inc., Shawnee, KS) and ketamine hydrochloride (Vetalar®, Parke-Davis, Division of Warner Lambert Co., Morris Plains, NJ). Yohimbine hydrochloride (Yohimbine®, Sigma F and D Division, Ltd., St. Louis, MO) was used as a drug antagonist. Twenty individuals were outfitted with radio collars (Telonics, Inc., Mesa, AZ) and all captured animals were marked with ear-tags for future identification. Blood samples were taken from the jugular vein for blood chemistry determination and *B. burgdorferi* serologies. Serum samples were collected to determine antibody levels and were frozen until processed. Deer capture was conducted over an 18-month period to collect serial blood samples, which were used to determine the presence and persistence of

immunoglobulin levels.^{2,3} Serum samples were examined for humoral IgG antibodies to *B. burgdorferi* using both an indirect fluorescent antibody (IFA) test and an enzyme-linked immunosorbent assay (ELISA). The ELISA procedure⁴ was modified for deer serum by using alkaline-phosphatase anti-bovine IgG (heavy and light chain) immunoglobulin as the secondary antibody (Kirkegaard and Perry Laboratories, Gaithersburg, MD). The secondary IgG antibody used in the IFA tests was fluorescein isothiocyanate conjugated goat derived anti-bovine (Kirkegaard and Perry Laboratories).

RESULTS

Three tick species, *Ixodes dammini*, *Amblyomma americanum*, and *Dermacentor variabilis* were collected from deer on Fire Island. Approximately 26% of total ticks collected and examined ($n = 340$) were infected with spirochetes. *I. dammini* and *A. americanum* both contained spirochetes. Nymphs from both species revealed at least a 50% infection rate, and only one larval *I. dammini* was infected. *I. dammini* was the predominant species found on Fire Island deer, representing 92% of all ticks collected. *I. dammini* were also distributed along the entire island and were recovered in all 20 areas from which deer were sampled. *A. americanum* were found in only seven areas, often separated by several kilometers. While infected *I. dammini* were recorded in both uninhabited park areas and residential communities, *A. americanum* were found to be infected with *B. burgdorferi* only within residential communities.

Although telemetry data revealed deer home ranges generally <5 km in length, movements were recorded in excess of 17 km traversing both park and community boundaries.

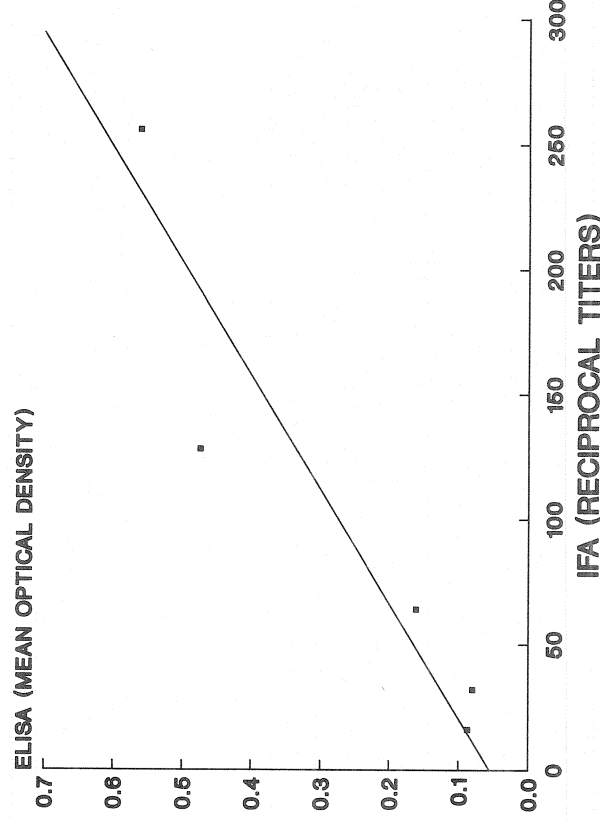


FIGURE 1. ELISA-IFA comparison on deer sera for IgG antibody levels to *Borrelia burgdorferi*.

TABLE 1. Antibody Levels for Serial Blood Samples Collected from White-tailed Deer on Fire Island, New York^a

Deer No.	Antibody Level		
	Date 1	Date 2	Date 3
1	0.150 (12/04/85)	0.270 (3/17/86)	—
2	0.091 (2/26/86)	0.148 (4/30/86)	—
3	0.116 (2/28/86)	0.091 (3/28/86)	—
4	0.202 (3/27/86)	0.043 (12/01/86)	0.150 (12/17/86)
5	0.039 (3/28/86)	0.041 (4/02/86)	—
6	0.295 (12/01/86)	0.319 (12/05/86)	0.184 (12/18/86)

^aValues listed represent optical density using an ELISA.

A comparison of serum IgG levels between ELISA and IFA tests showed a positive correlation ($r = .868$, $p < .01$) for both serological procedures (FIG. 1). Serial blood samples were collected from six deer; four deer demonstrated increased antibody levels over time as determined by two samples from each individual (TABLE 1). Two animals were sampled one additional time and had fluctuating titers. One of these two deer was sampled within a 3-week period, while the other was sampled over several months.

DISCUSSION

I. dammini and *A. americanum*, two vectors of Lyme disease, utilize the white-tailed deer as a host during all life stages.^{1,5} Our results indicate that *A. americanum* populations are currently lower than *I. dammini* populations and are focal on the island. We speculate that these localized populations of *A. americanum* will be further distributed throughout the island by deer movements. Given the widespread distribution of *I. dammini* on Fire Island, the relatively small deer home ranges may serve to maintain local tick populations, once established. Movements of deer and associated ticks may also serve to spread *B. burgdorferi* in this insular environment.

The paired serum samples that exhibited rising antibody titers during the winter months suggest reexposure to spirochetes. One possible mechanism of reexposure could be via feeding adult ticks.

The ELISA developed in this study proved to be a successful procedure for the detection of serum IgG levels in response to *B. burgdorferi* in deer serum.

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