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Monthly Incidence of *Theileria cervi* and Seroconversion to *Babesia odocoilei* in White-tailed Deer (*Odocoileus virginianus*) in Texas

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ABSTRACT: Monthly monitoring of fawns collected from an area in Texas endemic for *Theileria cervi* and *Babesia odocoilei* showed that transmission of *T. cervi* occurred during July and August, a time period consistent with the occurrence of *Amblyomma americanum*. Seroconversion to *B. odocoilei* occurred during October to December and possibly continued through January and February. The time of seroconversion was more suggestive of transmission of *B. odocoilei* by *Ixodes scapularis* than by *Amblyomma americanum*.

Key words: *Theileria cervi, Babesia odocoilei,* white-tailed deer, *Odocoileus virginianus, Ixodes scapularis, Amblyomma americanum,* ticks, incidence.

Theileria cervi is an intraerythrocytic protozoan parasite of white-tailed deer (*Odocoileus virginianus*) (Kreier et al., 1962) which is transmitted by the tick *Amblyomma americanum* (Kuttler et al., 1967; Laird et al., 1988). The geographic distribution of *T. cervi* in Texas is approximately the same as that of *A. americanum* (Robinson et al., 1967; Waldrup, 1991). *Babesia odocoilei* also is an erythrocytic parasite of white-tailed deer (Emerson and Wright, 1968, 1970). The geographic distribution of the parasite includes Texas and Oklahoma (Waldrup et al., 1989b) and Virginia (Perry et al., 1985). Adult *Ixodes scapularis* has been shown experimentally to transmit *B. odocoilei* from deer to deer after transstadial transmission in the tick from the nymph stage (Waldrup et al., 1990). Though *T. cervi* is commonly observed in stained blood smears of infected deer (Robinson et al., 1967), infections with *B. odocoilei* are difficult to diagnose by observing stained blood smears (Waldrup et al., 1989a). Serological diagnosis of *B. odocoilei* infection has been accomplished using the indirect fluorescent antibody (IFA) test (Waldrup et al., 1989b).

The purpose of this study was to determine, by monthly sampling, the incidence of *T. cervi* infection and seroconversion against *B. odocoilei* in white-tailed deer fawns in an endemic area and to relate that seroconversion to possible vector activity.

Sampling of free-ranging deer was done at Brushy Creek Experimental Ranch, Trinity County, Texas (95°45′W, 31°00′N). This site has been previously determined to be endemic for *T. cervi* (Waldrup et al., 1989a) and *B. odocoilei* (Waldrup et al., 1989b). Fawns of the year were collected by rifle shot or live capture and bled during each month of the year from June through May of 1987 to 1990. Serum from each fawn was frozen at −20 C until testing. Thin blood smears were made, stained with Giemsa, and observed under oil immersion for erythrocytic parasites. All serologic testing was done using the indirect fluorescent antibody (IFA) test (Waldrup et al., 1989b). The antigen for the IFA test was prepared from in vitro cultures of *B. odocoilei* infected erythrocytes (Holman et al., 1988). The *B. odocoilei* isolate originated from a deer in east Texas (Holman et al., 1988). Fawns maintained at Texas A&M University (College Station, Texas 77843, USA) in concrete floored pens were bled monthly to serve as controls. Specific acaricide treatment was not attempted with

TABLE 1. Monthly incidence of erythrocytic parasites and serologic reactivity to *Babesia odocoilei* in white-tailed deer (*Odocoileus virginianus*) fawns at Brushy Creek Experimental Ranch, Trinity County, Texas.

Month	Serologic reactivity to *B. odocoilei*	Blood smears positive for *T. cervi*
June		
Control	0/7 (0)[a]	0/7 (0)[a]
Free-ranging	1/2 (33)	1/2 (33)
July		
Control	0/10 (0)	0/100 (0)
Free-ranging	2/3 (40)	2/3 (40)
August		
Control	0/8 (0)	0/8 (0)
Free-ranging	0/3 (0)	2/1 (67)
September		
Control	0/15 (0)	0/15 (0)
Free-ranging	0/3 (0)	3/0 (100)
October		
Control	0/5 (0)	0/5 (0)
Free-ranging	2/6 (25)	6/2 (75)
November		
Control	0/5 (0)	0/5 (0)
Free-ranging	3/2 (60)	4/1 (80)
December		
Control	0/5 (0)	0/5 (0)
Free-ranging	6/1 (86)	7/0 (100)
January		
Control	0/5 (0)	0/5 (0)
Free-ranging	3/2 (60)	4/1 (80)
February		
Control	0/5 (0)	0/5 (0)
Free-ranging	3/1 (75)	4/0 (100)
March		
Control	0/6 (0)	0/6 (0)
Free-ranging	3/0 (100)	3/0 (100)
April		
Control	0/5 (0)	0/5 (0)
Free-ranging	4/0 (100)	4/0 (100)
May		
Control	0/4 (0)	0/4 (0)
Free-ranging	5/2 (71)	6/1 (86)

[a] +/− (% positive).

these animals, though efforts to combat fire ants (*Solenopsis evicta*) resulted in an absence of ticks on the control fawns.

The results of the serologic survey and blood smear observations are listed by month in Table 1. *Theileria cervi* was microscopically detected in stained blood smears prepared from samples collected during all study periods. Some serologic activity against *B. odocoilei* was noted in samples collected in June and July, but was not present in samples collected in August and September. Seroprevalence increased in October and continued through December when, for example, six of the seven samples (86%) were positive for antibody activity to *B. odocoilei*. This seroprevalence remained high in samples collected monthly from January through May. None of the control fawns exhibited any erythrocytic parasites or specific antibody activity during the study.

The lack of serologic activity and the absence of erythrocytic parasites in the control deer shows that without exposure to ticks, transmission of these parasites does not occur. The incidence of *T. cervi* increased from June to September indicating that transmission was occurring during that time. This time correlates well with the observed seasonality of *A. americanum* activity on deer which is primarily April through September (Patrick and Hair, 1977). These data are also consistent with the observations of Laird et al. (1988), concerning the incidence of *T. cervi* infection in *A. americanum* ticks in Oklahoma. The serologic reactivity to *B. odocoilei* is more difficult to interpret. The antibody activity seen in samples collected in June and July could be due to maternal antibody from colostrum since the antibody activity was not detected in the August and September samples. Positive reactions were obtained with 2 of 6 samples collected in October (Table 1). The majority of samples collected in subsequent months (November through May) were also positive. These data suggest that transmission of *B. odocoilei* may begin in October and continue for several months. Interpretation of the data for later months (January through May) is problematic since no data are available concerning the number of times

each fawn might have been infected and the decay of antibody activity following one exposure. Nevertheless, the pattern of apparent *B. odocoilei* transmission in late fall coincides with patterns of activity noted for adult *Ixodes scapularis* (Watson and Anderson, 1976).

While these data do not conclusively prove that *I. scapularis* is the natural vector of *B. odocoilei*, it can be seen that *B. odocoilei* and *T. cervi* have different patterns of transmission in free-ranging white-tailed deer. *Amblyomma americanum* is unlikely to be a significant vector of *B. odocoilei* in Texas for if it were, then the transmission patterns of *B. odocoilei* and *T. cervi* should be more similar.

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