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Transmission of *Babesia odocoilei* in White-tailed Deer (*Odocoileus virginianus*) by *Ixodes scapularis* (Acari: Ixodidae)

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ABSTRACT: Laboratory reared *Ixodes scapularis* proved to be an efficient vector of *Babesia odocoilei* Emerson and Wright between white-tailed deer (*Odocoileus virginianus*). Transtadial survival of the babesia occurred between nymph and adult stages of the tick, and the adult stage transmitted the babesia.

Key words: White-tailed deer, *Odocoileus virginianus*, *Babesia odocoilei*, vector transmission, *Ixodes scapularis*, transtadial survival, experimental infections.

Babesia odocoilei is an intraerythrocytic protozoan parasite of white-tailed deer (*Odocoileus virginianus*) (Emerson and Wright, 1968, 1970). The known geographic distribution of this parasite includes eastern Texas and Oklahoma (Waldrup et al., 1989a, b) and the Great Dismal Swamp in southern Virginia (Perry et al., 1985). Although the vector is unknown, Emerson (1969) and Perry et al. (1985) identified the lone star tick (*Amblyomma americana*) on deer at a time when the deer also were parasitized by *B. odocoilei*. Perry et al. (1985) mentioned *Ixodes scapularis* as a potential vector but did not find this tick on deer infected with *B. odocoilei*. The present study describes the transmission of *Babesia odocoilei* from deer to deer using laboratory-reared *Ixodes scapularis* as a vector.

To establish a patent *B. odocoilei* infection in a white-tailed deer whole blood was collected in sodium citrate from five, free-ranging white-tailed deer from Cookson Hills Wildlife Refuge, Cherokee County, Oklahoma (USA, 35°41′N, 94°48′W). This site has been identified previously as being an endemic area for *B. odocoilei* (Waldrup et al., 1989a). Blood was pooled and inoculated intravenously into a 6-mo-old captive-born white-tailed deer. This deer was determined to be free of babesial infection by stained blood smear examination and by the lack of specific antibody using the indirect fluorescent antibody test (Waldrup et al., 1989a). By similar criteria, all deer used in this study were determined to be negative for babesiasis and specific antibody before use. Blood and serum samples were collected on the day of inoculation and at 2 day intervals for 20 days. *Babesia odocoilei* were observed in stained blood smears at 6 days postinoculation. Specific antibody was detected at a dilution of 1:80 by 16 days postinoculation.

Ticks (*Ixodes scapularis*) were reared and maintained in colony at the Department of Entomology-Livestock Laboratory (Oklahoma State University, Stillwater, Oklahoma 74078, USA) by methods similar to those of Patrick and Hair (1975). Nymphal and adult ticks were fed on uninfected deer which remained negative for blood piroplasms in stained blood smears and specific antibody to *B. odocoilei*. Approximately 1,000 laboratory-reared *I. scapularis* nymphs were placed directly on the *B. odocoilei* infected deer which was housed inside a ventilated wooden box (1.8 m × 1.2 m × 1.0 m). After 12 hr, the deer was removed to a rubber-coated, expanded metal cage (2.0 m × 1.7 m × 1.1 m). Each of the floor supports was placed inside of a metal pan, and the margins of the pans were taped with double-sided adhesive tape to prevent the ticks from escaping. The animal was removed from the cage for 5 to 10 min twice daily for exercise and cage cleaning and to replace food and water which were provided *ad libidum*. Replete nymphs were collected from the cage and pans daily, placed in

paper cartons and held at 90 to 95% humidity and 25 C under a 14 hr light : 10 hr dark photophase until they had molted to adults.

Adult *I. scapularis*, molted from nymphs fed on the *B. odocoilei*-infected deer, were allowed to feed on a second 6-mo-old deer (WTD 1) following the procedure just described. The replete adults were collected and discarded. On day 14 post-infestation, deer WTD 1 was treated with an acaricide.

On day 25 after acaricide treatment, 1,000 nymphal *I. scapularis* from the colony were placed on WTD 1 as previously described. Replete nymphs were molted to adults and placed on another deer (WTD 2). Blood and serum samples were collected at 2 day intervals for 2 wk following tick infestation and then weekly for 6 mo.

Piroplasms were noted in peripheral blood smears from the first recipient deer (WTD 1) 6 days after tick infestation. Specific antibody, as detected by the indirect fluorescent antibody test, was present 26 days after tick infestation at a dilution of 1:80. Piroplasms were seen in peripheral blood smears from WTD 2 10 days after tick infestation, and specific antibody was detected at a dilution of 1:80 in the serum sample collected 22 days after tick infestation. Piroplasms were detectable in stained blood smears of deer WTD 2 for >12 mo.

These experiments have demonstrated that *B. odocoilei* can be transmitted from deer to deer using *I. scapularis*. *Babesia odocoilei* survives transtadial transmission in the tick (nymph to adult), and the adult stage of the tick can transmit the organism.

Further work is needed to delineate the epidemiology of *B. odocoilei*. *Amblyomma americanum* is a vector of the cervid blood parasite, *Theileria cervi* (Kuttler et al., 1967), and deer apparently are infected with both *B. odocoilei* and *T. cervi* throughout the entire range of *B. odocoilei* in Texas (Robinson et al., 1968; Waldrup et al., 1989a, b). However, the range of *T. cervi* extends more westward than that of *B. odocoilei* (Robinson et al., 1967). If *A. americanum* were an important vector of *B. odocoilei*, we suspect that the ranges of *B. odocoilei* and *T. cervi* would overlap more completely.

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