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Geographic Occurrence of *Ixodes scapularis* and *Amblyomma americanum* (Acari: Ixodidae) Infesting White-tailed Deer in North Carolina

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ABSTRACT: A state-wide survey to determine the occurrence and comparative numbers of ticks infecting white-tailed deer (*Odocoileus virginianus*) was conducted in North Carolina (USA). One thousand six hundred twenty nine deer were examined in 60 of 100 counties; with the exception of one county in the piedmont region, all tick-infested deer occurred in the coastal plain. *Ixodes scapularis* (46%) and *Amblyomma americanum* (53%) were the most prevalent species encountered and accounted for more than 98% of the 4,286 ticks collected. Some specimens of *Dermacentor albipictus* and *Amblyomma maculatum* also were collected.

Key words: Ticks, *Ixodes scapularis*, *Amblyomma americanum*, distribution, white-tailed deer, prevalence, survey.

White-tailed deer (*Odocoileus virginianus*) are preferred hosts of several species of ticks. The association between white-tailed deer and the lone star tick (*Amblyomma americanum*) and black-legged ticks (*Ixodes scapularis*) has been documented through surveys of ticks infesting deer (Smith, 1977; Cooney and Burgdorfer, 1974; Clymer et al., 1970) and indirectly demonstrated by monitoring the decline of ticks following exclusion of deer from tick-infested habitats (Bloemer et al., 1986). Both species of ticks recently have been implicated as potential vectors of Lyme disease (Levine et al., 1989; Schulze et al., 1984). In North Carolina, cases of Lyme disease were reported as early as 1983 (Levine et al., 1990) and antibodies to the Lyme spirochete have been found in white-tailed deer (Magnarelli et al., 1986). The northern deer tick (*Ixodes dammini*) is the established vector (Spielman et al., 1985) in the northeastern and midwestern United States where Lyme disease is endemic. Adults of this tick species, which was recently differentiated from *I. scapularis* (Spielman et al., 1979), also have a predilection to feed on deer and, where this species occurs deer are abundant (Main et al., 1981; Spielman et al., 1985). A state-wide survey was conducted to determine the geographic distribution of *A. americanum* and *I. scapularis*, and the possible occurrence of *I. dammini*. In this report, we present results of the survey of ticks infesting white-tailed deer in North Carolina.

The survey was conducted from September to December during 1983 to 1987; however, >90% of the deer were examined in 1985 and 1986. Assistance in examining deer for ticks was obtained from the North Carolina Wildlife Resources Commission biologists, members of various hunting clubs, taxidermists and volunteers at hunter check stations. Cooperators were given vials containing 80% ethanol, forceps and survey forms, and instructed to carefully check the head and ears of each deer. In a study recently completed by Bloemer et al. (1988), these body regions were shown to have the largest percentage of ticks. All ticks collected from each deer were placed in separate vials and a survey form was completed for each deer examined. The date, county and specific location where each deer was killed was recorded.

Ticks were identified to developmental stage and species using standard keys (Diamant and Strickland, 1965; Sonenshine, 1979), and counted. The presence or absence of each tick species was recorded for each county and the relative abundance of each species of tick was calculated as a

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TABLE 1. Occurrence of ticks on white-tailed deer in North Carolina.

Region	Number of deer examined	Number (%) of deer with ticks					
		Ixodes scapularis		*Amblyomma americanum*			
		Females	Males	Females	Males	Nymphs	Larvae
Coastal plain	382	206 (54)	164 (43)	21 (6)	85 (22)	106 (28)	57 (15)
Piedmont	478	0	0	0	0	0	1 (<1)
Mountains	769	0	0	0	0	0	0
Overall regions	1,629	206 (13)	164 (10)	21 (1)	85 (5)	106 (7)	58 (4)

percent based on the total number of deer examined or ticks collected in each geographic region and over all regions of North Carolina. Boundaries for geographic regions were based on the classification of soil systems presented by Daniels et al. (1984). Identifications of representative specimens of each species of tick were confirmed by James Keirans (U.S. National Museum, Smithsonian Institution, Washington, D.C. 20560, USA). This voucher collection has been deposited in the Insect Collection of the Department of Entomology at North Carolina State University (Raleigh, North Carolina 27695, USA).

One thousand six hundred twenty nine deer were examined from 60 of the 100 counties in North Carolina (Table 1). The largest number of deer (n = 769) were examined in the mountains, but no ticks were collected. With the exception of Wake County in the piedmont region, ticks were only found infesting deer that had been killed in the coastal plain. Three hundred eighty two (24% of total) deer collected were examined from the coastal plain and, of this number, 227 (59%) were infested with ticks. *Ixodes scapularis* and *Amblyomma americanum* were the predominant species collected from 206 (54%) and 168 (44%) deer, respectively. A few *Dermacentor albipictus* and *Amblyomma maculatum* also were collected. No *I. dammini* were found.

There were 4,286 ticks removed from the deer examined (Table 2). The majority (54%) of these ticks were adults. *Ixodes scapularis* (46%) was the most abundant adult tick found on deer with females and males comprising 30 and 16% of the collection, respectively. Although *A. americanum* (53%) was more abundant than *I. scapularis*, comparatively fewer females (<1%) and males (8%) of *A. americanum* were collected. *Amblyomma americanum* nymphs (25%) and larvae (19%) were the only immature ticks collected. The lower prevalence of adult lone star ticks on deer probably resulted from the time of year collections were made. Bloemer et al. (1988) and Patrick and Hair (1977) found numbers of lone star ticks on white-tailed deer declined precipitously in November and December after reaching peak numbers in June through August. Immature *I. scapularis* may not have been collected because the larvae are active in the spring (Rogers, 1953). In Arkansas, nymphs were

TABLE 2. Number of ticks found on white-tailed deer in North Carolina.

Region	Number of ticks examined	Number (%) of ticks					
		Ixodes scapularis		*Amblyomma americanum*			
		Females	Males	Females	Males	Nymphs	Larvae
Coastal plain	4,280	1,300 (30)	673 (16)	28 (<1)	321 (8)	1,089 (25)	821 (19)
Piedmont	6	0	0	0	0	0	6 (100)
Mountains	0	0	0	0	0	0	0
Overall regions	4,286	1,300 (30)	673 (16)	28 (<1)	321 (8)	1,089 (25)	827 (19)

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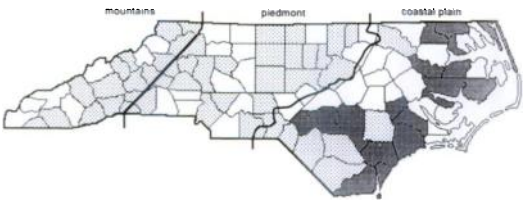


FIGURE 1. Occurrence of *Ixodes scapularis* on white-tailed deer in North Carolina. □, no deer examined; □, deer examined but not tick-infested; ■, deer infested with *Ixodes scapularis*.

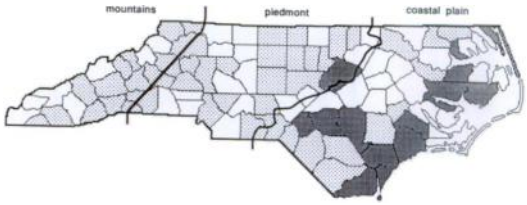


FIGURE 2. Occurrence of *Amblyomma americanum* on white-tailed deer in North Carolina. □, no deer examined; □, deer examined but not tick-infested; ■, deer infested with *Amblyomma americanum*.

collected in spring and summer (Harris, 1959). However, in North Carolina host-seeking nymphs have been collected in October (Levine et al., 1989) and, in Florida, host-seeking nymphs were collected from April to December (Rogers, 1953). Immature *I. scapularis* have been reported to primarily feed on lizards and not utilize deer as hosts (Rogers, 1953).

Few extensive surveys of ticks infesting deer have been conducted. Smith (1977) reports species of ticks removed from deer killed in 12 counties in the coastal plain of North Carolina including four counties not included in our study. In these four counties, *Ixodes scapularis* and *A. americanum* were the most common ticks collected from deer. Schulze et al. (1984) present a survey of ticks infesting white-tailed deer in New Jersey. *Amblyomma americanum* was restricted to the coastal plain while *I. dammini* was collected in the piedmont as well as throughout the coastal plain.

Although *I. scapularis* and *A. americanum* were largely restricted to the coastal plain (Figs. 1, 2), free-living specimens of both species have been collected in several counties in the piedmont and coastal plain of North Carolina (Levine et al., 1989) where deer were found not to be infested with ticks by our survey. Because a variety of mammalian (Cooney and Burgdorfer, 1974; Koch and Dunn, 1980), avian (Koch and Dunn, 1980; Sonenshine and Clifford, 1973) and reptilian (Rogers, 1953) hosts are parasitized by these ticks, their occurrence in the coastal plain and piedmont regions of North Carolina is probably more extensive than was determined by our single-host survey.

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