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First Records of Established Populations of *Ixodes scapularis* (Acari: Ixodidae) Collected From Three Nebraska Counties

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Abstract

Reported cases of Lyme disease in Nebraska have been assumed to be imported from other endemic areas. Previous surveillance efforts provided no evidence of established populations as only individual specimens of *Ixodes scapularis* (Say) had been collected. In the winter of 2018, adult *I. scapularis* were found on a dog at Two Rivers State Recreation Area, Douglas County, prompting tick collection at the site and nearby natural areas. In May 2019, all life stages of host-seeking *I. scapularis* were collected using dragging and flagging techniques in sites located near the Platte River in Douglas, Sarpy, and Saunders counties. This is the first documentation of established populations of *I. scapularis* in Nebraska.

Keywords: Nebraska, *Ixodes scapularis*, Lyme disease, *Borrelia burgdorferi*, tick

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Ixodes scapularis (Say), the blacklegged tick, is predominantly found in the eastern and central United States and in parts of eastern Canada (Ogden et al. 2009, Eisen et al. 2016). In its geographic distribution, it is the principal vector of *Borrelia burgdorferi* sensu lato (*Bbsl*), a complex of associated borreliae that cause Lyme borreliosis which includes *Borrelia burgdorferi* sensu stricto (*Bbss*), the predominant causative agent of human and canine Lyme disease. The tick may also transmit other spirochetes in the *Bbsl* complex including *B. bissettii* (Postic et al. 1998), *B. kurtenbachii* (Margos et al. 2010), *B. mayonii* (Pritt et al. 2016), and *B. miyamotoi* (Scoles et al. 2001, Krause et al. 2015), a relapsing fever borreliae. Other pathogens transmitted by the tick include *Babesia microti*, the causative agent of human babesiosis, *Anaplasma phagocytophilum*, the causative agent of human granulocytic anaplasmosis, tick-borne paralysis caused by a toxin, and Powassan virus (Gorman and Snead 1978, Piesman and Eisen 2008, Ebel 2010).

A summary of tick distribution in the United States demonstrates that *I. scapularis* has expanded its geographic distribution in Midwestern states (Eisen et al. 2016) including Nebraska's neighboring states, Iowa and South Dakota. Prior to 2000, *I. scapularis* in Iowa were primarily found along the Mississippi River, but by 2005, ticks were found in central and western Iowa (Lingren et al. 2005). Additionally, the proportion of *B. burgdorferi*-infected ticks increased (Oliver et al. 2017) and molecular evidence of *B. burgdorferi* in *I. scapularis* collected from eastern South Dakota was found (Maestas et al. 2016).

Compared to states in Lyme endemic areas, the annual incidence of human Lyme disease in Nebraska is low and established populations of the blacklegged tick have not been found (Diuk-Wasser et al. 2010, Cortinas and Spomer 2014, Centers for Disease and Prevention 2017). Prior to the 1990s, blacklegged ticks had not been reported in Nebraska and since then, ticks have only been sporadically reported. Adult *I. scapularis* were first reported in Nebraska in 1990 from a hunter-harvested deer in Cass County and a dog in Pawnee County, both located in the southeastern corner of the state (Cortinas and Spomer 2014). In 2005 and 2006, there were single tick reports, each from dogs; the former from Butler Co. and the latter from Lancaster Co. and, in March 2011, as part of a statewide tick collection survey, a single host-seeking female adult *I. scapularis* was collected

in Prairie Pines Nature Preserve, Lancaster Co. (Cortinas and Spomer 2014). On 22 November 2018, an adult female *I. scapularis* was reported from a dog that had visited Two Rivers State Recreation Area (TRSRA) along the Platte River in Douglas County. On 8 January 2019, another female *I. scapularis* was found on the same dog at the same site. Based on these findings, we sought to evaluate if *I. scapularis* populations had become established and began tick collections at TRSRA and other nearby natural areas.

Materials and Methods

Field Surveys

Spurred by the above-mentioned findings, we set out to conduct tick surveillance beginning in April, though we were delayed due to extensive and historic flooding along the Platte River, field sites were underwater or inaccessible until late May. Sites selected for sampling included TRSRA as well as Mahoney State Park, Cass County; Camp Ashland, Sarpy County; Schramm State Park, Sarpy County; and Camp Carol Joy Holling, Saunders County. The first four locations are located adjacent to the Platte River and comprised tall grass prairie and continuous mixed hardwood riparian zones along the river's banks and intermittent wooded areas within the floodplain. Common tree species include cottonwood (*Populus deltoides*), oak (*Quercus* spp.), mulberry (*Morus* spp.), and eastern red cedar (*Juniperus virginiana*). Mahoney State Park and Camp Carol Joy Holling are located on the western side of the Platte River, opposite the other collection sites. The CCJH site is the only location not bordered by the Platte River, characterized by mixed cedar and oak canopy with a brome grass (*Bromus* spp.) understory.

Ticks were collected using 1 m² cloth drags, cloth flags, and a cloth sweep as described previously (Carroll and Schmidtman 1992). Dragging/flagging took place in wooded areas containing leaf litter and limited understory growth and along ecotones between wooded and grassy habitats. Collected ticks were placed on strips of masking tape or in 90% alcohol. Strips of masking tape with ticks were placed in an iced cooler in the field and subsequently stored at -20°C.

Tick Identification

Ticks were identified using morphological keys as previously described (Cooley and Kohls 1945, Keirans and Litwak 1989). All ticks were identified to species, sex, and life stage at 100× magnification under a compound light microscope (Leica S9i, Leica Microsystems, Germany). Voucher specimens of *I. scapularis* nymphs and larvae are kept with the entomology program at the Nebraska Department of Agriculture. Voucher specimens of all three life stages are kept at the University of Nebraska-Lincoln in Lincoln, NE.

Results

Three tick species were collected during the scope of the study to include *Dermacentor variabilis* (Say), *Amblyomma americanum* (Linnaeus), and *I. scapularis*. All three life stages of the blacklegged tick were collected at the Camp Ashland training site, Sarpy Co., NE; Two Rivers State Recreation Area, Douglas Co., NE (nymph); and at Camp Carol Joy Holling, Saunders Co., NE (nymphs and larvae). In one of the areas (Schramm State Park, Sarpy Co., NE), no ticks were collected. In the other four collection sites, *A. americanum* adults and nymphs were the predominant tick collected (144/214 or 67%) with *D. variabilis* also detected (11/214 or 5%) in four of these sites (**Table 1**).

Discussion

Prior to 2019, only single blacklegged ticks have been collected via active and passive surveillance (Cortinas and Spomer 2014, Eisen et al. 2016) in Nebraska. Our finding of three life stages at Camp Ashland and two life stages at Two Rivers State Recreation Area and Camp Carol Joy Holling meet the Centers for Disease Control and Prevention criteria of an established tick population (Dennis et al. 1998). Established population criteria require the collection of at least six individuals or at least two different life stages at a location within 12 mo. These collections indicate that a population of *I. scapularis* is established in Douglas, Sarpy, and Saunders Counties, in east-central Nebraska.

Table 1. Summary of June 2019 field collection surveys in Nebraska

Location	County	Coordinates	Date	Survey Hours	Species	Life Stage ^a
Camp Ashland (5)	Sarpy	41.08323°, -96.33341°	6/1/19	6	<i>Amblyomma americanum</i> <i>Dermacentor variabilis</i> <i>Ixodes scapularis</i>	Adult F(6), M(3); Nymph (50) Adult F(1) Adult M(1); Nymph (2); Larva
Mahoney State Park	Cass	41.03424°, -96.313912°	6/5/19	4	<i>Amblyomma americanum</i>	Adult F(2); Nymph (2)
Schramm State Park	Sarpy		6/5/19	2	No ticks collected	N/A
Two Rivers State Recreation Area	Douglas	41.02197°, -96.25091°	6/5/19	2	<i>Amblyomma americanum</i> <i>Dermacentor variabilis</i>	Adult M(2); Nymph (2) Adult M(1)
Two Rivers State Recreation Area	Douglas	41.21203°, -96.34641°	6/7/19	6	<i>Amblyomma americanum</i> <i>Dermacentor variabilis</i> <i>Ixodes scapularis</i>	Adult F(4), M(2); Nymph (12) Adult F(4) Nymph (1)
Camp Ashland	Sarpy	41.08323°, -96.33341°	6/8/19	6	<i>Amblyomma americanum</i> <i>Dermacentor variabilis</i> <i>Ixodes scapularis</i>	Adult F(9), M(7); Nymph (21) Adult F(1), M(3) Nymph (2); Larva (19)
Camp Carol Joy Holling	Saunders	41.30867°, -96.32462°	6/8/19	4	<i>Amblyomma americanum</i> <i>Dermacentor variabilis</i> <i>Ixodes scapularis</i>	Adult F(1), M(1); Nymph (20) Adult M(1) Nymph (3); Larva (26)

Numbers represent the physical count of tick collect by life stage and sex.
a. F = female, M = male, N/A not applicable.

Further statewide tick surveillance to describe *I. scapularis* and *Borrelia burgdorferi sensu lato* distribution and Lyme borreliosis risk are warranted, as is focal characterization of these newly identified sites of establishment as they lie within the Omaha-Lincoln urban corridor, the most densely populated portion of the state (Census and Bureau 2019).

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