ARTICLE

Birds Disperse Ixodid (Acari: Ixodidae) and *Borrelia burgdorferi*-Infected Ticks in Canada

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ABSTRACT A total of 152 ixodid ticks (Acari: Ixodidae) consisting of nine species was collected from 82 passerine birds (33 species) in 14 locations in Canada from 1996 to 2000. The Lyme disease spirochete *Borrelia burgdorferi* Johnson, Schmidt, Hyde, Steigerwaldt & Brenner was cultured from the nymph of a blacklegged tick, *Ixodes scapularis* Say, that had been removed from a common yellowthroat, *Geothlypis trichas* L., from Bon Portage Island, Nova Scotia. As a result of bird movement, a nymphal *I. scapularis* removed from a Swainson's thrush, *Catharus ustulatus incanus* (Godfrey), at Slave Lake, Alberta, during spring migration becomes the new, most western and northern record of this tick species in Canada. *Amblyomma longirostre* Koch, *Amblyomma sabanerae* Stoll, *and Ixodes baergi* Cooley & Kohls are reported for the first time in Canada. Similarly, *Amblyomma americanum* L., *Amblyomma maculatum* Koch, and *Ixodes muris* Bishopp & Smith are reported for the first time on birds in Canada. After removal of an *I. muris* gravid female from a song sparrow, *Melospiza melodia* Wilson, at St. Andrews, New Brunswick, eggs were laid, which developed into larvae, and this new tick-host record demonstrates that birds have the potential to start a new tick population. We conclude that passerine birds disperse several species of ixodid ticks in Canada, and during spring migration translocate ticks from the United States, and Central and South America, some of which are infected with *B. burgdorferi*.

KEY WORDS ticks, *Ixodes scapularis*, birds, *Borrelia burgdorferi*, Lyme disease, Canada

SONGBIRDS PLAY A role in the introduction and dispersal of ixodid (hard-bodied) ticks in Canada as they do elsewhere. These parasites attach to the skin of avian hosts, take a blood meal, and drop off a few days later. Engorged ticks are normally found on the head of the bird because this area is not subject to bill preening. The blacklegged tick, *Ixodes scapularis* Say (northern populations previously considered *I. dammini* [deer tick]) (Oliver et al. 1993, Keirans et al. 1996), is of particular interest because it is a competent vector of the Lyme disease spirochete *Borrelia burgdorferi* Johnson, Schmidt, Hyde, Steigerwaldt & Brenner. It also acts as a vector of the etiologic microorganisms that cause human granulocytic ehrlichiosis (Pancholi et al. 1995, des Vignes and Fish 1997) and human babesiosis (Piesman et al. 1986, Mather et al. 1990). Some passerine birds act as competent reservoir hosts for *B. burgdorferi* (Anderson et al. 1986, 1990; Weisbrod and Johnson 1989; Stafford et al. 1995; Rand et al. 1998).

With high-energy reserves and a good tailwind, passerine species are capable of carrying ticks long distances during migration. Leberman and Browne (1976) documented a red-eyed vireo, *Vireo olivaceus* (L.), that flew 483 km from Pennsylvania to North Carolina in 1974 on an overnight flight. In addition, Brewer et al. (2000) reported a white-throated sparrow, *Zonotrichia albicollis* (Gmelin) flying from Bradley, Ontario (in Chatham-Kent), to Lakeview Heights, Ontario, in May 1977, traveling 681 km in a single day (corrected distance and endpoints not as reported; personal communication, Lucie Métras).

The first Canadian record of *I. scapularis* was a specimen removed from a human in May 1904 at Bracebridge, Ontario (Nuttall and Warburton 1911). Much later, Barker et al. (1988) found *B. burgdorferi* in a blacklegged tick collected in 1987 at Long Point, Ontario, on the north shore of Lake Erie, an endemic area for Lyme disease. Artsob et al. (1992) isolated the first culture of *B. burgdorferi* from an *I. scapularis* specimen collected in Prince Edward Island, Atlantic Canada, and Banerjee et al. (1995a) isolated the first culture in central Canada collected from *I. scapularis* at Kenora, Ontario, in 1994. Birds likely introduced both infected ticks from the South. In late May 1990, Bell et al. (1992) reported the first *I. scapularis* in Canada on a bird (a common yellowthroat, *Geothlypis trichas* L.) collected at Windsor, Nova Scotia. At Thunder Cape on Sibley Peninsula near Thunder Bay,

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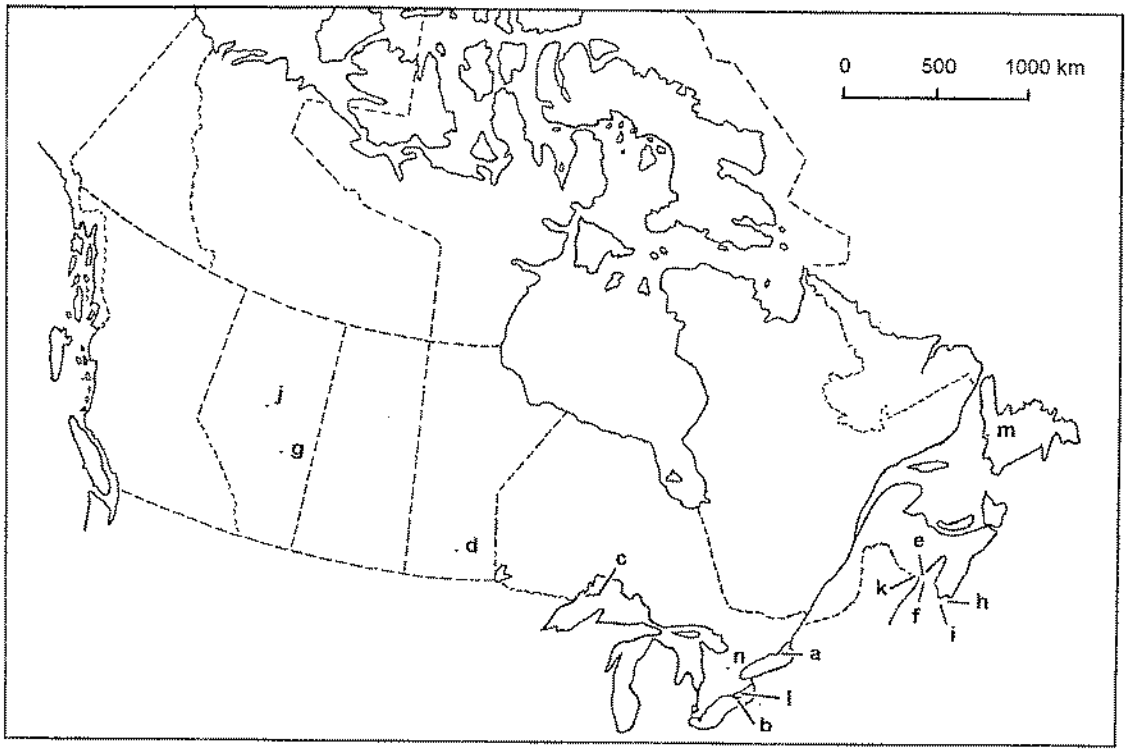

Fig. 1. Locations in Canada where ticks were collected from birds. (a) Prince Edward Point Bird Observatory, Prince Edward Point (Picton), Ontario. (b) Long Point Bird Observatory, Long Point (Port Rowan), Ontario. (c) Thunder Cape Bird Observatory, Sibley Peninsula (Pass Lake), Ontario. (d) Delta Marsh Bird Observatory, Delta (Portage la Prairie), Manitoba. (e) Fundy Bird Observatory, Grand Manan Island (Castalia), New Brunswick. (f) Kent Island, New Brunswick. (g) Beaverhill Bird Observatory, Tofield, Alberta. (h) Atlantic Bird Observatory, Bon Portage Island, Nova Scotia. (i) Atlantic Bird Observatory, Seal Island, Nova Scotia. (j) Lesser Slave Lake Bird Observatory, Slave Lake, Alberta. (k) Huntsman Marine Science Centre, St. Andrews, New Brunswick. (l) Haldimand Bird Observatory, Selkirk, Ontario. (m) Gros Morne National Park, Rocky Harbor, Newfoundland. (n) Elora, Ontario. Mailing addresses are listed in parentheses.

Ontario, Klich et al. (1996) reported immature (larvae, nymphs) ticks of *I. scapularis*, *Haemaphysalis leporispalustris* Packard, and *Haemaphysalis chordeilis* Packard on spring migratory birds captured in May–June 1995, and Banerjee et al. (1996) reported *B. burgdorferi*-infected *I. scapularis* in the same area. Recently, several *B. burgdorferi*-positive *I. scapularis* were removed from dogs across southern Ontario that had no out-of-province travel, and distribution of these ticks is attributed to birds (Banerjee et al. 2000).

In this epidemiological study, we document many new avian-tick records, and provide the first record of three species of ticks in Canada. We provide evidence that birds are transporting *B. burgdorferi*-positive *I. scapularis* to non-endemic areas in Canada. From a clinical perspective, patients may contract Lyme disease in areas where *B. burgdorferi* is not endemic or cycling enzootically.

Materials and Methods

Tick Collection. During five calendar years (1996–2000), ticks were collected from birds across southern Canada. This study was separated into three activity periods: spring (1 March–30 June), summer (1 July–31 August), and fall (1 September–30 November). With the exception of *Ixodes baergi* Cooley & Kohls, ticks were removed by bird banders during regular banding activities. These ticks were collected at 14 locations: namely, Prince Edward Point Bird Observatory, Prince Edward Point, Ontario; Long Point Bird Observatory, Long Point, Ontario; Thunder Cape Bird Observatory, Sibley Peninsula, Pass Lake, Ontario; Delta Marsh Bird Observatory, Delta, Manitoba; Fundy Bird Observatory, Grand Manan Island, New Brunswick; Kent Island, New Brunswick; Beaverhill Bird Observatory, Tofield, Alberta; Atlantic Bird Observatory, Bon Portage Island and Seal Island, Nova Scotia; Lesser Slave Lake Bird Observatory, Slave Lake, Alberta; Huntsman Marine Science Centre, St. Andrews, New Brunswick; Haldimand Bird Observatory, Selkirk, Ontario; Gros Morne National Park, Rocky Harbor, Newfoundland; and by a veterinarian at Elora, Ontario (Fig. 1). Readily visible ticks were removed with fine-pointed tweezers, and put in polystyrene vials with tulle-netting caps kept in ziplock bags with moist paper towel, and sent for identification.

Spirochete Isolation. At the British Columbia Centre for Disease Control (BCCDC) laboratory, ticks were surface sterilized using 10% hydrogen peroxide followed by 70% isopropyl alcohol, and rinsed with sterile water and transferred to sterile tissue to remove excess water. Live ticks were cultured in Barbour-Stoenner-Kelly (BSK) II medium at 34°C, and observed weekly by dark-field microscopy. Dead ticks were directly analyzed by polymerase chain reaction (PCR) for the presence of *B. burgdorferi*. Eighteen ticks (14 accession numbers: 97-5M1, 97-5A12, 97-5M2, 98-5A19, 98-5A5, 98-5A6, 98-5A8, 98-5A20, 98-5A17, 99-5A18, 99-5A27, 99-5A28, 99-5A69, 00-5A26) were kept as voucher specimens at the Lyme Disease Association of Ontario.

PCR Amplification. PCR was used to amplify the *ospA* gene of *B. burgdorferi* with this specific procedure developed at BCCDC. DNA was extracted from the midgut contents of ticks using the QIAamp blood kit (Qiagen, Santa Clarita, CA) according to the manufacturer's recommendation. Ten microliters of the supernatant was used for PCR analysis. PCR was carried out with a 40-microliter reaction mixture that contained 50 mM KCl, 2.5 mM $MgCl_2$, 10 mM Tris-HCl (pH 8.8), 1U *Taq* polymerase (Gibco-BRL, Gaithersburg, MD), each of the four deoxyribonucleotide triphosphates (Amersham Pharmacia Biotech Inc., Piscataway, NJ) at a concentration of 100 micromoles, 1.0 micromoles of the outer and inner primers, OspA-2 (5′GCAGTTAAAGTTCCTTCAAG3′) and OspA-A2 (5′TTCTGACGATCTAGGTCAAA3′). The PCR cycle consisted of an initial denaturation at 95°C for 5 min, denaturation at 95°C for 30 s, annealing at 55°C for 30 s, and extension at 72°C for 30 s. The procedure was repeated 50 times, and the final extension was done at 72°C for 7 min. The final 249-bp PCR amplicon products were visualized by 2% agarose gel electrophoresis in UV light after ethidium bromide staining. For PCR quality assurance, *B. burgdorferi* sensu stricto B31 was used as a positive control and sterile water as a negative control.

Monoclonal Antibodies. Motile spirochetes were immunostained with monoclonal antibodies of *B. burgdorferi*, namely, species-specific H5332, which reacts with 31 kDa outer surface protein A (OspA); species-specific H6831, which reacts with OspB (34 kDa); H107-IIF3 reactive with P39 (39 kDa); and *Borrelia* (genus)-specific H9724, which reacts with flagellin (41 kDa) (all provided by Alan G. Barbour, University of California, Irvine, CA).

Results

During a 4.5-yr period (1 March 1996 to 31 August 2000), bird banders and a veterinarian from 14 locations (Fig. 1) in southern Canada submitted 152 ticks (nine species) removed from 82 passerine birds (33 species). Sixty-seven rabbit ticks, *H. leporispalustris*, common across southern Canada, parasitized 33 different birds (Table 1). These rabbit ticks were all negative for the Lyme disease spirochete. Four *Ixodes* spp. (i.e., *I. baergi*, *I. brunneus* Koch, *I. muris* Bishopp & Smith, and *I. scapularis*) were the most common with 75 ticks on 42 different birds (Table 2). The four *Amblyomma* spp. (i.e., *A. americanum* L., *A. longirostre* Koch, *A. maculatum* Koch, and *A. sabanerae* Stoll), which are not indigenous in Canada, were all removed as immature stages during the spring period between 12 May and 3 June. These findings provided strong evidence that they were transported by tropical-wintering birds recently returning from the South (Table 3). During the same period (1996–2000), we also identified 35 *A. americanum* and 14 *A. maculatum* adults removed from domestic dogs and cats in Ontario, which had no out-of-province travel.

The highest number of ticks on infested birds was recorded during the spring migration from 28 March to 30 June, with 87 ticks removed from 49 birds. During July and August, 19 attached ticks were removed from 12 birds. From 2 September to 26 October, 46 ticks were removed from 21 birds. The mean intensity of ticks on infested birds was 1.85 (range, 1–16). Ticks were more prevalent on the common yellowthroat, Swainson's thrush, and song sparrow occurring 13, 12, and nine times, respectively. *Ixodes scapularis* occurred on 30 different birds, and attached most frequently on the common yellowthroat and Swainson's thrush, with 10 and six occurrences, respectively.

We documented the first report of *A. americanum*, *A. maculatum*, *A. sabanerae*, *I. baergi*, and *I. muris* on birds in Canada. A gravid female *I. muris* collected on 10 June 2000 from a song sparrow at St. Andrews, New Brunswick, which was naturally mated in the field before removal, started to lay eggs on 23 June 2000 in the laboratory at a temperature of 18–21°C. After 31 d these eggs began developing into active larvae, and subsequently developed into nymphs and adults. In general, immature ticks were much more common on birds; however, 11 female adult ticks were removed that consisted of: one *I. baergi*, seven *I. brunneus*, two *I. muris*, and one *H. leporispalustris*. Since the majority of these ticks were documented for the first time on birds in Canada, they are listed individually.

One hundred and thirty-four of the 152 ticks underwent spirochetal testing. Motile spirochetes were cultured from a live, nymphal *I. scapularis* removed from a common yellowthroat collected on 28 May 1999 from Bon Portage Island, Nova Scotia. The isolate was reactive for monoclonal antibodies directed against OspA, OspB, P39, and flagellin, and was positive by PCR for *B. burgdorferi*.

Discussion

Spring migrating birds act as important hosts in transporting ticks from their indigenous areas to more northerly locations. The immature stages of the *Amblyomma* spp. ticks recovered during this study provide clear evidence of extensive travel from southern areas, because they are not native to Canada (Bishopp and Trembley 1945). All 10 individual *Amblyomma* spp. ticks were removed from birds during spring migration, indicating they were acquired in their natural habits in South and Central America, or the southern

Table 1. Occurrence of rabbit ticks, *H. leporispalustris* on passerine birds in southern Canada, by province, 1996–2000

Bird species	Location[a]	Date ticks removed	larva(e)	nymph(s)	female
		Ontario			
Dark-eyed junco, *Junco hyemalis*	b	09 Oct 1996	0	1	0
Northern cardinal, *Cardinalis cardinalis*	b	09 Oct 1996	1	0	0
Common yellowthroat, *Geothlypis trichas*	b	02 Sep 1997	2	0	0
Swainson's thrush, *Catharus ustulatus*	b	13 Sep 1997	7	0	0
Swainson's thrush	b	18 Sep 1997	0	1	0
Carolina wren, *Thryothorus ludovicianus*	b	22 Sep 1997	1	0	0
Swainson's thrush	b	29 Sep 1997	0	1	0
Swamp sparrow, *Melospiza georgiana*	b	09 Oct 1997	1	0	0
Song sparrow, *Melospiza melodia*	b	09 Aug 1999	0	3	0
Gray-cheeked thrush, *Catharus minimus*	b	28 Sep 1999	1	0	0
White-throated sparrow, *Zonotrichia albicollis*	b	10 Oct 1999	1	1	0
White-throated sparrow	b	01 May 2000	0	1	0
		Manitoba			
Gray-cheeked thrush	d	18 May 1996	0	1	0
Yellow warbler, *Dendroica petechia*	d	13 Aug 1997	0	0	1
White-throated sparrow	d	11 Sep 1997	1	0	0
White-throated sparrow	d	15 Sep 1997	1	0	0
Indigo bunting, *Passerina cyanea*	d	28 May 1999	1	0	0
		New Brunswick			
Savannah sparrow, *Passerculus sandwichensis*	f	14 Jul 1998	1	1	0
Swainson's thrush	e	16 Jul 1999	0	1	0
		Alberta			
Least flycatcher, *Empidonax minimus*	g	30 Jun 1999	2	0	0
		Nova Scotia			
Song sparrow	i	14 May 1999	1	0	0
Song sparrow	h	16 May 1999	2	0	0
Winter wren, *Troglodytes troglodytes*	h	17 Aug 1999	1	0	0
Swainson's thrush	h	23 Aug 1999	2	1	0
Fox sparrow, *Passerella iliaca*	h	07 Sep 1999	0	1	0
Song sparrow	h	09 Sep 1999	12	4	0
Ruby-crowned kinglet, *Regulus calendula*	h	27 Sep 1999	1	0	0
Myrtle warbler, *Dendroica coronata*	h	29 Sep 1999	1	0	0
White-throated sparrow	h	29 Sep 1999	3	0	0
White-throated sparrow	h	30 Sep 1999	1	0	0
Common yellowthroat	h	26 Oct 1999	1	0	0
		Newfoundland			
Northern waterthrush, *Seiurus noveboracensis*	m	18 Aug 2000	1	0	0
Common yellowthroat	m	29 Aug 2000	3	0	0
Total birds 33 (18 species)			49	17	1

[a] See Fig. 1 for locations.

United States, and transported directly to Canada. In the United States, nine species of the genus *Amblyomma* principally inhabit southern latitudes (Keirans and Durden 1998); however, *A. longirostre*, in the adult stage, is only indigenous from Panama to Brazil (Jones et al. 1972). In the case of the lone star tick, *A. americanum*, travel from the nearest established population in southern Iowa to Tofield, Alberta, would be 1,900 km. The travel distance for the Gulf Coast tick, *A. maculatum* from central Georgia to Long Point, Ontario, would be 1,100 km. The *A. americanum* and *A. maculatum* adults collected from untraveled canine and feline hosts in Ontario provide further evidence that passerine birds introduce these ticks as larvae and nymphs.

In this study, neotropical migrants carried immature *A. longirostre* ticks the farthest distance. A Canada warbler, *Wilsonia canadensis* L.; Traill's flycatcher, *Epidonax traillii* Audubon; and red-eyed vireo, *Vireo olivaceus*, carried immature *A. longirostre* to Long Point, Ontario, a distance of at least 3,400 km from its indigenous area in the northern part of South America or Panama. Similarly, a Traill's flycatcher carried two *A. longirostre* larvae to Delta, Manitoba, a distance of at least 5,000 km. Previously, nine immature *A. longirostre* were reported on birds in the United States, one as far north as Butler, PA (Jones et al. 1972).

Ticks collected during the summer and fall would likely have been picked up locally as birds carried out ground-foraging activities. Notably, on 3 August 1996 a blacklegged tick was removed from a yellow warbler, *Dendroica petechia* L., suggesting that it was picked up locally in Manitoba. The closest known breeding population for the *I. scapularis* nymph removed at the town of Slave Lake, Alberta, would be east-central Minnesota (Drew et al. 1988, Durden and Keirans 1996), a distance of 1,760 km.

Table 2. Occurrence of *Ixodes* spp. ticks on passerine birds in southern Canada, by province, 1996–2000

Bird species	Location	Date tick removed	*Ixodes* ticks						
			I. baergi	*I. brunneus*	*I. muris*			*I. scapularis*	
			F	F	L	N	F	L.	N
		Ontario							
Northern waterthrush, *Seiurus noveboracensis*	a	10 May 1996	0	0	0	0	0	0	6
Song sparrow, *Melospiza melodia*	b	13 Apr 1997	0	1	0	0	0	0	0
Northern waterthrush	b	17 Aug 1997	0	0	0	0	1	0	0
Dark-eyed junco, *Junco hyemalis*	b	16 Apr 1998	0	1	0	0	0	0	0
Common yellowthroat, *Geothlypis trichas*	a	20 May 1998	0	0	0	0	0	0	1
Black-capped chickadee, *Parus atricapillus*	b	07 Oct 1998	0	0	0	0	0	1	0
Lincoln's sparrow, *Melospiza lincolnii*	c	19 May 1999	0	0	0	0	0	0	3
Cliff swallow, *Hirundo pyrrhonota*	n	14 Jul 1999	1	0	0	0	0	0	0
Fox sparrow, *Passerella iliaca*	b	28 Mar 2000	0	1	0	0	0	0	0
Song sparrow	l	13 Apr 2000	0	1	0	0	0	0	0
Song sparrow	b	14 Apr 2000	0	1	0	0	0	0	0
Hermit thrush, *Catharus guttatus*	a	19 Apr 2000	0	1	0	0	0	0	0
Common grackle, *Quiscalus quiscula*	b	06 Jun 2000	0	0	0	0	0	0	1
		Manitoba							
Common yellowthroat	d	25 May 1996	0	0	0	0	0	0	2
Yellow warbler, *Dendroica petechia*	d	26 May 1996	0	0	0	0	0	1	2
Magnolia warbler, *Dendroica magnolia*	d	29 May 1996	0	0	0	0	0	0	1
Yellow warbler	d	31 May 1996	0	0	0	0	0	0	1
Song sparrow, *Melospiza melodia*	d	27 Jul 1996	0	0	0	1	0	0	0
Yellow warbler	d	03 Aug 1996	0	0	0	0	0	0	1
Mourning warbler, *Oporomis philadelphia*	d	07 Sep 1996	0	0	0	1	0	0	0
Common yellowthroat	d	24 May 1997	0	0	0	0	0	0	2
American redstart, *Setophaga ruticilla*	d	03 Jun 1998	0	0	0	0	0	0	1
House wren, *Troglodytes aedon*	d	18 May 1999	0	0	0	0	0	1	1
Swainson's thrush, *Catharus ustulatus*	d	22 May 1999	0	0	0	0	0	3	1
Gray catbird, *Dumetella carolinensis*	d	24 May 1999	0	0	0	0	0	0	2
Swainson's thrush	d	29 May 1999	0	0	0	0	0	4	0
House wren	d	07 May 2000	0	0	0	0	0	0	1
Gray-cheeked thrush, *Catharus minimus*	d	10 May 2000	0	0	0	0	0	0	1
		New Brunswick							
Fox sparrow	e	18 Apr 1997	0	1	0	0	0	0	0
Song sparrow	k	10 Jun 2000	0	0	0	0	1	0	0
		Alberta							
Swainson's thrush	g	19 May 1998	0	0	0	0	0	0	1
Swainson's thrush	j	29 May 2000	0	0	0	0	0	0	7
		Nova Scotia							
Common yellowthroat	i	14 May 1999	0	0	0	0	0	0	1
Common yellowthroat	i	15 May 1999	0	0	0	0	0	1	0
Common yellowthroat	h	18 May 1999	0	0	0	0	0	0	1
Northern waterthrush	i	22 May 1999	0	0	0	0	0	3	0
Common yellowthroat	i	23 May 1999	0	0	0	0	0	0	2
Common yellowthroat	i	27 May 1999	0	0	0	0	0	0	4
Swainson's thrush	i	27 May 1999	0	0	0	0	0	2	1
Common yellowthroat	h	28 May 1999	0	0	0	0	0	0	1
Common yellowthroat	h	28 May 1999	0	0	0	0	0	0	1[a]
Swainson's thrush	h	29 May 1999	0	0	0	0	0	0	1
Total birds 42 (19 species)			1	7	0	2	2	16	47

F, female; L, larva(e); N, nymph(s). See Fig. 1 for locations.
[a] *Borrelia burgdorferi* cultured from this *I. scapularis* nymph.

The rabbit tick, *H. leporispalustris* is common across Canada, and may be picked up locally by ground-frequenting birds as they forage within their nesting area. In our study, all analyzed *H. leporispalustris* ticks were negative for *B. burgdorferi*. However, Nicholls and Callister (1996) removed 60 larval and nymphal *B. burgdorferi*-infected *H. leporispalustris* from eight species of birds in northwestern Wisconsin. As well, Banerjee et al. (1995b) cultured *B. burgdorferi* from nymphal and female *H. leporispalustris* removed from a roadkill snowshoe hare, *Lepus americanus* Erxleben, recovered at Grand Prairie, Alberta. On the east coast, Anderson et al. (1989) found the eastern cottontail rabbit, *Sylvilagus floridanus* (J. A. Allen), to be a competent host for the rabbit spirochete strain *Borrelia andersonii* Marconi, Liveris & Schwartz, a member of the *B. burgdorferi* sensu lato complex (Marconi et al. 1995). Oliver et al. (1998) isolated *B. burgdorferi* from the lone star tick, *A. americanum*, collected from a cottontail rabbit in southern Missouri. However, earlier studies by Sanders and Oliver (1995) showed that this species of tick is an incompetent vector of *B.*

Table 3. Occurrence of *Amblyomma* spp. ticks on passerine birds in southern Canada, by province, 1996–2000

Bird species	Location	Date ticks removed	*Amblyomma* ticks							
			A. americanum		*A. longirostre*		*A. maculatum*		*A. sabanerae*	
			L	N	L	N	L	N	L	N
Ontario										
Traill's flycatcher, *Empidonax traillii*	b	30 May 1997	0	0	0	1	0	0	0	0
Swainson's thrush, *Catharus ustulatus*	a	19 May 1998	0	0	0	0	2	0	0	0
Canada warbler, *Wilsonia canadensis*	b	26 May 1998	0	0	1	0	0	0	0	0
Veery, *Catharus fuscescens*	b	18 May 1999	0	0	0	0	0	0	0	2
Red-eyed vireo, *Vireo olivaceus*	b	24 May 2000	0	0	0	1	0	0	0	0
Manitoba										
Traill's flycatcher	d	03 Jun 1998	0	0	2	0	0	0	0	0
Alberta										
Gray-cheeked thrush, *Catharus minimus*	g	12 May 1998	0	1	0	0	0	0	0	0
Total birds 7 (6 species)			0	1	3	2	2	0	0	2

Bird nomenclature follows Godfrey (1986).
L, larva(e); N, nymph(s). See Fig. 1 for locations.

burgdorferi and does not maintain infection transstadially.

Some species of birds, including the common yellowthroat, act as competent reservoirs for the Lyme disease spirochete *B. burgdorferi*, which is evident when infected larval ticks are removed (Anderson et al. 1986, 1990; Weisbrod and Johnson 1989, Stafford et al. 1995, Rand et al. 1998). We have a report of a *B. burgdorferi*-positive *I. scapularis* nymph removed from a common yellowthroat collected at Bon Portage Island, Nova Scotia (Morshed et al. 1999). Based on migration flight patterns (Brewer et al. 2000) and the fact that the common yellowthroat does not overwinter in Canada, we speculate that this tick was likely carried 290 km to Bon Portage Island, Nova Scotia, on a direct flight over the Atlantic Ocean from Monhegan Island, ME, the closest reported area endemic for Lyme disease (Smith et al. 1993). In a recent 11-yr study in Rhode Island, Hyland et al. (2000) also found that the common yellowthroat, a ground nesting and foraging species, was the bird parasitized with ticks most frequently, and *I. scapularis* was the most common tick species. Previously, Smith et al. (1996) found immature *B. burgdorferi*-infected *I. scapularis* on birds that transported them from the endemic mainland on the east coast (Maine, USA) out 9.7 km to Appledore Island.

The development of motile larvae hatched from eggs laid in the laboratory by a gravid *I. muris* female collected from a song sparrow at St. Andrews, New Brunswick, is a new record of a naturally mated *I. muris* female, removed from a bird, producing viable progeny. This new phenomenon clearly shows the potential of a bird to start a new tick population. Survival may not be possible in more northerly areas; however, *I. muris* is present in much of eastern Canada (Durden and Keirans 1996). Although the vector competence of *I. muris* for *B. burgdorferi* is limited, Dolan et al. (2000) provide evidence that this tick species can act as a vector.

In the case of *I. scapularis*, several immature ticks would need to be dropped at one location to start a new population. If the host bird is a competent reservoir for *B. burgdorferi*, the etiologic agent of Lyme disease could be introduced. After the engorged immature *I. scapularis* ticks dropped, and molted to either nymphs or adults, they could transmit infection to new vector-competent hosts. Subsequently, males and females could establish a breeding population, and all motile stages of *I. scapularis* could perpetuate an endemic focus. For instance, at Rondeau Provincial Park on the north shore of Lake Erie where large numbers of spring migratory birds occur, Morshed et al. (2000) recently found *I. scapularis* established and *B. burgdorferi* present in these ticks.

In conclusion, this is the first multi-location study in Canada of ticks on birds. The discovery of an *A. longirostre* nymph on a Traill's flycatcher removed at Long Point, Ontario on 30 May 1997 is the first report of this species in Canada. The *A. americanum* nymph on a gray-cheeked thrush, *Catharus minimus* Lafresnaye collected on 12 May 1998 at Tofield, Alberta, is the first report of this species of tick on a bird in Canada. The presence of two *A. maculatum* larvae on a Swainson's thrush, *Catharus ustulatus swainsoni* (Tschudi), collected on 19 May 1998 at Prince Edward Point, Ontario, is also a premier discovery in Canada. The two nymphs of *A. sabanerae* removed from a veery, *Catharus fuscescens* Stephens, on 18 May 1999 is unique, because it is the first recovery in Canada, and for that matter, on any bird. These two nymphal ticks were fully engorged, and one was allowed to molt to an adult (male) for confirmation of identity. All previously documented host records for *A. sabanerae* are from turtles (Barnard and Durden 2000). The female *I. baergi* on an immature cliff swallow removed on 4 July 1999 at Elora, Ontario, was the first time this tick species has been reported in Canada. The occurrence of an *I. muris* nymph on a song sparrow, *M. melodia*, collected on 27 July 1996 at Delta, Manitoba, is a first time report of this species of tick on a bird in Canada. The *I. muris* collections from Manitoba and New Brunswick represent new province records for this tick in Canada. An *I. scapularis* on a Lincoln's sparrow,

Melospiza lincolnii Audubon, that was collected 19 May 1999 constitutes a new host record in North America. The *I. scapularis* nymph on the Swainson's thrush, *Catharus ustulata incanus* (Godfrey), retrieved on 19 May 1998 was the first discovery of this species of tick in Alberta. The discovery of *I. scapularis* nymphs on a Swainson's thrush retrieved on 29 May 2000 at Slave Lake, Alberta, significantly extends the northwest occurrence of this tick species in Canada as a result of bird movement. The isolation of *B. burgdorferi* from an *I. scapularis* nymph removed from a common yellowthroat was the first reported occurrence in Canada. Prior studies in the United States, within a given area, have found that some passerine birds act as competent hosts of *B. burgdorferi*, but our report is the first time that *I. scapularis* attached to a bird has maintained the viability of this bacterium over a long distance. The *I. scapularis* discoveries from Bon Portage Island, Nova Scotia, to Slave Lake, Alberta, clearly show that songbirds play an important role in broad dispersal especially during their northward movement into Canada during spring migration. An understanding of the wide distribution of *I. scapularis* is indispensible in recognizing the presence of tick-borne pathogens in southern Canada. Moreover, *B. burgdorferi*-infected immature *I. scapularis* dropped from a bird in a non-endemic area may also start a focus of Lyme disease in the new area.

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