Diversity of Tick Species Biting Humans in an Emerging Area for Lyme Disease

ABSTRACT

Background. Although most tick bites in humans in areas of the northeastern United States in which Lyme disease is highly endemic are due to *Ixodes dammini*, no study documents the frequency of *I. dammini* bites in low-prevalence or emerging areas for Lyme disease. Data on the proportion of tick bites in humans that are due to *I. dammini* in a region may have implications for public health policy and clinical management.

Methods. A statewide survey of the tick species that parasitized humans in Maine was conducted during 1989 and 1990. Tick submissions from throughout the state were elicited through media announcements. All ticks that had been removed from humans were identified, and data were collected that included bite seasonality and geography and demographics of tick bite victims.

Results. Of 709 ticks submitted, only 17% were *I. dammini. Ixodes cookei*, a vector for Powassan encephalitis, accounted for 34% of bites, and *Dermacentor variabilis* accounted for 45%. Other tick species were occasionally implicated.

Conclusions. The likelihood that a tick bite was due to *I. dammini* was lower in Maine than in areas in the northeastern United States in which Lyme disease is highly endemic. Other tick vectors, associated with diseases other than Lyme disease, were more frequently implicated. Regional tick bite surveys may prove useful in assessing the risk of Lyme disease following a tick bite. (*Am J Public Health.* 1992;82:66–69)

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Introduction

In areas in which Lyme disease is highly endemic, the northern deer tick, *Ixodes dammini*, accounts for up to three fourths of tick bites in humans.[1,2] As many as 30% to 70% of nonlarval deer ticks in these areas may be infected with *Borrelia burgdorferi.*[3–6] Because unrecognized Lyme disease can have severe consequences, many physicians in high-prevalence areas routinely treat patients with a recent history of a tick bite with oral antibiotics in an attempt to prevent the development of infection. One double-blind placebo-controlled study of this practice failed to demonstrate a clear benefit with treatment, even though all study participants were bitten by *I. dammini* and tick infection rates were 30%.[7] Because of public fear of Lyme disease and a lack of regional data on the likelihood of tick bites by *I. dammini*, physicians in regions with any Lyme disease risk may consider antibiotic treatment of all tick bites. But in areas recently colonized by *I. dammini*, or at the edge of its range, the risk of Lyme disease following tick bites may be negligible because of limited distribution and a low population density of *I. dammini.*

From 1985, when the deer tick was first identified in Maine,[8] through 1989 there have been only 14 reported cases of Lyme disease acquired in Maine that meet the Centers for Disease Control's case definition. Most cases have been reported from two counties in southwest coastal Maine. Although deer ticks have been found in many coastal areas of the state, only these two counties were considered endemic areas for Lyme disease in 1989 by the Centers for Disease Control. This study characterizes tick species that parasitize humans in Maine, an emerging area of Lyme disease with a low prevalence of infection.

Materials and Methods

As part of a multifaceted study of *I. dammini* distribution in Maine, the Research Laboratory at the Maine Medical Center and the Maine Department of Conservation Insect and Disease Laboratory collaborated on a study of human parasitism by ticks during 1989 and 1990. Requests for ticks were publicized in brochures, public health notices, and the media. Individuals bitten by ticks in Maine were encouraged to save the ticks in alcohol and submit them for identification to either laboratory. The bite victim's name, age, and address; the data and locale of the bite; and any associated symptoms were requested. All ticks received were examined under a dissecting microscope and identified according to standard keys and taxonomic references.[9–13] All ticks submitted to state agencies were identified by the state entomologist; specimens received at the Maine Medical Center Research Laboratory were identified by research personnel with training and experience in tick identification (E.H.L., R.P.S.). Unusual specimens were submit-

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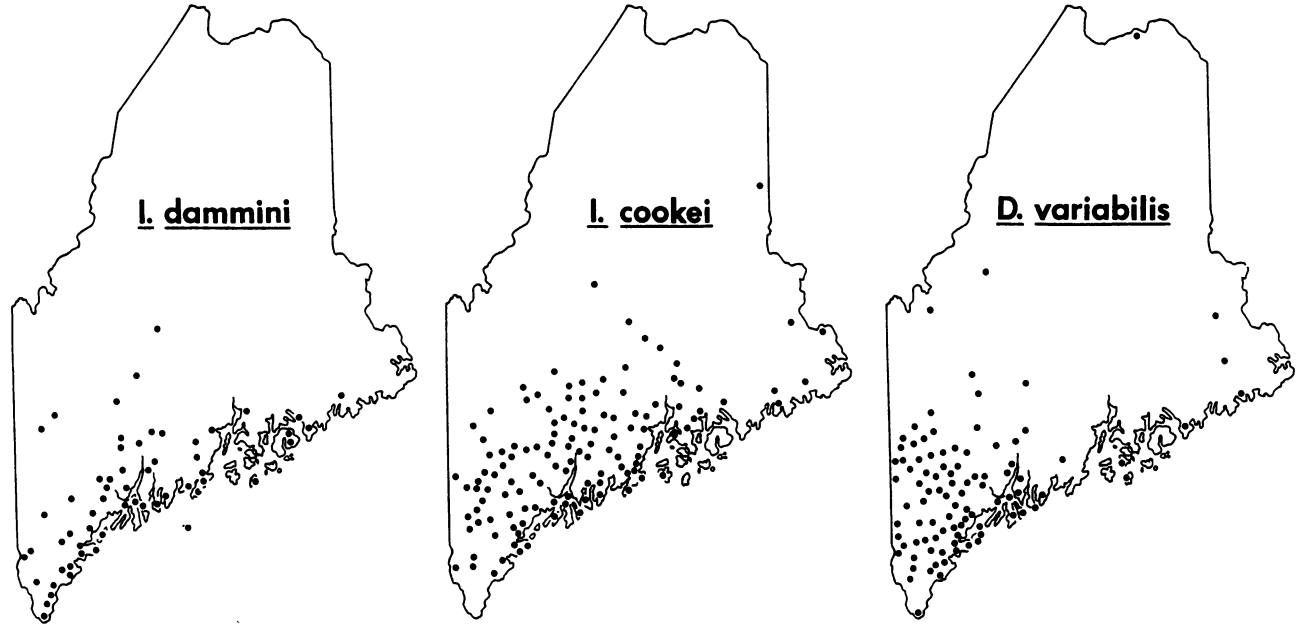

FIGURE 1—Distribution of common tick species removed from humans in Maine, 1989–1990. Each dot represents a town of origin of identified ticks.

ted to Dr J. E. Keirans, Smithsonian Institution, for confirmation of species identification.

Results

A total of 709 ticks that had been removed from 646 humans in Maine were submitted for identification. Ninety percent of all *Ixodes* ticks had been attached at time of removal. Although submitted ticks were received from residents of all of Maine's counties, few specimens were sent from northern areas (Figure 1). In the two known endemic counties, only 13% of ticks removed from humans were *I. dammini.* Of all *Ixodes* ticks submitted from these counties, 43.7% were *I. dammini*, compared with 26.3% in the remaining counties.

Tick species and stages are listed in the Table. Distribution of biting ticks of common species is shown in Figure 1. Seasonal distribution of tick bites by species is illustrated in Figure 2. The ages of tick bite victims ranged from 1 month to 89 years. Fifty percent of the *Ixodes cookei* ticks were removed from children under 16 years old, as opposed to 23% of *I. dammini* (odds ratio, 3.38 [95% confidence interval, CI, 2.05–5.57], $P < .001$) and 28% of *Dermacentor variabilis* (odds ratio, 2.52 [95% CI, 1.74–3.65], $P < .001$).

Ticks Removed from Humans in Maine, 1989–1990

	Hosts (n)	Ticks (n)	Larvae	Nymphs	Adults
I. dammini	120	123	2	19	102
I. cookei	217	230	24	179	27
I. muris	8	8	—	1	7
I. marxi	19	20	—	15	5
D. variabilis	276	320	—	2	318
D. albipictus	6	8	5	3	—
Total	646	709	31	219	459

Discussion

Tick surveys of deer and small rodents in Maine document the presence of *I. dammini* in widely dispersed coastal sites.[14,15] In contrast to reports from areas in which Lyme disease is highly endemic, however, this study demonstrates that *I. dammini* accounts for only a minority of tick bites in humans, even in the two Maine counties recognized as endemic in 1989. Sampling bias due to a low level of vigilance for small ticks could underestimate the abundance of *I. dammini* in an emerging area for Lyme disease, and such a bias is suggested by a low ratio of nymphal to adult *I. dammini* in this study.[1,2] However, the most common *Ixodes* tick species in our survey, *I. cookei*, is similar in size to *I. dammini*, and numerous specimens of the nymphal and larval stages of this tick were submitted.

Given the small proportion of tick bites due to *I. dammini*, the potential for exposure to Lyme disease from a tick bite in Maine is very low. As disease transmission requires attachment for 24 hours or more, many bites by disease-carrying ticks will not result in infection if the tick is removed.[16,17] One study in an area in which Lyme disease is highly endemic did not show a clear benefit from antibiotic treatment of deer tick bites, with only one of 30 untreated bites resulting in disease.[7] A second epidemiologic study of Lyme disease in outdoor workers, however, suggested a protective effect from incidental antibiotic use during summer months.[18] Our study demonstrates striking regional differences in the likelihood that a tick bite is due to a deer tick and supports the need for caution in applying results from studies in highly endemic areas to regions of lower prevalence of Lyme disease.

In contrast to previous surveys in the northeastern United States, this study documents frequent human parasitism by *I. cookei*, the "woodchuck tick." This small tick feeds on medium-sized mammals and cannot be distinguished from *I. dammini* without the aid of a dissecting microscope.[19–21] It has been reported as a

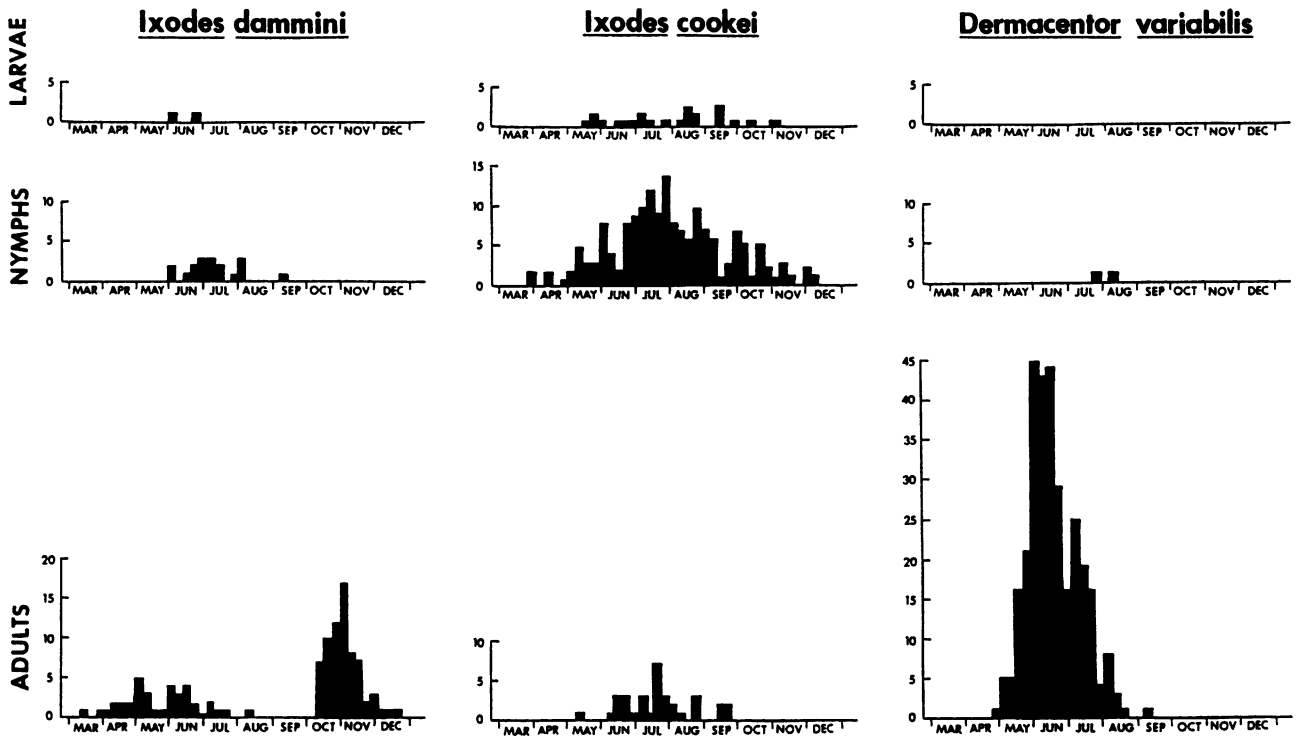

FIGURE 2—Seasonality of tick bites of common species biting humans in Maine, 1989–1990.

common cause of tick bites in Ontario, but has rarely been found to parasitize humans in other studies.[1,2,22] Although *B. burgdorferi* infection of *I. cookei* has been documented in a few tick specimens,[23] the role of this tick as a possible vector of Lyme disease has not been well studied. Unlike *I. dammini*, in its immature stages *I. cookei* does not parasitize mice.[20] *I. cookei* is a vector of Powassan encephalitis, a Group B arbovirus disease reported from upstate New York and Canada,[24,25] but not from Maine. Powassan encephalitis, although rarely diagnosed, can cause meningoencephalitis and radiculoneuritis with a spectrum of symptoms that could be confused with neurological complications of Lyme disease.[25–27]

Other small *Ixodes* species (*I. muris, I. marxi*) occasionally parasitized humans in Maine. *I. marxi* is another known vector of Powassan encephalitis.[21] The vector competence of both of these species for *B. burgdorferi* is unknown. *I. muris* feeds primarily on small rodents and could theoretically be an occasional vector of Lyme disease to humans.[28] Another mouse-feeding tick, *I. angustus*, has been cited as a vector of Lyme disease in one case report from the northwestern United States.[29] Despite its abundance on mice and red-backed voles in Maine, no examples of human parasitism by this tick were documented. *I. angustus* appears to be an unimportant vector of Lyme disease to humans in the northeastern United States.

D. variabilis, which accounted for 45% of bites, is widely distributed in southwestern Maine.[30] *D. variabilis* ticks may occasionally be infected with *B. burgdorferi*, but laboratory studies indicate that they are an ineffective vector of the disease.[31] *D. albipictus*, which is host specific for deer and moose, rarely bites humans but was in fact detached from one deer processor. It is not known to be a vector of disease to man.

Marked differences in the seasonal activity of tick species are illustrated by this study. In Maine, as in other areas of the northeastern United States, humans were parasitized by *I. dammini* nymphs in early summer and by adults in late fall.[32] The presence of biting *I. dammini* adults in late fall is of possible epidemiologic importance and may account for a bimodal peak of Lyme disease incidence reported in two previous studies.[5,33] Also of interest was the sporadic presence of biting adult deer ticks throughout the spring and summer months. These adult deer ticks, when engorged, may overlap in size with unengorged adult *D. variabilis*, for which they were sometimes mistaken by physicians. *I. cookei* infestation occurred throughout the summer, with no relationship between tick stages and month of bite. Ticks removed from humans in August and September, when active *I. dammini* are predominantly larvae, were almost exclusively *I. cookei*.

To the extent that they demonstrate changes in the abundance of *I. dammini* in emerging areas over time, surveys of human parasitism by ticks provide essential information for the development of regional public health policy regarding Lyme disease. In addition, tick identification services may highlight unexpected vectors, such as *I. cookei*, that may be the cause of other infectious diseases that could be mistaken for Lyme disease. However, because the diversity and abundance of tick species may vary markedly over small areas, depending on the presence or absence of appropriate host animals, habitat type, and other factors, the risk of exposure to Lyme disease from tick bites may vary substantially at different sites in the same region.[36]

This study underscores the need for caution in the identification of tick species. Although the majority of "small" ticks biting people in some areas of the northeastern United States may be *I. dammini*, this is clearly not the case in Maine. The identification of different tick species in the *Ixodes* genus depends on the recognition of subtle morphological differences and

requires training and experience. A lack of government and academic support for arthropod biosystematics has contributed to the paucity of entomologists or others with these skills.[37] Effective regional tick surveys, therefore, may require cooperative arrangements between state health personnel and entomologists at colleges and universities, or others with training in tick identification. □

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