Identification And Diseases Of Common U.S. Ticks

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Abstract

Background: Ticks are a major vector for cutaneous and systemic disease. In the United States, eight ticks are primarily responsible for ten different diseases. Physicians are asked by patients and other practitioners to remove and identify ticks. Accurate tick identification may be important to prevent, predict and treat tick-borne illness. We present a simple method of tick identification using six criteria. Specific tick-borne diseases are listed, as are their endemic areas and hosts.
Observation: We describe six major features from which most ticks affecting humans in the United States can be identified. The features are body shape, size, mouth parts (capitulum), color, dorsal shield (scutum) and festoons.
Conclusion: With the use of information presented, ticks affecting humans in the United States can often be identified by a physician and in difficult situations, by an entomologist, allowing the prediction and diagnosis of potential tick-borne illness and provision of appropriate patient care.

INTRODUCTION

In the United States, ticks are responsible for the transmission of more vector-borne diseases than any other arthropod. [1] Tick-borne diseases, tick regions and hosts are listed in Table I. Lyme disease now accounts for more than 95% of all reported vector-borne illness in the United States and has been documented in 48 states (16,273 reported cases in 1999) [2]. In addition to Lyme disease, tick bites in the United States have been responsible for the transmission of rocky mountain spotted fever (579 cases in 1999), Colorado tick fever (200-400 cases annually), tularemia (150-300 cases annually), ehrlichiosis (202 cases of human granulocyte ehrlichiosis and 99 cases of human monocyte ehrlichiosis in 1999), babesiosis (100+ cases reported since 1969), relapsing fever (sporadic, number unknown), Q fever (number unknown), tick paralysis (few sporadic cases), and painful tick bite reaction (number unknown). [1,2,3,4,5,6,7,8,9,10] Several tick-borne systemic infections have prominent skin findings and it is not uncommon for the physician to be consulted. If the tick remains attached to the skin or has been recovered, accurate identification, along with knowledge of endemic vector-borne diseases, can allow the physician to counsel and treat the patient appropriately. Available sources of tick identification are often difficult to use. [8,10,11] We propose a simple, rapid method of tick identification using six criteria based on published guides and personal observation. [7,8,9,10,11,12]

Figure 1

Table I: Tick Born Diseases

TICKS	DISEASES	REGIONS	HOSTS
Dermacentor andersoni (Wood tick)	Rocky mountain spotted fever Tularemia Colorado tick fever Q fever Tick paralysis	Western states south to Arizona and New Mexico	Livestock Mammals Man
Dermacentor variabilis (Dog tick)	Rocky mountain spotted fever Tularemia Q fever Tick paralysis Ehrlichiosis	Eastern two thirds of United States	Dogs Mammals Man
Ornithodoros hermsi (Relapsing fever tick) *Ornithodoros turicata* (Relapsing fever tick)	Relapsing fever	Idaho, Oregon, Washington, California, Nevada and Colorado Southwest U.S.	Chipmunks Squirrels Man
Ornithodoros coriaceus (Pajaroello tick)	Painful tick bite reaction	California	Mammals Man
Ixodes scapularis (Deer tick)	Lyme disease Ehrlichiosis Babesiosis Tick paralysis	Most of United States, especially Northeast, Upper North central and Northern California	Mammals Birds Man
Ixodes pacificus (Black-legged tick)	Lyme disease Babesiosis	Western U.S.	Livestock Mammals Man
Amblyomma americanum (Lone star tick)	Rocky mountain spotted fever Lyme disease Tularemia Tick paralysis Ehrlichiosis	East of central Texas to Atlantic coast, north to Iowa	Livestock Dogs Deer Birds Man

METHODS

Ticks known to cause human disease in the United States were obtained from the Department of Entomology at Penn State University and the Institute of Arthropodology and Parasitology, Georgia Southern University to provide a frame of reference for identification. In addition, ticks

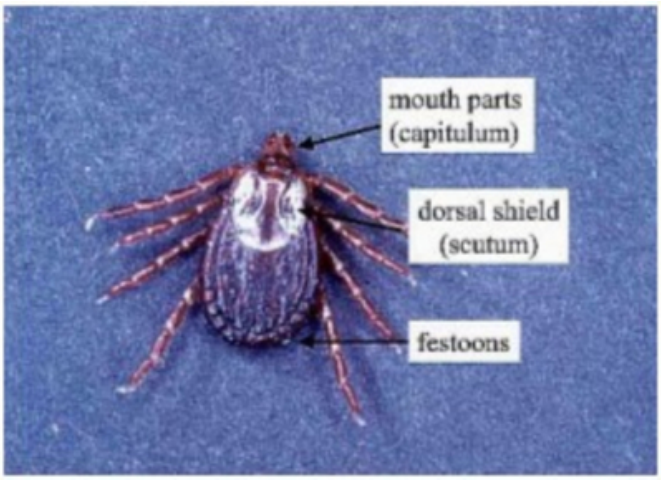
removed from or brought in by our patients, were included in this evaluation. To determine the six major identifying features, the ticks were compared and published data were reviewed. [7,8,9,10,11,12]

RESULTS

In most cases, tick identification can be made based on six major features which are shape, size, mouth parts (capitulum), color, dorsal shield (scutum), and festoons (posterior abdominal markings) [8,10,11] (Fig 1).

Figure 2

Fig 1: Dermacentor variabilis (adult female) with labeling of mouth parts, dorsal shield and festoons.



BODY SHAPE

In adult, non-engorged ticks, the three major body shapes are teardrop, full oval and rounded. One can see in the comparison photo (Fig 2) that these subtle differences are detectable. Both Dermacentor and Ixodes ticks have a teardrop shape with a tapering at the mouthparts (capitulum). Ornithodoros has a characteristic full oval body shape and Amblyomma is more rounded.

Figure 3

Fig 2: Top row left to right: Dermacentor andersoni (adult female), Dermacentor andersoni (adult male), Dermacentor variabilis (adult female) and Ornithodoros hermsii (adult).

Bottom row left to right: Ixodes scapularis (adult female), Ixodes scapularis (adult female engorged), Amblyomma americanum (adult female partially engorged) and Amblyomma americanum (adult male).

SIZE

Size is a less specific but commonly used feature for identification. Although male ticks are often somewhat smaller than female ticks, the comparison with a sesame or poppy seed is made because it provides a practical frame of reference (Fig 3). Adult Ixodes and adult male Amblyomma ticks are approximately one-half the size of a sesame seed. The larger adult Dermacentor and Ornithodoros are approximately the size of a sesame seed. The female Amblyomma is larger than a sesame seed. Ixodes nymphs are approximately the size of a poppy seed. In general, larva and nymphs are significantly smaller (Fig 4 and 5) and engorged ticks are significantly larger (Fig 2 and 5) than non-engorged adults.

Figure 4

Fig 3: Top row left to right: Ixodes scapularis (nymph) and poppy seed. Bottom row left to right: Dermacentor variabilis (adult male) and sesame seed.

Figure 5

Fig 4: Left to right: Ixodes scapularis larva, nymph and adult female.

Figure 6

Fig 5: Left to right: Amblyomma americanum larva, nymph, adult male and adult female partially engorged.

MOUTH PARTS (CAPITULUM)

Mouth parts also known as the capitulum (Fig 1). Mouth parts of soft ticks (Ornithodoros) are on the ventral surface and are not visible dorsally. For adult hard ticks, mouth parts are visible dorsally and are either short (Dermacentor), long (Ixodes) or the longest (Amblyomma) (Fig 2).

COLOR

Color is affected by tick type, sex and engorgement. Color patterns are listed (Table II) and seen in photos (Fig 2). Season or developmental stage does not appear to affect color although engorgement causes a uniform grey color.

DORSAL SHIELD (SCUTUM)

The scutum is the dorsal sclerotized plate or shield covering the anterior part of the body in female and entire dorsal surface in male hard ticks (Fig 1). Soft ticks (Ornithodoros) have a leathery or wrinkled appearance due to their lack of dorsal shield. The full dorsal shield of male hard ticks limits the increase in size with engorgement that is seen in female ticks having a partial shield. Massive blood meals taken by females provides adequate nutrition needed for egg production. Color patterns are listed (Table II) but can change with engorgement.

Figure 7

Table II: Adult Tick Identification

TICKS	SHAPE	SIZE	MOUTH PARTS (capitulum)	COLOR	DORSAL SHIELD (scutum)	FESTOONS
Dermacentor andersoni (Woodtick) and *Dermacentor variabilis* (Dog tick)	teardrop	sesame seed	short	Female- white shield & brown abdomen Male- brown with white markings *D. Variabilis* has more white	Female- partial Male- full	eleven
Ornithodoros hermsi & turicata (Relapsing fever ticks) and *Ornithodoros coriaceus* (Pajaroello tick)	full oval	sesame seed	not visible dorsally (visible ventrally)	grey	none (soft tick)	none
Ixodes scapularis (Deer tick) and *Ixodes pacificus* (Black-legged tick)	teardrop	Adult One-half sesame seed Nymph poppy seed	long	Female- black shield & brick red abdomen Male- black shield & minimal brick red	Female- partial Male- full	none
Amblyomma americanum (Lone Star tick)	rounded	Female greater than sesame seed Male One-half sesame seed	longest	Female- red-brown with white spot "star" Male- red-brown	Female- partial Male- full	yes

FESTOONS

Festoons are delicate, usually rectangular, grooves seen on the posterior edge of some hard ticks and appear as a string of pearls (Fig 1). Dermacentor and Amblyomma have

festoons present whereas Ornithodoros and Ixodes ticks do not.

DISCUSSION

BACKGROUND

Our proposed method for tick identification was developed specifically to aid in office identification of recovered ticks from humans. Identification is aided with a magnifying lens or microscope on low power. The six identifying features which include shape, size, mouth parts, color, dorsal shield, and festoons in combination with knowing endemic areas should allow determination of tick types affecting humans in the United States.

Ticks, mites, spiders and scorpions are arthropods of the class Arachnida which all have four pairs of legs as adults. Ticks belong to the subclass Acari, order Parasitiformes, and suborder Ixodida. Ixodida includes two major families, Ixodidae (hard ticks) with 13 genera and approximately 645 species and Argasidae (soft ticks) with 5 genera and approximately 170 species distributed worldwide. [13]

TICK DEVELOPMENT

Ticks go through a four-stage life-cycle which includes eggs, larva, nymphs and the adult. All stages except the egg require a blood meal from a host for transition to the next stage of development. Engorgement after a blood meal can make tick identification difficult. Hard ticks (Ixodes, Dermacentor and Amblyomma) take one very large blood meal (10-100X their body weight) only once for each stage. Soft ticks (Ornithodoros) take several smaller blood meals (up to 5X their body weight) between each stage. [13],[14] Engorgement significantly distorts features and color is often grayish.

HOST ATTACHMENT AND QUESTING

Non-nidicolous ticks (species like Ixodes and Dermacentor that occupy open, exposed habitats) will remain attached to vegetation in wait (questing) for a host. Questing and subsequent orientation to the host for attachment may involve movement, odor, sweat, color, size, carbon dioxide and other factors. Questing height is the height on vegetation located above ground where a tick can position for attachment to a passing host. Although few have studied questing height, host specificity is the likely determinant. Ixodes pacificus positions at a mean height of 55 centimeters above the ground to allow contact with a passing deer or medium-sized mammal. Larval and nymphal Dermacentor variabilis quest near the base of vegetation or leaf litter to allow contact with mice, voles, and other small mammals. The adult Dermacentor variabilis quest higher for contact with raccoons, foxes, dogs or even man. Larval and nymphal Ixodes scapularis quest near the ground in brush locations or at the edges of wooded areas to allow contact with the white-footed mouse or other small mammals. Adult Ixodes scapularis ticks tend to quest in brush at around one meter to allow contact with the white-tailed deer. [7]

Once attached to the host, the tick will often take several hours to find the desired location for attachment. Attachment is then initiated with the use of toothed chelicerae which perform as cutting tools to allow penetration of a barbed hypostome which acts as a barbed hypodermic needle. A cement-like substance is secreted during the first few hours of the attachment process to hold the hypostome in place until feeding is complete over several days to two weeks. The tick will then detach, fall off and use the nutrition gained from the blood meal to advance to the next stage of development, or in the adult female, lay eggs.[7],[8],[9],[10]

TICK-BORNE ILLNESS TRANSMISSION TIME

The ultimate outcome after a tick bite can include a local reaction, possible infection and rarely tick paralysis. Infectious agents can be transmitted to the host via infected saliva only after sufficient attachment time to the host. Stages of tick development (larva vs. nymph vs. adult) affect disease transmission. Ixodes scapularis nymphs are more likely to transmit Lyme disease than adult ticks[1]. An engorged tick signifies longer attachment time and increased risk of disease transmission. For example Ixodes scapularis usually requires undisturbed attachment and feeding for approximately 24 to 48 hours before the spirochete Borrelia burgdorferi can be transmitted and cause Lyme disease. [15] Ornithodoros requires less than one hour of attachment time, usually at night, to transmit the Borrelia spirochete causing Relapsing fever. [16] Ticks causing tick-paralysis such as Dermacentor andersoni usually require 5 to 7 days of attachment time before ascending paralysis occurs. [7]

LYME DISEASE

The most prevalent tick-borne disease in the United States is Lyme disease or Lyme borreliosis. It is now reported in 48 states. [2] The hard tick, Ixodes scapularis, is the main vector for Lyme disease. Most tick researchers consider Ixodes dammini (occurring in the Northeast and upper Midwest) the same as Ixodes scapularis. This conforms to the standard code of rules of the International Commission of Zoological Nomenclature. [16] Older references will still refer to Ixodes

scapularis as Ixodes dammini.

Ixodes scapularis tends to be widely distributed in temperate regions with woodlands, brush, and grassy vegetation where there is protection from dehydration. The tick may be absent in groomed residential areas but present in adjoining woodlands inhabited by appropriate vertebrate species. They typically complete their four-stage life cycle in two to three years. [15] Eggs hatch to larva, which seek a host often the white-footed mouse (Peromyscus leucopus) and feed for three to seven days. Mice that harbor Borrelia can then infect the larva. Larva drop and molt (shed its' cuticle) to the nymph stage. Nymph seeks a host and feed for three to four days in late spring or early summer. Since Ixodes can feed on almost any vertebrate, unlike many host specific ticks, humans can become a host and potentially acquire Lyme disease from the nymph. Between 10% and 90% of Ixodes scapularis ticks may be infected with Lyme borrelia.[15] The risk of Lyme disease after the bite of an infected tick has been reported to be less than 10%. [15] Nymphs then drop from their host and molt to an adult. In northeastern U.S., adult females often feed in the autumn. Adult males guided by phermones find a host, often the white-tailed deer (Odocoileus virginiana) in order to find a female to mate. Mating occurs often on the host and throughout engorgement of the female over eight to eleven days after which the female will fall off the host to lay thousands of eggs before she dies. [15] Humans can be bitten by all stages of the tick but Lyme disease mainly results from nymphal biting from May to August. Adult ticks can transmit Lyme disease but usually later in the year. In western United States, Ixodes pacificus nymphs and larva feed from March to June and adults feed from November to May. [15]

SOFT TICKS

Soft ticks like Ornithodoros usually feed on one type of animal during their lifetime. They tend to stay near the habitations of the host animal. Sheltered burrows, dens, nests and resting places of the host are favored locations with intermittent feeding upon host return. Humans are usually bitten by entering a cave, crawling under a building or sleeping in primitive cabins, all areas where host rodents nests are located. Ornithodoros ticks can live up to fifteen to twenty years and can survive without blood meals for several years. [16] The risk of relapsing fever after a bite from an infected Ornithodoros ticks is 50% or higher. [16]

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