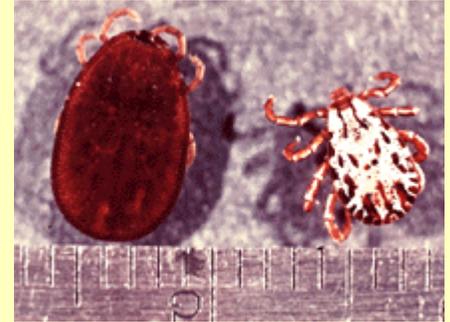


Background Information on the Biology of Ticks

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Ticks are blood feeding external parasites of mammals, birds, and reptiles throughout the world. Approximately 850 species have been described worldwide (Furman and Loomis 1984). There are two well established families of ticks, the Ixodidae (hard ticks), and Argasidae (soft ticks). Both are important vectors of disease causing agents to humans and animals throughout the world. Ticks transmit the widest variety of pathogens of any blood sucking arthropod, including bacteria, rickettsiae, protozoa, and viruses. Some human diseases of current interest in the United States caused by tick-borne pathogens include Lyme disease, ehrlichiosis, babesiosis, rocky mountain spotted fever, tularemia, and tick-borne relapsing fever.



Soft tick (left) and Hard tick (right)

Hard Ticks: Family Ixodidae

Hard ticks have three distinct life stages. Larvae which emerge from the egg have six legs. After obtaining a blood meal from a vertebrate host, they molt to the nymphal stage and acquire eight legs. Nymphs feed and molt to the next and final stage - the adult, which also has eight legs. After feeding once more, the adult female hard ticks lay one batch of thousands of eggs and then die. Only one blood meal is taken during each of the three life stages. The time to completion of the entire life cycle may vary from less than a year in tropical regions to over three years in cold climates, where certain stages may enter diapause until hosts are again available. Many hard ticks can go for several months without feeding if not unduly duressed by environmental conditions.

The mouthparts of hard ticks are readily visible from above. There are three visible components: the two outside jointed parts are the highly mobile **palps**; between these are paired **chelicerae**, which protect the center rod-shaped structure, the **hypostome**. The palps move laterally while the tick is feeding and do not enter the skin of the host. The rough hypostome has many beak-like projections on it. This is the structure which plunges into the host's skin while feeding. The backward directed projections prevent easy removal of the attached tick. In addition, most hard ticks secrete a cement-like substance produced by the salivary glands which literally glues the feeding tick in place; the substance dissolves after feeding is complete.

Hard ticks seek hosts by an interesting behavior called "questing." Questing ticks crawl up the stems of grass or perch on the edges of leaves on the ground in a typical posture with the front legs extended, especially in response to a host passing by. Certain biochemicals such as carbon dioxide as



well as heat and movement serve as stimuli for questing behavior. Subsequently, these ticks climb on to a potential host which brushes against their extended front legs. Hard ticks are most commonly collected for research by the use of "flags" or "drags" which are made from 1 m square pieces of roughly textured fabric such as fleece or flannel attached to a rod handle. The flags are slowly dragged across the surface of vegetation to collect questing ticks. Hard ticks feed for extended periods of time on their hosts, varying from several days to weeks, depending on such factors as life stage, host type, and species of tick. The outside surface, or cuticle, of hard ticks actually grows to accommodate the large volume of blood ingested, which, in adult ticks, may be anywhere from 200-600 times their unfed body weight (Sonenshine 1991).



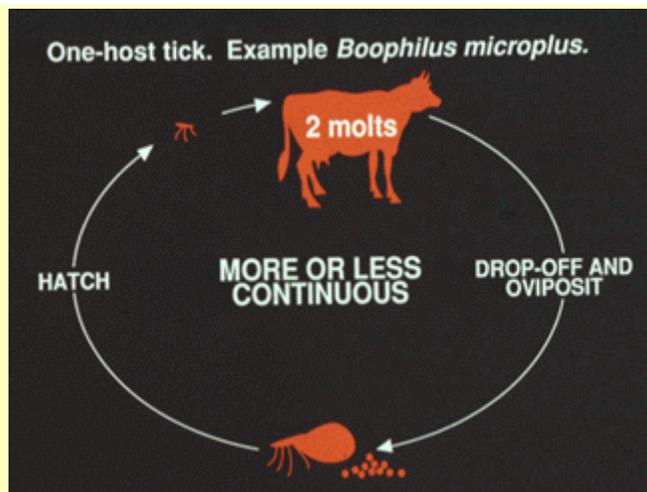
Questing Hard Tick

(*Ixodes scapularis*)

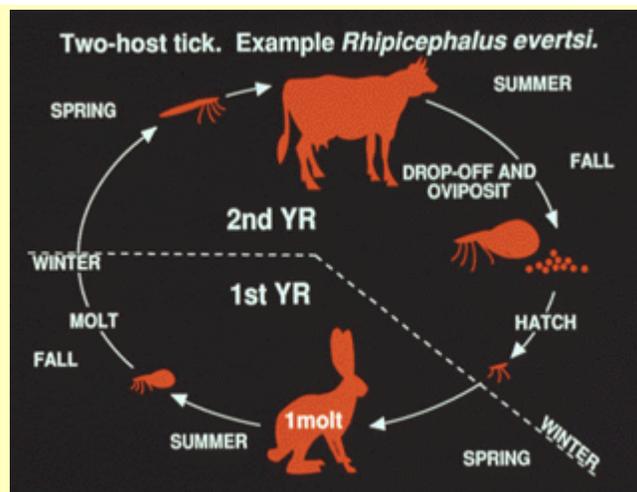
Scanning Electron Micrograph of Tick Mouthparts

Lifecycles of Hard Ticks

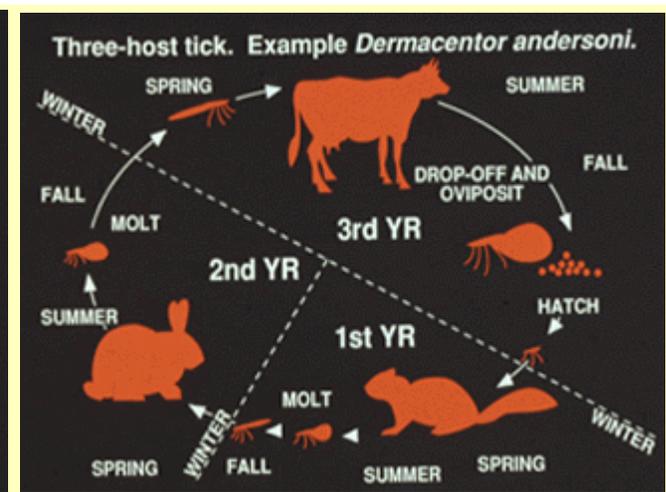
Hard ticks have a variety of life histories with respect to optimizing their chance of contact with an appropriate host to ensure survival. Some ticks feed on only one host throughout all three life stages. These ticks are called **one host ticks**. This type of tick remains on one host during the larval and nymphal stages, until they become adults, and females drop off the host after feeding to lay their batch of eggs. Other ticks feed on two hosts during their lives and are called **two host ticks**. This type of tick feeds and remains on the first host during the larval and nymphal life stages, and then drops off and attaches to a different host as an adult for its final blood meal. The adult female then drops off after feeding to lay eggs. Finally, many ticks feed on three hosts, one during each life stage, and are appropriately named **three host ticks**. These ticks drop off and reattach to a new host during each life stage, until finally the adult females lay their batch of eggs. In each case, the fed adult stage is terminal, that is, after laying one batch of eggs the female dies, and after the male has reproduced, he dies as well.



One Host Tick Lifecycle



Two Host Tick Lifecycle



Three Host Tick Lifecycle

Soft Ticks: Family Argasidae

The life stages of soft ticks are not readily distinguishable. The first life stage to come out of the egg, a six legged larva, takes a blood meal from a host, and molts to the first nymphal stage. Unlike hard ticks, many soft ticks go through multiple nymphal stages, gradually increasing in size until the final molt to the adult stage. Some soft ticks pass through up to seven nymphal molts before they become adults. Soft ticks feed several times during each life stage, and females lay multiple small batches of eggs between blood meals during their lives. The time to completion of the entire life cycle is generally much longer than that of hard ticks, lasting over several years. Additionally, many soft ticks have an uncanny resistance to starvation, and can survive for many years without a blood meal (Furman and Loomis 1984).

The mouthparts of soft ticks are not readily visible from above. There are three visible components: the two outside jointed parts are the highly mobile **palps**; between these are paired **chelicerae**, which protect the center rod-shaped structure, the **hypostome**. The palps move laterally while the tick is feeding and do not enter the skin of the host. The rough hypostome has many beak-like projections on it. This is the structure which plunges into the host's skin while feeding. The backward directed projections prevent easy removal of the attached tick.

Some soft ticks seek hosts by questing on low-lying vegetation, but the vast majority are nest parasites, residing in sheltered environments such as burrows, caves, or nests. Certain biochemicals such as carbon dioxide as well as heat and movement serve as stimuli for host seeking behavior. Soft ticks feed for short periods of time on their hosts, varying from several minutes to days, depending on such factors as life stage, host type, and species of tick. The feeding behavior of many soft ticks can be compared to that of fleas or bedbugs, as once established, they reside in the nest of the host, feeding rapidly when the host returns and disturbs the contents. The outside surface, or cuticle, of soft ticks expands, but does not grow to accommodate the

large volume of blood ingested, which may be anywhere from 5-10 times their unfed body weight (Sonenshine 1991).

Soft ticks can be readily collected via dry ice traps. Blocks of dry ice emit large amounts of carbon dioxide, a host seeking stimulant. Traps are set in and around nesting areas of animal hosts. Soft ticks can be observed running along the surface of the ground towards the trap and are collected by hand, or inside a collection chamber in the trap. Many types of soft ticks can be artificially fed in the laboratory, thus reducing or eliminating the use of animals for certain studies. Some (ie: *Ornithodoros coriaceus*) will feed through sausage casings filled with almost any type of mammal blood heated up to 37° C. Others can be fed blood through various types of membranes in the presence of biochemical and environmental feeding stimulants such as ATP, carbon dioxide, heat, and animal fur (Sonenshine 1993).

[Commonly Encountered Ticks in California](#)

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