# General

Ticks are small animals related to mites, scorpions and spiders. Ticks are also known as Metastigmata.

Ticks differ from insects. Their bodies are divided into two parts rather than three. Ticks do not have antennae nor wings. The adults have eight legs instead of six. Ticks have 6 legs in the larval stage (nymphs and adult ticks gain a pair of hind legs). Ticks that have climbed onto grass or other plants become aware of their potential host by vibration, warmth, $CO_2$, moisture and smell (all mammals secrete butyric acid). They remain attached to feathers, fur, skin or clothing, after which they seek a suitable place to suck blood.

There are two types of life cycles. In some species of tick, the larva, nymph and adult remain on the same, individual host not dropping to the ground between stages. In others, the different stages feed on 2 or 3 different individuals. The host can be identified by the origin of the blood in the tick's stomach, e.g. by PCR analysis. Ticks with a host change are usually better vectors for pathogenic organisms.

**Tick species**

There are approximately 840 different species of ticks which are classified into 3 families:

- Argasidae: argasids or soft ticks, with a tough, leathery skin and a concealed ventrally projecting capitulum (± 170 species). There is no scutum in adult animals. A scutum is a dorsal shield.
- Ixodidae: ixodids or hard ticks have a rigid scutum and a capitulum with mouthparts projecting forwards (± 670 species). This capitulum is visible when viewed from dorsal.
- Nutalliellidae

**Overview of tick genera in the three families**

- Argasidae : *Argas, Ornithodoros, Otobius, Antricola, Nothoaspis*
- Ixodidae : *Amblyomma, Aponomma, Boophilus, Cosmiomma, Dermacentor, Haemaphysalis, Hyalomma, Ixodes, Margaropus, Nosomma, Rhipicentor, Rhipicephalus*

- Nutalliellidae : only 1 species, rare

## Ticks as vectors

Ticks are always obligate blood suckers, in contrast to mites which occupy much more varied ecological niches. All ticks need blood to complete each stage of their development. The chelicera dilate the skin, so that the hypostome can be inserted. This hypostome is equipped with barbs to keep them anchored in place and thus permit them to suck blood for several days in case of hard ticks. Many ticks cement their mouth parts to the skin for better attachment. This cement needs to be enzymatically broken down when they detach.

Ticks can be important vectors of various infectious organisms for humans (including protista such as babesias; viruses such as Crimean-Congo haemorrhagic fever or tick-borne encephalitis and bacteria such as *Borrelia*, *Rickettsia*, *Ehrlichia/Anaplasma*). Ticks can also transmit diseases in animals: Q fever (*Coxiella burnetii*), theileriosis (*Theileria* sp.), cowdriosis (heartwater, *Cowdria* sp.), dermatophilosis (*Dermatophilus congolensis,* a bacterium), anaplasmosis, babesiosis, sweating sickness (toxin of *H. truncatum*) and a number of others. The micro-organisms, ticks and their usual natural hosts have developed together over the course of thousands of years with mutual adaptation as a result. As a general rule, the microbes cause little or no damage to the tick and usually persist for the whole of the vector’s life. There is often trans-stadial transmission (from larva to nymph to adult) and sometimes transovarian transmission (from tick to eggs, so the following generation is born infected). The micro-organisms usually have little effect on the natural vertebrate hosts. Many of these warm-blooded animals act as a lifelong reservoir and as an amplifier for both pathogens and ticks. Poorly adapted hosts such as humans, often develop diseases following accidental infection with a pathogenic micro-organism. The term “adaptation” can be open to misinterpretation. It is not the case that the long-term persistence of a pathogen in a specific population automatically entails the reduced virulence of this organism.

A significant obstacle for all ticks in obtaining a blood meal is counteracting the haemostatic system of the host, such as thrombin, factor X and platelet aggregation. Ticks have several antihaemostatic agents which are essential for their survival. These products are present in salivary glands, as expected, but also in eggs and haemolymps. It appears that their

function is not only to prevent blood clot formation in the host and the blood meal but also to regulate hemolymph coagulation in the tick itself. Besides thrombin-inhibitors, inhibitors of tissue factor and factor X or Xa, tick saliva contains a plethora of vasodilators, platelet inhibitors, fibrin (ogen)olytic agents and immunomodulators.

## Ticks, Argasidae

Soft tick, Ornithodoros moubata. Copyright ITM

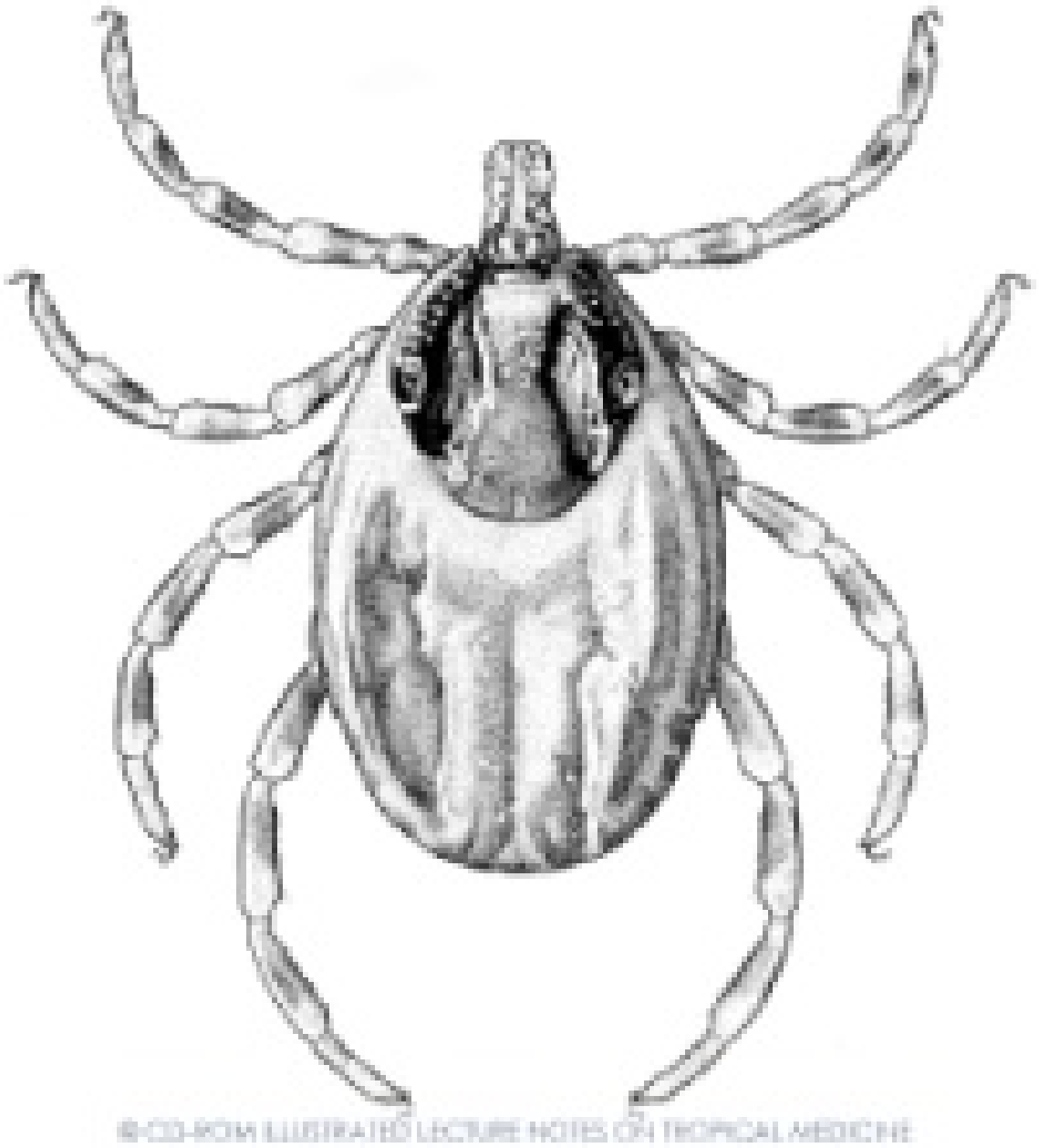
**Argasids** take short (a few minutes) but repeated feeds. After feeding excess water in the blood meal is eliminated partly in the saliva and partly as coxal fluid (e.g. in *Ornithodoros moubata* – syn. *Ornithodorus moubata*). This coxal fluid is secreted by specialised glands between the first and second pairs of legs in the soft tick. *Borrelia duttoni* can be found in this fluid. When this fluid is rubbed into the bite wound an infection can follow. Argasids can cause persistent pruritus at the site of the bite. Some will suck blood from humans if their natural host disappears (e.g. *Argas vespertilionis*, a bat tick). *Argas reflexus* is a tick which came originally from Middle Eastern countries and has now spread throughout Europe and large parts of Asia via the domesticated pigeon, the host for this animal. Other hosts are hens and ducks. The adults can survive for months to years without a blood meal. Humans can be bitten when visiting an abandoned dovecote. The bite is often painful and the skin will swell and redden.

## Ticks, Ixodidae

**Hard ticks (Ixodidae)** are dispersed world-wide. There are 13 genera, of which *Ixodes,*

*Dermacentor, Rhipicephalus, Haemaphysalis, Hyalomma* and *Amblyomma* are the most well-known.


Hard ticks. There are four morphological stages: (left to right) larva, nymph, adult male and female. Copyright ITM



Hard tick: female *Hyalomma aegyptium*. Copyright ITM

The ticks have a hard scutum (dorsal shield) that in the adult male covers the whole back. Males can only suck a limited quantity of blood. The scutum of the female is also hard and cannot distend. It is however smaller so that remarkable distension of the animal's body is possible when it takes a large blood meal.

They feed for 6-12 days. It is very important for the tick that during this period it should not be noticed by the host. Tick bites are painless, since a component of the tick's saliva reduces the sensitivity of the receptors in the host's skin. The males remain on the host for several weeks to months. After the adult female is sated, she falls to the ground in order to lay her eggs. After laying the eggs the female dies. A six-legged larva emerges from the egg and waits for a long time on the ground or on vegetation until a host passes to which it can attach itself. The larva takes one large blood meal over a period of 4 to 6 days.

An eight-legged nymph then develops from the larva, which afterwards develops into an adult animal following a subsequent blood meal (duration 5-8 days). The life cycle of most hard ticks lasts 2 years.

The longer the tick remains in place and sucks blood, the larger the quantity of micro-organisms which are transmitted. For example, transmission of Lyme disease is unlikely if the tick is removed rapidly.

This is in contrast to the Argasidae, where infections such as relapsing fever can be relatively rapidly transmitted as these animals have a different feeding behaviour. The attachment time needed for transmission of *Borrelia burgdorferi* is much shorter in European ticks than in American ticks.

## Tick paralysis

The saliva of some ticks is neurotoxic and "tick paralysis" can occur. This has been described for 60 different tick species in animals, but only a few are important for humans: in the USA and Canada *Dermacentor variabilis* and *D. andersoni* and in Australia *Ixodes holocyclus*, a marsupial tick. Paralysis occurs in animals (dogs, sheep) and humans. Usually the tick needs to have been present for 4 (2-7) days before the symptoms appear. The neurotoxin is still poorly characterised, but it prevents the release of acetylcholine from the pre-synaptic membrane (cf. botulinum toxin). The condition presents as a flaccid, ascending paralysis with areflexia and with bulbar involvement and ataxia, without neck stiffness and without sensory disorders. Unsteady jerky movements of the limbs and breathing difficulties occur. The paralysis is more pronounced in children younger than 10 years, probably because of their smaller body weight. Evolution towards death is possible (respiratory failure). The disorder

can resemble poliomyelitis, but motor involvement is symmetrical. Consciousness is clear. It can also resemble Guillain-Barré syndrome, including the EMG findings. On removal of the tick there is a progressive recovery over the course of the following hours to days.

## Prevention

Prevention of infections transmitted by ticks includes the avoidance of areas where there are ticks. Argasids are often found in mud huts, campsites or places where pigeons or bats nest. It is best not to sleep on the floor and if possible to avoid such places entirely. The use of concrete or plaster in houses diminishes the population of soft ticks. Hard ticks are found in places where domestic or wild animals (including birds) congregate, drink, feed or rest. It helps to tuck trousers into socks, wear dark clothing (attracts ticks less) and to wear permethrin or DEET impregnated cloths. A ‘skin-check’ after a walk through dense vegetation is useful.

## Removing ticks

Hard ticks are relatively difficult to remove without damaging them. They have barbs on their hypostome (a section of the mouthparts). Tick larvae are small (<1 mm) and colourless before they suck any blood. They should be removed carefully with tweezers, without squashing them. The tick should be grasped as close as possible to the site of attachment in order to minimise the risk of the mouthparts breaking off and remaining embedded in the skin. The broken-off mouthparts of a tick can cause irritation and local infection. They should be scraped out and the wound disinfected e.g. with alcohol or povidone-iodine. It is sometimes claimed that applying vaseline, butter or fat to the animal (interfering with respiration) causes the tick to react by detaching itself from the skin, after which it can be removed more easily. While this does apply to the removal of fly larvae (myiasis), it is less straightforward in ticks. Burning the animal with a cigarette is not indicated: it can cause burns (particularly in children and pets), the tick might burst, thus spreading infectious material, and finally heat encourages the tick to produce more saliva and regurgitation.

**Diseases transmitted by ticks**

**Soft ticks**

Relapsing fever: *Borrelia duttonni* via soft ticks such as *Ornithodoros moubata*

**Hard ticks**

1. Lyme disease: *Borrelia burgdorferi*
2. Rickettsioses: various types such as Rocky Mountain Spotted Fever, fièvre boutonneuse, Queensland tick typhus, Japanese spotted fever, Israeli tick typhus, Siberian tick typhus, Flinders Island spotted fever, Mongolian spotted fever
3. Ehrlichioses and the related anaplasmosis: monocytic (*E. chaffeensis*) and granulocytic (bacteria related to *E. equi*).
4. Arboviral meningo-encephalitis: TBE (FSME and RSSE), Looping ill, Powassan encephalitis, Colorado Tick Fever (= orbivirus)
5. Arboviral haemorrhagic fever: Crimean-Congo HF, Omsk HF, Kyasanur HF
6. Febrile atypical syndrome: Colorado tick fever, Kemerovo tick fever
7. Babesiosis, e.g. *Babesia divergens, B. gibsoni, B. microti*
8. Tularaemia, caused by *Francisella tularensis*
9. Tick paralysis: paralysis from neurotoxic substances (e.g. holocycline) in tick saliva