Theileria parva infections

Author: Dr Hein Stoltsz

Adapted from:


Licensed under a Creative Commons Attribution license.

Epidemiology

Buffalo-derived T. parva is morphologically and serologically indistinguishable from cattle-derived T. parva and has an identical life cycle. It is mainly transmitted by R. appendiculatus, although R. zambeziensis replaces R. appendiculatus as the vector in the more arid areas of southern Africa. Epidemiological evidence suggests that in Angola the disease is transmitted by R. duttoni.

View an animation on Theileriosis (http://preview2.bluematrix.co.za/sites/default/files/Theilerioses/animation/theileriosis-animation.swf)

Theileria parva, the causal organism of East Coast fever, alternates between cattle and the tick in its life cycle. The sexual stage of development occurs in the gut of the tick following ingestion of piroplasms in the erythrocytes of the ox. Completion of development occurs in the immature stages of the tick only after they have detached from the host. As the tick moults, a club-shaped motile kinete forms within the zygote. This is liberated into the body cavity and migrates to the salivary glands via the haemolymph. The kinete invades an epithelial cell of the salivary gland, and develops into a large syncytial sporoblast within which many thousands of minute elongated sporozoites develop during the early part of the next feeding stage of the tick.

The sporozoites are liberated into the saliva and inoculated into the skin of the ox as the tick feeds. They enter lymphocytes and develop within them, becoming multinucleate schizonts after a period of about three days. Differentiation into the schizont stimulates the host lymphocyte to transform into a lymphoblast and thereafter the schizont divides in synchrony with the host cell as it undergoes mitosis. Schizont-infected cells proliferate exponentially, becoming distributed throughout the lymphoid system, with metastasis of infected cells to non-lymphoid tissues also occurring. Initially the schizonts have large chromatin particles and are called macroschizonts. The macroschizont is often known as a "Koch’s body" or a "Koch’s blue body", the latter name emphasizing its appearance when stained by a Romanowsky technique. Later, a generation of schizonts called microschizonts develops with small chromatin particles.
Merozoites liberated from the microschizonts invade the erythrocytes, in which they are frequently referred to as piroplasms, thus completing the life cycle.

Schizonts are found intracellularly in lymphoblasts in lymphoid tissues throughout the body (including lymph nodes, spleen, thymus, Peyer’s patches and the lymphoid aggregations in parenchymatous organs which are a feature of theilerial infections) as well as in the blood.

The majority of intra-erythrocytic piroplasms are rod-shaped, but round or oval forms are also seen. Although usually single, there may be several parasites in one erythrocyte in heavy infections.

Impression smear from prescapular lymph node: drawing of lymphoblasts and lymphocytes containing macro- and microschizonts. Note several schizonts are extracellular after disintegration of lymphocytic cells

*Theileria parva* depends on its vector tick *R. appendiculatus* for transmission from host to host. The potential distribution of East Coast fever is thus restricted to those areas of eastern, central and southern Africa where ox and tick co-exist. In eastern and central Africa, this includes much of Kenya, Uganda, Rwanda, Burundi, the eastern part of the Democratic Republic of Congo, areas of southern Sudan bordering Uganda and much of Tanzania. In southern Africa its range is more limited, and it is confined to the northern and central regions of Malawi, the northern, eastern and central regions of Zambia, and the Tete Province of Mozambique, all lying to the north of the Zambezi River.

*Theileria parva* is probably originally a parasite of African buffalo (*Syncerus caffer*), which has become adapted to cattle. It has been found to infect waterbuck (*Kobus defassa*) under natural conditions, and the Asiatic buffalo (*Bubalus bubalis*) under experimental conditions. It is not infective to other ungulates, nor to any species of laboratory animal.
The classical disease is seen in cattle of European origin which have been exposed to infected ticks. Cattle of African origin have a very variable response to infection and the disease may be insignificant or subclinical in Zebu calves born from immune dams and raised in endemically infected areas.

Within the infected areas, the incidence of the disease can vary widely depending on numerous factors, including the abundance of the vector and the susceptibility of the host. This situation is commonly referred to as endemic stability. However, endemic stability to *T. parva* infection appears to be relatively limited in its distribution and may not be achieved easily. The more common situation seen in the region is that of endemic instability, in which varying degrees of clinical disease are experienced.

Epidemic East Coast fever occurs when the disease is introduced to areas previously free of the disease, and often occurs on a seasonal or secular basis at the margins of *R. appendiculatus* distribution.

In the field, transmission of East Coast fever takes place only through the medium of the tick vector. The natural vector is *R. appendiculatus*, a common parasite principally infesting the ears of cattle and other herbivores in the more humid areas of southern and eastern Africa.

Zimbabwe theileriosis occurs sporadically on the highveld of Zimbabwe during the period December to May. The strictly seasonal occurrence of clinical disease coincides with the seasonal distribution of adult *R. appendiculatus*. Development of antibodies to *T. parva* has been demonstrated in cattle in the field during the period September to November, indicating that transmission by nymphs, which has been demonstrated experimentally, may cause subclinical infection.

Most cases occur between January and March and the disease usually affects cattle over the age of one year; it is rarely seen in calves. Primary outbreaks usually occur in herds with a moderate to heavy tick burden and are often associated with new additions to the herd. The disease may appear in the resident cattle (suggesting initiation of infection by introduced carriers) or in the introduced cattle (suggesting introduction of susceptible animals into an endemically stable environment). Morbidity in an outbreak is usually less than 10 per cent. The disease is likely to recur each year on an infected property unless good tick control is achieved, but shows little tendency to spread to neighbouring properties.

Serological evidence suggests that infection with the parasite is widespread in both the highveld and lowveld of Zimbabwe. It is not yet known whether the limited occurrence of clinical disease, in spite of the widespread prevalence of infection, is evidence of the existence of avirulent strains of the parasite or of an endemically stable balance between virulent strains and cattle.

Other members of the genus *Rhipicephalus* and several *Hyalomma* spp. have been shown to be capable of transmitting *T. parva* in laboratory conditions. There is, however, no evidence to suggest that any tick other than *R. appendiculatus* plays a significant role in transmission of the disease in nature.

*Rhipicephalus appendiculatus* is a three-host tick, and transmission of *T. parva* is achieved only by nymphs infected during the preceding larval stage or by adults infected during the preceding nymphal
Livestock Health, Management and Production › High Impact Diseases › Vector-borne Diseases ›.

*Theileria parva* Infections

stage. Ticks will transmit infection if, during the preceding stage of development, they have fed on an ox with circulating piroplasms. Infective cattle may be clinically ill, recently recovered, or persistent carriers. Transovarial transmission does not occur, nor is there transmission between larva and adult if the intervening nymph feeds on a non-susceptible host.

Artificial transmission of *T. parva* can be achieved by the inoculation of a suspension of sporozoites prepared from homogenized tick salivary glands or whole ticks, the so-called GUTS (ground-up tick supernatant) preparation. The method is widely used for the characterization of isolates of *T. parva* in cattle and for the infection and treatment method of immunization. A second method of artificial transmission is by the inoculation of schizonts. Infection can be transmitted to recipient cattle when very large numbers of infected donor cells are administered subcutaneously. The critical factor appears to be the ability of the inoculated cells to survive for a sufficient period for the parasite to transfer to the recipient host cells — this depends on the degree of histocompatibility between donor and recipient.

Transmission of *T. parva* by the inoculation of blood can be achieved but the results are very erratic as success depends on the presence of sufficient numbers of infected lymphoblasts in the circulation.

Buffalo-derived *T. parva* can be considered to be a group of *T. parva* strains which are adapted to tick transmission within the African buffalo population, including the red dwarf buffalo (*Syncerus caffer nanus*), wherever a suitable tick vector of the parasite occurs. It is universally distributed in wild buffalo throughout eastern, central and southern Africa, except in the Addo Elephant National Park in South Africa. It is usually non-pathogenic in this species although fatal disease can occur following experimental infection. The parasite persists indefinitely in infected buffaloes in both schizont and piroplasm form and can be recovered consistently by tick transmission or culture of lymphocytes from such animals.

Buffalo-derived *T. parva* is not well adapted to the ox and, when transmission from buffalo to ox occurs, it usually fails to complete its development; many cattle die before sufficient time has elapsed for development of piroplasms, and in those that survive, piroplasms are very scanty and recovered animals are not commonly infective for ticks. In southern Africa the disease is self-limiting within a population of cattle once it is removed from the source of infection. Onward transmission from cattle has been demonstrated experimentally and in eastern Africa repeated passage of infection in cattle has resulted in a change of the character of the organism on a number of occasions, the parasite behaviour and the disease that it causes becoming indistinguishable from classical East Coast fever. This change is attributed to a "transformation" of the parasite as it adapts to the ox, but an alternative explanation, namely that the phenomenon represents selection of a *T. parva* strain from a mixed population in the buffalo, must also be considered. There is no evidence that "transformation" of buffalo-derived *T. parva* occurs in the region south of the Zambezi River, where classical East Coast fever is absent. This may reflect the infrequent contact between buffalo and cattle in the region. Furthermore, the seasonal appearance of the various tick stages reduces the likelihood of an animal being infected by one stage and infection being acquired by the following stage, since piroplasms are present only transiently and at a low level. In contrast, in eastern Africa, all tick stages may be present on the animal at the same time.
Buffalo-derived *T. parva* has been shown to infect a waterbuck (*Kobus ellipsiprymnus defassa*) from which infection was transmitted to ticks; this was not achieved using cattle-derived *T. parva*. Buffalo-derived *T. parva* will also infect and cause fatal disease in the Asiatic domestic buffalo (*Bubalus bubalis*).

Buffaloes in *T. parva* endemic areas become infected soon after birth and the vast majority survive to become extremely efficient carriers of *T. parva* and remain so even in the absence of reinfection. Almost all buffaloes in endemic areas in eastern Africa are *T. parva* carriers and ticks feeding on carrier buffaloes become heavily infected. Corridor disease occurs only in cattle that graze pastures on which African buffaloes are or have recently been present. Such situations occur where buffaloes and cattle regularly share the same pasture, where cattle are moved into or through buffalo areas or where buffaloes stray from their natural habitat or game reserves into farming areas. It is not always easy to detect the presence of wild buffaloes in a farming area. They may travel long distances and remain hidden in wooded areas, and the presence of a single buffalo for a relatively short period may be sufficient to cause a serious outbreak of disease amongst the cattle.

Possibilities for infection occurring in southern Africa are limited as buffaloes do not usually inhabit densely populated or intensively farmed land. Contact is most common in the vicinity of game parks or in extensive cattle-raising areas with a substantial wildlife population. Increasing density of human population and the policy of prohibiting buffalo/cattle contact as a foot and mouth disease control measure are likely to reduce the prevalence of the disease progressively in the future. However, in South Africa game ranching in conjunction with or in the absence of cattle is becoming increasingly more popular in certain areas. As one of the so-called “Big Five” African game trophy animals, the buffalo is amongst the most sought-after game species for introduction to many game farms and game conservation areas in South Africa. Buffaloes which are Corridor disease- and foot and mouth disease-free are in short supply for stocking purposes and consequently have an exceedingly high commercial value.

In eastern Africa, the absence of game fences, the mode of life of cattle-keeping pastoralist communities and the widespread distribution of the buffalo populations all contribute to Corridor disease being a more significant problem.