Theileriosis

Introduction
Theileriae are obligate intracellular protozoan parasites that infect both wild and domestic Bovidae throughout much of the world (some species also infect small ruminants). They are transmitted by *Ixodes* ticks, and have complex life cycles in both vertebrate and invertebrate hosts. Of the many Theileria species that infect cattle, the two most pathogenic and economically important are *T. parva* and *T. annulata*. *T. parva* occurs in sub-Saharan Africa causing East Coast fever (ECF), whilst *T. annulata* (Tropical/Mediterranean Theileriosis) occurs in southern Europe as well as North Africa and Asia. Other species cause milder forms of theileriosis in cattle.

Prevalence in India
A review of literature on the incidence of theileriosis in India over the last four decades gives a varied range from 0.2 to 71% and 3.5-15% in cattle in field and farm conditions respectively. The details are given in the table. Though theileriosis is uncommon in the Himalayan region, an outbreak has been reported in a herd of Holstein crossbred cows maintained at Graphic Era University, Dehradun, Uttarakhand, India, purportedly due to introduction of native *T. annulata* schizonts (in WBC) and piroplasms (in RBC) in a blood smear (Giemsa staining).

<table>
<thead>
<tr>
<th>No</th>
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</table>
Red Sindhi cows to the herd. (Kohli et al. 2013)

**Transmission**

*T. annulata* is transmitted by ticks of the genus *Hyalomma*. (below)

Ticks can remain infected on the pasture for up to 2 years, depending on the climatic conditions. The disease is not maintained in the absence of these field vectors.

Transovarial transmission does not occur with either *T. parva* or *T. annulata*.

Inside the host, theileria sporozoites undergo a complex life cycle involving the replication of schizonts in leukocytes and piroplasms in erythrocytes. Cattle that recover from theileria infections usually become carriers.

**Infection source**

Sporozoites in salivary glands of infected *Hyaloma* ticks are the main infection source. In tropical theileriosis infected cattle, schizonts occur in spleen, lymph nodes, liver and whole blood (mononuclear cells) and transmission occurs readily by inoculation of schizonts.

However such transmission is erratic in ECF infected animals.

**East Coast Fever (ECF)**

ECF has not been reported in India and therefore is not being discussed here.

**Tropical theileriosis**

It is caused by *T. annulata* (*T. disper*) and is reported in India. It is highly virulent for European dairy cattle. Infection in zebu cattle is often subclinical due to endemic stability, which is a state of interaction between the host, tick vector and pathogen, whereby calves are infected with contaminated ticks, exhibit non-acute or mild clinical disease, which further develops into a high level of immunity in adult cattle with absence of clinical disease.

*T. annulata* affects cattle and is transmitted trans-stadially (remains infected through different life stages).

In endemic areas, virtually all adult animals are infected, but case fatality is about 10-20% and is confined mainly to calves. Recently introduced exotic animals may have 20-90% mortality. The disease occurs when there is much tick activity, mainly during summer. But even a single tick can cause fatal infection.

*T. annulata* infects cattle, camel and yak, with milder infections usually seen in water buffalo. The water buffalo is considered to be the natural host in which the parasite evolved.

**Risk Factors for tropical theileriosis**

The normal state is that of endemic stability. This balance is disturbed when exotic animals are introduced and heavier losses occur. Recovered animals show a solid, long lasting immunity, but they remain as carriers. Buffaloes may also act as carriers. Immunity is mainly cell mediated but is poor in calves that die from the disease.

**Economic importance**

The disease is a major constraint to livestock improvement programme in many parts of the Middle East and Asia. The economic impact of *T. annulata* in India was estimated to be 800 million USD, based on direct losses due to mortality and production losses (milk yield, growth rate, meat, infertility, abortion, calving interval and hides) and the indirect costs of control measures (dipping, vaccination, chemotherapy, veterinary legislation and monitoring).

**Pathogenesis**

Sporozoites of *T. annulata* are injected into the bovine host by the tick through its saliva. Ticks must feed for 2-4 days before sporozoites in their salivary glands will mature and become infective to cattle.

One tick can transmit sufficient sporozoites to cause a fatal infection in a susceptible animal. The damage is caused by both schizonts in lymphocytes and piroplasms in erythrocytes. Consequently, there is lymphadenopathy and panleukopenia on one hand, and *haemolytic anaemia* with icterus on the other. Over 90% of erythrocytes may be parasitized, each by one or more merozoites. Immunosuppression may occur in the acute phase.

Piroplasms of most species of theileria may persist for months or years in recovered animals, and...
may be detected intermittently in subsequent examinations; however, negative results of microscopic examination of blood films do not exclude latent infection.

**Clinical Pathology**
Examination of smears of blood and lymph node biopsy will reveal **piroplasms** in **erythrocytes** and **schizonts** in **lymphocytes**. **Anaemia** is a significant feature of tropical theileriosis, and is associated with bilirubinemia, haemoglobinuria, and bilirubinuria. Animals dying from the disease show persistent and severe lymphocytopenia.

**Clinical findings**
In a stable endemic situation, (endemic stability) there may be no clinical disease in local zebu cattle. There may be **enlargement** of lymph nodes in the area draining the site of tick attachment. There is **drop in milk yield** in dairy animals. In later stages, there may be **nasal and ocular discharges**, dyspnoea, generalized lymph node enlargement and splenomegaly. **Frothy nasal discharges** may occur **terminally**. Occasionally **brain involvement** occurs and is characterised by circling, hence called **turning sickness** or **cerebral theileriosis**.

Clinical signs in exotic cattle are similar to those in ECF, but the course is longer and may last for weeks before death. **Anaemia** develops within a few days. **Petechiae of mucous membranes** which may occur which may later become **icteric**.

**Necropsy findings**
Massive pulmonary oedema, hyperaemia and emphysema, along with hydrothorax and hydropericardium may be seen. **Copious froth** is present in **airways**. The carcass is emaciated and **haemorrhages** are evident in a variety of tissues and organs. The liver, kidney, lung and alimentary tract may contain **lymphoid nodules**. **Ulceration** may occur in abomasum and intestines. The **mucous membranes** are **pale** with **yellowish discoloration** of tissues. Some lymphoblasts contain schizonts, which are better seen in impression smears stained with Giemsa stain.

**Specimens to submit**
Blood/buffy coat, impression smears from lung, spleen, kidney and lymph node, air-dried and fixed in methanol, for demonstration of schizonts, and serum for antibody detection.

**Diagnosis**
Theileriosis should be suspected in tick–infested animals having fever and enlarged lymph nodes. In en-
demic areas, the mortality rate may be high only in calves.

In the field, diagnosis is usually achieved by finding theileria parasites in Giemsa-stained blood smears and lymph node needle biopsy smears, but species specific diagnosis is difficult as most theilerial piroplasms are morphologically identical. Moreover, schizonts are not always present in the superficial lymph nodes during the course of the disease.

**Pirolasms** can sometimes be found in the blood of carrier animals.

**Laboratory Diagnosis**

The OIE prescribed test for international trade is **Agent Identification.**

In live animals, theileriosis is diagnosed by the identification of schizonts in thin smears from blood and lymph node. At necropsy, schizonts may be found in impression smears from most internal organs. However, there is considerable similarity between schizonts of other theileria parasites.

The most widely used test is Immuno Fluorescent Assay (IFA). Both schizont and piroplasm antigens may be used. IFA is sensitive, fairly specific, and usually easy to perform but cross-reactions can occur with other species of Theileria.

Enzyme-linked immunosorbent assays (ELISAs) have been successfully adapted for the detection of antibodies to *T. annulata,* and have been shown to detect antibodies for a longer period of time than the IFA. Serological tests however may not be sensitive enough to detect all infected cattle.

A number of **PCR methods** can also be used to detect *T. parva* and *T. annulata.*

**Differential Diagnosis**

Babesiosis, Trypanosomosis, Ehrlichiosis (Heartwater), Anaplasmosis, Malignant Catarrhal Fever (MCF), Contagious Bovine PleuroPneumoniae (CBPP). The species of theileria must also be differentiated from each other.

**Prevention and Control**

1. **Tick Control:** It is an important step in the control of Theileriosis.

2. **Vaccination**: For *T. annulata,* the vaccine is prepared from schizont-infected cell lines. The vaccine must remain frozen until shortly before administration. Indian Immunologicals Limited (IIL) is the only manufacturer of this vaccine in India. Cattle above 2 months of age can be vaccinated. Vaccination is for lifetime if animals are constantly exposed to ticks. Revaccination is recommended every 3 years if animals are maintained in a tick free environment.

**Treatment**

1. Buparvaquone - 2.5 mg / Kg body weight deep intramuscularly. This has high efficacy when used in the early stages of the disease and less effective if treatment is delayed.

2. Oxytetracycline (Long Acting)- 20 mg/Kg body weight deep intramuscularly but has only moderate efficiency.

Animals that recover following treatment often remain unproductive for several months.

**Zoonotic implications**

*Theileria microti* is a parasitic blood-borne piroplasm transmitted by deer ticks. It was previously classified as *Babesia microti.* *T. microti* is responsible for human theileriosis, similar to babesiosis, a malaria-like disease which also causes fever and hemolysis.

**Sources**