



VETERINARY PROTOZOLOGY

PROTOZOAN PARASITES OF VETERINARY IMPORTANCE

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Protozoa

- Protozoans are unicellular, eukaryotic chemoheterotrophic organisms.
- Most protozoa have two stages
 - Trophozoite – the feeding and growing stage
 - Some protozoa will produce a protective capsule called a cyst.
 - A cyst allows the parasite to exist outside of the host and be the infective stage allowing the parasite to get to another host.

PROTOZOA

- Protozoa reproduce sexually and asexually
 - Asexually : Fission (mitosis), Budding, Schizogony
 - Sexually : Conjugation, Gamete formation
 - ***Definitive Host*** harbors the sexually reproducing stage of parasite
 - ***Intermediate Host*** harbors asexually reproducing portion of the parasite's life cycle
- Movement:
 - A single or multiple flagella
 - Cilia, Balantidium
 - Pseudopodia, Entamoeba
 - No obvious means of locomotion, Eimeria

Protozoa

Table 6 Classification of the Protozoa.

PHYLUM:

Protozoa
(Unicellular, eukaryotic animals)

SUBPHYLUM:

Sarcomastigophora
(locomotion by pseudopodia and/or flagella)

Sporozoa[†]
(locomotion by gliding, life cycle largely intracellular, both sexual and asexual phases occur)

Ciliophora
(locomotion by cilia)

Microspora
(little veterinary significance. Intracellular parasites multiplying asexually)

CLASS:

Sarcodina
(amoeboid movement by pseudopodia)

Mastigophora
(one or more flagella)

Coccidia
(parasites of epithelial cells in which both asexual and sexual reproduction takes place)

Piroplasmida
(parasites of blood cells, have ticks as vectors in which sexual reproduction occurs)

Haemosporidia
(parasites of blood cells, have blood-sucking dipterans as vectors in which sexual reproduction occurs)

Entamoeba

Trypanosoma

Eimeria

Babesia

Plasmodium

Leishmania

Isospora

Theileria

Haemoproteus

Trichomonas

Cryptosporidium

Cytauxzoon

Leucocytozoon

Histomonas

Toxoplasma

Hexamita

Sarcocystis

Giardia

Besnoitia

Hammondia

Hepatozoon

Neospora

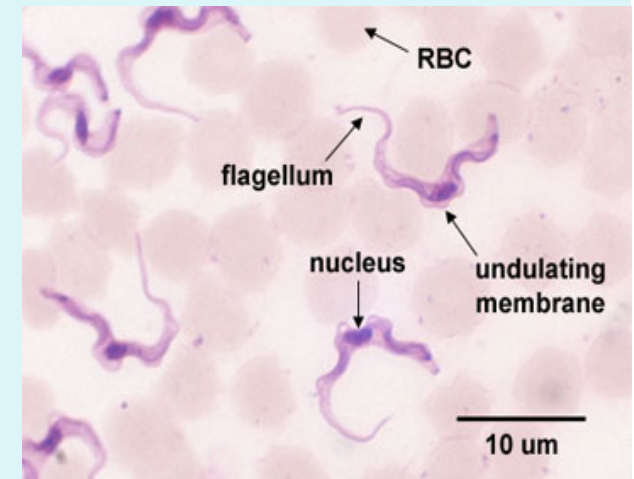
[†] Also called **Apicomplexa**. This alternative name refers to the group's possession of an 'apical complex', a structure which apparently assists penetration of the host cell. It is only visible with the electron microscope.

PROTOZOA

Protozoans of Vet. Importance

Trypanosomes

- Found in the bloodstream and tissues of vertebrates
- Distributed through out the world
- A few species are of overwhelming importance as a serious cause of morbidity and mortality in animals and man in tropical regions
- All are transmitted by arthropod vector, except for *Trypanosoma equiperdum* (venereal)
- Transmission: Either Cyclical or Non-cyclical
 - Cyclical: the arthropod is the necessary intermediate host
 - Non-cyclical: Mechanical transmission by biting flies (*Tabanids* and *Stomoxys*)



Trypanosomes

TRYPANOSOMES

'Tse-tse transmitted Trypanosomoses'- The Salivaria, African Trypanosomoses

- The most significant, compromises livestock production (serious economic challenge)
- All are transmitted cyclically by Glossina in much of sub-Saharan Africa
- Hosts: All domestic livestock, but especially important in cattle. Also common in many wild animals such as the warthog, bush pig and various antelopes.
- Intermediate host: Most species of Glossina, of which *G. morsitans* is perhaps the most widespread.

TRYPANOSOMES

Salivaria

- **Site:**

- All three species of trypanosome are characteristically present in the bloodstream.
- *T. brucei* is also found extravascularly in, for example, the myocardium, the central nervous system and the reproductive tract.

- **Major species:**

- *Trypanosoma brucei*
- *T. congolense*: the most common species
- *T. vivax*.

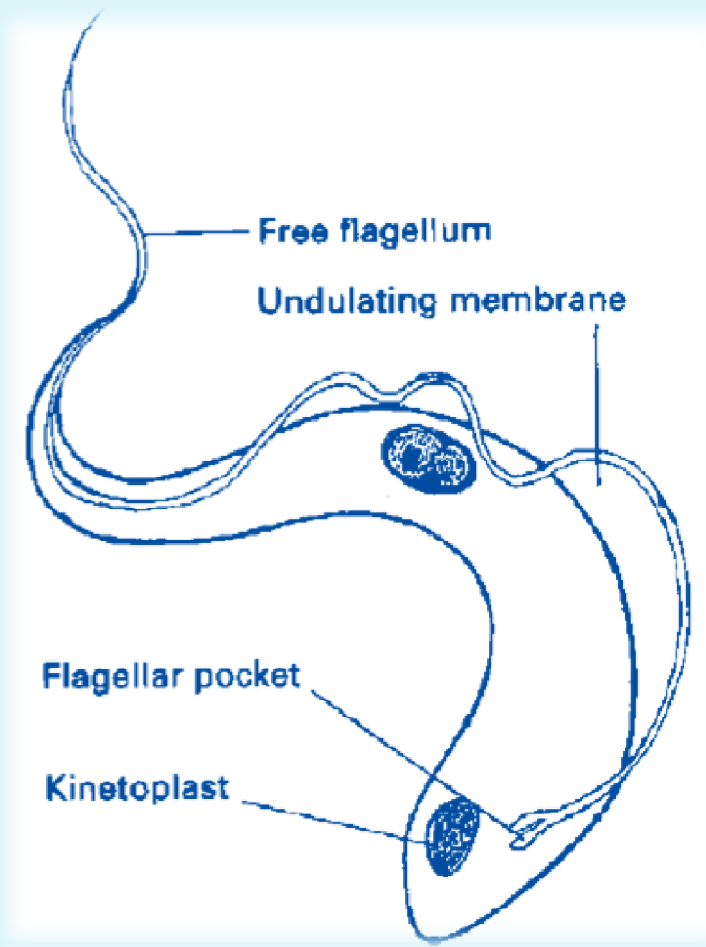
- **Minor species:**

- Probably the most important is *T. simiae* which is primarily a parasite of pigs and camels and morphologically resembles *T. congolense*.

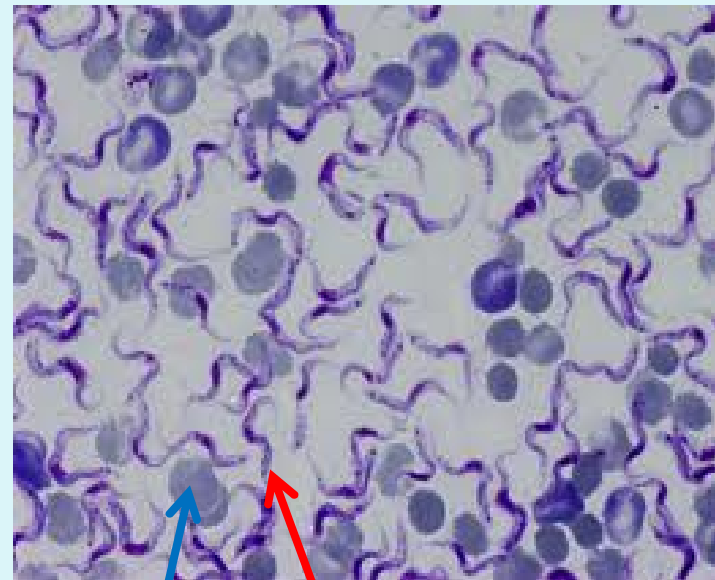
Salivarian trypanosome groups

- *Trypanosoma vivax* – Old and New World of large mammals – Mechanical transmission using many vectors
- *Trypanosoma congolense* – Old World of large mammals– Mouthpart development in *Glossina*
- *Trypanosoma brucei* group
 - *T. brucei brucei* –Nagana in cattle
 - *T. brucei gambiense* – Chronic or West African sleeping sickness
 - *T. brucei rhodesiense* – Acute or East African sleeping sickness All have full development in *Glossina*
- *Trypanosoma evansi* group
 - *T.evansi* – mechanical transmission in many vectors including vampire bats
 - *T. equinum* – mechanically transmitted by horse flies
 - *T. equiperdum* – sexually transmitted

Morphology of Trypanosome



Trypanosoma brucei



Red blood cells

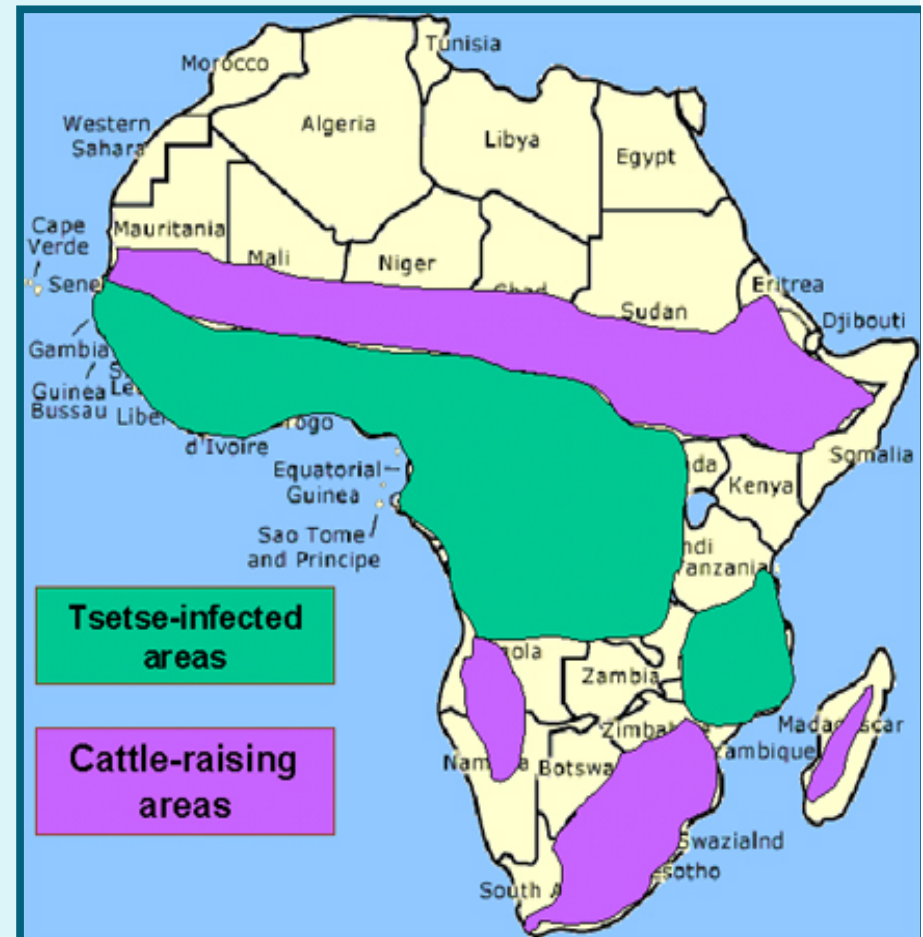
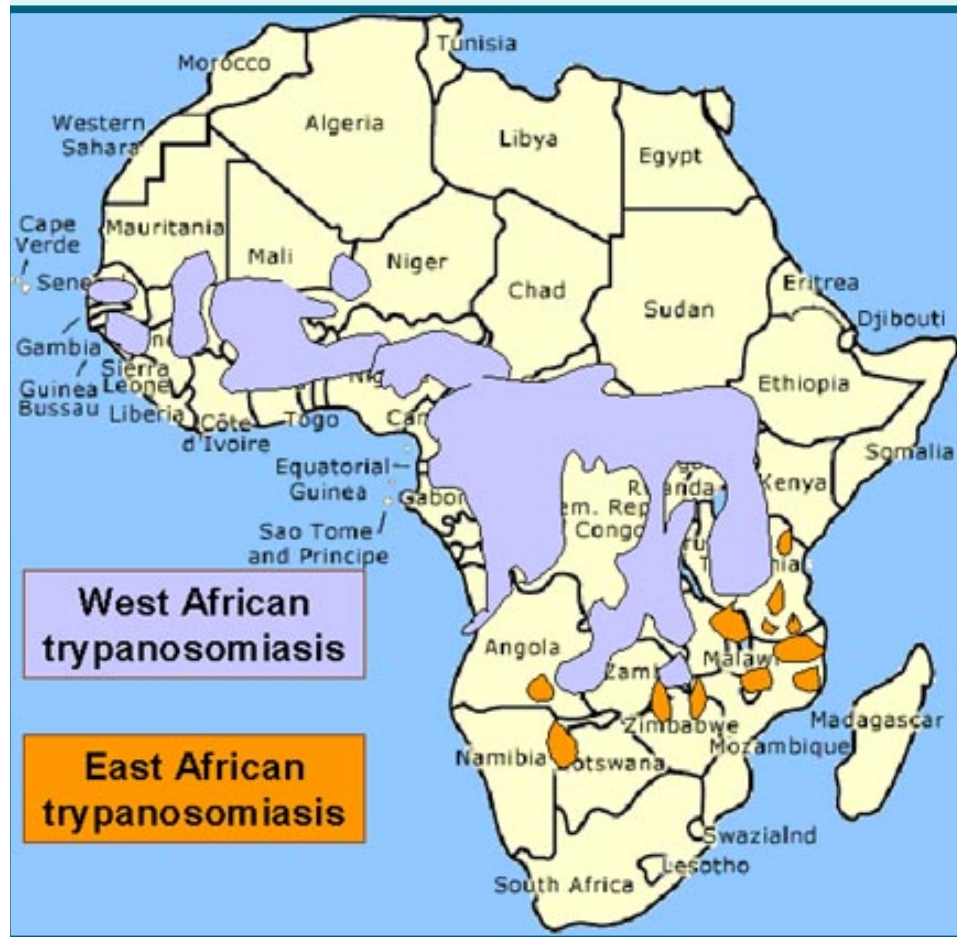
Trypanosome

Trypanosome

Tsetse Vectors and Vertebrate Hosts of Human and Animal Trypanosomiases (From Hoare, 1972)

Disease	Disease agent	Vectors	Hosts
West African sleeping sickness	<i>Trypanosoma gambiense</i>	<i>Glossina fuscipes</i> , <i>G. palpalis</i> , <i>G. tachinoides</i>	Humans
East African sleeping sickness	<i>T. rhodesiense</i>	<i>G. morsitans</i> , <i>G. pallidipes</i> , <i>G. swynnertoni</i>	Humans, antelopes (bushbuck, hartebeest)
Nagana	<i>T. brucei</i>	<i>G. fuscipes</i> , <i>G. longipalpis</i> , <i>G. morsitans</i> , <i>G. palpalis</i> , <i>G. pallidipes</i> , <i>G. tachinoides</i>	All domestic mammals; antelopes (e.g., impala, hartebeest, wildebeest); warthog, hyena, lion
	<i>T. suis</i>	<i>G. brevipalpis</i> , <i>G. vanhoofi</i>	Suids (domestic pigs, warthogs)
	<i>T. congolense</i>	<i>G. morsitans</i> group; <i>G. brevipalpis</i> , <i>G. fuscipes</i> , <i>G. palpalis</i> , <i>G. tachinoides</i> , <i>G. vanhoofi</i>	All domestic mammals, elephant, zebra, antelopes (e.g., impala, hartebeest, duiker, gnu); giraffe, bushpig, hyena, lion
	<i>T. simiae</i>	<i>G. austeni</i> , <i>G. brevipalpis</i> , <i>G. fusca</i> , <i>G. fuscipleuris</i> , <i>G. longipalpis</i> , <i>G. morsitans</i> , <i>G. pallidipes</i> , <i>G. palpalis</i> , <i>G. tabaniformis</i> , <i>T. tachinoides</i> , <i>G. vanhoofi</i>	Domestic pig, warthog, camel, horse, cattle
	<i>T. uniforme</i>	<i>G. fuscipes</i> , <i>G. palpalis</i>	Cattle, goats, sheep, antelopes (e.g., bushbuck, sititunga, waterbuck); buffalo, giraffe
Nagana or souma	<i>T. vivax</i>	<i>G. morsitans</i> group; <i>G. fuscipes</i> , <i>G. palpalis</i> , <i>G. tachinoides</i> , <i>G. vanhoofi</i>	Domestic mammals (esp. cattle, horses, mule); wild bovids, zebra, antelopes (e.g., impala, hartebeest, gnu); giraffe, warthog, lion

African trypanosomiasis - Distribution



West African = *Trypanosoma gambiense*

East African = *Trypanosoma rhodesiense*

African Trypanosomiasis

Resistant and susceptible cattle



N'dama



Zebu



African trypanosomiasis

The tsetse fly



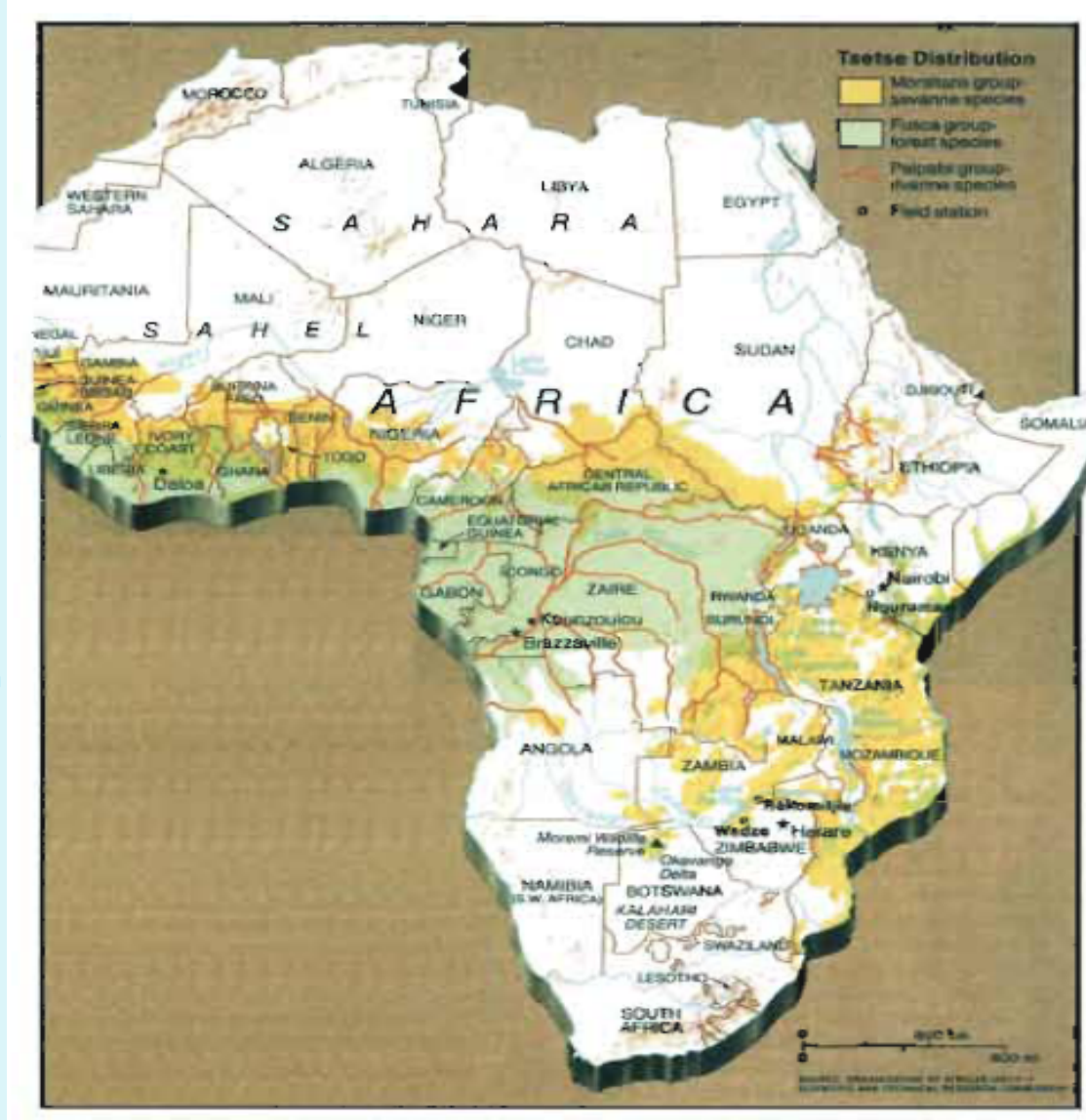
African Trypanosomiasis

Tsetse distribution

Morsitans (Savanna)

Fusca (Forest)

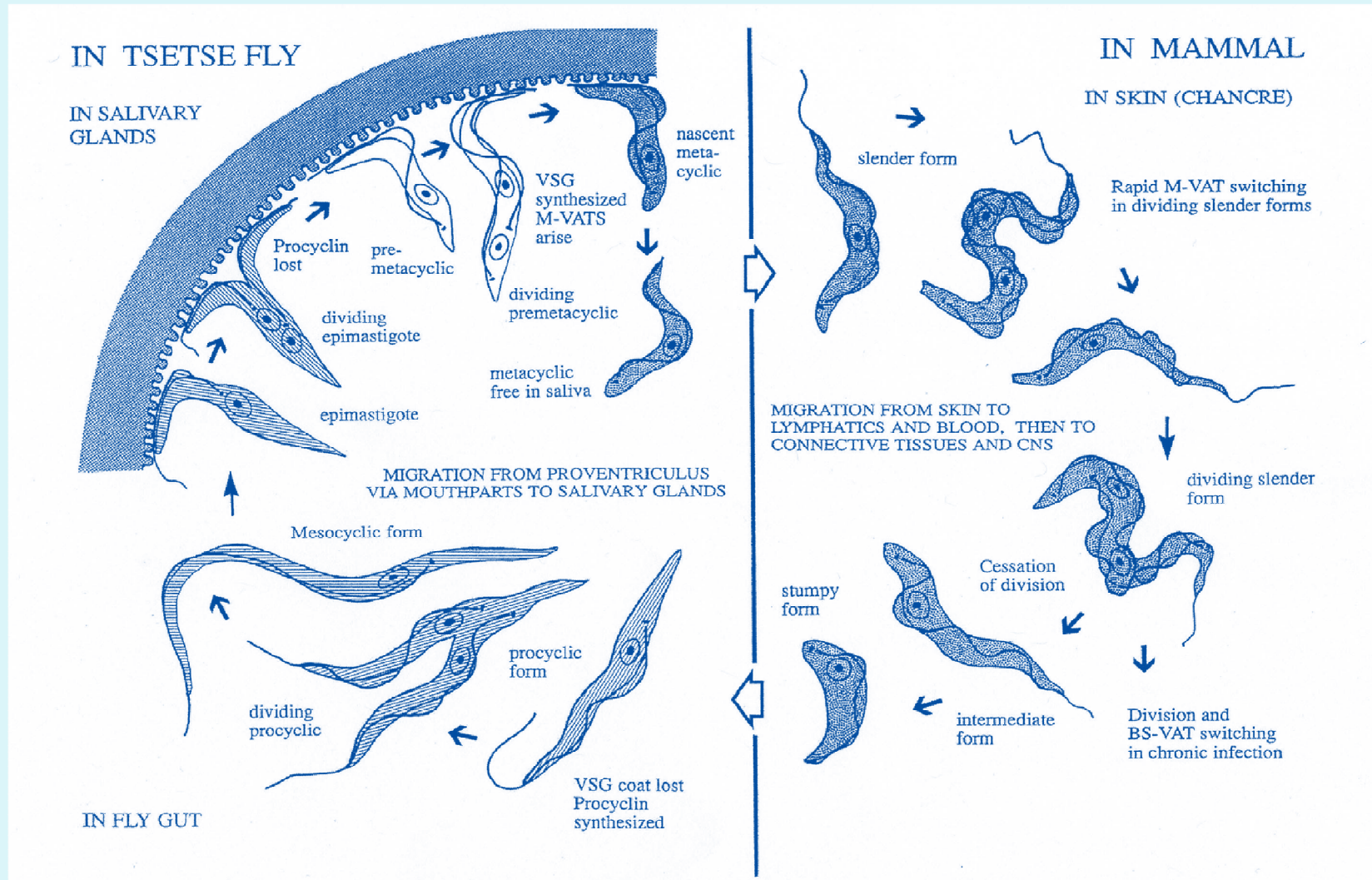
Palpatis (Riverways)



Distribution of the following *Tsetse* species groups in Africa: *morsitans* group (savanna); *fusca* group (forest); *palpatis* group (riverways).

African trypanosomiasis

Life cycle



African trypanosomiasis Prevention and Control



Class Coccidia

- Two families of veterinary importance: *Eimeriidae* and *Sarcocystidae*

Eimeriidae

- Mainly intracellular parasites of the intestinal epithelium
- Three genera of considerable veterinary importance
 - *Eimeria*, *Isospora* and *Cryptosporidium*
 - *Eimeria* and *Isospora* cause coccidiosis

Eimeria

- **Hosts:** Poultry, cattle, sheep, goats, pigs, horses and rabbits.
- **Site:** Epithelial cells of the intestine and in two species the kidney and liver respectively.

Class Coccidia

Table. The major features of the life cycles of important Coccidia

	<i>Eimeria</i>	<i>Isospora</i>	<i>Cryptosporidium</i>	<i>Toxoplasma</i>	<i>Sarcocystis</i>
Life cycle	Direct	Direct	Direct	Indirect or direct Also between intermediate hosts	Always indirect
Infective stage for final host	Oocyst (4 sporocysts each with 2 sporozoites)	Oocyst (2 sporocysts, each with 4 sporozoites)	Very small oocyst with 4 sporozoites	Bradyzoite cysts Tachyzoites Small oocyst (2 sporocysts each with 4 sporozoites)	Bradyzoite cysts
Infective stage for intermediate host	—	—	—	Bradyzoite cysts Tachyzoites Oocyst	Sporocyst (4 sporozoites)
Asexual phase	Single host	Usually single host	Single host	Many hosts	Many hosts
Sexual phase				Cat	Dog and cat

Class Coccidia

Eimeria

- **Important Species:**

- *Eimeria tenella*, *E. necatrix*, *E. brunetti*, *E. maxima*, *E. mitis* and *E. acervulina* ----- chickens
- *E. meleagrimitis* and *b. adenoeides* ----- turkeys
- *E. anseris*, *E. nocens* and *E. truncata* (kidney) ----- geese
- *E. zuernii*, *E. bovis* and *E. alabamensis* -----cattle
- *E. crandallis*, *E. ovinoidalis*, *E. bakuensis*----- sheep
- *E. arloingi* and *E. ninakohlyakimovue* - goats
- *E. deblickei* ----- pigs
- *E. leuckarti* ----- horses
- *E. flrrescens*, *E. intestinalis* and *E. stiedae* (liver)---rabbits.

Toxoplasma

- Single species: *Toxoplasma gondii*
- Definitive host -cat,
- Oocyst shed in feces
- Form trophozoites-tachyzoites(fast)
- Multiply in host tissues-all cells except RBCs
- Intracellular parasite ruptures cells

Signs and Symptoms of Toxoplasmosis

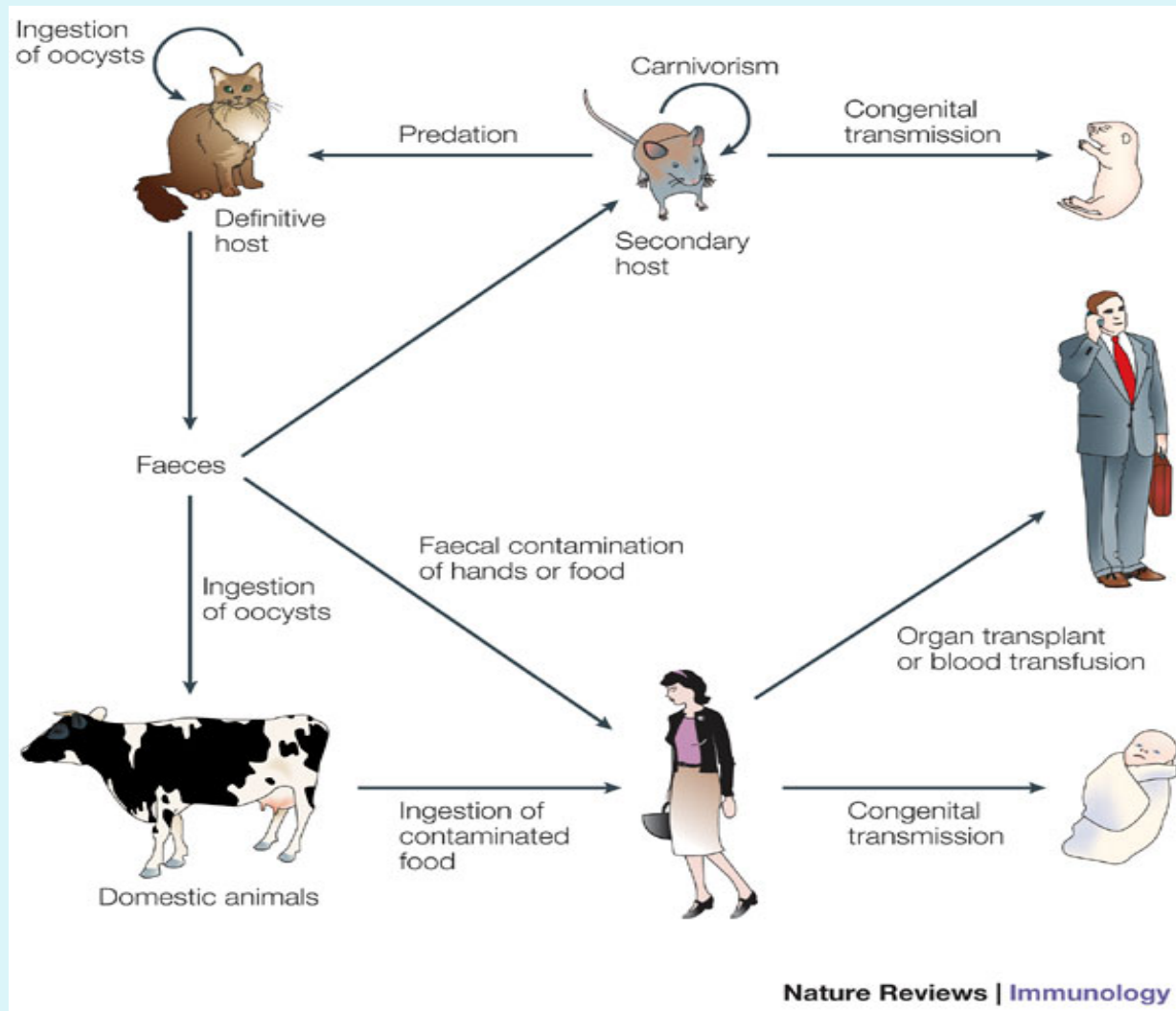
- Fever, malaise, sore throat, swelling of lymph nodes
- Immune system contains disease-chronic infection
- Tissue cyst forms containing bradyzoites
- Reactivate later when immune system breaks down
- Can form lesions on eyes or any other organ

Toxoplasma

Life cycles

- Humans ingest undercooked meat or contact with cat feces- contain oocysts
- Trophozoites released and feed on bacteria and fecal material
- Most have mild symptoms unless immunocompromised

Toxoplasma Transmission



Toxoplasma Transmission



A fetus may contract toxoplasmosis through the placental connection with its infected mother

The mother may be infected by:

Improper handling
of cat litter



Handling or ingesting
contaminated meat



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Babesia

- Are intraerythrocytic parasites of domestic animals
- Cause anaemia and haemoglobinuria.
- Transmitted by ticks (in which the protozoan passes transovarially, via the egg, from one tick generation to the next).
- The disease, babesiosis, is particularly severe in naive animals introduced into endemic areas
- Babesiosis is a severe constraint on livestock development in many parts of the world
- **Hosts:** All domestic animals.
- **Intermediate hosts:** Hard ticks of the family Ixodidae

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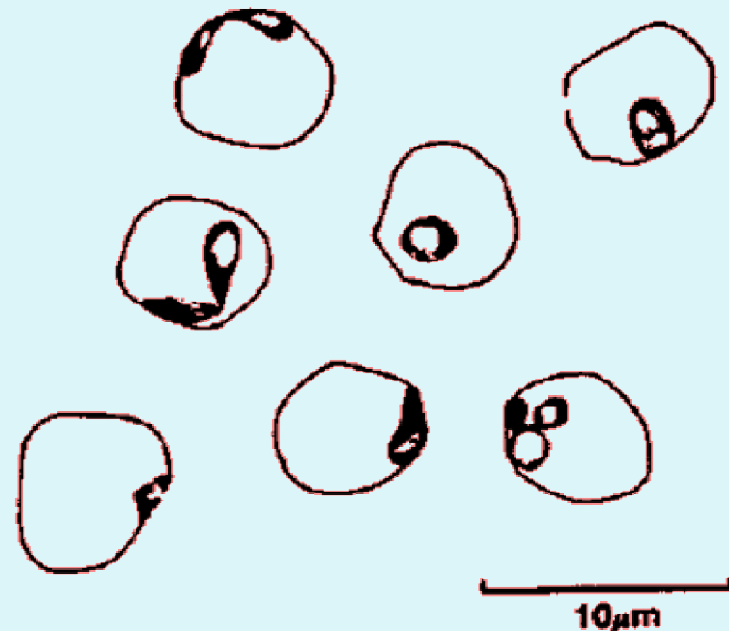
Babesia

Site:

- Babesia lie singly or in pairs inside the red blood cells.

Species:

- *Babesia divergens*, *B. major*, *B. bigemina*, *B. bovis*----cattle
- *B. molasi*, *B. ovis*---- sheep and goats
- *B. caballi*, *B. equi*----- equines
- *B. perroncitoi*, *B. tralirmanni*--- pigs



Diverse forms of *Babesia divergens* in bovine red cells.

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Babesia

Epidemiology

□ The epidemiology of babesiosis depends on the interplay of a number of factors and these include:

1. *The virulence of the particular species of Babesia*

- E.g. *B. divergens* in cattle and *B. canis* in dogs are relatively pathogenic while *B. major* in cattle and *B. ovis* in sheep usually produce only mild and transient anaemia

2. *The age of the host*

- There is an inverse age vs resistance relationship

3. *The immune status of the host*

4. *The level of tick challenge*

5. *Stress*

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Babesiosis of Cattle (Caused by *B. bigemina* and *B. bovis*)

- **Disease:** Babesiosis (bovine), Texas fever, red water fever, piroplasmosis.
- **Host:** Cattle, deer.
- **Habitat:** Erythrocyte.
- **Identification:** Trophozoites usually pyriform, may be round or oval, characteristically in pairs. Size is 2-3 μ in diameter and 4-5 μ m long.
- **Transmission:** By the one-host tick *Boophilus*
- **Diagnosis:** Confirmed by detection of characteristic forms of the parasite within the erythrocyte.

Treatment

- Imidocarb and the diamidine derivatives such as diminazene aceturate, amicarbalide and phenamidine, are all effective against *B. Bovis* and *A. bigemina*, especially if given early in the disease.

Vaccination

- Vaccination of cattle against both *B. bovis* and *b. bigemina* infection is commonly practiced in many countries by inoculating blood from donor animals.

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Canine Babesiosis [Caused by *Babesia canis* (*Piroplasma canis*)]

- **Disease:** Babesiosis (canine), malignant jaundice, biliary fever, canine piroplasmosis.
- **Host:** Dog and wild carnivores.
- **Habitat:** Erythrocyte.
- **Identification:** Organism pyriform, 4-5 μm long. Usually 1 pair to a cell, occasionally several pairs are seen in 1 erythrocyte.
- **Transmission:** Bite of the infected ticks *Rhipicephalus sanguineus* and, probably, *Dermacentor spp.*
- **Signs and pathogenicity:**
 - Infection varies from quite mild to severe with the strain of the organism.
 - Young and old dogs become infected

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Canine Babesiosis

❖ *Signs and pathogenicity:*

- Infection varies from quite mild to severe with the strain of the organism.
- Young and old dogs become infected
- less severe disease occurs in young animals.
- Incubation period is 10-21 days in naturally infected animals.
- Usual signs are fever of 102-105⁰ F.
- Loss of condition, anemia, icterus, prostration, and death.
- In chronic forms of the disease signs are vague.
- The patient may be listless, weak, and emaciated and have intermittent fever

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Canine Babesiosis

- **Diagnosis:** Demonstration of parasite in the erythrocyte, best accomplished by taking capillary smears from the margin of the ear.
- **Control:**
 - Tick control and treatment of infected individuals.
- **Treatment**
 - Acriflavine and trypanflavine have both given good results.
 - Phenamidine is less toxic and quite effective.

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Theileria

- The diseases caused by several species of *Theileria* are a serious constraint on livestock development in Africa, Asia and the Middle East
- Theileriosis limits the movement of cattle between countries
- Can result in production losses and high mortality in susceptible animals
- Theileria are widely distributed in cattle and sheep in Africa, Asia, Europe and Australia
- Have a variety of tick vectors
- Are associated with infections which range from clinically inapparent to rapidly fatal.

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Theileriosis

*East Coast Fever,
Corridor Disease,
Theileriasis,
January Disease,
Zimbabwean Tick Fever,
African Coast Fever;
Tropical Theileriosis,
Mediterranean Coast Fever,
Mediterranean Theileriosis*

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Theileriosis

- ❑ The two diseases with the greatest economic impact in cattle:
 - East Coast fever (infection with *Theileria parva*) and
 - *Tropical theileriosis* (infection with *Theileria annulata*).

- ❑ Minor and mildly pathogenic species infecting cattle include *T. mutans* and *T. taurotragi* in Africa and *T. sergenti* in Asia

- ❑ *Theileria lestoquardi*, which causes a severe disease with a high morbidity and mortality rate, is the most important species in sheep and goats.

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Theileriosis

Table. A comparison of three species of *Theileria* of veterinary importance.

Species	Host	Vector	Disease	Distribution
<i>T. parva</i>	Cattle	<i>Rhipicephalus</i>	East Coast Fever	East and Central Africa
<i>T. annulata</i>	Cattle	<i>Hyalomma</i>	Mediterranean or tropical theileriosis	North Africa, South Europe, Middle East, Asia
<i>T. hirci</i>	Sheep Goats	<i>Hyalomma</i>	Malignant ovine (caprine) theileriosis	North Africa, South Europe, Middle East, Asia

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Theileriosis

Geographic Distribution

- *T. parva* (*East Coast fever*) is found in sub-Saharan Africa.
- *T. annulata* (tropical theileriosis) occurs from southern Europe and the Mediterranean coast through the Middle East and North Africa, and into parts of Asia.
- *T. mutans* has been found in African and on some Caribbean islands

East Coast Fever (Caused by *T. parva*)

- Disease: Theileriosis (bovine), East Coast fever.
- Host: Cattle, water buffalo, white-tailed deer
- Habitat: Erythrocytes, lymphocytes, histiocytes, and occasionally endothelial cells.

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Theileriosis

Transmission

- Theileria spp. are transmitted by ticks acting as biological vectors
- *Rhipicephalus appendiculatus* is the most important vector for *T. parva*
- But *R. zembeziensis* and *R. duttoni* carry this organism in parts of Africa. *T. annulata* is transmitted by ticks in the genus *Hyalomma*.
- *Hyalomma* spp. are also the vectors for *T. lestoquardi*, *T. ovis* and *T. separata*
- *T. buffeli* and *T. sergenti* are transmitted by *Haemaphysalis* spp,
- *T. mutans* and *T. velifera* are transmitted by *Amblyomma* spp.
- Ticks in the genus *Rhipicephalus* spread *T. taurotragi*

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Theileriosis

Clinical Signs

- In East Coast fever, the clinical signs include
 - Generalized lymphadenopathy, fever, anorexia and loss of condition with decreased milk yield.
 - Terminally ill animals often develop pulmonary edema, severe dyspnea and a frothy nasal discharge.



Lymph nodes swelling in
T. parva infected cattle

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Theileriosis

- Petechiae and ecchymoses may be found on the conjunctiva and oral mucous membranes.



Petechial haemorrhage on the surface (epicardium) of the heart



Petechial haemorrhage of the spleen caused by *T.parva*



Petechial haemorrhage on the intestinal serosa caused by *T.parva*

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Theileriosis

- Lacrimation, nasal discharge, corneal opacity and diarrhea can also be seen.

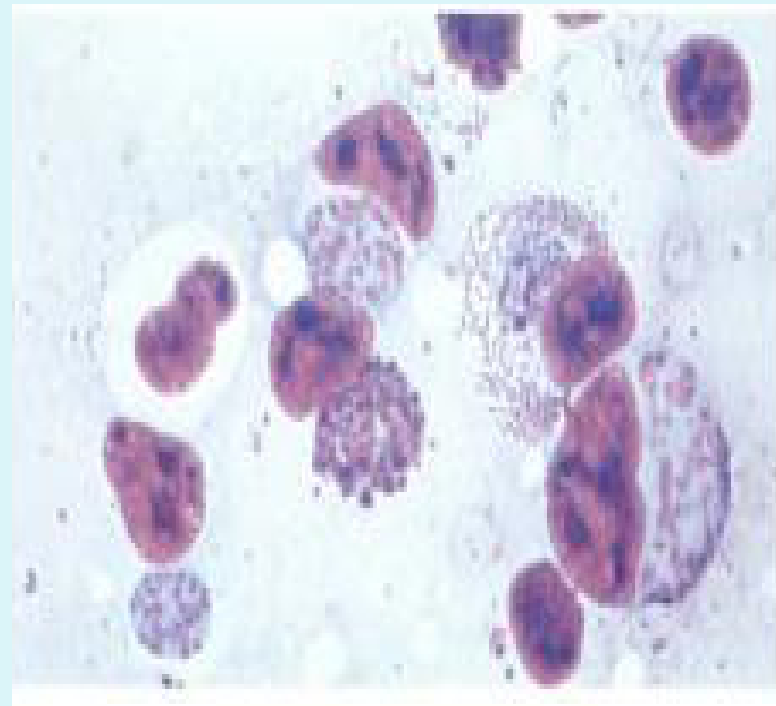


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Theileriosis

Diagnosis

- In sick animals, macroschizonts are readily detected in biopsy smears of lymph nodes



Theileria spp, macroshizonts (Koch's blue bodies') and microshizonts in lymph node smears

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Theileriosis

Diagnosis

- In dead animals, impression smears of lymph nodes and spleen
- In advanced cases, Giemsa-stained blood smears show piroplasms in the red cells, up to 80% of which may be parasitized
- Indirect FAT

Treatment

- Tetracycline for early stage of infection
- For clinical cases: naphthaquinone compounds parvaquone and buparvaquone and the anti-coccidial drug halofuginone.

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Theileriosis

Vaccination

- Great efforts have been made to develop a suitable vaccine, but these have been thwarted by the complex immunological mechanisms involved in immunity to East Coast Fever and by the discovery of immunologically different strains of *T. parva* in the field

TABLE II

Examples of Arthropod-Borne Diseases of Medical-Veterinary Importance

Arthropod vectors	Diseases grouped by causative agents
Mosquitoes	Viruses: yellow fever, dengue, Rift Valley fever, myxomatosis; eastern equine encephalomyelitis, western equine encephalomyelitis, Venezuelan equine encephalomyelitis, St. Louis encephalitis, LaCrosse encephalitis, Japanese encephalitis, Murray Valley encephalitis, Chikungunya fever, O'nyong nyong fever, Ross River fever, West Nile fever. Protozoans: malaria. Filarial nematodes: Wuchererian filariasis, Bancroftian filariasis, dog heartworm
Black flies	Filarial nematodes: human onchocerciasis (river blindness), bovine onchocerciasis
Biting midges	Viruses: bluetongue disease, epizootic hemorrhagic disease, African horse sickness, leucocytozoonosis, Oropouche fever. Filarial nematodes: equine onchocerciasis, mansonellosis
Sand flies	Viruses: sand fly fever, vesicular stomatitis. Bacteria: Oroya fever (Veruga Peruana). Protozoans: leishmaniasis
Horse flies and deer flies	Viruses: equine infectious anemia, hog cholera. Bacteria: tularemia. Protozoans: surra (livestock trypanosomiasis). Filarial nematodes: loiasis, elaeophorosis
Tsetse flies	Protozoans: African trypanosomiasis, nagana
Triatomine bugs	Protozoans: American trypanosomiasis (Chagas disease)
Lice	Viruses: swine pox. Bacteria: epidemic typhus, trench fever, louse-borne relapsing fever
Fleas	Viruses: myxomatosis. Bacteria: plague, murine (endemic) typhus, tularemia
Ticks	Viruses: tick-borne encephalitis, Powassan encephalitis, Colorado tick fever, Crimean-Congo hemorrhagic fever, African swine fever. Bacteria: Lyme disease, Rocky Mountain spotted fever, Boutonneuse fever, tick-borne ehrlichiosis, Q fever, heartwater fever (cowdriosis), anaplasmosis, tick-borne relapsing fever, avian spirochetosis, theileriosis (East Coast fever), bovine dermatophilus. Protozoans: babesiosis
Mites	Bacteria: tsutsugamushi (scrub typhus), rickettsialpox