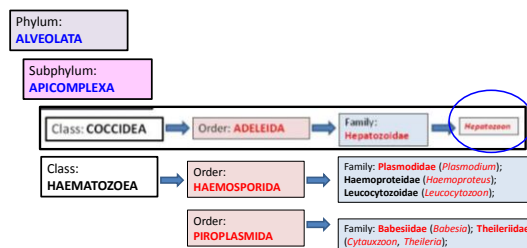


Class: **HAEMATOOZEA**

Blood protozoan parasites



Order: **Piroplasmida** - The piroplasms

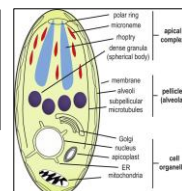
- Tick-borne blood protozoan parasites of vertebrates (IH)
 - ✓ occur in erythrocytes
 - ✓ some occur in leukocytes or other blood system cells
 - ✓ Small round, pleomorphic
 - ✓ Reproduction by binary fusion or schizogony
 - ✓ Vectors and FH are ticks
- Two genera contain parasites of domestic animals
 - **Babesia** and **Theileria**

Genus: **Babesia**

- **Babesia/Babesiosis** originally discovered by Babes (Rumania, 1888) is an important cattle disease that affects all **cattle** and domestic animals such as **cats** and **dogs** throughout the world.
- Occasionally humans are infected as well.
- **Babesia** is transmitted by **ticks**

Pyriform, round or oval parasites of:

- **Erythrocytes**
- **Lymphocytes**
- **Histiocytes**
- **Erythroblasts**



| Host | Species | Occurrence |
|---------------------|-----------------------------|--|
| Large ruminants | <i>B. bovis</i> | Africa, America, Asia, Australia, Europe |
| | <i>B. bigemina</i> | Africa, America, Asia, Australia, Europe |
| | <i>B. major</i> | Asia, Europe |
| | <i>B. occultans</i> | Africa |
| | <i>B. ovata</i> | Asia |
| | <i>B. divergens</i> | Europe |
| Horses | <i>B. equi</i> | Europe, America |
| Horse, donkey, mule | <i>B. caballi</i> | Africa, America, Asia, Europe |
| Pigs | <i>B. trautmanni</i> | Africa, Europe |
| Sheep, Goats | <i>B. crassa</i> | Asia |
| | <i>B. ovis</i> | Africa, America, Asia |
| | <i>B. motasi</i> | Africa, America, Asia |
| Sheep | <i>B. sp. Xinjiang</i> | China |
| Dogs | <i>B. vogeli</i> | Africa, America, Asia, Australia, Europe |
| | <i>B. conradae</i> | America (USA) |
| | <i>B. gibsoni</i> | Asia, (Africa, America, Europe) |
| | <i>B. vitalii</i> | America (Brazil) |
| | <i>Babesia sp.</i> | America (USA) |
| | <i>B. rossii</i> | South Africa |
| | <i>T. annae</i> | Spain, Portugal |
| | <i>B. canis</i> | Europe |
| Cats | <i>B. felis</i> | South Africa |
| | <i>B. (canis) presentii</i> | Asia (Israel) |

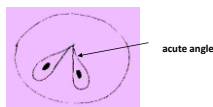
Babesia – zoonotic species

- **Babesia divergens** Russia, Ireland, Scotland, Croatia, ... **Europe**)
- **B. bigemina** (Tropics and Subtropics)
- **B. equi** (South America)
- **B. microti** (North America, Asia, Russia, India, Africa, **Europe**)

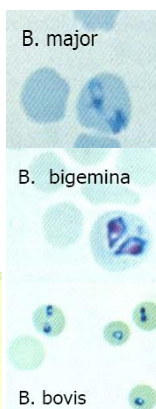
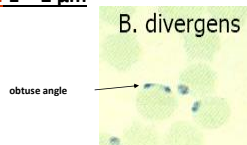
Morphology

According to the size and location :

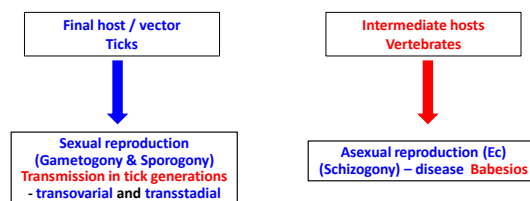
➤ Large babesia 2 – 5 µm



➤ Small babesia 1 – 2 µm



Babesia – Life cycle

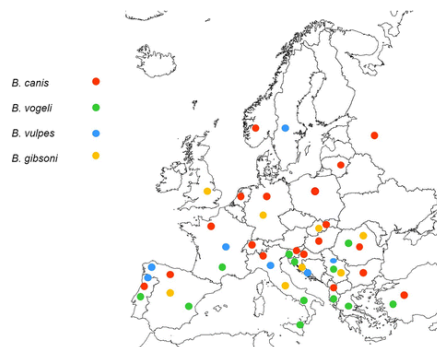


Canine babesiosis

➤ Canine babesiosis is a significant tick-borne disease caused by various species of the protozoan genus *Babesia*.

➤ Although it occurs worldwide, data relating to European infections have now been collected for many years.

➤ Both the large and small forms of *Babesia* species (*B. canis*, *B. vogeli*, *B. gibsoni*, and *B. microti*-like isolates also referred to as "*B. vulpes*" and "*Theileria annae*") infect dogs in Europe, and their geographical distribution, transmission, clinical signs, treatment, and prognosis vary widely for each species.



The distribution of canine *Babesia* species in Europe in dogs based mainly on molecular analysis. Note the presence of *B. canis* and *B. microti*-like sp. mostly in the cooler climate zones of north and central Europe while infection with *B. vogeli* is mainly around the Mediterranean basin.

Canine babesiosis

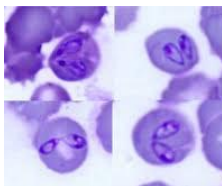
- Dogs attack three species of *Babesia*:
Babesia canis, *Babesia gibsoni*, *Babesia vogeli* and small *Babesia* „microti-like“ (*B. vulpes*, *Theileria annae*);
- *Babesia canis rossi* – geographically expanding in South Africa and the Sahara. It is the most pathogenic of dog babesias;
- *Babesia canis vogeli* - is less pathogenic, often without clinical signs of disease; is widespread in France, Australia, Japan, Brazil, South Africa, and America. In adult dogs a mild course of the disease is observed, but it is fatal in puppies. It is transmitted by a brown tick of *Rhipicephalus sanguineus*.
- In Europe, the cause of canine babesiosis is a species of *Babesia canis canis*, which according to the current knowledge transmitted by a tick (*Dermacentor reticulatus*). It has a large geographic area, mostly covering Southern Europe, Africa, Asia, North America, Central America, and South America

Epidemiology

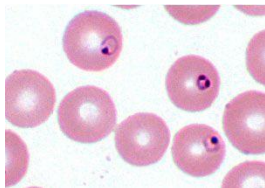
- *B. canis canis*: Europe, Asia **large babesia**
- *B. canis rossi*: South Africa
- *B. canis vogeli*: USA, tropical and subtropical areas
- Vector: *Rhipicephalus sanguineus*, *Dermacentor reticulatus*, *Ixodes ricinus*
- *B. gibsoni* Asian type: Asia **small babesia**
- *B. gibsoni* Spanish type: Europe
- *B. gibsoni* California type: USA
- Vector: *R. sanguineus*, *Haemaphysalis longicornis*



Morphology



B. canis usually appears as paired pyriform organisms in canine red blood cells.



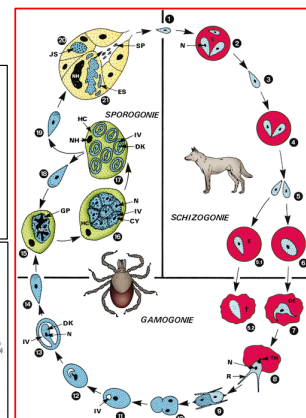
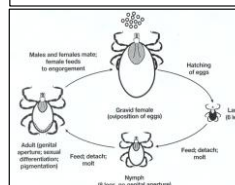
B. gibsoni usually appears as single ring form organisms in canine red blood cells.

Life cycle

➤ Transstadial transmission

➤ larvae > nymph > female

➤ Transovarial transmission



Pathogenesis

- The transmission of parasites takes place **after 2-3 days** of attachment of the tick, at which time infective sporozoites migrate from the tick's salivary glands into the host's circulation.
- *Babesia* organisms are **obligate intracellular** parasites that invade, divide within, and rupture **erythrocytes**.
- The direct parasite-induced red cell damage resulting in an **intravascular haemolysis**, but the severity of this is usually not proportional to the low parasitemia that is typically observed.
- It is now recognised that other significant mechanisms are involved, including immun-mediated lysis and oxidative injury of the red cell membrane.

Clinical signs

- **Acute form:**
general findings such as pyrexia, weakness, mucous membrane pallor, depression, lymphadenopathy, splenomegaly, and general malaise;

- **Chronic form:**
irregular temperature, capricious appetite, and loss of conditions;



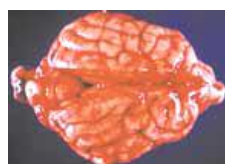
Scleral haemorrhage in a dog with babesiosis complicated by disseminated intravascular coagulation.



Dog with severe icterus due to babesiosis.

Symptoms

- Lack of energy
- Lack of appetite
- Pale gums
- Fever
- Enlarged abdomen
- Colored urine
- Yellow or orange skin
- Weight loss
- Discolored stool



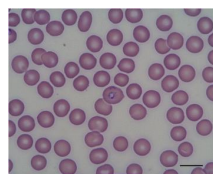
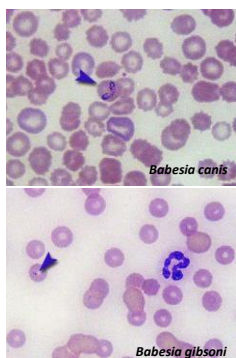
Brain of a dog that died from cerebral babesiosis, showing generalized congestion.



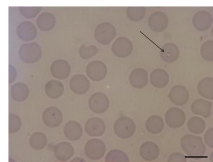
Brain of a dog that died from cerebral babesiosis, showing focal areas of necrosis.

Diagnosis

- Examination of stained blood films (Giemsa-Romanowski, Diff-Quick, Pappenheim...)
- First drop of capillary blood (*B. canis*)
- Specific serology (indirect fluorescent antibody test -IFAT), ELISA
- Significance of test - indicates exposure only - not disease.
- Must utilize clinical data to distinguish infection from disease

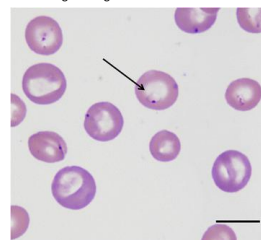


Photomicrograph showing a large sized *Babesia* spp. (*B. canis*) in canine erythrocytes. Scale-bar: 10 µm



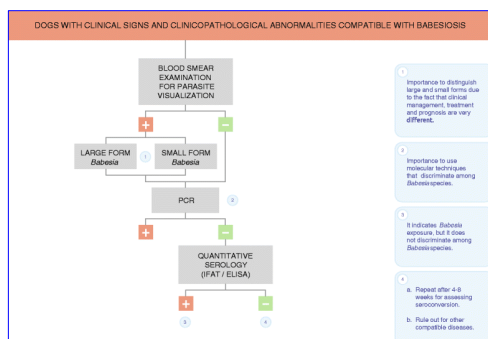
Photomicrograph of a small *Babesia* (*B. microti*-like sp., arrow) in canine erythrocytes. Scale-bar: 10 µm

- Blood smear examination is a useful diagnostic tool for clinical babesiosis in dogs.
- Microscopy evaluation continues to be the easiest and most accessible diagnostic test for most veterinarians.
- However, the sensitivity of this method is lower than that of molecular diagnosis in assisting the veterinarian in making a positive diagnosis and is rather dependent on the species infecting the dog.



Photomicrograph of a small-sized *Babesia* spp. (*B. gibsoni*, arrow) in canine erythrocytes. Scale-bar: 10 µm

Diagnostic algorithm for canine babesiosis



Therapy

- Preparations with the active substance **imidocarb** at a dose of 2-5 mg / kg bw, s.c., i.m.
- **Diminazen-diacetate** 3-7 mg/kg bw, i.m.,
- **Trypan blue** 2-3 mg/kg bw i.v.
- Dogs not eating - **infusion therapy**
- Apply **vitamins B**, **iron preparations** to improve hematopoiesis
- When vomiting, administer anti-emetics
- Symptomatic therapy

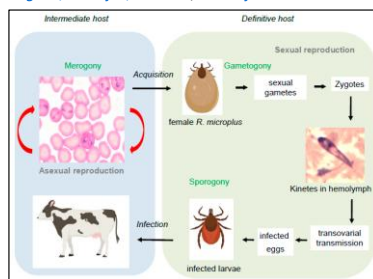
PREVENTION

- Tick control

- Antiparasitic collars: propoxur and flumetrin (Kiltix)
- Chewable tablets: afoxolaner (NexGard), fluralaner (Bravecto)
- Antiparasitic sprays
- Anti-parasitic shampoos and powders

Bovine babesiosis

- *Babesia bovis* and *B. bigemina* are the most important
- *B. divergens*, *B. major*, *B. ovate*, and *B. jakimovi*

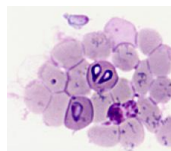


Incubation period

- The symptoms of *B. bigemina* infections usually appear **2–3 weeks** after tick infestation;
- *B. bovis* takes slightly longer. After direct inoculation of blood, the incubation
- Period is **4–5 days** for *B. bigemina* and **10–12 days** for *B. bovis*.
- Large inocula can result in shorter incubation times.

Babesia bigemina

- 1890's entire southeastern US plagued by a cattle disease – „Texas Red Water fever“, „**Texas cattle fever**“
- Red colored urine, and cattle died within a week of infection
- Vector: *Boophilus annulatus*
- *B. bigemina* affects a variety of ruminants
- Deer, water buffalo, zebu and cattle



Babesiosis – General feature

- **Severe in adult** cattle than calves
- Calves less 1 yr seldom affected
- Mortality in untreated adult cattle 50% to 90%
- Incubation period is **8 to 15 days**, acutely ill animals may die within 4 – 8 days
- Cattle that recover are usually immune for life

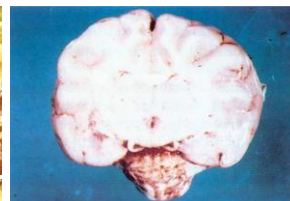
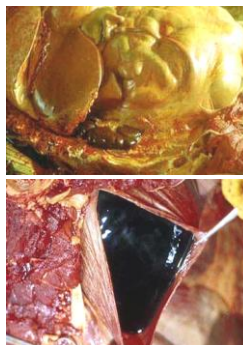
Clinical signs - *B. bigemina*

- *B. bigemina* develop **anorexia** and a **high fever**, with rectal temperatures up to **41.5 °C**
- Animals may **separate from the herd**, stand with an **arched back**, and display a **roughened coat**, **dyspnea**, and **tachycardia**.
- At the start of an infection, the **mucus membranes** are usually **red** and **injected**. As the disease progresses, they become **pale from anemia**. The anemia often develops rapidly and is frequently accompanied by **hemoglobinuria** and **hemoglobinemia**. The anemic crisis usually passes within a week.
- Central nervous system signs are not common during *B. bigemina* infections petechiae be seen.

Clinical signs - *B. bovis*

- *B. bovis* is generally **more virulent** than *B. bigemina*.
- Cattle infected with *B. bovis* usually develop a **high fever**, **anorexia**, **depression**, **ataxia**, and **circulatory shock**.
- **Hemoglobinuria** and **hemoglobinemia** are **less common** than in *B. bigemina* infections.
- Sequestration of infected erythrocytes in brain capillaries may result in **incoordination**, **teeth grinding**, and **mania**.
- Animals may be found on the ground with the involuntary movements of the legs. Death often follows CNS signs petechiae be seen.

Babesiosis - post mortem lesions



Pink haemorrhage. Cerebral form of babesiosis caused by *B. bovis*. It is characterized by formation of thrombi and emboli in brain capillaries.

Treatment and prevention

Treatment

- Diminazine (Berenil) 3 - 5 mg/kg im

Prevention

- Tick control
- Regular dipping of cattle
- Sentinels

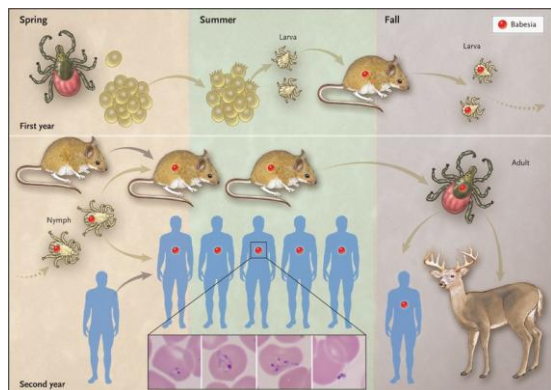
Human Babesiosis

➤ majority of cases associated with 2 species:

B. microti and *B. divergens*

| | <i>B. microti</i> | <i>B. divergens</i> |
|-----------|--------------------------|-----------------------|
| Location | United States | Europe |
| Reservoir | field mice, voles | cattle, ruminants |
| Vector | <i>Ixodes dammillini</i> | <i>Ixodes ricinus</i> |
| Cases | ~300 | ~30 |
| Fatality | 5% | 50% |

serological surveys suggests higher prevalence of asymptomatic cases



Laboratory Diagnosis:

Diagnosis can be made by microscopic examination of thick and thin blood smears stained with Giemsa. Repeated smears may be needed.

- **Diagnostic findings**
- Microscopy
- Antibody detection (IFA – indirect fluorescent antibody)
- Molecular methods
- Isolation of the organisms by inoculation of patient blood into hamsters or gerbils may also assist in diagnosis.
- Animals inoculated with infective blood typically develop parasitemia within 1 to 4 weeks.

Treatment:

Treatment with **clindamycin** plus **quinine** or **atovaquone** plus **azithromycin** are the options.

Family: Theileriidae

Genus:

➤ **Theileria**

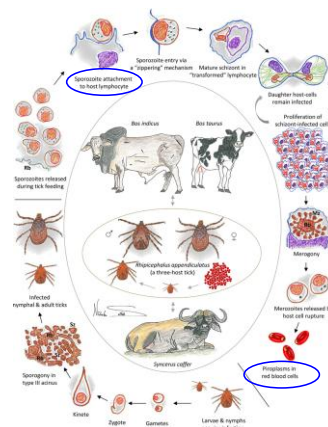
➤ **Cytauxzoon**

- Infects mainly ruminants (cattle, goats, sheep, deer)
- Several different species causing both pathogenic and benign disease
- Infection in wild animals is mostly asymptomatic

Theileria parva – East cost fever

Theileria annulata – Tropical theileriosis

Life cycle



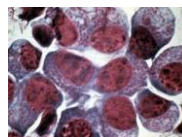
Theileria parva – East Coast Fever

- *T. parva* sporozoites are injected into cattle by infected vector ticks, *Rhipicephalus appendiculatus*, during feeding.
- Based on clinical and epidemiologic parameters
- 3 subtypes of *T. parva* are recognized, but these are probably not true subspecies.
- *T. parva parva*, transmitted mainly between cattle,
- *T. parva lawrencei*, transmitted mainly from buffalo to cattle, are both highly pathogenic and can cause high levels of mortality
- *T. parva bovis*, transmitted between cattle, is less pathogenic.

Pathogenesis



Lymph nodes are enlarged, hemorrhagic, and edematous



Lymphoblasts containing *Theileria* parasites

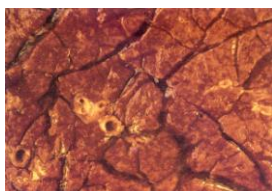
Clinical signs

- Just before death, a sharp fall in body temperature is usual, and pulmonary exudate pours from the nostrils.
- Death usually occurs 18-24 days after infection
- The most striking postmortem lesions are lymph node enlargement and massive pulmonary oedema and hyperemia.



generalized lymphadenopathy; note the prescapular lymph node

Post mortem findings



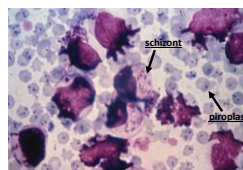
Theileriosis. Swollen edematous lungs and interstitial pneumonia.



Theileriosis. Infarcts, thrombosis and lymphoid hyperplasia in spleen.

Diagnosis of *T. parva*

- Demonstration of parasites in Giemsa-stained blood, lymph node and tissue impression smears
- Problems:
 - parasitemia in carriers below threshold of detection
 - difficult to discriminate between schizonts and piroplasms of different *Theileria* species
- **Diagnosis of *T. parva* - IFA test**
- Detection of serum antibodies using the indirect fluorescent antibody (IFA) test
- **PCR and probing**



Theileria parva (ECF)



Theileria mutans

Treatment

- **parvaquone** and, its derivative **buparvaquone**.
- **halofuginone**
- Treatment with these compounds is **highly effective** when applied in the early stages of clinical disease
- But is **less effective** in the advanced stages in which there is extensive destruction of lymphoid and hematopoietic tissues.
- Incidence of East Coast fever can be reduced by rigid **tick control**, but in many areas, this means biweekly acaricidal treatment.

Other *Theileria* species

- Several other *Theileria* species are known to occur in wild ruminants:
 - ◆ *T. mutans*
 - ◆ *T. taurotragi*
 - ◆ *T. velifera* – non-pathogenic
 - ◆ *T. buffeli*
 - ◆ *Theileria* sp. (buffalo)
 - ◆ *Theileria* sp. (sable)

- In mixed infections, they complicate the diagnosis of *Theileria parva*
- There is an urgent need for a highly sensitive, specific and rapid test to detect *T. parva*

Theileria annulata – cattle tropical or Mediterranean theileriosis

- north Africa, the Mediterranean coastal area, the Middle East, India, the former USSR, and Asia.
- **Vectors:** ticks of the genus *Hyalomma*.
- *T. annulata* can cause **mortality of up to 90%**, but strains vary in their pathogenicity.

- Characteristic signs include **fever** and **swollen superficial lymph nodes**;
- Cattle **rapidly lose condition** and **hemoglobinuria** may occur.
- The schizonts and piroplasms are morphologically similar to those of *T. parva*
- Attenuated strains produced by serial passage form the basis of vaccines used in several countries, including Israel, Iran, India, and the former USSR.

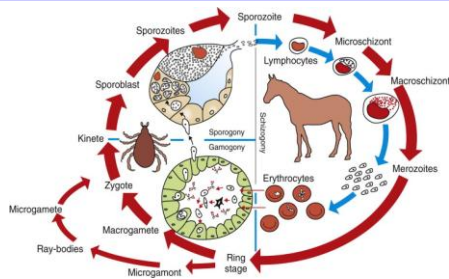
Sheep and goats

- 2 species of *Theileria*
- Mortality can approach **100%** with
- *T. lestoquardi* (formerly *T. hirci*), which is found in southern Europe, Africa, and throughout Asia.
- It is transmitted by *Hyalomma anatolicum* ticks in Asia.
- Schizonts can readily be demonstrated in Giemsa-stained biopsy smears from swollen superficial lymph nodes.

- Nonpathogenic *Theileria* spp.
- (**eg, *T. ovis***) are also widely distributed and are mainly transmitted by *R. evertsi* ticks in Africa and *Haemaphysalis punctata* ticks in Europe. Piroplasms of these species are polymorphic.

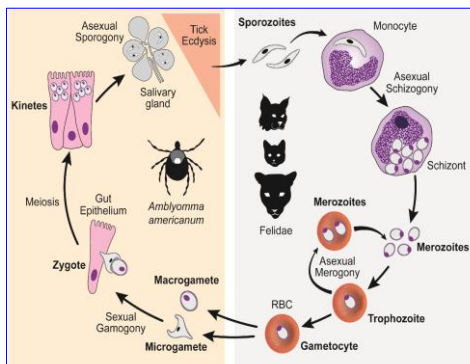
Horses

***Babesia equi* was reclassified as *T. equi* in 1998, based on DNA analysis and other biologic data.**



Genus: *Cytauxzoon*

- *Cytauxzoon felis* is a natural parasite of wild cats – bobcat [*Lynx rufus*] and the Florida panther [*Felis concolor coryi*] of North America.
- **Vector:** Ixodid tick *Dermacentor variabilis*
- as a parasite of wild cats its pathogenicity is unknown.
- Tick transmission to domestic cats results in an acute and almost always fatal disease.
- Most cases occur in the south and southeast states of the USA and are usually associated with access to wooded areas



C. felis life cycle. The right panel demonstrates asexual reproduction occurring within the host feline, while the left panel demonstrates the sexual and asexual reproduction occurring within the tick transmission vector.

Cytauxzoonosis - Clinical signs

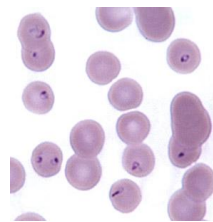
- Onset of clinical signs for cats infected with
- *C. felis* usually occurs ~10 days after infection by tick transmission.
- Severe signs are usually evident 6 days later.
- Cats are **febrile, anorectic, weak, depressed, dyspnotic, and dehydrated**.
- Temperatures may be as **high as 40.5°C** but usually become subnormal in extremis.
- Mucous membranes are often **icteric**.

Post mortem findings

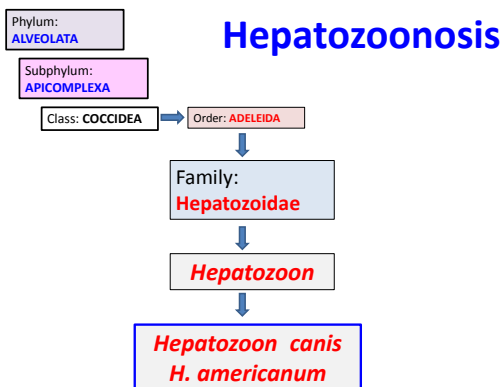


Diagnosis

- *Cytauxzoon felis*, **feline blood smear**
- Hematology shows a normochromic, normocytic anemia with a declining leukopenia and pronounced lymphopenia.
- Giemsa-stained peripheral blood smears reveal **pleomorphic, intraerythrocytic protozoan parasites** that usually appear ~10 days after infection. Parasites may be round, oval, anaplasmod, bipolar, or rod-shaped.
- Infection with *Cytauxzoon* spp must be differentiated from *Babesia* spp, which may have similar blood forms but do not have a schizont tissue stage, and the chain-forming *Haemobartonella felis*.

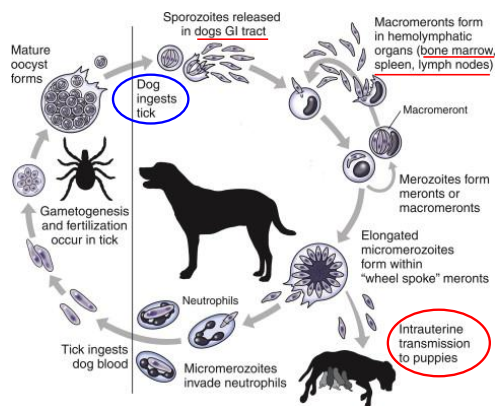


Treatment
➤ atovaquone and azithromycin



Hepatozoon canis - Old World
Hepatozoon americanum - NA

- Tick-transmitted by **ingestion !!!**
- *Rhipicephalus sanguineus* (old world), *Amblyomma maculatum* (new world).
- Gametocytes in circulating leukocytes and tissue "cysts" in muscle.
- Dogs often asymptomatic unless concurrently infected, immunosuppressed or younger than 4 months;

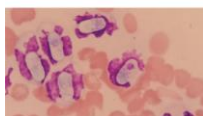


Clinical signs

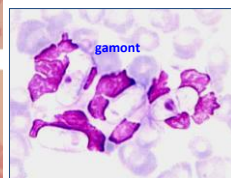
- Some of the clinical signs that may develop are: **fever, lymphadenopathy, ocular and nasal discharge, anorexia, cachexia, anemia, leukocytosis, paraparesis, depression, muscular hyperesthesia, and a reluctance to move.**
- The animal may develop **severe cachexia, vasculitis and renal failure.**
- Cysts containing macromeronts and micromeronts may be found in **muscle** biopsies. Leukocytes may contain gamonts.

Diagnosis

- blood smear – micromeronts in neutrophils
- muscle biopsy



Schizont *H. canis*



gamont

Treatment

- Dimazene aceturate,
- Imidocarb dipropionate
- tetracycline, for 14 days, or doxycycline
- toltrazuril for 5 days

HAEMOSPORIDA

Plasmodioidosis of human and animals – morphology, location, geographic distribution, prevalence, life cycle, epidemiology, pathogenesis and clinical signs, pathology, diagnosis, methods of prevention and control.

HAEMOSPORIDA

Family: Plasmodiidae

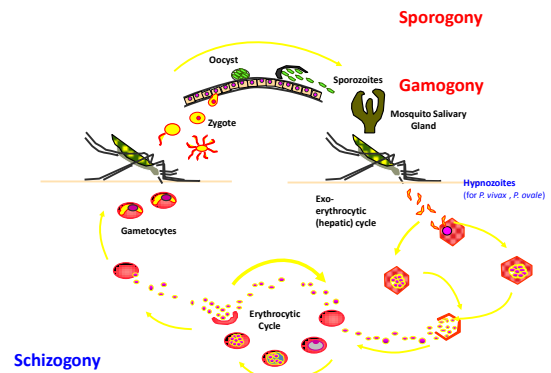
Genus: *Plasmodium* / Malaria

- Intracellular parasites
- Gamont occur in the Erythrocytes
- Microgamont produces a moderate number (generally 8) of flagellates microgametes
- Zygote is motile – **ookinete**
- All are heteroxenous
- Schizogony takes place in a vertebrate host (IH)
- **Gametogony and sporogony** in an avertebrate (FH)
- There are **no sporocysts**, sporozoites lie in the oocyst

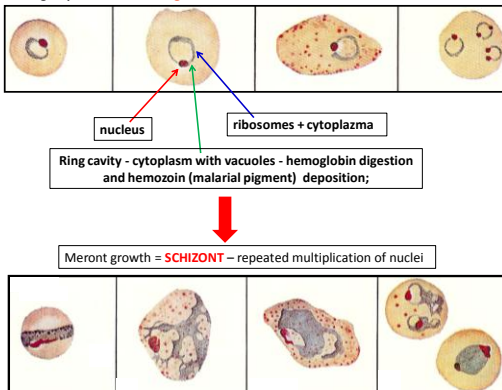
Plasmodium

- causative agent of **malaria**
- ~155 named species
- vertebrate hosts include: reptiles, birds, rodents, monkeys, humans
 - specific for host
 - and vector
 - 5 human species
- transmitted by insect **vector**
 - *Anopheles mosquito* (mammalian)

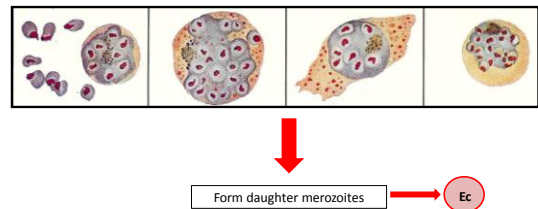
| |
|--|
| <i>Plasmodium vivax</i> (75 %) |
| <i>Plasmodium ovale</i> (5 %) |
| <i>Plasmodium malariae</i> (5 %) |
| <i>Plasmodium falciparum</i> (15 %) |
| <i>Plasmodium knowlesi</i> (1-5 %) |



Young trophozoite called **ring form**

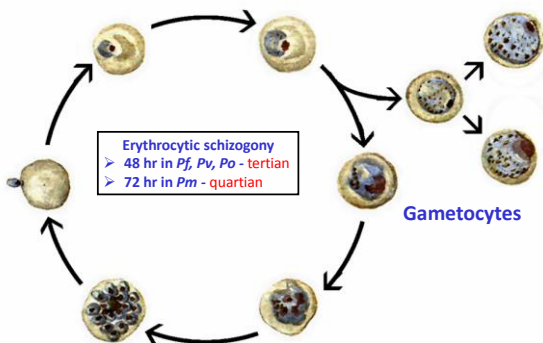


In the schizont, the nucleus is repeatedly divided = ROSETTA (segmenter); instead of vacuoles - **yellow-brown pigment (hemozoin)**



- **synchronization** of meront development...
- moment of Ec decay and release of merozoites = **triggers a feverish malaria attack**

SCHIZOGONY/MEROGONY - Humans



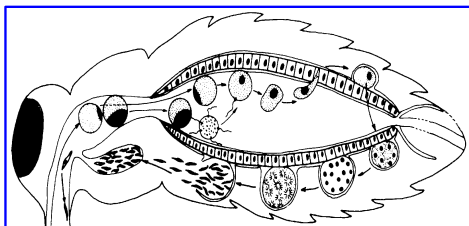
Gametogony



- occurs in mosquito gut

Sporogony

- occurs in mosquito (9-21 d)
- fusion of micro- and macrogametes
- zygote → ookinete (~24 hr)
- ookinete transverse gut epithelium ('trans-invasion')
- sporozoites migrate through hemocoel
- sporozoites 'invade' salivary glands



Clinical presentation

- Acute febrile illness, may have periodic febrile paroxysms every 48 – 72 hours with afebrile asymptomatic intervals;
- Tendency to recrudesce or relapse over months to years;
- **Early symptoms**
 - Headache
 - Malaise
 - Fatigue
 - Nausea
 - Muscular pains
 - Slight diarrhea
 - Slight fever, usually not intermittent
- Could mistake for influenza or gastrointestinal infection;
- **Signs**
 - Anemia
 - Thrombocytopenia
 - Jaundice
 - Hepatosplenomegaly
 - respiratory distress syndrome
 - renal dysfunction
 - Hypoglycemia
 - Mental status changes
 - Tropical splenomegaly syndrome

Prodromal Symptoms

- end of incubation period
- 2-3 days before 1st paroxysm
- includes: malaise, fatigue, headache, muscle pain, nausea, anorexia (i.e., flu-like symptoms)
- can range from none to mild to severe

Febrile Attack (Malaria Paroxysm)

- periodic febrile episodes alternating with symptom-free periods
- initially fever may be irregular before developing periodicity
- may be accompanied by splenomegaly, hepatomegaly (slight jaundice), anemia

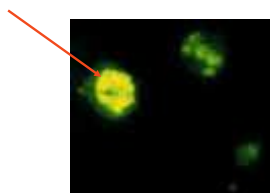
Immunity

➤ Acquired

- Transferred from mother to child
- ✓ 3-6 months protection
- ✓ Then children have increased susceptibility

Diagnosis

- 1. Microscopic- stained blood smear
- 2. PCR and RT-PCR
- 3. ELISA, IFAT



Therapy and prevention

➤ Mefloquine

➤ Doxycycline

➤ Malarone™

➤ Chloroquine

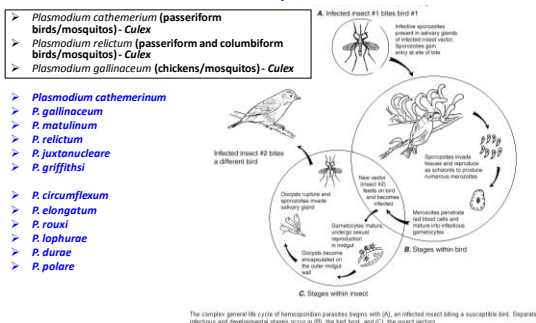
➤ Hydroxychloroquine

Avian Haematozoa

Plasmodium *Leucocytozoon* *Haemoproteus*

PLASMODIUM/Bird malaria

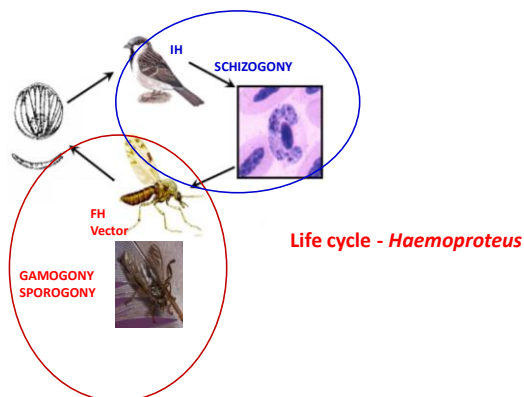
Blood coccidiosis characterized by **intermittent fever, splenomegaly and secondary anemia.**



Haemoproteus/Haemoproteosis

- Blood coccidiosis - endoflebitis of capillaries and erythrocytes decay;
- *Haemoproteus* parasites in reptiles (16), amphibians (3) and birds (140); Within the genus we know 173 species, 5 varieties and 1 subspecies.
- *Haemoproteus antigonis* - cranes
- *Haemoproteus canachites* - partridges
- *Haemoproteus columbae* - pigeons
- *Haemoproteus danilewski* - free living birds
- *Haemoproteus lophortyx* - quail
- *Haemoproteus meleagridis* - turkeys
- *Haemoproteus nettionis* - ducks, geese, swans
- *Haemoproteus sacharovi* - pigeons

- Intracellular parasites - **ERYTHROCYTES**
- Heteroxene parasites
- **Definitive hosts and vectors** - *Culicoides*; avian keds (*Ornithomyia*, *Lynchia*, *Pseudolynchia*, *Stilbometopa*); horse fly (*Chrysops*), mosquitoes (?)



PATHOGENESIS AND SYMPTOMS

- Subclinical infections; acute form - pigeon
- **Enlarged stomach**
- Enlarged (hypertrophy) **spleen, liver and kidney**
- They may have a chocolate-brown color due to accumulated hemozoin
- Infected birds may have movement pain
- The appearance of fluffy feathers
- Exhaustion, weakness, death
- Anemia (merozoites surround and destroy the nucleus of erythrocytes)
- Large megaloschizonts may be present in skeletal muscle
- The average flock mortality may be above 20%

THERAPY, PREVENTION

- chloroquine
- Elimination of vector populations (insecticides, active efficient ventilation)

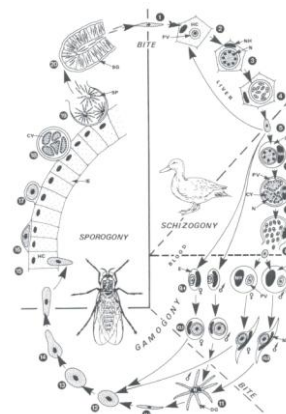
Leucocytozoon

L. simondi (ducks, geese), *L. smithi* (turkey),
L. caulleryi (chicken), *L. andrewsi*, *L. bonasae*,
L. mansoni (more than 100 species, of which
 3 are the most significant)

1884 – Danilewski – owl

Location: capillary endothelial cells, RES organs (liver, spleen),
 leukocytes, erythrocytes;

Final host and vector: black flies (*Simulium* spp.)



PATHOGENESIS

5 days after infection

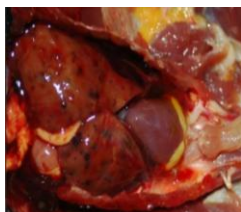
- many schizonts in hepatocytes
- cell rupture

7 days after infection

- megaloschizonts in the spleen, lymphatic and other tissues –
- accumulation of gametocytes in the liver

12 days after infection

haemorrhagic scars after megaloschizont rupture

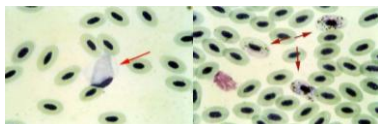


CLINICAL SYMPTOMS

- Most birds infected with the birds are free from overt clinical symptoms;
- Visible anorexia I
- leukocytosis emaciation
- anemia Weakness, depression
- Difficulty in breathing Inability to fly
- The limbs are non-governmental, movement is more difficult, uncoordinated with manifestations of paralysis
- Weakening of organism and increased sensitivity to secondary bacterial infection
- Granulomatous lesions are visible in the lungs, heart, brain, and peripheral nerves
- For young birds - death within 24 h
- After overcoming the disease - immunity - adult birds are reservoirs of parasites

DIAGNOSIS

- Microscopic examination of stained blood smears - finding of gametocytes
- Histopathological examination of the liver, spleen and brain with the finding of megaschizonts
- Pathological anatomical autopsy - enlargement of the liver and spleen



THERAPY, PREVENTION

- Therapy is usually not effective
- As a precaution, the vector must be disposed of
- As a precaution we can serve in feed:
 - **Pyrimethamine** (1 ppm)
 - **Sulfadimethoxin** (10 ppm) **Clopidol** (0.0125-0.025%)
- vector control Quinacrin hydrochloride or Trimethoprim / Sulfamethoxazole solution
- used when parasitemia is reduced but infection is not obvious Oral anti-Leucocytozoonous vaccine