

Babesiidae

BABESIOSIS

- Babesiosis is a protozoan disease that is found in domestic and wild animals, and humans in tropic and subtropics regions.
- This disease is seen mainly in cattle, sheep, goat, horse, dog, cat, pig, rodent and various mammals.
- Vectors of *Babesia* species are ticks belonging to *Ixodidae* family.
- Local names of babesiosis are "Ağrıma", "Ağrık", "Sarılık" in Turkey.
- There are zoonotic species of *Babesia* spp.

- Ixodid ticks transmit *Babesia* species to the susceptible hosts as transstadial and transovarial.
- Distribution of the disease is determined by the vector ticks. The disease is seen in seasons in which vector ticks are active.

Biology

- Vector: *Ixodidae* ticks (transovarial and transstadial)
 - Gametogony (in intestine of ticks)
 - Sporogony (in salivary glands of ticks)

Haemaphysalis spp.

Rhipicephalus spp.

Dermacentor spp.

Hyalomma spp.

- Hosts: Cattle, sheep, goat, dog, cat, pig and rodents.
 - They multiply by binary or multiple division in erythrocytes (Piroplasm).
 - *Babesia* species locate in only erythrocytes and can multiply by gemmation.

Development in erythrocytes.

- The infected ticks give the sporozoites to the susceptible hosts during blood feeding. These sporozoites enter the erythrocytes. The entry into the erythrocytes is occurred without forming vacuoles by endocytosis.
- *Babesia* sporozoites inside of the erythrocytes turn into piroplasm (trophozoite).
- Merozoites (daughter cells) are formed by dividing (two or four) of trophozoites.
- Free merozoites that are released as a result of breakdown of infected erythrocytes infect other healthy erythrocytes.

Erythrocytic development

- *Babesia* species are classified according to their sizes as small (1-2,5 μm) and large (2,5-5 μm).
- - Small *Babesia* species (*B. bovis*, *B. divergens*, *B. ovis*, *B. felis*, *B. microti*, *B. equi* etc.) are round and pear-shaped (it can be single or double) appearance (the double pears have a wide angle).
 - Large *Babesia* species (*B. bigemina*, *B. motasi*, *B. crassa*, *B. caballi*, *B. canis*, *B. trautmanni*) are oval, amoeboid and pear-shaped (it can be single or double) appearance (the double pears have a narrow angle).

Developmental stages in vector ticks

- Gamonts (gametocytes) are taken by vector tick turn into two different form.
- Zygote are formed by the gamets and they infect epithelial cells of tick intestine.
- Active ookinets (vermiculs, sporokinets) are formed by dividing in there.
- Kinets pass to hemolymph of ticks and infect various organs of ticks including ovaries. They also multiply in these organs.
- The kinets enter salivary glands of ticks by means of hemolymph, and sporoblasts and later sporozoites are formed in there.

Developmental stages in vector ticks

- Development of sporozites in transovarially infected (*B. bigemina*) larvae begins with blood feeding of the vector tick. However, it takes about 9 days for infective sporozoites to appear. Therefore, the infective sporozoites can be given by nymph and adult stages of ticks.
- This situation is different in *B. bovis*. The formation of infective sporozoites in *B. bovis* occurs within 2-3 days after starting the larvae's blood-feeding. Therefore, *B. bovis* is also transmitted by larvae.

Ray bodies of the gametes

Fusion of two gametes

Kinet

Sporoblast containing
numerous sporozoites

Sporozoites in the salivary glands

Babesiosis in cattle

● *B. bigemina* (Vectors: *Rhipicephalus annulatus*, *Rh. decoloratus*, *Rh. calcaratus*, *Rh. evertsi*, *Rh. bursa*, *Rh. appendiculatus*, *Haemaphysalis punctata*)

● Narrow angled, large species.

● Texas fever or hemoglobinuria disease.

● It is common in Turkey. It is seen in Africa, Australia, Central and Southern America, Middle East and Southern Europe.

● Mortality is about 30-90%.

Babesia bigemina
(4-5x2-3µm)

Babesiosis in cattle

- *B. bovis* (Vectors: *Rh. annulatus*, *Rh. microplus*, *Rh. bursa*, *Ixodes persulcatus*)
- Wide angled, small species.
- Hemoglobinuria disease of cattle.
- It exists in Turkey and is seen in Southern Europe, Middle East, Russia, Asia, Africa, Australia, Central and Southern America.
- The vaccination application is used in Australia and Israel.
- **It is also zoonotic?**

Babesia bovis
(2,4x1,5µm)

Babesiosis in cattle

- *B. divergens* (Vector: *Ixodes ricinus*)
- Wide angled, small species.
- It has been reported from Turkey.
- It is common in Middle and Northern Europe and Russia.
- **It is zoonotic and causes infection in humans.**

Babesia divergens
(1,5x0,4 μ)

Babesiosis in cattle

- *B. major* (Vectors: *Rh. annulatus*, *Haemaphysalis punctata*)

- Narrow angled, large species.

- Low pathogenicity.

- It has been reported from Turkey and is seen in Europe, North Africa and Russia.

- *B. occultans* (Vectors: *Hyalomma marginatum*, *H. rufipes*, *H. excavatum*)

- Pathogenicity? (low?)

- Clinical symptoms have been reported from Europe.

- It has been reported from Turkey and reported from Europe and Africa.

Babesia major
(2,6x1,5µm)

Babesiosis in sheep and goats

- *B. motasi* (Vectors: *Rh. bursa*, *Ha. punctata*, *Ha. sulcata*, *Ha. parva*, *Dermacentor* spp., *I. ricinus*)
- Narrow angled, large species
- Pathogenic species.
- It has been reported from Turkey and is seen in Europe, Middle East, Russia, North and East Africa.

Babesia motasi
(2-4x2 μ m)

Babesiosis in sheep and goats

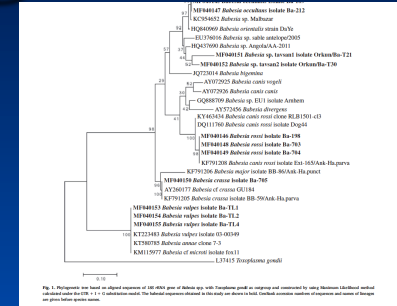
- *B. ovis* (Vectors: *Rh. bursa*, *Rh. turanicus*, *Rh. evertsi*, *H. excavatum*, *I. persulcatus*)
- Wide angled, large species.
- Moderate pathogenic.
- It is common in Turkey and Near and Middle East, Asia, Europe, and Africa.

Babesia ovis

(1x2,5µm)

Babesiosis in sheep and goats

- *B. crassa* (Vectors: *Haemaphysalis* spp.)
- It has been reported from Turkey and Iran.
- The pathogenicity is unknown.



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PLOS | NEGLECTED TROPICAL DISEASES

Identification of Tick-Borne Pathogens in Ticks Feeding on Humans in Turkey



Ömer Orkun*, Zafer Karaer, Ayşe Çakmak, Serpil Nalbantoğlu

Department of Parasitology, Faculty of Veterinary Medicine, Ankara University, Ankara, Turkey

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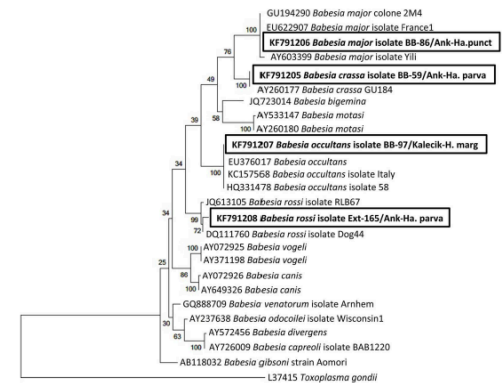
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Tick-Borne Pathogens in Ticks in Turkey



Research paper

Molecular characterization of *Babesia* species in wild animals and their ticks in Turkey

Ömer Orkun*, Zafer Karaer

Department of Parasitology, Faculty of Veterinary Medicine, Ankara University, Ankara, Turkey

Babesiosis in Horses

- *B. caballi* (Vectors: *Dermacentor marginatus*, *D. reticulatus*, *D. nitens*, *D. silvarum*, *Rhipicephalus* spp., *Hyalomma* spp.)
- Narrow angled, large species.
- It is resemble to *B. bigemina*.
- It is seen in South and Central America, Asia, South Europe, Africa, Russia and Turkey.

Babesia caballi
(2,5-4x2 μm)

Babesiosis in Horses

- **B. equi* or *Theileria equi* (Vectors: *Hyalomma* spp., *Dermacentor marginatus*, *D. reticulatus*, *Rhipicephalus* spp.)
- It is also called as *T. equi* because of the similarity to the development of *Theileria* species.
- *Schizogony occurs in lymphocytes (macro and microschorizonts). The merozoites enter erythrocytes and continue their developmental stages.
- Small species.
- Pathogenic.
- It is seen in Europe, Africa, South America, Asia and Turkey.

Theileria equi
(2-3 μm)

Babesiosis in Dogs

- *Babesia canis* complex
 - Large *Babesia* species.
 - It is common in Asia, Africa, Europe and America.
- *Babesia canis* s. s. (Vector: *Dermacentor reticulatus*)
 - Pathogenic species.
 - It has been reported from Turkey.
- *Babesia vogeli* (Vector: *Rhipicephalus sanguineus*)
 - Pathogenic species.
 - It has been reported from Turkey.
- *Babesia rossi* (Vectors: *Haemaphysalis* spp.)
 - Highly pathogenic species.
 - It has been reported from ticks in Turkey.

B. canis
4-5 μ m

Babesiosis in Dogs

- *Babesia gibsoni* (Vector: *Rhipicephalus sanguineus*)
- Small species.
- It causes a chronic disease in dogs.
- It is seen in Asia, North Africa, Mediterranean countries, and North America.

Babesiosis in cats

- **Small *Babesia* species**

- *Babesia felis* (Vector: *Haemaphysalis* spp.)

- It has been reported from Turkey? and is seen in Europe and South Africa.

- The younger cats are susceptible.

- *Babesia cati*

- **Large *Babesia* species**

- *Babesia herpailuri*

- *Babesia pantherae*

Babesiosis in Pigs

- **Large *Babesia* species**
- *Babesia trautmanni* (Vectors: *Rhipicephalus* spp., *Dermacentor reticulatus*)
 - It is seen in South Europe, Africa and Russia.
- **Small *Babesia* species**
- *Babesia perroncitoi* (Vectors: unknown)
 - It is seen in South Europe, Africa and Russia.

Babesiosis in rodents

- *Babesia microti* (Vectors: *Ixodes ricinus*, *Ixodes* spp.)
 - Small species
 - It is common in Europe and America, and has been reported from Turkey, China, Taiwan, Egypt, South Africa and Mexico.
 - **Zoonotic species.**
- *Babesia rodhani* (Vector: *Hyalomma excavatum*)
 - Large species
 - It was characterized in a wild rodent in Congo.

Babesia microti

- It is suggested that *B. equi*, *B. rodhaini* and *B. microti* should be placed in the *Theileria* genus instead of *Babesia* genus due to their extra-erythrocytic development stages.
- As a result of the phylogenetic analysis of *B. equi*, it has been accepted that it is included in the *Theileria* genus and that its name is changed as *Theileria equi*.
- *B. rodhaini* and *B. microti* have been excluded from the *Theileria* and *Babesia* genus due to the differences in the sequence of the small subunit-ribosomal RNA gene (*18S RNA*), and thus have been claimed to be classified in a new genus.

Pathogenesis

- In acute babesiosis, the level of kinin and active kallikrein increases and the level of kininogen decreases.
 - Dilatation of vessels, slowing of blood flow, deterioration of capillary walls are seen and the permeability of vessel walls increases.
- There is a decrease in conglutinin and fibronectin levels.
 - Clustering of the erythrocytes and obstruction of capillary vessels occur.
- Fibrinogen-related products increase while plasminogen decreases.
 - Coagulation failures and erythrocyte accumulation are seen.
 - This type of pathogenesis is seen in *B. bovis* in which infected erythrocytes accumulate and block vessels.
 - The most important pathological effect in *B. bigemina* and *B. divergens* infections is erythrocyte damage, because the capillary blockage does not occur in these infections.

Pathogenicity

- Large *Babesia* species are more pathogenic.
- Age (more severe in old age except for sheep and dogs),
- Strain resistance (*Bos indicus* cattle against *B. bigemina* is more resistant than *Bos taurus*),
- and stress factors are important.

Symptoms

- Incubation period of the disease is about 9-12 days.
- High fever (1 week after the infection, 41,5-42°C)
- Anemia (severe hemolytic anemia)
- Hemoglobinuria
- Icterus

Icterus on subcutaneous connective tissue, adipose tissue and serosa located in the abdominal cavity.

Dark-reddish brown urine accumulation in urine

Splenomegaly

Dark green bile accumulation in bile and swollen appearance along with hepatomegaly.

Swelling and icterus on the cross section of the liver.

Hydropericardium and icterus in the heart due to *Babesia*
infection

Diagnosis

- Epidemiological information (season, tick infestation, instable region)
- Clinical findings (in the region where the disease is endemic)
- Microscopic examination
 - Thin blood smear
 - Thick blood smear
- Serological methods
 - IFA, DFA, ELISA, CF etc.
- Species identification
 - PCR

Prevention and Control

- Tick Control
 - In the stables
 - On the host
- Preimmunisation (the animal is infected with less pathogenic strain of *Babesia* and appropriate medical treatment is done)
- Vaccination (cattle, sheep and dog)
 - Live vaccines
 - frozen
 - Recombinant vaccines

Treatment

- Quinorium sulphate (Acaprin) 1mg/kg sc
- Diminazene (Berenil) 2-3,5 mg/kg im
- Imidazole (Imidocarb) 1-3 mg/kg im, po, sc