Haemoparasites of equines: impact on international trade of horses

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Summary: The geographical distribution of Babesia equi and Babesia caballi and their tick vectors is discussed. Control of infections with these protozoa is hampered by the lack of a suitable antiprotozoal drug and a reliable serological test. No vaccine is available. Ehrlichia risticii (the causal agent of Potomac horse fever) and E. equi are rickettsial parasites which are difficult to control. Little is known of their geographical distribution and vectors. Early diagnosis is required for tetracycline therapy to be effective and there is a need for a rapid test to provide an early diagnosis.

KEYWORDS: Disease control - Geographic distribution - Horse diseases - Ixodidae - Protozoal infections - Rickettsial infections - Tickborne diseases - Vectors.

Babesia and Ehrlichia infections are tickborne diseases as far as is known today. Two Babesia and two Ehrlichia species have been identified in equines. Babesia caballi and B. equi may infect all breeds of horses, donkeys and zebras but no other mammals. Thus, horses or ponies have to be used for experimental studies. This explains the rather limited research activities in this field.

B. caballi is a typical Babesia species; it invades exclusively red blood cells of the equine host, where it produces two pear-shaped merozoites. Typical signs of acute disease are: fever (39.2-42.3°C), dyspnoea and hyperaemia of mucous membranes (including haemorrhages, oedemas, icterus but only rarely haemoglobinuria).

B. equi is not a typical Babesia species; it initially invades lymphocytes where macro- and micromeronts are produced. The micromeronts are multiple fission bodies that release a large number of micromerozoites. These finally enter red cells. Here they reproduce by simultaneous formation of four merozoites. Thus, B. equi should be reclassified as a Theileria species once the report of Schein et al. (11) has been confirmed.

Acute symptoms are similar to those seen in horses infected with B. caballi; however, icterus is usually more pronounced whereas haemoglobinuria is more common. While parasitaemia rarely exceeds 1% in B. caballi infections, it usually ranges from 1% to 7% in B. equi infections, but may reach 80% in some cases.

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Geographical distribution

B. caballi and B. equi are frequently associated because they share common vectors. However, infections with B. equi are more prevalent than B. caballi infections. Both infections are widespread throughout tropical and subtropical zones, but B. caballi infections extend far more to the north. The African continent as a whole is highly endemic for B. equi. Our sero-epidemiological studies have shown that in Zaire and in the Sudan virtually all horses are infected with B. equi. Similar results were reported for zebras in East Africa by Young and Purnell (17). While B. caballi infections are very common in the Sudan, such infections were not identified in Zaire. Thus, the geographical distribution of B. caballi in Africa south of the Sahara requires further investigation.

Equine babesioses are probably endemic throughout Asia except Siberia. High infection rates have been reported from the Near and Middle East and from India (5). Recent reports indicate that B. equi and B. caballi are common in China (9) and in Korea. However, autochthonous infections obviously do not occur on the Japanese islands (16).

In Europe, equine babesioses extend from Portugal and Spain, through France and Italy to the whole of the Balkan peninsula, and from there to the southern and central parts of the European Soviet Union. Autochthonous infections probably do not occur in Germany, Austria and Switzerland north of the Alpine mountain range, although some vector ticks (Dermacentor species) are endemic in this area. The same is true for England and Wales where Dermacentor reticulatus occurs.

In the forest belt of central Russia, B. caballi infections extend as far north as the 58th degree of latitude. This is the distribution area of Dermacentor reticulatus, an important vector tick.

Australia is the only continent where equine Babesia has not become established, although B. equi was introduced with imported horses in 1976. There was some spread of the infection, probably by contamination of injection needles or other instruments with blood. These foci could be extinguished because suitable vector ticks were obviously absent.

In the New World, both equine Babesia species are highly endemic in Latin America with the exception of the southern parts of Chile and Argentina. Almost all horses examined from Colombia and Brazil were seropositive for B. equi, and nearly as many for B. caballi. Horses in these countries are often heavily infested with ticks. Similar reports have been published for nearly all Latin American countries ranging from Cuba to Argentina.

B. caballi and B. equi were not introduced into the United States until 1959. B. caballi infections became established in Florida and some adjacent states when a vector tick, Dermacentor nitens, was also introduced. Although further spread of B. caballi was prevented by intensive control measures, attempts to eradicate the disease in Florida have not yet been successful.

Transmission

Babesia caballi is transmitted in Europe by at least six tick species, five Dermacentor and one Hyalomma species (4).
In the New World, the only known vector is the one-host tick *Dermacentor (Anocentor) nitens*, the so-called tropical horse tick. However, *Dermacentor albipictus*, the winter tick, may be another vector, as shown experimentally (14). Altogether, 13 tick species of the genera *Dermacentor*, *Hyalomma* and *Rhipicephalus* have been incriminated as vectors of *B. caballi*. This accounts for the high incidence and wide distribution of this parasite in the equine population. However, almost nothing is known of the transmission of *B. caballi* in the tropics and the Southern Hemisphere. In Latin America, the highly abundant *D. nitens* is probably the principal vector.

*B. equi* is known to be transmitted in the Old World by at least eight tick species of the genera *Dermacentor*, *Hyalomma* and *Rhipicephalus* (4). No vector is known for *B. equi* in the New World, even though this parasite infects most of the horses in Latin America, as indicated above.

*B. equi* is usually acquired by nymphs and transmitted by both male and female adults. Single male ticks can transmit *B. equi* to several horses because of their longevity and mobility. *Hyalomma* males, for instance, may infest horses or other hosts for several weeks or even months. This facilitates the spread of infection.

*B. equi* is highly infective for nymphs of *Hyalomma anatolicum* and *Rhipicephalus turanicus*: 85% to 92% of the nymphs may acquire infection despite low parasitaemia. Up to 17 acini of the salivary glands become infected in the ensuing adult ticks. Many thousands of sporozoites are produced in a single acinus cell.

Nymphs of two tick species have become infected by feeding on a horse that was negative in the complement fixation (CF) test. These ticks transmitted *B. equi* to other horses in the adult stage. Hence, even CF-negative horses may constitute a source of infection for suitable vector ticks (Friedhoff *et al.*, unpublished data).

**Epidemiology**

There are few reports on severe outbreaks, although several have been reported in India (12), as were several others during the Second World War. In general, acute disease is uncommon in endemic areas.

There have been a few outbreaks in the USA, Germany and Switzerland without tick vectors being involved. In these disease-free areas, *B. equi* had been transmitted by the use of contaminated needles or instruments. It may be concluded that a horse may remain infected with *B. equi* for many years, perhaps for life. The authors also conclude that ticks can acquire the infection while feeding on infected horses which are negative to the CF test. Thus, infected horses are the reservoir of infection with *B. equi*, but not the vector ticks, because there is no transovarial but only stage-to-stage transmission. On the other hand *B. caballi* infections are self-terminating, usually limited to 1-3 years. It is not known whether ticks can acquire infection from seronegative or from latently infected horses. It appears that horses are infective for ticks only during the rather short period of a latent *B. caballi* infection. Thus, ticks, rather than horses, are the reservoir of infection with *B. caballi* because the infection may persist in ticks throughout several generations, with trans-stadial and transovarial transmission.

During the last ten years there have been several studies of the prevalence of equine babesiosis in various countries, as revealed by serodiagnosis using the CF test and
the indirect immunofluorescent antibody (IFA) test. Results obtained at the Central Veterinary Laboratory at Weybridge and at the Hanover Veterinary School during the last ten years, together with other sources of information, have led to the following conclusions:

Equine babesioses are not endemic in Ireland, the United Kingdom, the Netherlands, the Scandinavian countries and Germany. Belgium, Switzerland, Austria, the CSFR and Poland are probably marginal areas where autochthonous infections may occur. Most infections of horses examined in England and Germany have been traced back to Spain, France, Italy and the Soviet Union.

Spreading of the infections from marginal into disease-free areas (e.g. to Germany or England) has not yet occurred, although potential vector ticks of the genus *Dermacentor* do exist in these countries.

Tick infestation rates are close to 100% in some Latin American countries. Mainly two tick species infest horses in the New World: the tropical horse tick, *D. nitens*, and *Amblyomma cajennense*. However, these two tick species did not transmit *B. equi* in the laboratory (Friedhoff *et al.*, unpublished data).

In the Old World, tick infestation rates appear to be low in most countries. *Dermacentor* species are more common at the northern boundary of the distribution area and in marginal areas, whereas *Hyalomma* and *Rhipicephalus* ticks predominate in southern Europe, North Africa and the Near and Middle East, including India and the southern regions of the Soviet Union.

There is a potential risk of *Dermacentor, Rhipicephalus* and *Hyalomma* species becoming established in the New World or in Australia, if these ticks are introduced with horses or other hosts.

**Control**

Control of the equine babesioses depends on the epidemiological situation. In disease-free areas, tickborne infections do not occur. The only sources of infection are the introduction of infected equines or ticks, and the transmission of disease by blood-contaminated instruments.

Thus, control measures are directed mainly against the importation of infected equines, e.g. into the USA, Canada, Australia, Japan and certain other countries. There are no such restrictions in Germany, the Netherlands, Denmark and other European countries. The authorities of the latter countries have evidently decided that the spread of babesia infections cannot occur. This assumption is based on the historical experience that, throughout centuries of unrestricted horse traffic, no foci of tickborne infections have become established.

All countries take measures to prevent the introduction of ticks; however, this is an almost impossible task. During the past 25 years, numerous tick species have been introduced into Germany with domestic, zoo or other exotic animals.

*Hyalomma, Rhipicephalus* and *Dermacentor* species from the Old World could become established in the New World and the American tropical horse tick in the Old World. There is certainly constant risk of the introduction of potential vector ticks into the New World (1). The consequences of the spreading of ticks are much
worse than the introduction of infected horses. The potential distribution of vector ticks can be estimated by using the climatic matching programme ("CLIMAX") of Sutherst and Maywald (15).

In marginal areas, eradication should be attempted. Again, this is a difficult task. Since the first outbreak of equine piroplasmosis in Florida in 1959, control measures have not achieved eradication of *B. caballi.*

In endemic areas, there have been attempts to protect stud farms or military horses, e.g. in the Soviet Union and in India. As far as we know, these attempts have been unsuccessful to date, with a few exceptions. However, strict isolation of horses and intensive tick control are extremely expensive. Complete tick control is impossible in larger endemic areas.

Control measures have been quite unsatisfactory up to now, for the following reasons:

1. There is no drug that eliminates *B. equi* infections. It has been claimed that treatment with imidocarb derivatives can eliminate *B. equi* infections. From our experience, four doses of imidocarb dipropionate in the toxic dosage range of 6-8 mg/kg body weight may reduce CF titres. Such horses may become CF-negative for a few weeks or months, but remain positive in the IFA test and — more importantly — they remain infective for vector ticks.

2. The CF test does not identify all infected horses. The proportion of these false-negative CF reactions tends to increase when horses have been treated before testing. Therefore, we recommend an additional IFA test whenever horses have been outside a country such as Germany, or have been in close contact with seropositive horses.

Thus, there is an urgent need for:

1. A non-toxic drug that eliminates *B. equi* infections.

2. A serological test that allows safe identification of an infection. This test should give negative results a few weeks after elimination of the infection. Furthermore, such a test should be capable of standardisation. Test results achieved in various laboratories must agree, otherwise horse owners and agencies involved in the transportation of horses will lose confidence in the reliability and usefulness of expensive control measures and severe restrictions. Contradictory test results from a European laboratory and the official testing agency in the USA or Canada may cause expenses of 20,000 US dollars for a single horse.

In cooperation with colleagues at Weybridge, the authors recently succeeded in cultivating the erythrocytic stages of *B. caballi* and *B. equi in vitro.* This opens the possibility of testing drugs *in vitro* and producing antigens from cultures for the development of a suitable test.

3. Finally, no vaccines against *B. equi* or *B. caballi* infections are available to protect horses shipped into endemic areas.

**Ehrlichia infections**

The genus *Ehrlichia* belongs to the order Rickettsiales. *Ehrlichia* species parasitise the leukocytes or other cells of some mammals, including man. During the acute clinical disease, loosely-packed rickettsias are observed to form morulae or inclusion bodies in the cytoplasm.
Two species have been identified in horses: *Ehrlichia equi*, which parasitises in neutrophil and eosinophil granulocytes, and the recently described *Ehrlichia risticii*, which parasitises macrophages, mast cells and deep glandular epithelial cells in the lamina propria and submucosa of the large colon; also, to a lesser extent, macrophages of the small colon and of other organs, and blood monocytes (3).

The experimental host range of *E. equi* includes donkeys, sheep, goats, dogs, cats and monkeys, but clinical disease has been observed only in horses and donkeys. The disease is characterised by fever, depression, anorexia, ataxia, limb oedema, leukopenia, thrombocytopenia and mild anaemia. Equine granulocytic ehrlichiosis was observed at first in California in 1969 (13, 7) but later also in other states of the USA. In 1984, the disease was observed in a horse that had never been outside Germany (2). In the meantime, two additional cases of equine granulocytic ehrlichiosis were reported from Switzerland (8), and the infection was identified in 4 other horses (6). Thus, 7 cases have been reported from central Europe to date. *Ehrlichia risticii* is the etiologic agent of equine monocytic ehrlichiosis, also known as Potomac horse fever or equine ehrlichial colitis, a recently recognised disease of horses characterised by fever, depression, diarrhoea and leukopenia. Several days after the acute phase of the disease, about 30% of the affected animals exhibit other signs, such as colic, oedema of the legs and ventral abdomen, and laminitis. Some horses may develop profound ileus and severe colic (10). Mortality rates are approximately 25%.

Gross lesions from field cases include ulceration of the glandular and pyloric regions of the stomach, patchy congestion of the duodenum, caecum, anterior and middle colon, with watery contents in these organs. Multifocal areas of necrosis in mucous membranes were observed in experimentally infected horses (3).

Potomac horse fever has been confirmed in at least 17 states in the USA and in Ontario.

Control of the equine ehrlichioses faces some difficulties.

1. Tetracyclines are recommended for treating acute ehrlichiosis. Early treatment is important in Potomac horse fever. However, tetracyclines exacerbate diarrhoea caused by *Salmonella*, and may cause “antibiotic-associated diarrhoea”. Therefore, a rapid diagnostic test is needed to provide an early diagnosis.

2. Since geographical distribution, prevalence and vectors of equine *Ehrlichia* species are unknown, preventive measures are not available. Therefore, sero-epidemiological studies and searches for potential vectors should be encouraged.

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Résumé : Ce travail est consacré à la répartition géographique de Babesia equi et Babesia caballi et des tiques vecteurs. La lutte contre ces protozooses est difficile car il n'existe pas d'antiprotozoaire adapté ni de test sérologique fiable. On ne dispose pas non plus de vaccin. *Ehrlichia risticii* (agent causal de la fièvre équine de Potomac) et *E. equi* sont des rickettsies contre lesquelles il est
même difficile de lutter. La répartition géographique et les vecteurs de ces parasites sont mal connus. L'administration de tétracyclines n'est efficace que si le diagnostic est précoce, ce qui suppose l'existence d'un test rapide.


Resumen: Se trata de un trabajo sobre la distribución geográfica de Babesia equi, de Babesia caballi y de las garrapatas vectoras. La lucha contra estas protozoosis es difícil porque no existe antiprotzoario adaptado ni prueba serológica fiable. Tampoco hay vacuna. Ehrlichia risticii (agente de la fiebre equina de Potomac) y E. equi son rickettssias contra las que también es difícil luchar. No se conocen bien ni la distribución geográfica ni los vectores de estos parásitos. Sólo es eficaz la administración de tetraciclinas cuando el diagnóstico es precoz, pero esto supone la existencia de una prueba rápida.

PALABRAS CLAVE: Distribución geográfica - Enfermedades de los équidos - Enfermedades propagadas por garrapatas - Infecciones por rickettssias - Ixodidae - Profilaxis - Protozoosis - Vectores.

REFERENCES


