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Haemoparasites in small ruminants in European countries: Challenges and clinical relevance

S. Stuen

Norwegian University of Life Sciences, Department of Production Animal Clinical Sciences, N-4325 Sandnes, Norway

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ABSTRACT

Small ruminants could be infested with several haemoparasites in Europe, whereas most of them are transmitted by vectors, and especially ticks. Anaplasmosis, babesiosis and theileriosis are the most important tick-borne diseases in small ruminants. In addition, *Mycoplasma* (*Eperythrozoon*) *ovis* transmitted mainly by biting flies are widespread and may also cause disease. In Europe, the main tick species associated with small ruminants are *Dermacentor marginatus*, *Haemaphysalis punctata*, *Rhipicephalus bursa* and *Ixodes ricinus*, whereas *I. ricinus* is the dominant species. Vector-borne pathogens may cause mild or unspecific clinical manifestations, an active surveillance is therefore necessary in order to investigate the real distribution of these pathogens. The present review focus on the following haemoparasites: *Anaplasma ovis*, *Anaplasma phagocytophilum*, *Babesia ovis/motasi*, *Theileria* spp. and *M.* (*Eperythrozoon*) *ovis*. Only scattered information exists concerning the distribution of these pathogens. Climate change in Europe may have a huge effect on the distribution and establishment of these infections. In addition, millions of ticks are annually spread by migrating birds, making the possibility for ticks and pathogens to be transmitted and established in new geographical areas. Integrated tick control strategies including breeding for genetic resistance should be implemented in order to control these infections. However, controls of vectors and vector-borne infections are a challenging issue.

1. Introduction

Vector-borne pathogens (especially tick-borne pathogens) could cause serious infections in several mammal species, including small ruminants and humans. Several ticks have been found associated with small ruminant worldwide (Taylor et al., 2007). In Europe, at least 12 species have been found on sheep, whereas the main tick species associated with small ruminants are *Dermacentor marginatus* ("the ornate sheep tick"), *Haemaphysalis punctata* ("the red sheep tick"), *Ixodes ricinus* ("the sheep tick") and *Rhipicephalus bursa* (Estrada-Peña et al., 2004). Of these ticks, *I. ricinus* is widely distributed especially in northern Europe, while more scattered distribution has been reported for *H. punctata, D. marginatus* and *R. bursa* in southern Europe. However, climate change in Europe may have an effect on the distribution and establishment of populations of ticks, and climate-warming models predict that several tick species are likely to establish more northern permanent populations (Gray et al., 2009). In addition, millions of ticks are annually spread by migrating birds, making the possibility for ticks and pathogens to be transmitted and established in new geographical areas. In the last decades, the range of for instance *I. ricinus* seems to have increased to more inland and northern areas (Jaensson et al., 2012). Other vectors may also cause challenges for small ruminant, such as biting flies, midges and mosquitoes. The present review will focus mainly on ticks and tick-borne infections.

2. Vector-borne infections

The present review focus on tick-transmitted haemoparasites such as: *Anaplasma ovis*, *Anaplasma phagocytophilum*, *Babesia ovis/motasi* and *Theileria* spp. In addition, *Mycoplasma* (Eperythrozoon) *ovis* infection transmitted mainly by flies will be presented. The infection prevalence in vectors may vary within geographical areas, between pastures, during the grazing season and also from year to year. Data on prevalence and especially on incidence of these infections in Europe are however scarce (Uilenberg, 1999).

2.1. Anaplasmosis

2.1.1. Species

Anaplasmosis in sheep and goats is caused by *A. ovis*. In addition, a similar pathogen, *Anaplasma mesaeterum*, may also cause

E-mail address: snorre.stuen@nmbu.no

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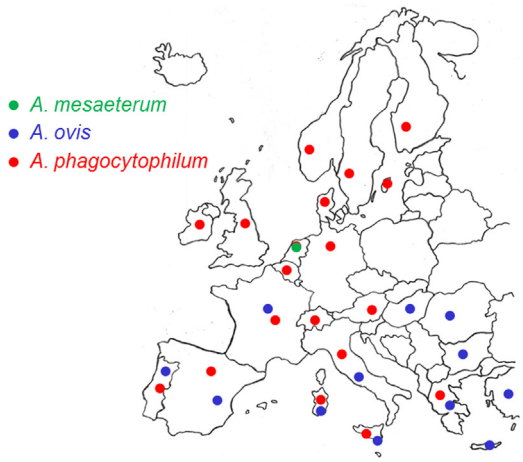

Fig. 1. *Anaplasma* spp. infections in small ruminants in Europe.

anaplasmosis in small ruminants. Both are obligate pathogens of erythrocytes (Dumler et al., 2001; Uilenberg et al., 1979).

2.2. Distribution

Anaplasmosis, caused by *A. ovis*, is one of the most widespread tick-borne diseases in the Mediterranean countries, and has been reported from Bulgaria, France, Germany, Greece, Hungary, Italy, Portugal, Romania and Turkey. *A. mesaeterum* has only been reported in the Netherlands (Fig. 1). *A. ovis* has a wide host range including several deer species. The infection is spread by a variety of ticks, particular *Rhipicephalus* and *Dermacentor* species, in Europe mainly by *R. bursa* (Friedhoff, 1997; Renneker et al., 2013). The northernmost distribution of *A. ovis* reported so far seems to be in Hungary (Hornok et al., 2007). Subclinical infection with *A. ovis* may occur (Renneker et al., 2013). An active surveillance is therefore necessary in order to investigate the real distribution.

2.3. Clinical expression

A. ovis is commonly reported as haemolytic anaemia in sheep and goats. Anaplasmosis in sheep is normally subclinical, and outbreaks of severe illness in sheep are rare, and seem to occur only under extreme conditions (Friedhoff, 1997). Clinical signs may be related to stress factors such as hot weather, poor-health condition, heavy tick infestations, long distance transportation and coinfections (Torina et al., 2010; Renneker et al., 2013). In addition, breed variation in sheep has been observed, which seems to be related to differences in the erythropoietic and haemoglobin system (Pieragostini et al., 2011; Ciani et al., 2013).

Infection with *A. ovis* may predispose animals to other infections and parasite infestation resulting in clinical disease or even death (Kocan et al., 2004). Anaplasmosis can therefore be a serious disease in sheep. Several strains/variants of *A. ovis* exists (De la Fuente et al., 2007), that may have an impact of sheep's health and thus their milk and meat production (Ndung'u et al., 1995). *A. ovis* appears to be more pathogenic for goats than for sheep, but this may be related to strains/variants and animal breeds involved. The bacterium may cause a persistent infection, and clinical cases are then mostly identified during periods of nutritional stress (Ilemobade, 1982; Palmer et al., 1998). *In utero* transmission of *A. ovis* has been recorded in both sheep and goats that may cause anaemia and death of fetus *in utero* (Barry and Van-Niekerk, 1990). Earlier studies indicate that several genera and species may be involved in the transmission of *A. ovis*, such as for instance *Melophagus ovinus* (Hornok et al., 2011; Renneker et al., 2013). Recently, human anaplasmosis involving an *A. ovis* variant has been detected in Cyprus (Chochlakis et al., 2010).

2.4. Diagnostics

The organisms can be detected on erythrocytes by microscopy of stained blood smears early in clinical disease (Dumler et al., 2001). However, the bacteraemia may be low. Detection of *A. ovis* may also be done by PCR and gene sequencing (Palmer et al., 1998; Torina et al., 2012). In addition, several serological tests are available, such as the capillary tube agglutination and ELISA (Mallick et al., 1979; Ndung'u et al., 1995). Necropsy of infected animals may show watery blood, pallor, ichteric tissues and increasing amount of fluid in the body cavities. In addition, the liver may be enlarged (Smith and Sherman, 2009).

2.5. Treatment and control

Treatment is most efficient during the bacteremic phase of the infection and is directed at reducing the rate of erythrocyte infection, although treatment during the prepatent period does not prevent bacteraemia. Stress should be avoided during handling and treatment. Oxytetracycline or tetracycline hydrochloride has been used successfully to treat clinically affected goats given once a day for one or two days). However, five day treatment will not eliminate the carrier state (Smith and Sherman, 2009).

Efforts should be focused on controlling tick infestation through regular dipping, spraying or pour-on treatment. No specific vaccine for *A. ovis* is currently available. In case of an outbreak, prophylactic antibiotic administration might be used to prevent spread of the infection (Smith and Sherman, 2009). However, all these treatments are not environmentally friendly.

2.6. Species

2.6.1 Anaplasma phagocytophilum

Tick-borne fever (TBF) is caused by *A. phagocytophilum* (formerly *Ehrlichia phagocytophila*). The infection has mainly been associated with *I. ricinus* ticks, but has also been found in several tick species, such as *D. marginatus*, *Ixodes persulcatus*, *Ixodes trianguliceps*, *H. punctata, Hyalomma marginatum*, *R. bursa* and *Rhipicephalus sanguineus*. In addition, several strain of *A. phagocytophilum* may exist even on the same pasture (Ladbury et al., 2008).

2.7. Distribution

Although *A. phagocytophilum* is widespread in Europe, the infection seems to cause severe infection in sheep mainly in northern Europe. The reason for this is unknown, but may be due to different grazing management and variants of the bacterium involved (Stuen, 2003).

2.8. Clinical expression

The most characteristic symptom of the disease in domestic ruminants is high fever; although clinical signs may vary according to the age of the animals, the variant of *A. phagocytophilum* involved, the host species and immunological status of the host (Stuen and Longbottom, 2010).

Differences in response to an *A. phagocytophilum* infection have also been observed among sheep breeds, however this seems not entirely attributable to past ancestral exposure to the pathogen (Scott, 1983).

TBF is seldom fatal, unless complicated by other infections. However, the infection may cause immunosuppression for at least six weeks that makes affected animals vulnerable to secondary