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Bluetongue disease—Global overview and future risks☆

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ABSTRACT

Bluetongue disease (BT) has spread after the first reported outbreak more than 100 years ago to nearly all the tropical and temperate regions worldwide in a geographic band between the latitudes 40°N and 35°S. Bluetongue virus (BT) is transmitted by biting midges of the genus Culicoides to susceptible ruminants like sheep, cattle, goats, and wild ruminants. Probably due to the global warming the dispersal area of the transmitting Culicoides species and by this of the BTV expanded to northern regions up to the latitude 50°N. Independent of expansion of the insect vectors BTV serotype 8 was introduced into Central Europe in 2006. The source of the BTV 8 introduction is still unknown. In Central Europe the virus found a new insect vector, midges of the *Culicoides obsoletus* group, indigenous in Central and Northern Europe and highly adapted to ruminants, overwintering in the stables. In summer and autumn 2006 and in the following years BT spread from the tri-border region between Germany, the Netherlands and Belgium to all neighbouring countries up to Scandinavia and United Kingdom. In the naive and genetically highly susceptible European sheep and cattle population the disease killed more than 1.5 million sheep. Trade restrictions and secondary diseases increased the economic losses. The spread could be stopped by a mandatory vaccination campaign using inactivated serotype specific vaccines. By this Central Europe could be sanitated from BT.

1. Introduction

Bluetongue is an arthropod-transmitted viral disease of ruminants and certain other animals that was recognized and described more than 100 years ago in South Africa, where it has probably been endemic in wild ruminants since antiquity (Coetzee et al., 2012). Bluetongue (BT) is a disease listed under the OIE Terrestrial Animal Health Code and must be reported to the World Organization for Animal Health (Anonymous, 2013). Bluetongue virus (BTV) infection of ruminants and vector Culicoides insects is enzootic throughout tropical and temperate regions of the world; however their have been drastic recent regional alterations in the global distribution of BTV infection, particularly in Europe since 1998. Multiple novel BTV serotypes also have been detected since 1998 in the South-Eastern United States, apparently encroaching from the adjacent Caribbean ecosystem, and novel serotypes of BTV have been identified recently in other historically enzootic regions of the world, including the Middle East and Australia. It has been proposed, but certainly not proven, that global climate change is responsible for these events (Maclachlan, 2011).

2. Bluetongue virus

BTV belongs to the family Reoviridae of the Genus Orbivirus. It has a double stranded RNA with 10 segments. The RNA codes for 3 non-structure proteins, and 7 structure proteins (VP1–VP7). It has actually 26 serotypes which show no cross protectivity (Maan et al., 2012a). The viruses

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are mainly transmitted by insects, especially by biting midges species as Culicoides.

3. Transmission

There are more than 1000 Culicoides species but less than 20 are considered competent vectors of BTV. Therefore the geographical distribution of the vector generally limits the distribution of the disease. The vector is the key for the transmission of BTV between animals. Vectors are infected with BTV after ingesting blood from infected animals. Without the vector, the disease cannot spread from animal to animal (Anonymous, 2013). According to Tabachnick (2004) the main vector species are *Culicoides imicola* in Africa, *Culicoides insignis* in South America, *Culicoides sonorensis* in North America, *Culicoides brevitaris* and *Culicoides wadai* in Australia, and *Culicoides brevitarsis*, *C. wadai*, and *Culicoides fulvus* in Asia and Indonesia. Depending on the temperature transmission via Culicoides spp. occurs in Northern Europe between April and end of October, with two maxima in June and September/October correlated with the population of the midges (Mehlhorn et al., 2009). The main activity of these little insects is general in dusk and dawn. Due to the significant multiplication of the virus in the salivary glands of the insects the stitch of a single biting midge is sufficient for the infection of a ruminant with BTV. The optimal temperature for virus replication in the insect is >25 °C. Beneath 10–12 °C there is no replication of the virus in the insects. An infected insect remains infected its whole live. The colder and the longer the Culicoides spp. live. Their habitat is connected to humid areas. There is no transovarial transmission of the virus between following generations of the insects. Culicoides spp. are not very active flyers. They are driven mainly passively by the wind. Besides Culicoides spp. BTV can be transmitted more passively by all biting and sucking insects, as well as iatrogen and also intra-uterine in ruminants. BTV infection of ruminants is often subclinical, but outbreaks of severe disease occur with regular frequency especially at the upper and lower limits of the virus' global range where infection is highly seasonal – occurring in the late summer and autumn (Maclachlan, 2011). Infection of ruminants with BTV induces feverish generalized disease. In Northern Europe more cattle than sheep or even goats were affected. But the clinical signs were in general more severe in sheep than in cattle. The clinical signs of Bluetongue disease are strictly depending on the ruminant species, including game and wild ruminants, and the virus strain. Within sheep there are severe breed differences in susceptibility. The 24 serotypes and the double stranded RNA make the diagnosis difficult.

4. Historical distribution of Bluetongue virus

Sperlova and Zendulkova (2011) summarized the history of Bluetongue: "Traditionally, the virus was present in a geographic band between the latitudes 40°N and 35°S where its vectors, certain species of biting midges, were living. In North America and China the virus spread even further, up to 50°N. Before the 1940s the occurrence of BT was limited to South Africa. The first well recorded epidemic beyond the African continent dates back to 1943 in sheep in Cyprus, but there are indications that Bluetongue had been there since 1924. In 1943–1944 BT was found in Israel, in 1948 it was reported in Texas, USA, between 1956 and 1957 a large epidemic broke out on the Iberian peninsula, and subsequently BT was also found in the Middle East, Asia and Southern European countries. In Australia it first appeared in 1977, and in South America it was found in the 1980s. BT is also present in Central America and Mexico, Papua New Guinea, Thailand, China, Japan, the Indian subcontinent, Mediterranean countries (Greece, Spain, Italy, Corsica), Portugal, Bulgaria and other countries."

In 1998 the disease was notified in Greece, followed by Turkey and Bulgaria in 1999, thereafter on the Balkan. In 2000 the disease spread to the Mediterranean islands Sardinia, Sicily, Corsica, Menorca, and Mallorca as well as to mainland Italy. In 2001 there was further distribution on the Balkan region to Croatia followed by Bosnia and Albania in 2002. In the first years of the 21st century BT was only occasionally notified in Southern Europe (Spain, Portugal, Greece and Cyprus) (Mellor and Wittmann, 2002; Mellor et al., 2008; Saegerman et al., 2008).

4.1. The BTV 8 epidemic in Central Europe

The BTV 8 epidemic in Central Europe in 2006–2010 showed that BTV can find new insect hosts which are very effective in virus transmission.

Bluetongue virus serotype 8 was endemic in African regions south of the Sahara desert. Between 1998 and 2006 different BTV serotypes were found already in the Mediterranean states of the EU – Greece, Italy, France, and Spain. These BTV infections were always connected with the virus transmission by *C. imicola*, which had its habitat before 1998 at the southern shore of the Mediterranean Sea. After 1998 *C. imicola* migrated north to the European shores of the Mediterranean (Purse et al., 2005a; Tabachnick, 2004). Entomologists and virologists anticipated that BTV could move north along the Rhone delta and across the Alps together with *C. imicola* due to the global warming (Purse et al., 2005b) . But already Savini et al. (2004) reported that Bluetongue virus was isolated in regions where *C. imicola* was not present but midges of the *C. obsoletus* complex.

In July and August 2006 clinical symptoms of Bluetongue occurred first in cattle at the tri-border region between Germany, the Netherlands and Belgium. At the 20th August 2006 BTV serotype 8 was diagnosed for the first time in Germany (Anonymous, 2006). Thereafter the infections spread over large areas of Western, Central and even Northern Europe, and caused substantial losses in farm ruminants (Vellema 2008). Especially sheep and cattle were severely affected, leading to a case fatality rate of nearly 40% in sheep (Conraths et al., 2009). Obviously this was independent of the infections persisting partly since 1988 in Southern Europe. *C. imicola* was not found as a BTV vector in Northern Europe (Clausen et al., 2009). BTV 8 had found a new host insects from the *C. obsoletus/Culicoides scoticus and Culicoides dewulfi* group, which had been indigenous in Northern Europe from time immemorial. It was found that both potential vectors