Establishment of an early warning system against Bluetongue virus in Switzerland

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Abstract

Bluetongue (BT) is a vector-borne animal disease of economical importance due to the international trade restrictions likely to be put into place in a country once the infection is discovered. The presence of BT and its vectors in countries adjacent to Switzerland stresses the need of implementing a surveillance system and to raise disease awareness among potential stakeholders. A national survey in Switzerland 2003 indicated freedom of Bluetongue virus (BTV), although a single individual of the main BT vector *Culicoides imicola* was caught in the canton of Ticino. The survey also demonstrated that potential BT vectors, *C. obsoletus* and *C. pulicaris* are locally abundant in Switzerland. Therefore, a new surveillance method based on sentinel herds in high risk areas was implemented in 2004 for the early detection of both an incursion of BT vectors into Switzerland, and potential virus circulation among cattle.

Keywords: Bluetongue virus, Culicoides, sentinel herd surveillance, early warning system

Aufbau eines Frühwarnsystems gegen das Blauzungenvirus in der Schweiz

Die Blauzungenkrankheit (BT) ist eine Tierseuche mit sozial und wirtschaftlich gravierenden Folgen, weil bei ihrem Auftreten internationale Handelbeschränkungen erlassen werden. Daher ist es wichtig, in der Schweiz das Seuchenbewusstsein durch Aufklärung der Öffentlichkeit und der potenziellen Entscheidungsträger zu erhöhen. Eine Übersichtsuntersuchung über die Krankheit zeigte, dass die Schweiz 2003 frei war von der Blauzungenkrankheit, auch wenn ein einziges Exemplar des BT Vektor *Culicoides imicola* im Kanton Tessin gefunden wurde. Die Bestandesaufnahme zeigte auch, dass andere BT Vektoren, *C. obsoletus* und *C. pulicaris*, örtlich reichlich vorhanden sind. Auf Grund dieser Tatsache wurde eine neue Überwachungsmethode mit Sentinelherden in den potenziell gefährdeten Siedlungsräumen im Jahr 2004 eingeführt. Dies einerseits als Frühwarnsystem für den Einfall von BT Vektoren in die Schweiz, andererseits um die Verbreitung des Virus in den Herden nachzuweisen.

Schlüsselwörter: Blauzungenvirus, Culicoides, Tierbestandskontrolle, Frühwarnsystem

Since the time of writing, dynamic changes in the current epidemic of Bluetongue in Europe have occurred. In the recent outbreaks in northern Europe (Belgium, France, Germany, and Holland), clinical symptoms have been seen in cattle, caused by Bluetongue virus serotype 8. This serotype has never been previously recorded in Europe. The vector responsible for outbreaks in southern Europe *(Culicoides imicola)* has not been detected in the affected regions mentioned as to date, but other Culicoides species were trapped (www.oie.int). In reaction to this development, two further sentinel farms located in the north of Switzerland will be added to the surveillance system.

Emergence and consequences of vector-borne diseases

Over the past few decades, vector-borne diseases have been emerging and spreading into areas previously free of such manifestations. Factors such as the shift in the style of husbandry management and the intensification of livestock production have contributed to the maintenance of the disease once it has occurred, but climate change has had the most profound effect on the capability of vector survival and establishment into new areas (Walther et al., 2002). One of the major current epidemics involving at least 17 countries in

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the Mediterranean region is being caused by Bluetongue disease virus (BTV), and has caused the deaths of over 1 million sheep (Purse et al., 2005). BT entered Europe via two paths. The first detection of the disease originated from the Greek islands in 1998 and consequently spread northward into the Balkan area and westward onto the French and Italian islands of Corsica, Sicily and Sardinia, respectively. This was followed in 2000 by an incursion from Tunisia and Algeria and spread onto mainland Italy (Tuscan area) and the Spanish Balearic islands. The second detected movement started in Morocco in 2004 and spread northward into Spain and Portugal. The latter two countries are still reporting cases at present (www.oie.int).

Switzerland shares borders with mainland France, where *Culicoides imicola* has been found, as well as with Italy where the disease and its vector are present (Breard et al., 2004; Liberato et al., 2005). BT disease occurs exclusively where its competent vector is present and in terms of the European epidemic, the main insects responsible for the spread of this disease are *C. imicola*. It has been recently determined that *C. obsoletus* and *C. pulicaris* are also considered as potential vectors (Caracappa et al., 2003; Savini et al., 2005). All three of these species have been found in Switzerland (Cagienard et al.,in press). The risk of BT spreading into Switzerland is attributable to its vicinity to Italian BT outbreak locations (last outbreak was 360 km from the Swiss border) and to the fact that we are experiencing a temperature rise much higher than the global trend (www.umwelt-schweiz.ch). This could allow vectors to find new suitable habitats or cause a shift in vector competence. Although the alps form an important natural barrier for the further spread of the vectors, the southern and western part of Switzerland could be affected by windborne vectors originating from Italy and France, respectively.

Bluetongue disease

Bluetongue disease is a non-contagious, infectious insect-transmitted viral disease that affects domestic and wild ruminants (Purse et al., 2005). The virus belongs to the genus Orbivirus in the Reoviridae family with 24 serotypes occurring worldwide. Although the virus replicates in most, if not all ruminant species, severe disease only occurs in certain breeds of sheep. Cattle, however, play an important role as amplifying hosts since insect vectors such as *C. imicola* have been shown to prefer them as opposed to sheep (Nevill et al., 1978), and they can remain viremic for approximately 60 days post infection. Because cattle do not develop clinical signs, there is a risk that the virus is maintained in silent circulation. However, cold weather limits the overwintering capacity of vectors whereby susceptible hosts would not be affected by these potential viremic hosts. Symptoms in sheep vary from fever, hyperaemia and oedema possibly leading to cyanosis although the actual clinical sign of a blue tongue is rarely seen. Infection of pregnant ewes may lead to abortions as well as mummified, stillborn or weak lambs (www.defra.gov.uk).

Although there are 24 recognized BTV serotypes occurring worldwide, the current epidemic in Europe involved serotypes 1, 2, 4, 9 and 16. BTV 1, 4, 9 and 16 have entered Europe from the east, whilst another path from the south introduced BTV 2 and 4. Each serotype is usually linked to a certain geographic region in the world, for example, BTV 1 has been isolated in India, and BTV 2 usually occurs in South Africa and the United States, where BTV 10, 11, 13 and 17 also occur. Australian cases are caused by BTV 1, 3, 9, 15, 16, 20, 21 and 23 serotypes. BTV 1–16, 18, 19 and 24 are responsible for African outbreaks whilst BTV 1, 3, 4, 6, 8, 12 and 17 circulate in the Central American-Caribbean Basin (www.fas.org). The effect and severity of disease on the individual host depends on the BTV serotype, the vector species, as well as the actual breed of animal host involved.

Bluetongue vectors

BT is exclusively related to the presence of the virus in the competent vector: insects of the Culicoides species. In concurrence with BTV seroytpes, a large number of Culicoides midges are responsible for the spread of the disease in different countries. The principle vectors in Australia are *C. wadai, C. brevitarsis, C. fulvus* and *C. actoni* midges while in the United States, *C. sonorensis* is the main vector (www.fas.org). The midge species of *C. imicola*, also responsible for Asian and African BT outbreaks, has established itself in Europe and is considered the main cause of the current European epidemic. The presence of different *Culicoides* midges in various countries is due to the specificity of habitat preference displayed by each vector (Kline and Wood, 1988; Schmidtmann et al., 2000). The peculiarity of the European epidemic brings to light the ability of certain insects to develop a vector competent status as is the case with *C. obsoletus* and *C. pulicaris*. BTV serotypes 2 and 9 have been isolated from wild-caught *C. obsoletus* (Liberato et al., 2005; Savini et al. 2005) and *C. pulicaris* (Caracappa et al., 2003). Previous and ongoing surveillance has demonstrated a high abundance of *C. obsoletus* in certain regions of Switzerland followed by a considerable number of *C. pulicaris*, among other *Culicoides* spp. (Cagienard et al., 2003).

Surveillance in Switzerland

In order to monitor rare or exotic diseases such as Bluetongue disease or other vector-borne diseases i. e. African Horse sickness (AHS) which is also transmitted by Culicoides spp, it is important to achieve and maintain sufficient disease awareness by informing all potential stakeholders. Pamphlets describing BT disease have already been distributed by the Swiss Federal Veterinary Office (www.bvet.admin.ch) and surveillance has been implemented since 2002 (Cagienard et al., 2003). Presently, in the Swiss Ordinance of Epizootics, BT is listed in the highly contagious disease section. In addition to the current surveillance, veterinarians should be aware of the typical symptoms prevailing in sheep, although clinical diagnosis of BT in cattle is difficult. Increased vigilance is required especially during and shortly after the vector season (June-September). Upon the suspicion of BT symptoms, the respective cantonal veterinarian should be immediately alerted, and further investigations will consequently follow.

Surveillance system implemented for Bluetongue monitoring

The aim of initiating BT surveillance was to create an early warning system to detect the primary incursion of the agent and/or vector before substantial spread may occur. The current surveillance system in Switzerland evolved from an initial baseline surveillance phase using random sampling into an early warning phase using risk-based sampling in established sentinel herds. The main methods used consist of entomological surveillance (vector trapping) and serological surveillance of hosts. The initial objectives of BT surveillance were to establish the status of Switzerland with respect to vector presence and host immune status. The current focus is on the early detection of changes in vector populations and/or host status. The evolution of the existing surveillance is explained in more detail below.

Initial baseline surveillance

To determine the immune status of Swiss cattle, a nationwide serological survey was conducted in 2003, involving 660 randomly selected cattle farms. Cattle were chosen as the target species primarily since they act as the reservoir species for the BTV in sheep. They also present an earlier antibody response post-infection (www.oie.int), cattle farms are more abundant and more widely distributed in Switzerland and, finally, it has been shown that Culicoides midges have a feeding preference on cattle compared to sheep (Nevill et al., 1978). High-risk locations based on vector habitat requirements were defined as areas with an average annual temperature ≥12.5 °C as well as an annual average humidity > 60%. In addition to the main climatic factors, host number and geographic location were also taken into account. The farm should have > 3 cattle present which remain at an altitude of <1100 meters above sea level during the summer period. The serological survey confirmed the freedom-of-BTV-infection status of Switzerland according to international standards (Cagienard et al., 2003). The entomological part of early surveillance consisted of 41 trapping sites distributed in high-risk areas for the occurrence of Culicoides. These sights were sampled in July and September, 2003. Regarding vectors, *C. obsoletus* and *C. pulicaris* were found to be abundant in many locations but only 1 single specimen of the main vector *C. imicola* was caught (Cagienard et al., in press).

Early warning system based on sentinel herds

The monitoring of sentinel herds was shown to be an effective method for the surveillance of vector-borne diseases including BT in other countries such as Saudi Arabia, China and Australia (Ward et al., 1995; Abu et al., 1998; Kirkland et al., 2002). A sentinel herd is defined as a cohort of animals at a pre-determined location, which is monitored over a specified period of time with respect to a specified disease agent (Ward et al., 1995). Sentinel herds are usually carefully selected to be located in high-risk areas of disease occurrence or likely vector establishment. Such an approach is categorized as a targeted surveillance system as opposed to random surveillance (Stärk, 2005). This is an important difference in order to increase the probability of detection of any first incursion of disease at the earliest time possible.

Figure 1: Location of sentinel farms for serological surveillance (farms shown as ■).

Serological surveillance of sentinel herds

The sentinel herds used in BT surveillance in Switzerland were selected based on an assessment of risk factors and the experience made in other countries. The most influential factors were location in terms of altitude and climatic conditions, occurrence of vector competent species as well as host species. The establishment of sentinel farms as an early warning system for *C. imicola* introduction and BTV infection was established in 2004, modified in 2005 and will continue to run in the future. The aim is to determine the immune status of the sentinel herds regarding BTV. Sentinel herds are also used as trapping sites to monitor the frequency and distribution of the BTV vectors in Switzerland. Using the same criteria as in the baseline survey, sentinel farms were selected in locations considered at risk in Switzerland (Fig. 1). Cattle were the sentinel species of interest. Additionally, sentinel locations were included if the farm had a limited or absent utilization of insecticides on the farm. Serum samples are annually collected in November and sent to the Institute of Virology and Immunoprophylaxis for diagnostic procedures. Given the fact that Switzerland is presently BTV-free, this study will allow for the determination of incidence rates of new infections in the sentinel herds.

Figure 2: Location of Culicoides trapping sites in the canton of Ticino, 2005 (farms shown as ■)
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Entomological surveillance

The entomological part of the surveillance involves setting up Onderstepoort black light traps (Venter et al.,1997) at the selected sites in high risk areas of Switzerland, focusing on the canton of Ticino and collecting samples during the months of June to September. Due to its neighboring location to Italy and its specific micro-climate, Ticino was considered as a high-risk zone for both the occurrence of BTV and its vectors. A total of 7 trapping locations (Fig. 2) were used in 2005 and samples were first microscopically analysed according to the protocol established by the Institute of Animal Health (IAH) to determine the frequency of Culicoides spp, especially *C. imicola, C. obsoletus* and *C. pulicaris* if present. Samples were also analysed by PCR to confirm absence of *C. imicola* (Cetre-Sossah et al., 2004). In addition to the sentinel herds described above for serological surveillance, horse stables and goat farms were also chosen as trapping locations within high-risk areas since it has been demonstrated that BTV vectors are recorded in high numbers near these hosts (Racloz, unpublished data).

Results 2004-2005

Results of the entomological samples collected in 2004 and 2005 confirm the abundance of the *C. obsoletus* species as well as the variety of different Culicoides spp. caught in the light traps during a single night. The main vector for BTV transmission, *C. imicola,* has not been not detected since 2003 (Fig. 3). The serological sampling of sentinel herds has confirmed the infection-free status of Swiss cattle for BTV. It can therefore be concluded that Switzerland is currently a BTV-free country.

Conclusion

The occurrence of BT is dependent on vector habitat, host preference and vector competency. It is thus possible to determine locations considered to be at

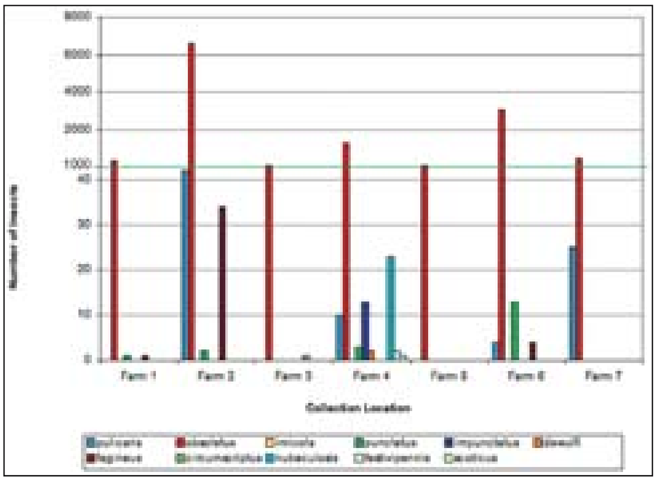

Figure 3: Number of Culicoides species collected in a single night catch in Ticino, Switzerland – June 2005.

risk of disease occurrence. In the case of the current entomological surveillance, the biology of *Culicoides* spp. has been taken into consideration when determining risk locations. Only a few sites fulfill all selection criteria. They are all included in the current surveillance system. Therefore, the specific trapping sites currently used allow for the recording of changes in vector abundance and species composition. Switzerland has recorded one specimen of *C. imicola* in 2003. The fact that it has been the only case so far in the two years of surveillance that followed combined with the unsuitability of overwintering conditions, limit the potential of BT disease being spread by this vector. Countries where BT outbreaks have occurred in the absence of *C. imicola* are investigating the potential role of *C. obsoletus* and *C. pulicaris* and their capability of spreading the virus efficiently. Therefore, a targeted entomological and serological surveillance needs to continue in order to monitor the presence of the virus and these latter vectors which seem to be adapted to the climatic and environmental conditions of certain regions in Switzerland.

Finally, this early warning system will not only serve for BT surveillance, but also as a model of surveillance for other vector borne diseases such as anaplasmosis and babesiosis, two tick-borne diseases. The fact that the main vector of these agents, *Ixodes ricinus,* is commonly found in Switzerland, combined with the recent outbreak of anaplasmosis in 2002 in a single farm (Brulisauer et al., 2004; Hofmann-Lehmann et al.,2005), and the presence of Babesia spp in Switzerland (Gern and Brossard, 1986), support the usefulness of an early warning system to monitor the occurrence of these diseases.

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Etablissement d'un system d'alerte précoce contre le virus de Bluetongue et ses vecteures

La fièvre catarrhale du mouton (Bluetongue disease) est, en raison des restrictions commerciales appliquées une fois le foyer d'infection isolé, une maladie pouvant avoir de graves conséquences économiques. La présence simultanée de vecteurs du virus de la fièvre catarrhale et de la maladie dans des pays voisins renforce le besoin d'une amélioration du dispositif de surveillance par un système d'alerte précoce. Un programme de surveillance à l'échelle nationale en 2003 a montré l'absence du virus de la fièvre catarrhale en Suisse, bien qu'un individu de *Culicoides imicola,* le vecteur principale de la fièvre catarrhale ait été découvert. Ce programme a aussi mis en évidence l'abondance de *C. obsoletus* et *C. pulicaris* en Suisse, qui sont des vecteurs potentiels de la maladie. Aussi un nouveau programme de surveillance basé sur des fermes sentinelles présentant un risque élevé a été implémenté en 2004, afin de créer un système d'alerte précoce des vecteurs ou de la maladie.

Organizzazione di un sistema di sorveglianza precoce contro la Bluetongue in Svizzera

La Bluetongue è una malattia degli animali che ha gravi conseguenze sia a livello sociale che economico poiché implica delle limitazioni al commercio internazionale. Perciò è indispensabile per la Svizzera aumentare una certa «sensibilità epidemica» tramite chiarimenti alla popolazione e ai potenziali responsabili. Una visione d'insieme sulla malattia ha mostrato che nel 2003 la Svizzera non è stata toccata dalla malattia anche se è stato trovato nel canton Ticino un vettore di Bluetongue il *Culicoides imicola.* Il rilevamento ha pure mostrato che altri vettori di Bluetongue, *C. obsoletus* e *C. pulicaris,* sono presenti localmente. Nel 2004 sulla base di questi fatti è stato introdotto un nuovo metodo di sorveglianza con mandrie sentinelle nelle zone di residenza potenzialmente minacciate. Questo metodo vuole promuovere da una parte il sistema di sorveglianza precoce di invasione di vettori di Bluetongue in Svizzera e d'altra parte sorvegliare la propagazione del virus nelle mandrie.

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