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Short communication

Schmallenberg virus antibody development and decline in a naturally infected dairy cattle herd in Germany, 2011–2014

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ABSTRACT

In late 2011, the novel insect-transmitted orthobunyavirus Schmallenberg virus (SBV) emerged in Central Europe. Since that year, a dairy cattle herd kept in the German region in which the virus was initially detected was continuously monitored. In order to evaluate the development of the within-herd seroprevalence, but also to assess the long-term persistence of antibodies against SBV in individual animals, blood samples of all cows older than 24 months were taken yearly after the respective vector season and serologically analyzed. In December 2011, in 74% of the tested animals SBV-specific antibodies were detectable. Additional scattered seroconversions were observed between the 2011 and 2012 vector seasons, thereafter all seronegative animals remained negative. Until December 2014, the intra-herd seroprevalence decreased to 58%. A total of 122 cows infected presumable in autumn 2011 were sampled every year, 9 of them became seronegative until December 2014. Consequently, though SBV-specific antibodies were detected in about 90% of the monitored animals for more than three years, a lifelong antibody-based immunity is not expected in every animal. The loss of anti-SBV antibodies in individual animals combined with the missing infection of young stock results in a declining herd seroprevalence and increases the risk of a renewed virus circulation to a greater extent within the next years.

1. Introduction

Schmallenberg virus, a novel orthobunyavirus present in European livestock since late 2011, causes only a mild transient disease in adult ruminants but may result in severe fetal malformation, abortion and stillbirth when naïve animals are infected during a vulnerable period of pregnancy (Beer et al., 2013; Hoffmann et al., 2012). In cattle, first SBV-specific antibodies which confer immunity against a second infection (Wernike et al., 2013) are detectable between 1 and 3 weeks after natural or experimental infection (Wernike et al., 2013, 2014c), how long they persist in individual animals, however, is currently unknown. Until now, neutralizing antibodies against SBV were detected in cattle for up to 19 months after a natural infection (Elbers et al., 2014a), but antibodies against Akabane virus, another orthobunyavirus closely related to SBV, persist for at least two years (Inaba and Matumoto, 1990). To evaluate whether this persistence of virus-specific antibodies for 24 months is also true for SBV or whether they are present for a longer period in individual animals, the duration of immunity was monitored in all adult cows kept in a private dairy cattle holding (Agricultural Centre Haus Riswick, Kleve) located in the German federal state North Rhine-Westphalia, the initially most by SBV-infections affected area.

2. Materials and methods

All cows older than 24 months were blood-sampled in December 2011 or January 2012 (total of 311 animals), again in January 2013 (331 animals), in December 2013 (324 animals), and in December 2014 (330 animals). From 122 cattle blood samples were available from all four sampling dates. The cows included in the study were kept indoors year-round, but all animals younger than 24 months are kept outside. All samples were taken by jugular venipuncture by the responsible farm veterinarian in the context of the health monitoring program of the farm under the control of the Bovine Health Service (Chamber of Agriculture for North Rhine-Westphalia, Bonn) and analyzed by a commercially available SBV antibody ELISA (ID Screen® Schmallenberg virus Competition, ID vet, France), using the recommended cut-off of 40% relative optical density compared to the negative control (S/N, %), doubtful results

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Table 1
Number of sera tested for the presence of SBV-specific antibodies and percentage of positive results. – no sample available.

No. samples	No. positive/doubtful samples (%)			
	Dec 2011/Jan 2012	Jan 2013	Dec 2013	Dec 2014
80	63 (78.75)	–	–	–
60	41 (68.33)	44 (73.33)	–	–
49	38 (77.55)	40 (81.63)	40 (81.63)	–
122	91 (74.59)	102 (83.61)	99 (81.15)	93 (76.23)
29	–	25 (86.21)	–	–
10	–	8 (80.00)	8 (80.00)	–
61	–	56 (91.80)	56 (91.80)	56 (91.80)
23	–	–	7 (30.43)	–
59	–	–	37 (62.71)	37 (62.71)
88	–	–	–	11 (12.50)

were considered as positive. All samples taken from an animal were tested on the identical ELISA plate.

3. Results and discussion

From 122 cows blood samples from all 4 sampling dates were available. 89 of these animals (72.95%) were seropositive at the first sampling, 2 (1.64%) resulted in the doubtful measuring range of the ELISA, and 31 (25.41%) scored negative, 11 of them seroconverted until January 2013 (Table 1); in the remaining 20 cows no SBV-specific antibodies were detectable throughout the study. Further 5 out of 30 animals which were sampled in 2011 and 2013, but not until 2014, tested negative in 2011 and positive in January 2013, consequently a total of 16 out of 61 (26.23%) animals were infected in the 2012 vector season. Every animal seronegative at the first 2013 sampling stayed negative until the end of the study which corresponds to previous sero-epidemiological studies conducted in the German–Dutch–Belgium border region, the European area in which SBV emerged in 2011. After the first transmission period, the seroprevalence in adult cattle was between 70% and nearly 100% (Elbers et al., 2012; Meroc et al., 2013a; Wernike et al., 2014c). In the following vector season (2012), the virus still circulated in that region, but the spread had considerably slowed down (Conraths et al., 2013; Meroc et al., 2013b; Wernike et al., 2014a). In summer and autumn 2013 and the following winter SBV-cases were detected only sporadically (Friedrich-Loeffler-Institut, 2015) suggesting a virus circulation in Germany at a very low level which is further supported by the missing seroconversion in or after 2013 within the cattle herd observed in the present study.

Though cross-reaction with antibodies against closely related viruses may occur with the applied commercial ELISA, all positive results are most probably caused by SBV since it is the only member of the Simbu serogroup of orthobunyaviruses in the European Union.

In 89 out of 100 cows (89.00%) sampled in January 2013 for the first time SBV-specific antibodies were detectable, 44 out of 82 animals (53.66%) first tested in December 2013 scored positive or doubtful, and of the 88 animals from which serum samples were taken in December 2014 for the first time, only 11 (12.5%) resulted in the positive or doubtful measuring range of the used SBV-ELISA (Table 1). The high proportion of seropositive animals in cows first tested in January 2013 which even exceeded that observed after the 2011 vector season may be correlated to the management system in that particular herd. All animals younger than two years are kept outdoors while all other animals are inside the stable year-round. As only the cows that are older than 24 months were tested, all animals blood-sampled at the beginning of 2013 for the first time were younger than 1 year in 2011 and as a consequence kept outdoors which increases the odds of a high herd seroprevalence when compared to herds that are not grazed during the vector season (Veldhuis et al., 2014). The higher infection rate of the grazed animals together with the new infections in 2012 is reflected in the increase of the within-herd seroprevalence between 2011 and January 2013. 73.63% of all animals tested in 2011 were seropositive, while one year later 82.48% of all analyzed sera tested positive by ELISA. Thereafter, the seroprevalence declined to 75.00% until December 2013 and further to 57.88% within the following year (Fig. 1). This lower number of animals with measurable anti-SBV antibodies is most likely caused by the absence of infection of the young stock, especially as the year with the highest virus circulation was 2011 and the proportion of animals born after 2011 among the blood-sampled increased from

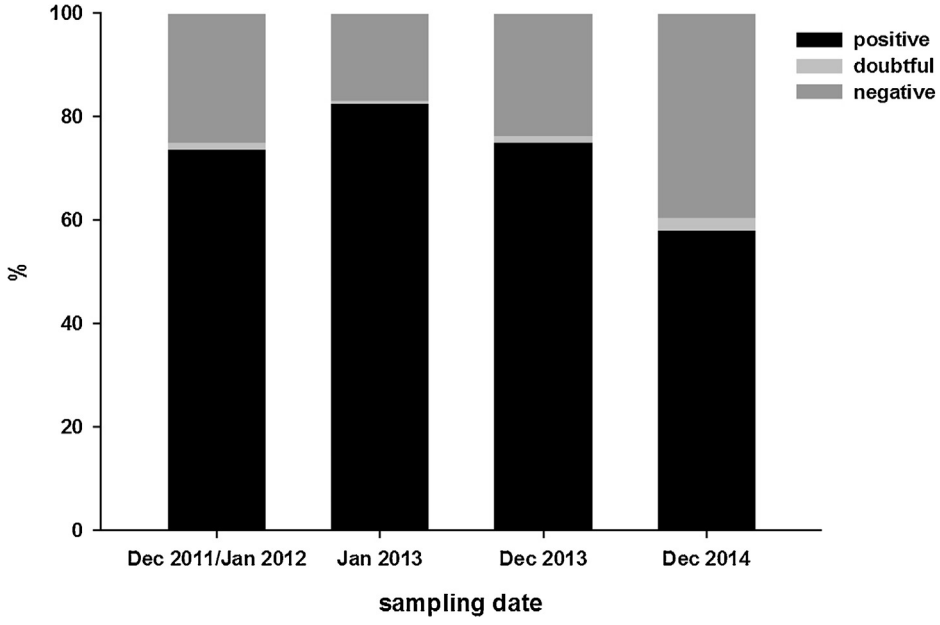

Fig. 1. Intra-herd seroprevalence in December 2011/January 2012, January and December 2013, and December 2014, respectively.