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Preventive vaccination contributes to control classical swine fever in wild boar (*Sus scrofa* sp.)

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ABSTRACT

Over the last 20 years, oral vaccination implementing a live attenuated vaccine has been experimented in Europe in order to control classical swine fever (CSF) in Wild Boar (*Sus scrofa* sp.). This has generally led to an enhanced seroprevalence and a decreased viroprevalence at the scale of the whole vaccinated populations, but no quantitative analysis has demonstrated the protective effect of preventive vaccination or intensive baiting. In the present paper we conducted a retrospective analysis at the scale of the municipality, taking into account the local dynamics and possible covariates of infection to test the effect of preventive vaccination and of the baiting effort. To be efficient, vaccination was expected to increase seroprevalence above the level considered as suitable for preventing disease invasion (40–60%) independently of infection, to protect free areas from disease invasion or contribute to control subsequent disease intensity and duration. We also hypothesized that a better baiting effort would be correlated with an improvement of immunisation and disease control. In uninfected municipalities, seroprevalence increased up to 40% after 1 year, *i.e.*, three vaccination campaigns. We observed a significant protective effect of preventive vaccination, especially within municipalities that had been vaccinated at least 1 year before disease emergence and where virus detection did not last more than one quarter. On the other hand, we did not detect a significant effect of the baiting effort on local seroprevalence or disease dynamics, suggesting that the baiting system could be improved. We discuss these results regarding the improvement of management measures and further research perspective.

1. Introduction

The control of classical swine fever (CSF) in the Wild Boar (*Sus scrofa* sp.) is required in the European Union, since this species may act as a wild reservoir of the virus (Fritzmeier et al., 2000; Anonymous, 2001; Artois et al., 2002).

Mathematical models of this host–virus system have been developed and suggested that preventive immunisation (40–60%) of susceptible populations may prevent disease emergence (Hone et al., 1993; Guberti et al., 1998).

In the field, oral vaccination has been implemented using a Riems C-strain vaccine and baits attractive to wild boars (Kaden et al., 2000). This process has been improved in Germany during the 2000s to maximize individual antibody titre and seroprevalence (Kaden et al., 2002, 2003, 2004). Retrospective analysis showed that high seroprevalence (>60%) and low viroprevalence (<0.1%) were maintained in vaccinated areas (Kaden et al., 2002,

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2003, 2006; Louguet et al., 2005; Rossi et al., 2006a; Von Rüden et al., 2008).

However, assessing the effect of vaccination on disease dynamics has been a difficult issue because antibodies generated by the Riems C-strain vaccine and by the natural infection are similar (Kaden et al., 2000). Furthermore, retrospective studies have often considered data from a large infected area as a whole and have thus not taken into account the complex spatio-temporal evolution of outbreaks. During the epizootic phase, the virus spreads over space and locally decreases over time, moreover many other covariates interfere with disease dynamics such as population size and landscape structure (Rossi et al., 2005a,b; Kramer-Schadt et al., 2007). According to the principle of pseudo-mass action and critical community size developed by modellers, the number of hosts is supposed to favour disease invasion and persistence at both local and global level (Hone et al., 1993; Begon et al., 2002; Rossi et al., 2005b; Kramer-Schadt et al., 2007). Forest continuity is known to influence the probability of contacts between neighbouring wild boars and the resulting probability of disease spreading and persistence at the scale of the whole area (Grenfell and Harwood, 1997; Rossi et al., 2005b; Kramer-Schadt et al., 2007, 2009). Lastly, even though the baiting effort, *i.e.*, the number of baits delivered per wild boar, is strongly related to the cost of vaccination, its effect has not been tested so far.

In the present paper we assess the effectiveness of preventive vaccination by considering data at the municipality level, *i.e.*, at a spatial scale where wild boars experienced the same epidemiological situation, where we could differentiate preventive from post-active vaccination and avoid confounding effects of other covariates. We considered the data collected in the Vosges mountains from 2003 to 2007. We targeted the following questions:

1. In uninfected areas, did vaccination increase seroprevalence above the level considered as suitable for preventing disease invasion (40–60%)?
2. Did preventive vaccination protect from disease invasion or contribute to control subsequent disease intensity and duration?
3. Was baiting effort correlated with a better immunisation and control of the outbreak?

2. Materials and methods

2.1. Study area, epidemiological context and vaccination process

The study area is located in France in the Vosges Mountains (48°50′N and 7°30′E); it covers 3030 km^2 including 1180 km^2 of forest land (Fig. 1). Motorways, canals, rivers or towns constitute relative barriers to wildlife movements towards the west, east and south. Towards the north there is no physical barrier: the forest is uninterrupted between the Vosges and the Palatinate forest (Germany) which constitute a large metapopulation (Rossi et al., 2005a).

In this area a previous outbreak of CSF occurred during the 90s and disappeared by 2000 (Rossi et al., 2005a). However, since April 2003 CSF has re-invaded the whole study area (Louguet et al., 2005; Pol et al., 2008). Oral vaccination has been implemented since

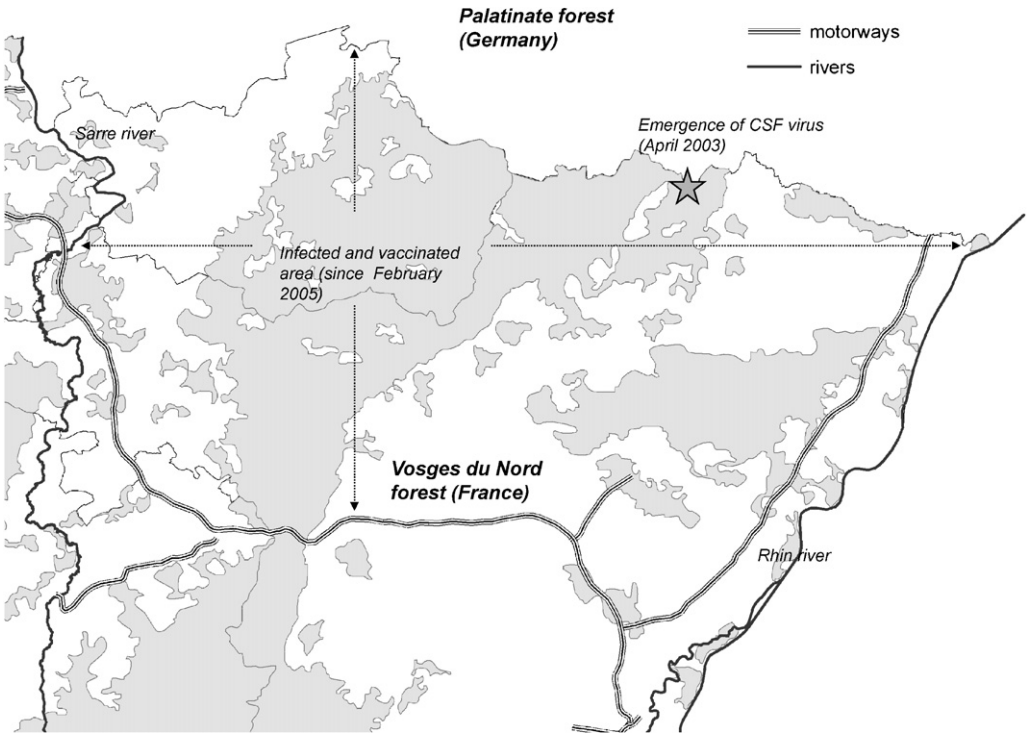

Fig. 1. The study area is located in north-eastern France at the border of the Palatinate region (Germany).