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Comparison of African swine fever virus prevalence and risk in two contrasting pig-farming systems in South-west and Central Kenya

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ABSTRACT

We describe a horizontal survey of African swine fever virus (ASFV) prevalence and risk factors associated with virus infection in domestic pigs in two contrasting production systems in Kenya. A free range/tethering, low input production system in Ndhiwa District of South-western Kenya is compared with a medium input stall fed production system in Kiambu District of Central Kenya. Analysis of variance (ANOVA) of data derived from cluster analysis showed that number of animals, number of breeding sows and number of weaner pigs were a significant factor in classifying farms in Nhiwa and Kiambu. Analysis of blood and serum samples using a PCR assay demonstrated an average animal level positivity to ASFV of 28% in two independent samplings in South-western Kenya and 0% PCR positivity in Central Kenya. No animals were sero-positive in either study site using the OIE indirect-ELISA and none of the animals sampled exhibited clinical symptoms of ASF. The farms that contained ASFV positive pigs in Ndhiwa District were located in divisions bordering the Ruma National Park from which bushpig (*Potamochoerus larvatus*) incursions into farms had been reported. ASFV prevalence ($P < 0.05$) was significantly higher at distances between 6 and 16 km from the National Park than at distances closer or further away. One of the 8 bushpigs sampled from the park, from which tissues were obtained was PCR positive for ASFV. The data therefore indicated a potential role for the bushpig in virus transmission in South-western Kenya, but there was no evidence of a direct sylvatic virus transmission cycle in Central Kenya. ASF control strategies implemented in these areas will need to take these epidemiological findings into consideration.

1. Introduction

African swine fever (ASF) is a rapidly lethal epidemic disease of domestic swine that constrains the development of the smallholder pig industry in Sub-Saharan Africa. The ASF outbreaks result in significant economic losses in developing countries (reviewed by Penrith et al., 2004). The effects of the disease for small-scale pig keepers include the loss of a major source of income for farmers, and a major source of high quality and cheap protein for poor communities (el Hicheri et al., 1998; Nana-Nukechap and Gibbs, 1985). Infection with virulent strains of Africa swine fever virus (ASFV) causes a rapidly lethal disease in naive domestic pigs and slaughter with quarantine of infected areas is the only currently available method of disease control (Costard et al., 2009).

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The African swine fever virus (ASFV), the causative agent of ASF, is a large double-stranded DNA virus, which is the only member of *Asfaviridae* family (Dixon Linda et al., 2006). The ASFV is the only known DNA *arbovirus*. The arthropod host for ASFV is *Ornithodoros* spp. This was initially discovered in *Ornithodorus erraticus* ticks from the Iberian Peninsula (Penrith et al., 2004; Penrith and Vosloo, 2009) and subsequently confirmed in Africa in *Ornithodorus moubata* ticks present in warthog (*Phacochoerus aethiopicus*) burrows (Plowright et al., 1969). ASFV can infect hosts through either a sylvatic cycle or a domestic cycle. In the sylvatic cycle, ASFV infects warthogs (*P. aethiopicus*) in which infection is asymptomatic and ticks in the genus *Ornithodoros* (De Kock et al., 1940; Detray, 1957, 1963; Detray et al., 1961; Montgomery, 1921; Steyn, 1932) and there is a well described transmission between ticks and neonatal warthogs in the burrows. Outbreaks can occur when domestic pigs are bitten by ticks that have fed on infected warthogs (Anderson et al., 1998). In the case of another African wild suid, the nocturnal bushpig (*Potamochoerus larvatus*), which is also asymptomatic following experimental infection (Anderson et al., 1998), the role of the species in the transmission of ASF to domestic pigs in natural agro-ecosytems is currently not established (Jori and Bastos, 2009). Direct transmission between bushpigs and domestic pigs has however been demonstrated experimentally (Penrith et al., 2004). The virus can also be transmitted between domestic pigs through either direct or indirect contact (Costard et al., 2009; Mebus, 1988). This can occur between acutely infected, recovered or carrier pigs and naïve animals. Fomites and contaminated feed are also important sources of infection.

The first description of the disease was from Kenya (Montgomery, 1921). A number of outbreaks have subsequently been reported in the country. These include 1954 in Laikipia District; 1958 in Kiambu District; and 1964 on a farm in Trans-Nzoia District in Kenya (Kenya Department of Veterinary Services). In 1994 further outbreaks of ASF occurred after an absence of 30 years. Eleven farms in Kiambu, Thika and Nairobi districts comprising a total of 9000 pigs were affected. Further outbreaks were reported to OIE in May 2006 (Busia District) and November 2006 to early 2007 in Rift Valley and central provinces (OIE disease report, February, 2007). The five outbreaks affected 1011 out of the total population of 13,601 domestic pigs present in these areas resulting in 630 pig deaths. The affected pigs were housed in different sties but ranged freely in search of food. The EU-OIE reference laboratory at CISA-INIA, Spain tested and confirmed samples from the affected areas as positive for ASFV by indirect enzyme-linked immunosorbent assay (OIE-ELISA), immunoblotting and PCR (Gallardo et al., 2009a).

Preliminary studies of pig production systems among rural smallholders in Western and Central Kenya have recently been initiated. These have focused primarily on farmer perceptions relating to pig keeping (Mutua et al., 2010), market value chain analyses (Kagira et al., 2010) and pig farming system characterization (Wabacha et al., 2001, 2004). However, the prevalence and risk of ASF and other porcine diseases has not yet been assessed in these production systems.

The data reported herein was collected as part of wider study on the epidemiology of African swine fever in Kenya and was designed for the purposes of assessing the risk factors associated with African swine fever (ASF) virus prevalence, including the potential role of the bushpig in ASFV transmission in a free range system in Ndhiwa District, Homabay County, Kenya. ASFV prevalence in a stall feeding pig production system in the central region of Kenya, where the sylvatic cycle was not thought to be important was also assessed.

2. Materials and methods

2.1. Study areas

The study was conducted in Homabay and Kiambu Counties (Fig. 1). In addition Ruma National Park was selected for bushpig sampling. Homabay County is located in South-west Kenya close to Lake Victoria and is one of the 6 counties within Nyanza Province. The Country is divided into six administrative districts namely: Homabay, Ndhiwa, Gwasi, Rachuonyo South, Rachuonyo North and Mbita. Ndhiwa District, where the study was located, is divided into four administrative divisions namely: Ndhiwa, Nyarongi, Riana and Kobama. The specific study area, Ndhiwa District, was selected because it represents a predominantly free-range smallholder pig production system and lies in close proximity to the national park, factors increasing the risk of ASF occurrence. Ruma National park is situated along the western border of Ndhiwa District adjacent to Ndhiwa, Nyarongi and Kobama divisions. The park contains a population of bushpigs (*P. larvatus*). The exact number of wild suids in the park is difficult to quantify, but estimated at 300 (Ruma National Park KWS Warden, personal communication).

Kiambu County (Fig. 1) is located in central Kenya; it borders Muranga County to the North and North East, Machakos County to the East, Nairobi and Kajiado counties to the South, Nakuru County to the West, and Nyandarua County to the North West. The study was located in Kiambaa District.

2.2. Selection of pig farming households and animals

With the help of Department of Veterinary Services of the Ministry of Livestock Development, a list of pig farming households was obtained. Pig-farming households within each administrative division (a subunit of a district) were selected using a systematic random sampling approach. This sampling approach selected the households at a fixed interval throughout the sampling transect from a random starting point. Using a list of 800 and 600 pig-farming households every 20th and 15th household was selected in Homabay and Kiambu, respectively. The final number of households selected was limited by logistics and available financial resources. In total 44 farms were selected in the first period in April and May 2008 and 39 in the second sampling period in March 2009 in Homabay District. A total of 40 farms were selected in Kiambu County in the period January to April 2010. All pigs (all sexes and ages) in each of the selected farms were sampled. A total of 143 and 103