Epidemiology of African swine fever

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Summary: The epidemiology of African swine fever virus infection in Africa is reviewed. The virus is maintained by a cycle of infection between ticks of the Ornithodoros moubata complex and newborn wart-hogs, and by trans-stadial, trans-ovarian and horizontal transmission in the tick population. The mechanisms of virus spread from ticks and wart-hogs to domestic pigs are discussed. The establishment of African swine fever as an endemic infection in southern Europe was associated with a decrease in virus virulence. The resultant lower mortality and virus persistence in recovered pigs can lead to further spread of the disease following virus reactivation when the animals are subjected to stress.

KEYWORDS: Africa - African swine fever virus - Disease control - Epidemiology - Europe - Iridovirus - Persistent infection - Swine diseases - Tickborne diseases - Viral diseases - Virulence - Wart-hog - Wild animals.

African swine fever (ASF) is one of the most important virus diseases of pigs which may be introduced into previously uninfected countries at any time from endemic areas of the world. The virus is present in many areas of Africa south of the Sahara, where it persists in wild pigs (principally wart-hogs) and soft ticks (Ornithodoros moubata), which inhabit the burrows of the wild pigs. There seems little hope of eliminating the virus from such a habitat and it is very likely that this part of the world will be the main reservoir of ASF virus for the foreseeable future. During the last 20 to 30 years the virus has spread to countries outside Africa in southern Europe, the Caribbean and South America; it has caused serious outbreaks of disease in all affected areas and has become endemic in domestic pigs in Spain, Portugal and Sardinia (Fig.1).

**DRASTIC ERADICATION MEASURES**

ASF is a disease for which there is no effective prophylaxis, and control and eradication depend on the rapid recognition of clinical disease in the field, followed by laboratory confirmation of the diagnosis and slaughter of all infected and in-contact animals. The control and eradication of this disease has proved to be very expensive and is a continuous drain on the resources of those countries where it has become endemic. It has only been possible to eradicate ASF from some infected countries such as Malta, the Dominican Republic and Haiti by expensive programmes involving the eventual slaughter of all pigs, followed by cleaning, disinfection and the complete re-building of the pig industry by importing new breeding stock. In addition to the costs incurred by the eradication programme, there arise losses due to the curtailment of both internal trade and international export of pigs and pig meat products.

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Occurrence of African swine fever (1978 - 1985)
A DANGEROUS RESERVOIR IN WART-HOGS AND SOME TICKS

Studies on the role of wart-hogs and ticks of the *O. moubata* complex have shown that, while wart-hogs in many parts of Africa are infected with ASF virus, they are apparently unaffected and do not transmit the virus to other animals (5). Ticks which live in the burrows inhabited by infected wart-hogs are infected with ASF virus in both eastern and southern Africa and, within an infected tick population, trans-stadial, trans-ovarial and horizontal transmission of virus can occur (4), although it is not known whether these mechanisms alone are sufficient to maintain the virus in tick populations in the absence of fresh introductions of virus. While adult wart-hogs contain low levels of virus in their tissues, they rarely have virus in the blood and, since neither horizontal nor vertical transmission of virus occurs in wart-hogs, baby wart-hogs are born uninfected. They may become infected if infected ticks feed on them, when they develop a low level of viraemia ($10^4 \text{HAD}_{50}/\text{ml}$) for the first 10-14 days after infection (8, 9). These titres are sufficiently high to infect, in turn, ticks which feed on them (11). The virus is thus probably maintained by a cycle of infection between ticks and newborn wart-hogs and by trans-stadial, trans-ovarial and horizontal transmission within the tick population.

The spread of virus from the tick-wart-hog cycle into domestic pigs can occur in one of two ways. Infected ticks can live for many years and may transmit virus to domestic pigs while feeding on them (4) or pigs may become infected by eating the tissues of acutely infected wart-hogs (8). Most African isolates of ASF virus produce acute disease in domestic pigs and the virus is readily transmitted by contact between infected and healthy animals and by the ingestion of infected or contaminated food. However, ASF is not present in domestic pigs in all parts of Africa where the virus is known to occur in wart-hogs and *O. moubata*. In Zambia, for example, ASF virus has been isolated from ticks collected from wart-hog burrows in the National Parks of Northern, Eastern, Central and Southern Zambia, but the disease has only ever been reported in the Eastern Province, where it is apparently endemic, although both domestic and indigenous pigs are located in many of the areas where virus is present. The epidemiology of ASF has been little studied in areas where the disease has become endemic in domestic pigs. It has recently been established that ASF is endemic in much of the western part of the Central Region of Malawi (2) in an area where there are no wart-hogs but *O. moubata* are present in the domestic pig pens.

VIRAL EXCRETION BY TICKS

The role of ticks in the transmission of virus in such areas depends on the proportion of ticks which become infected after feeding on viraemic pigs and then on the proportion of infected ticks which can transmit virus to susceptible pigs whilst feeding on them. There is considerable variation in the ability of different isolates of virus to infect a population of *O. moubata*. Two groups from a laboratory colony of *O. moubata* were fed on a viraemic pig infected with ASF virus isolated from a tick from Livingstone Game Park in Southern Zambia or on a pig infected with a virus isolate from the Mchinji District of Central Malawi. Sixteen weeks after infection, ticks were fed individually through artificial silicone membranes to determine the proportion of ticks which excreted virus during feeding and all ticks were subsequently assayed to determine the infection rate. The Zambia isolate
infected all the ticks which fed on the viraemic pig and, of these, 98% excreted virus while feeding (Table I). The Malawi isolate, however, only infected 38% of ticks which fed and, of these, 13% excreted virus. In addition to this variation in infection and excretion rates in ticks infected with different isolates of ASF virus, there is also the possibility that different tick populations may not be equally susceptible to infection with a particular virus isolate. The part played by *O. moubata* in the epidemiology of ASF in the areas of Africa where the disease is endemic in domestic pigs would therefore depend on the interaction of the virus and the tick population in the area. Where the virus produces a high infection and excretion rate, then ticks associated with domestic pigs may be very important reservoirs and vectors of the virus.

### TABLE I

*Infection and excretion rates in *Ornithodoros moubata* 16 weeks after infection with Zambia and Malawi isolates of African swine fever virus*

<table>
<thead>
<tr>
<th>Virus</th>
<th>Infection rate (No. positive/No. tested)</th>
<th>Excretion rate (No. excreted/No. infected)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zambia</td>
<td>54/54 100%</td>
<td>53/54 98%</td>
</tr>
<tr>
<td>Malawi</td>
<td>24/63 38%</td>
<td>3/24 13%</td>
</tr>
</tbody>
</table>

**CHANGE OF THE ASF SYNDROME IN SOUTHERN EUROPE**

The spread of ASF from Africa to other countries has occurred mainly as a consequence of feeding pigs with infected pig meat or meat products, introduced through ports or airports or by travellers bringing infected meat products from ASF-endemic areas (10). In this way, ASF has spread to the Western Hemisphere, from which it has apparently been eradicated, and to southern Europe, where it has become established as an endemic disease in the Iberian peninsula and Sardinia.

Since becoming endemic in southern Europe, the patterns of disease have changed. Whereas the syndromes seen in pigs infected with African isolates are predominantly per-acute and acute with high morbidity and mortality rates, those seen in southern Europe in recent years are much less acute and, while morbidity rates are still high, mortality may be well below 50% (7). In these areas it is often difficult to differentiate ASF not only from classical swine fever but also many other pig diseases and, consequently, the disease may be spread by the movement of infected pigs in addition to transmission by infected waste food. Pigs which survive infection with the less virulent types of virus may recover quite rapidly and become clinically normal, although transmission to other pigs can occur by direct contact up to one month after infection, up to 2 months via the blood, and waste meat may be infectious for up to 3-4 months (3, 12).

In addition to transmitting virus in these ways, recovered pigs may be important in the epizootiology in other ways. Recovered pigs are resistant to challenge with homologous virus (6), but challenge with related heterologous viruses may result in virus replication without clinical signs (11) or virus reactivation may occur if pigs are subjected to stress and the levels of virus produced may be sufficient for transmission to occur by the shedding of blood, contamination of waste food or infection of ticks.
A RECENT OUTBREAK OF ASF IN BELGIUM

The problems posed by the introduction of ASF into a country for the first time are well illustrated by the outbreak which occurred in Belgium at the beginning of 1985. The origin of the outbreak was attributed to the illegal importation of contaminated pig meat from Spain which infected a small breeding herd in West Flanders (1). Only one animal was infected initially and the presenting clinical signs did not immediately lead anyone to suspect swine fever. The animal was treated and virus was subsequently spread to four breeding herds by the use of a contaminated syringe and needle. The movement of piglets from two of these herds transmitted disease to four fattening herds before it was confirmed that the disease was ASF. Once it had been established that this was an outbreak of ASF, 21,000 pigs were slaughtered on these infected premises and movement controls were instigated. In order to detect whether disease had occurred on any other premises, a serological investigation of all farms in the control zone had to be carried out. During the course of this survey, another infected premises was discovered in May, from which infection had spread to two other farms. A total of more than 116,300 sera were tested from some 3,000 premises during the summer and, although the last cases of clinical disease had been seen in March, it was not until September that Belgium could be officially declared free of ASF.

The small number of infected farms in a limited area and the successful eradication of the disease was due to several factors, including the relatively slow spread of disease which had clearly recognisable clinical signs and lesions, once the diagnosis of ASF had been established, and the action taken in slaughtering all pigs on the infected premises, effective movement control, rapid and efficient tracing of movement of both people and animals and the thoroughness of the serological survey.

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L’ÉPIDÉMIOLOGIE DE LA PESTE PORCINE AFRICAINE. — P.J. Wilkinson.

Résumé : L'épidémiologie de la peste porcine africaine en Afrique est passée en revue. Le virus est entretenu par un cycle d'infection entre les tiques de l'espèce Ornithodoros moubata et les phacochères nouveau-nés, ainsi que par sa transmission d'un stade à l'autre, ovarienne et horizontale dans la population de tiques. L'auteur étudie les mécanismes selon lesquels le virus se propage des tiques et des phacochères aux porcs domestiques. L'installation de la peste porcine africaine sous une forme enzootique dans l'Europe méridionale s'explique partiellement par une diminution de la virulence du virus. La plus faible mortalité qui en découle et la persistance du virus chez les porcs guéris peut favoriser une nouvelle dissémination de la maladie, notamment à la faveur d'une réactivation du virus lors des stress subis par les animaux.


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EPIDEMIOLOGÍA DE LA PESTE PORCINA AFRICANA. — P.J. Wilkinson.

Resumen: Se revisa la epidemiología de la peste porcina africana en África. El virus es mantenido por un ciclo de infección entre las garrapatas de la especie Ornithodoros moubata y los facóqueros recién nacidos, así como por su transmisión de una fase a otra, ovárica y horizontal, en la población de garrapatas. Estudia el autor los mecanismos según los cuales se propaga el virus de las garrapatas y facóqueros a los cerdos domésticos. Se explica en parte la instalación de la peste porcina africana con un carácter enzoótico en la Europa meridional por la disminución de la virulencia del virus. La mortalidad más baja que se infiere y la persistencia del virus en los cerdos curados puede propiciar una nueva diseminación de la enfermedad, especialmente con motivo de la reactivación del virus en los stress sufridos por los animales.

PALABRAS CLAVE: Africa - Animales salvajes - Control - Enfermedades de cerdos - Enfermedades transmitidas por las garrapatas - Enfermedades víricas - Epidemiología - Europa - Facóquero - Infección persistente - Iridovirus - Virulencia - Virus de la peste porcina africana.

REFERENCES


