Foot and mouth disease occurrence in southern Africa shows a worrying upward trend, with unusual patterns of transboundary spread

In 2010, the OIE Collaborating Centre produced two FMD (foot and mouth disease) Bulletins for the southern African region; the first dealing with issues related to vaccines and the second focusing on the transboundary nature of FMD as it relates to wildlife conservation and transfrontier conservation areas (TFCAs). The latter analysis concluded that in order to accommodate TFCAs together with expansion of livestock production and increased access for animal products to international markets, countries will need to manage TFCAs in a more cross-sectorally integrated way to accommodate biodiversity conservation and animal health objectives, amongst others. We hope the third Bulletin in this series, concentrating on recent transboundary movements of SAT serotype viruses in southern Africa, will prove informative and useful; at the very least it demonstrates the complexity of the problem.

Summary of transboundary animal disease in the SADC region: 2005-2011

A summary of transboundary animal disease (TAD) events reported to the OIE over the period 2005-2010 is provided in Table 1. This shows that FMD followed by Rift Valley fever (RVF) and African swine fever (ASF) were the subjects of most reports. As is often the case anywhere in the world, reporting may be skewed by the level of importance attributed to particular diseases.

Events related to other high impact diseases in the region are reported on less than might otherwise be the case because they are long-standing local problems and tend to be erosive rather than epidemic in nature and also, because (in some cases) they are not ‘listed’ by the OIE, e.g. trypanosomiasis, tick-borne haemoparasitic diseases and bovine tuberculosis. FMD remains the most problematic TAD in the SADC region.
FOOT AND MOUTH DISEASE

Regional situation

The epidemiology of FMD in southern Africa is unique in that it mainly revolves around specific serotypes (SAT 1, 2 and 3) of viruses maintained and spread by wildlife, African buffalo in particular. Although the precise mechanism of spread of FMD from buffalo to cattle is only broadly understood, it is facilitated by direct contact between these two species. Once cattle are infected, they may maintain SAT infections without the further involvement of buffalo.

Figure 1 summarizes the occurrence of FMD outbreaks caused by SAT serotypes in cattle per decade in three southern African countries – Botswana, Namibia and South Africa – since 1931. These countries are recognized as being adept in the management of FMD and have a record of regular and prompt reporting of FMD since its re-emergence in the 1930s.

FMD had apparently disappeared from southern Africa in the early 20th Century as a result of the precipitous reduction of cattle and buffalo populations caused by the Great Rinderpest Pandemic of 1896-7. As these populations gradually recovered, FMD re-emerged as a problem. In the eight decades since 1931, 133 SAT outbreaks were recorded by these three countries.

In the 1940s-1970s the occurrence of outbreaks in Botswana and South Africa increased, while in Namibia there was no obvious pattern. However, in the 20 year period 1981-2000 there was a dramatic fall in the rate at which outbreaks occurred in Botswana and South Africa, probably related to increasing efficacy of control measures, including the commencement of local FMD vaccine manufacture in Botswana in the late 1970s and South Africa in the mid-1980s. Conversely, in the decade 2001-2010, the situation in Botswana and South Africa worsened appreciably and outbreak frequency approached or, in
AHEAD UPDATE

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the case of Botswana, exceeded historic highs (Figure 1). This trend has continued into 2011 and therefore represents the current situation.

The reasons for the regional upsurge in FMD outbreaks over the last 10-11 years are open to speculation, but obviously the control strategy applied in FMD-endemic regions of southern African countries (the strategies employed by individual countries of the region being very similar) have become less effective. This, firstly, needs to be recognized as a regional and not a country-specific problem and, secondly, the methods employed to manage FMD in the region need to be reassessed urgently.

The leaders of SADC countries have recently agreed to collaborate on renewed efforts to better manage FMD regionally and, as evidence of this, in July 2011 the Government of Botswana donated 2 million doses of vaccine to Zimbabwe to vaccinate 222,000 cattle every four months for the next two years along the Botswana-Zimbabwe border (http://allafrica.com/stories/201107160057.html). However, the reach of this collaboration, apart from mutual material assistance, may be insufficient in that the wider community (e.g. farming interests, rural development agencies and NGOs, conservation organizations/NGOs and the broader scientific community) does not appear, in general, to be involved or well informed. That is of concern, as the FMD situation is technically complicated and, furthermore, disease management policies and actions often have wide-ranging, cross-sectoral knock-on effects that animal disease specialists may not fully appreciate.

Occurrence of FMD outbreaks/incidents in the region in the first half of 2011

In the southern part of the SADC region, the genotypes (three each) of the SAT serotypes prevalent in the region have established historical distributions and therefore are usually referred to as topotypes. The areas where the three SAT 2 topotypes have historically occurred is shown by shading in Figure 2. When a topotype occurs outside the geographic area with which it has been historically associated, viral spread is demonstrable and, furthermore, the origin of that virus can often be broadly identified.

Three FMD outbreaks/incidents in the region were reported officially to OIE in the first half of 2011 but it would seem there were at least five apparently separate incidents (see below).

Botswana/Zimbabwe/Mozambique

Botswana has so far suffered four SAT 2 outbreaks in 2011, one of them in cattle within a recognized FMD-free zone (Zone 7). This has compounded the beef export problem in that country resulting from suspension of imports from Botswana into the European Union in early 2011, primarily because of

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2 A topotype is a genotype with a more or less defined distribution
3 A fourth outbreak occurred in northern Botswana in September 2011 but information on the virus involved is as yet not in the public domain

The first 2011 outbreak, caused by SAT 2 (topotype III) virus occurred in Zone 2d (Okavango, Ngamiland) in February within the vaccination area (i.e. outside the EU export zone), but was effectively resolved by June 2011 (WAHID, 2011 - http://www.oie.int). The outbreak was not epidemiologically linked to the SAT 2 outbreak (also topotype III) that had occurred in Zone 3a (Kasane) in July 2010 (WRLFMD/2011/00028). Topotype III viruses are endemic to buffalo populations of northern Botswana (Figure 2).

Two further SAT 2 outbreaks, but in these cases caused by topotype I viruses (i.e. viruses not traditionally associated with this part of southern Africa), occurred close to each other within a month in Botswana’s Zones 6 (Francistown area) and 7 (Selibwe-Phikwe area) in April-May 2011. Both outbreaks also occurred close to the Zimbabwean border (WAHID, 2011; Figure 2). Because Botswana’s Zones 6 and 7 lie immediately adjacent to the Matabeleland South Province of Zimbabwe, where SAT 2 outbreaks were reported to the OIE in 2010, it had been surmised that the Botswana outbreaks were likely to have been derived from Zimbabwe. However, two of four SAT 2 viruses isolated from cattle samples from Matabeleland South (Plumtree area) proved to belong to topotype II, so they were not epidemiologically linked to the Botswana viruses. Furthermore, although the genome sequences of two other SAT 2 viruses from the Plumtree area, obtained on the same day as the topotype II viruses, placed them in topotype I, they were not closely related to the outbreak viruses derived from Zones 6 and 7 in Botswana (Figure 3). This suggests that even the Zimbabwe topotype I viruses from Matabeleland South in 2010 could not have given rise directly to the outbreak viruses from Zones 6 and 7 in Botswana (Figure 3).
The above findings fail to reveal a clear epidemiological link between the Botswana viruses isolated from cattle in Zones 6 and 7 of Botswana and SAT 2 viruses isolated from cattle in Matabeleland South. Two possibilities could explain this unexpected finding: either at least two different variants of SAT 2/topotype I viruses were circulating in Matabeleland South in 2010/11 or, the viruses causing outbreaks in Botswana’s Zones 6 and 7 were not derived from Matabeleland South. In either event this represents a perplexing situation.

The complicated situation described above is compounded by a further unexpected finding, i.e. that the Botswana SAT 2/topotype I viruses isolated from cattle in Zones 6 and 7 are closely related to SAT 2 viruses isolated from FMD outbreaks in southern Mozambique from September 2010 onwards (WRLFMD/2011/0028; Figures 2 and 3). The Mozambique outbreaks were reported by the official animal health authority of Mozambique to the OIE as having arisen as a result of illegal movement of cattle from Chicalacuula on the Zimbabwe/Gaza border (WAHID, 2010). Chicalacuula is within the area associated with the historic distribution of SAT 2/topotype I viruses but is distant from Botswana’s Zones 6 and 7 (Figure 2).

It is therefore possible that two lineages of SAT 2/topotype I viruses may have been present in southern Zimbabwe in 2010/11 together with SAT 2/topotype II viruses (i.e. viruses historically endemic to western Zimbabwe/eastern Botswana). It is consequently possible that SAT 2/topotype I viruses originating from southern Zimbabwe crossed both the southeastern and western borders of the country into Mozambique and Botswana respectively. Similar events have occurred in the past, i.e. in Botswana’s Zone 7 in 2006. It is evident therefore that the Matabeleland South (western Zimbabwe/eastern Botswana border) is a FMD hot-spot.

Management of this issue is being tackled jointly by the Botswana and Zimbabwean Governments, as mentioned above. It is planned that cattle on both sides of the common border, 40 km deep on each side, will be vaccinated for the next 24 months. The exercise has already commenced (http://allafrica.com/stories/201107261444.html).

South Africa

In February-May 2011, South Africa reported (initially based on serology and later virus isolation) detection of SAT 1/topotype I infection, apparently in the absence of accompanying clinical signs, in the unvaccinated cattle population of northern KwaZulu-Natal (KZN), i.e. partly within the OIE-listed FMD-free zone of the country (Figure 4). South Africa’s internationally recognized FMD-free zone status therefore lapsed. Spread of the infection to a feedlot in

Figure 4: Map of South Africa showing the area where serological evidence of SAT 1 infection in cattle was detected in 2011; red and yellow borders delineate infected and protection zones respectively.
Gauteng, near Johannesburg, was subsequently also traced through cattle movement records. The cattle moved to the feedlot were healthy on arrival and remained so until their slaughter. It was reported by the country’s official Veterinary Service that the cattle moved to the feedlot and in-contact animals were slaughtered immediately upon the movement being traced, and the beef from these animals deboned.

The 2011 outbreak followed FMD outbreaks, also caused by SAT 1/topotype 1 viruses, in 2009 and 2010, although those outbreaks were not within South Africa’s internationally recognized FMD-free zone (as it then was). No direct link between these three SAT 1 outbreaks in South Africa is evident from the viral sequences (Figure 5).

Analysis of partial genome sequences of the two SAT 1 viruses recovered from cattle in the South African outbreak (one derived from the lymph nodes of the feedlot cattle) showed that they clustered with SAT 1 viruses (topotype I) isolated from wildlife and cattle in and around the Kruger National Park in the past as well as (although more distantly) being related to viruses from southern Zimbabwe (i.e. the known distribution of SAT 1/topotype I).

The 2011 incident was apparently only identified as a result of routine serological surveillance conducted in northern KZN, which is close to South Africa’s borders with southern Mozambique and eastern Swaziland (Swaziland is listed as a FMD-free country without vaccination by the OIE - [http://www.oie.int](http://www.oie.int)). Livestock industry representatives have raised the question as to whether disease surveillance was intensive enough in this area to be certain that all the infections identified by serology were subclinical. Furthermore, SAT 1 viruses were subsequently recovered from cattle epithelium which indicates that some clinical cases did occur. It needs to be remembered that in the 1950s-1970s, outbreaks of FMD occurred in the region that were difficult to diagnose because the clinical signs were not obvious. In Botswana such cases were referred to as ‘occult FMD’ and similar observations were also reported from Zimbabwe in the 1980s (Falconer, 1972; Kennedy et al., 1984). However, outbreaks that have been entirely clinically silent, other than in wildlife, have not previously been reported from southern Africa.

In February-March 2011, SAT 3 virus was recovered from probang samples collected from clinically normal buffalo in the Ndumu Game Reserve, the most northerly wildlife reserve in KZN, located immediately south of the Mozambique border. A border fence separates southern Mozambique from

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4 Veterinary Record 91: 354-359
5 Australian Veterinary Journal 61: 163-164

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Figure 5: Phylogenetic tree of SAT 1 (topotype I) viruses associated with FMD outbreaks in South Africa: 2009-2011.
South Africa although the fence has been widely, although unofficially, reported as being in a state of disrepair (http://www.defenceweb.co.za/index.php?option=com_content&view=article&id=10884&Itemid=195). These Ndumu buffalo were also serologically strongly positive for antibodies to SAT 3 but not the other two SAT serotypes. This showed that these buffalo had been infected with SAT 3 virus at some time in the possibly recent past because buffalo in wildlife reserves of northern KZN had previously been proven to be free of SAT viruses (likely a historical phenomenon – Esterhuysen et al., 1985). It is, however, impossible to be precise about when the SAT 3 spread to buffalo in Ndumu Game Reserve occurred.

The above SAT 1 (cattle) and SAT 3 (buffalo) incidents in South Africa do not appear to be epidemiologically linked although they occurred in the same general geographic area, possibly at roughly the same time. In both cases the viruses recovered and sequenced were closely related to viruses previously isolated in the area of the Kruger National Park or, more distantly, to viruses from southern Zimbabwe (Figures 5 and 6). However, neither the Kruger National Park nor southern Zimbabwe has direct connection with northern KZN, so the method and route of these introductions remain a matter of speculation (Figure 4).

Press reports indicate satisfactory progress with control measures, including the projected vaccination of 300,000 cattle in northern KZN, which apparently will be completed within the next 6 months (http://www.sowetanlive.co.za/news/2011/08/08/foot-and-mouth-is-under-control). The implication is that this area of South Africa will not regain its internationally recognized FMD-free status within the next 18 months at least. South Africa’s Red Meat Industry claims that this situation could cost the country R 4 billion (US $490 million) annually (http://www.thenewage.co.za/30829-1007-53-Meat).

CONCLUSIONS

Cross-border epidemiological events related to FMD in southern Africa have clearly occurred on a number of occasions in the recent past. This is perhaps associated with the disquieting incremental occurrence of FMD outbreaks in the SADC region over the last decade despite the best efforts to control the disease on the part of the various national animal health authorities. It should therefore be expected that unless improvement of FMD control in the region as a whole takes place, increasingly frequent FMD outbreaks in the region are likely.

Establishment and maintenance of large areas of southern Africa free from trade-sensitive TADs is demonstrably increasingly difficult. In some quarters this difficulty is ascribed to declining standards and

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Figure 6: Phylogenetic tree showing the relationship between SAT 3 (topotype I) virus isolated from buffalo in the Ndumu Game Reserve (Kwa-Zulu Natal Province, South Africa) and other recent topotype I virus isolates.
quality of veterinary services, the implication being that if these were improved the problem would disappear. It is, however, possible that the problem has more to do with application of disease management strategies that are inappropriate to rural environments of the region, especially in areas where large numbers of wildlife are present. For FMD (as well as several other diseases) we need to ask ourselves whether the strategies being followed are appropriate for the circumstances prevailing on the ground. These strategies are largely dictated by the norms of international animal disease control and trade in animal commodities and products. Where these norms and standards result in disease management approaches that are insufficiently effective it is reasonable – essential in fact – to re-assess them.

An important aspect of the FMD incidents discussed in this Bulletin is the demonstrably important role of molecular epidemiology and serology in understanding the occurrence and spread of infections. It is likely that without active serological surveillance, the occurrence of FMD in South Africa in 2011 would have remained undetected for a longer period and therefore have spread more widely before the problem became apparent. Similarly, without molecular epidemiological investigation into FMD outbreaks, we would be unable to appreciate the frequency and complexity of the transboundary movement of these infections. This begs the question of how molecular epidemiology and serological surveillance can be more effectively integrated with conventional physical inspection to improve the speed and accuracy of surveillance. The problems of establishing capacity, costs and associated logistics are significant where resources are limited. A particular problem relates to the slowness with which these essential data become available to the broader community concerned with rural development and even to those concerned with management of animal diseases on the ground, because currently, by the time information becomes available, it is often too late.

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COMMENT/DISCUSSION

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