Food and Agriculture Organization of the United Nations

TAD SCIENTIFIC

FMD Technical Bulletin

Food and Agriculture Organisation of the United Nations Initiative: Assistance to Zimbabwe with development of an updated foot and mouth disease control strategy

(Part of a wider regional project aimed at development of non-geographic approaches to management of FMD trade-risk through application of commodity-based trade)

Carrier Animals and the Transmission of Foot and Mouth Disease

It has long been widely believed by both animal health professionals and the farming community in Zimbabwe that carrier[1] cattle and carrier African buffalo are chiefly responsible for maintaining and spreading foot and mouth disease (FMD). However, the available scientific evidence is that this is a misconception, particularly when it comes to cattle. Scientifically, the consensus as reflected in Article 8.8.1 of the World Organisation for Animal Health's (OIE) Terrestrial Animal Health Code (TAHC – www.oie.int/index.php?id=169&L=0&htmfile=chaptre_fmd.htm), is that the only species 'from which (carrier) transmission of FMD has been proven' is the African buffalo, i.e. while it has sometimes been suspected, there is no credible evidence that transmission by carrier cattle occurs. The implication is that carrier cattle are epidemiologically insignificant when it comes to maintenance and spread of FMD. Therefore control strategies against FMD do not need to be complicated by consideration of the carrier status of cattle, especially when eradication of the disease is not an achievable objective (as is the situation in southern Africa generally – Thomson et al., 2015). In the discussion below the term 'buffalo' refers exclusively to African buffalo (*Syncerus caffer*), i.e. domestic/water buffalo (*Bubalus bubalis*) are not considered.

Persistent infection in animals recovered from FMD

In most ruminant species, the virus persists in a proportion of animals for more than 28 days following recovery from acute infection with FMD viruses, in the lining (mucosa) of the back of the throat (dorsal oro-pharynx) as well as the palatine tonsils and lymph nodes (glands) that drain that area. The persistent virus can be demonstrated through 'probang' sampling or a more recently developed method known as the 'tonsillar brush technique' (see *Figure 1*). Depending on the species, FMD viruses may persist in the throats of recovered animals for a few weeks or months (e.g. sheep, goats and kudu) or even for years in the case of buffalo. On average, persistently infected cattle retain the infection for about 6 months although some studies have found persistence to be longer lasting, even beyond a year (Thomson, 1996). Table 1 summarises what is known about FMD viral persistence in different animal species in relative terms.

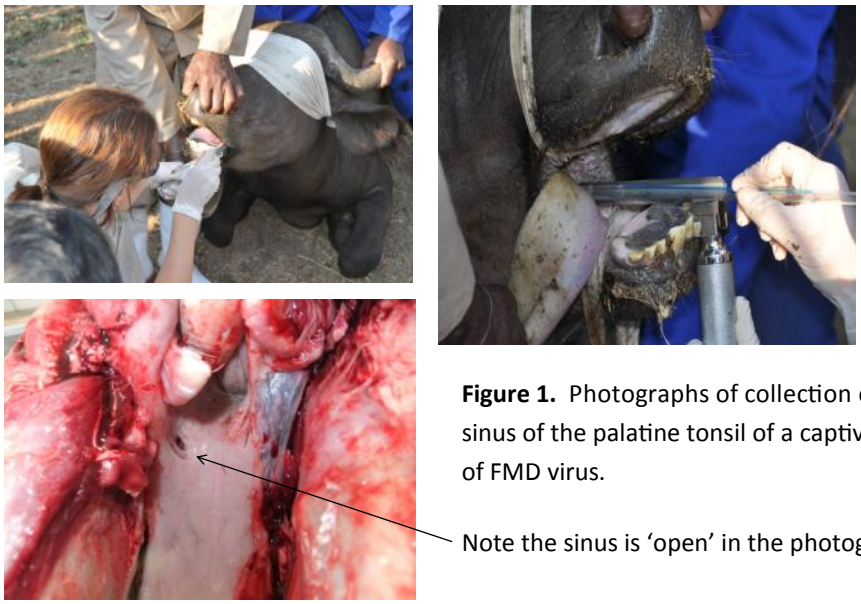

Figure 1. Photographs of collection of 'tonsillar brush' samples from the sinus of the palatine tonsil of a captive buffalo for detection of the presence of FMD virus.

Note the sinus is 'open' in the photograph on the left taken at *post mortem*:

[1] Carrier: An individual who harbours the specific organisms of a disease without manifest symptoms and is capable of transmitting the infection (www.medical-dictionary.thefreedictionary.com/carrier)

Table 1: Development of persistent SAT-type infection and carrier status in cloven-hoofed species commonly exposed to infection in the field in southern Africa

Species	Relative susceptibility to infection	Persistent infection demonstrated	Evidence for carrier transmission
African buffalo	++++	+++	+
Cattle	++++	++	-
Sheep/goats	++	+	-
Impala	+++	-	-
Kudu	?	+	-

There is no doubt that FMD viruses persist in the throats of some ruminants that have recovered from infection with FMD viruses. So, the crucial issue is whether, and the extent to which these persistently infected animals are able to transmit the infection to other animals.

Transmission of FMD viruses by persistently infected cattle

Suspicion that cattle carriers have been responsible for maintaining and spreading FMD have been reported periodically from many parts of the world, including Zimbabwe (Thomson, 1996). However, all the experiments conducted to prove that this actually occurs, involving persistently infected cattle being kept in intimate contact with susceptible cattle for prolonged periods, have been unsuccessful (Tenzin et al., 2008; Parthiban et al., 2015). This has included efforts to 'stress' the persistently infected cattle, either by physical or medical (corticosteroid administration) means.

This issue has a major practical implication in that it calls into question the logic of the duration of quarantine periods, that can be as long as 18 months, that are imposed on locations in Zimbabwe and other southern African countries where outbreaks of FMD in cattle have occurred. Prolonged quarantine has had, and continues to have, serious economic repercussions for cattle producers in Zimbabwe as well as other countries of the southern African region. It can also have other negative and undesirable effects by undermining efforts to control illegal livestock movement.

How do buffalo differ from cattle in respect of persistent infection/carrier transmission?

It is well established that although infection of buffalo with the SAT types of FMD occurs commonly in most natural populations in southern Africa, very few buffalo become diseased, i.e. these natural infections are almost always subclinical. It is also established that in around 50% of all buffalo that are past the acute stage of infection, SAT viruses persist in their throats for many months or even years. However, that persistence is not life-long (Vosloo – www.wrlfmd.org/50th_anniversary/Vosloo.pdf). Unlike cattle, persistently infected buffalo have been shown – albeit rarely – to transmit SAT virus types of FMD virus to cattle with which they come into close contact (Dawe et al., 1994). Persistently infected buffalo have also been shown to transmit SAT viruses to other buffalo, probably more efficiently than transmission to cattle (*Figure 2*). In the case of transmission from buffalo carriers to cattle, the available evidence indicates that the buffalo and cattle need to be in close contact for extended periods of time, i.e. fleeting contact between carrier buffalo and cattle does not appear to result in transmission. However, the precise mechanism by which carrier transmission occurs remains unknown. It is interesting that so far transmission of FMD from buffalo to cattle has not been shown to occur in East Africa.

The maintenance of SAT viruses within breeding herds of buffalo involves at least two transmission mechanisms as explained in Figure 2. In all probability breeding herds of buffalo containing recently infected calves constitute the most likely source of infection for other species such as cattle or antelope. And once infected, the virus can then be transmitted between cattle or between susceptible animal species.

The rarity of carrier transmission from buffalo to cattle has resulted in confusion because many people in rural areas of southern Africa have witnessed buffalo and cattle being in close contact without FMD transmission occurring. On the other hand, that such transmission occurs sometimes is indisputable (Vosloo et al., 2002). Hard evidence for this has only become available in the last 25 years or so as a consequence of our ability to sequence the genomes of FMD viruses quickly and efficiently. This enables accurate comparison of the identity or otherwise of virus isolates obtained from different species. So, for example, it has been possible to show in some well investigated FMD incidents that persistently infected buffalo in the locality concerned and diseased cattle or antelope in the same area were infected by essentially identical viruses (Vosloo et al., 2002; Vosloo – www.wrlfmd.org/50th_anniversary/Vosloo.pdf).

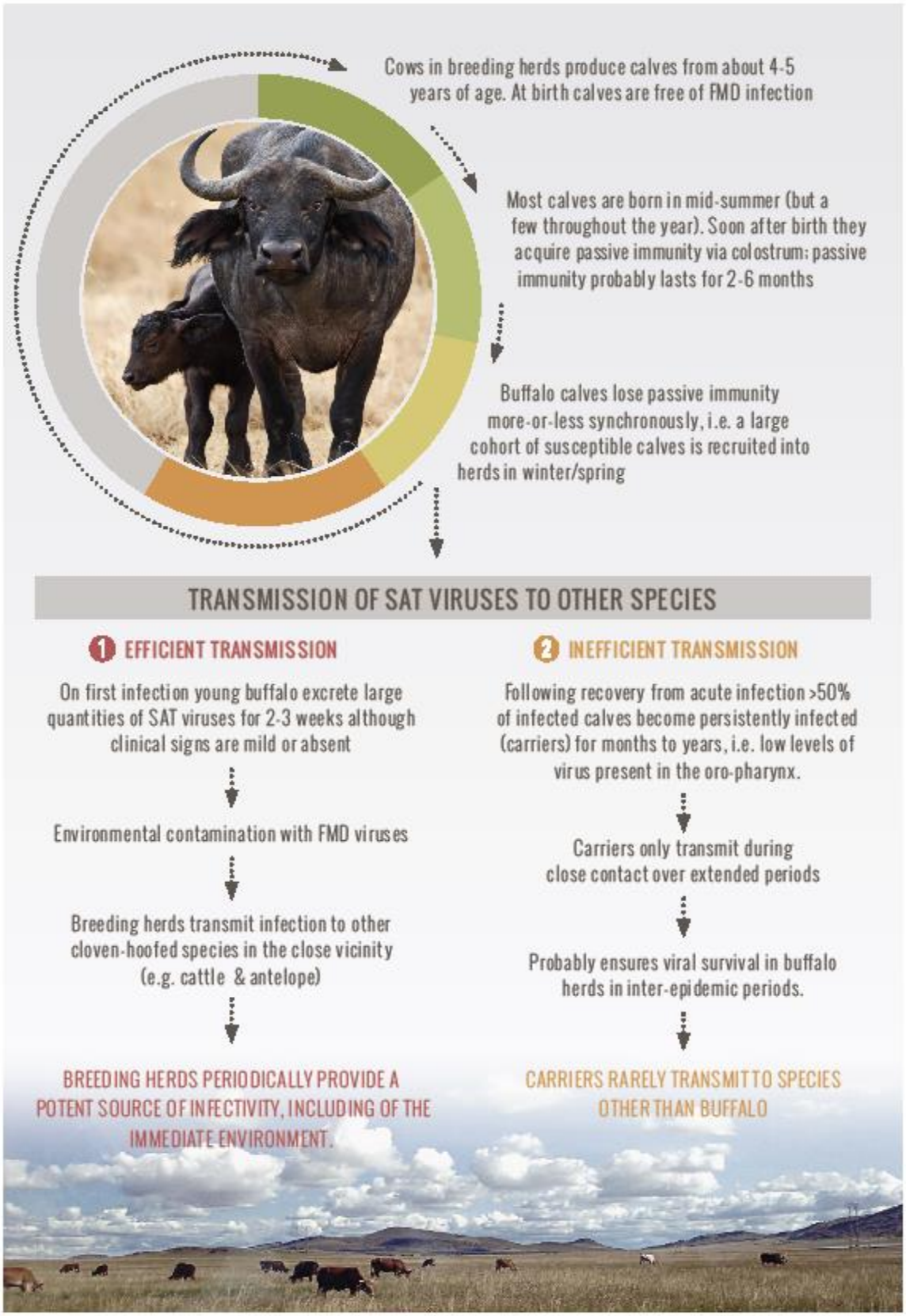

Figure 2. Diagrammatic representation of the transmission mechanisms for SAT-type viruses within breeding herds of African buffalo (seasonal breeders in southern Africa) and transmission of these viruses from acutely infected- (efficient) and carrier buffalo (inefficient pathway) to other cloven-hoofed species.

The above observations show that there are clear differences between the biological significance of persistently infected buffalo and cattle. In the case of persistently infected cattle, available evidence indicates that they are extremely unlikely to transmit the infection to other cattle.

In countries of southern Africa where wildlife and the nature of the SAT virus types render FMD more difficult to eliminate than in most other regions of the world (Thomson et al., 2015), the rationale of imposing prolonged quarantine periods in order to control the disease is therefore arguably unjustified. Quarantine aimed at managing an, at most, insignificant mechanism of FMD transmission imposes serious economic hardship on rural populations in particular.

Conclusion

The widely held belief in Zimbabwe that carrier cattle are responsible for maintaining and spreading FMD is not justified on the basis of current scientific understanding. On the other hand, carrier buffalo are probably important in the maintenance of SAT viruses within buffalo herds and therefore populations that, ultimately, are the primary source of SAT-type infections of domestic livestock including cattle. However, carrier buffalo are only able to transmit the infection to cattle inefficiently and therefore do so infrequently. This is presumably because the special circumstances that enable such transmission to occur (which we do not yet understand), happen rarely. It is also likely that most FMD transmission from buffalo to cattle results from buffalo herds, or portions thereof, containing calves shedding SAT viruses coming into close contact with cloven-hoofed livestock or other wildlife species.

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COMMENT/DISCUSSION

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