Spatial Distribution of Foot-and-Mouth Disease Viral Lineages in African buffalo (*Syncerus caffer*)

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Early Reports of FMD

• The earliest description of what was probably FMD was that by Hieronymi Fracastorii (1546). He described the disease, which occurred in Northern Italy in 1514, as being unusual and affecting only cattle.

• In 1780 in Southern Africa, Le Vaillant (1795) described a disease in cattle which "attacked the feet of oxen causing them to swell prodigiously and after producing suppuration, sometimes the hooves dropped off".

• Gordon Cumming (1850) and General S.J.P. Kruger (1858) also described a disease in Southern Africa which was probably FMD.

• Foot-and-mouth disease was present in Rhodesia (Sinclair, 1922) and Swaziland (Edmonds, 1922) in 1892 and in Rhodesia in 1894-5 (Edmonds, 1922). Hutcheon (1894) records an outbreak in South Africa, originating in Mashonaland and the Northern part of the Transvaal in 1893.
Affected FMDV diversity in Africa by severe reduction in numbers of susceptible hosts (possibly by 90-95%) prior to the pandemic. Famine and Smallpox followed! The pastoral Maasai, of whom perhaps two-thirds died, suffered the worst.
African buffalo (*Syncerus caffer*)

- **Cape buffalo** (*Syncerus caffer caffer*)
- **Dwarf forest buffalo** (*Syncerus caffer nanus*)
- **North Western Buffalo** (*Syncerus caffer brachyceros*)
- **North Eastern Buffalo** (*Nile Buffalo*) (*Syncerus caffer aequinoctialis*)
The Central African and West African savanna buffalo were combined as the northwestern buffalo (S. c. brachyceros including planiceros).

Three or four subspecies are usually distinguished: Forest Buffalo (S. c. nanus); West African Savanna Buffalo (S. c. brachyceros); Central African Savanna Buffalo (S. c. aequinoctialis); and Southern Savanna Buffalo (S. c. caffer).
Re-appearance of FMD in Africa

- **Libya**: A (1952)
- **Malawi**: SAT2 (1951) SAT1 (1955) SAT3 (1959)
- **Tanzania**: SAT2 (1948) SAT1 (1953) SAT3 (1974-buffalo)
- **Mozambique**: SAT2 (1951) SAT3 (1934) SAT1 (1937)
- **Zimbabwe**: SAT2 (1931) SAT3 (1934) SAT1 (1937)
- **Argentina**: SAT2 (1951) SAT1 (1955) SAT3 (1958)
- **South Africa**: SAT2 (1951) SAT1 (1955) SAT3 (1958)
- **Namibia**: SAT1 (1949) A (1958)
- **Angola**: A (1958)
- **D.R. Congo**: A, SAT2 (1953)
- **Nigeria**: untyped (1920) O (1955)
- **Congo**: O, SAT2 (1959)
- **Morocco**: A (1952)
- **Egypt**: SAT2 (1950) O (1951)
- **Sudan**: O, SAT1 (1952) A (1957)
- **Ethiopia**: O, C (1957)
- **Kenya**: SAT3 (1974-buffalo)
- **Zambia**: SAT2 (1948) SAT1 (1953) SAT3 (1974-buffalo)

Date of Re-appearance:
- **1905**: South Africa
- **1915**: D.R. Congo
- **1915**: Kenya
- **1920**: Liberia
- **1931**: Malawi
FMD Virus Pools in Africa

Pool 3 (O, A, Asia1)

Pool 5 (O, A, SAT2) (SAT1?)

Pool 4 (O, A, SAT1, SAT2) (SAT3?)

Pool 6 (SAT1, SAT2, SAT3)
FMD Viruses from Buffalo

• Most sampling of FMD virus from buffalo has been performed in the southern African region.

Summary of available FMDV isolates from Syncerus caffer

<table>
<thead>
<tr>
<th>Country</th>
<th>Date</th>
<th>SAT 1</th>
<th>SAT 2</th>
<th>SAT 3</th>
<th>Total</th>
</tr>
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<tbody>
<tr>
<td>Botswana</td>
<td>1998-2006</td>
<td>13</td>
<td>12</td>
<td>6</td>
<td>31</td>
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<tr>
<td>Kenya</td>
<td>1974-1981</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>5</td>
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<tr>
<td>Malawi</td>
<td>1985</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Namibia</td>
<td>1989-1998</td>
<td>5</td>
<td>6</td>
<td>3</td>
<td>14</td>
</tr>
<tr>
<td>South Africa</td>
<td>1986-2003</td>
<td>154</td>
<td>42</td>
<td>62</td>
<td>258</td>
</tr>
<tr>
<td>Uganda</td>
<td>1970-2002</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>Zambia</td>
<td>1993-2010</td>
<td>9</td>
<td>5</td>
<td>5</td>
<td>19</td>
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<tr>
<td>Zimbabwe</td>
<td>1983-1998</td>
<td>91</td>
<td>51</td>
<td>44</td>
<td>186</td>
</tr>
<tr>
<td>Totals</td>
<td></td>
<td>279</td>
<td>121</td>
<td>122</td>
<td>522</td>
</tr>
</tbody>
</table>
FMDV SAT 1 in Africa

Earliest historical reports (1937-present)

Most recent reports (since 2001)
SAT 1 Topotypes

- **NSA-1** (North Southern Africa 1)
- **ESA-1** (East Southern Africa 1)
- **WSA-1** (West Southern Africa 1)
- **EA-1** (East Africa 1)
- **WA-1** (West Africa 1)
- **NCA-1** (North Central Africa 1)
- **EA-2** (East Africa 2)
- **EA-3** (East Africa 3)
- **EA-4** (East Africa 4)
Earliest historical reports (1931-present)

Most recent reports (since 2001)
SAT 2 Topotypes

- **East Southern Africa 1 (ESA-1)**
- **West Southern Africa 1 (WSA-1)**
- **West Southern Africa 2 (WSA-2)**
- **East Africa 1 (EA-1)**
- **West Africa 1 (WA-1)**
- **West Africa 2 (WA-2)**
- **North Central Africa 1 (NCA-1)**
- **Central Africa 1 (CA-1)**
- **East Africa 2 (EA-2)**
- **Central Africa 2 (CA-2)**
- **West Southern Africa 3 (WSA-3)**
- **East Africa 3 (EA-3)**
- **East Africa 4 (EA-4)**
- **East Africa 5 (EA-5)**

The maps illustrate the distribution of SAT 2 Topotypes across various regions in Africa.
FMDV SAT 3 in Africa

Earliest historical reports (1934-present)
- Namibia (1958)
- Botswana (1958)
- Zambia (1974)
- Uganda (1970)
- Malawi (1976)
- Mozambique (1959)

Most recent reports (since 2001)
- South Africa (1958)
- Zimbabwe (1934)

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SAT 3 Topotypes

ESA-1 (East Southern Africa 1)

NSA-1 (North Southern Africa 1)

WSA-1 (West Southern Africa 1)

NSA-2 (North Southern Africa 2)

EA-1 (East Africa 1)
Buffalo in Southern Africa
SAT 3 Zimbabwe buffalo

Northwestern Zimbabwe (II)
- Urungwe SA 1991
  - SAT3/ZIM/P25/91 UR24
  - SAT3/ZIM/P27/90 DSA44
  - SAT3/ZIM/P27/90 DSA31

Southeastern Zimbabwe (I)
- Gonarezhou NP 1991
  - SAT3/ZIM/P7/94 MT3
  - West Nicholson 1983
    - SAT3/ZIM/P18/91 GN8
    - SAT3/ZIM/P26/90 HV5
  - Chikwarakwara 1991
    - SAT3/ZIM/P45/91 MT12
    - SAT3/ZIM/P45/91 HWANGE11
    - SAT3/ZIM/P30/90 CHER31
    - SAT3/ZIM/P30/90 CHER32
    - SAT3/ZIM/P40/91 BUM14
    - SAT3/ZIM/P43/91 MAT1
    - SAT3/ZIM/P43/91 MAT11

Western Zimbabwe (III)
- SAT3/ZIM/P43/91 MAT1

Map showing the distribution of SAT 3 strains in Zimbabwe with labels for specific geographic areas and buffalo movement.
Zimbabwe: FMD Threats from Buffalo
SAT 1 FMD Viruses from Buffalo

- South Africa (Kruger National Park)
- Zimbabwe
- Zambia
- Namibia
- Botswana
- Uganda

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Questions

• What is the role of buffalo in the epidemiology of FMDV in different regions of Africa?
• Have FMDV lineages been (re)-introduced into the buffalo population from domesticated animals?
• What are the interactions between buffalo and the European FMDV serotypes?
  – Infection?
  – Disease?
  – Persistence?
Understanding FMDV persistence in African buffalo

Nick Juleff & Bryan Charleston, IAH

- Wellcome Trust funded project in collaboration with the Kruger National Park, Onderstepoort Veterinary Institute, Institute for Animal Health, University of Glasgow and University of Edinburgh.

- Aim is to determine how FMDV is maintained and how antigenic diversity is generated in African buffalo.

- First study due to start in June 2011 (Skukuza, KNP)
  - Challenge 16 buffalo with SAT 1, 2 and 3 simultaneously
  - 4 cattle for contact challenge

- In 2012, samples will be collected during an extensive bovine tuberculosis survey in the KNP
  - Investigate the composition of FMDV in an endemically infected natural host
  - Determine the genetic diversity of FMDV circulating in the buffalo herds
Partnership for FMD Research in Southern Africa:

Collaboration between the following research projects:
SACIDS (Wellcome Trust), CIDLID (BBSRC-DFID), SADC TADs, National Govts e.g. ASDP

- **Tanzania:**
  - Central Veterinary Laboratory (CVL)
  - Sokoine University of Agriculture (SUA)
  - Tanzania Wildlife Research Institute (TAWIRI)
  - National Epidemiology Unit (NEU)

- **Zambia:**
  - University of Zambia (UNZA)
  - Central Veterinary Research Institute (CVRI)

- **SADC SECRETARIAT:** SADC TADs Regional Project

- **Republic of South Africa:** ARC-Onderstepoort Veterinary Institute (OVI)

- **Botswana:** Botswana Vaccine Institute (BVI)

- **United Kingdom:**
  - World Reference Laboratory for FMD, Pirbright (IAH)
  - Royal Veterinary College, London
  - University of Glasgow
  - University of Edinburgh
Proposed FMD Programme: SACIDS/CIDLID BBSRC-DfID/SADC-TADs Partners

BBSRC/DfID 2010-2014
- Univ. Glasgow UK
- WRLFMD IAH UK
- Prof. Brian Perry UK/East Africa

SACIDS 2009-2014
- SUA Tanzania
- NEU Tanzania
- TAWIRI and TANAPA Tanzania
- CVR Tanzania
- VIC Tanzania
- UNZA Zambia
- CVRI Zambia
- BVI Botswana
- OVI RSA
- RVC UK

SADC-TADs

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Understanding Endemic FMD

Wildlife, particularly buffalo, are likely to be important reservoirs of FMD in Tanzania.

Sampling wildlife and livestock around protected areas will allow us to map the genetic diversity of FMD viruses across Tanzania.
Buffalo sampling: Serengeti, Tanzania, April 2010
Conclusions

• Much is already known about the role of cape buffalo in FMD epidemiology in southern Africa.

• Little is currently known about the situation in other parts of Africa.
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