WRLFMD Quarterly Report October-December 2013

Reference Laboratory Contract Report

Foot-and-Mouth Disease

Copies of all the individual reports cited herein can be obtained from The Pirbright Institute and prior to presentation, publication or any other public use of these data, please contact Dr. Donald King, The Pirbright Institute, donald.king@pirbright.ac.uk.

Summary

New epidemiological events:

During this reporting period, sequences generated at Pirbright for samples received from Libya and Saudi Arabia were characterised as belonging to the O/ME-SA/Ind-2001 lineage, most closely related to FMD viruses from Bhutan and India. These were unexpected results and indicate that this lineage has been recently introduced into two new geographical areas (further details are provided below**).**

ASIA

Israel

On 15 November 2013, an outbreak of **FMD type O** was reported in cattle close to the Syrian border at Majdal Shams, Golan, Hazafon. FMD outbreaks at this time of year are very unusual in Israel; between 1975 and 2012 a total of 330 outbreaks have been reported and none of these have occurred in November. Genotyping revealed the virus to be O/ME-SA/PanAsia-2^{FAR-09}, most closely related to recent outbreaks in the Palestinian Autonomous Territories (Gaza Strip) and Turkey.

Mongolia

Three samples received from Mongolia, collected from cattle in an unknown location(s) in September 2013, belonged to A/ASIA/Sea-97 and were closely related to viruses received during the last reporting period.

Palestinian Autonomous Territories

Two samples collected from sheep on 21st and 24th November 2013 from Jericho (West Bank) were typed as **FMDV O**. These were most closely related to the samples from Israel described above.

Pakistan

Forty samples collected from various locations in Pakistan between September 2012 and August 2013 revealed the presence of **FMDV types O, A and Asia 1**. Four of the **FMD type O** viruses (from 2012 and 2013) belonged to a novel lineage within the ME-SA topotype (lying between the previous characterised PanAsia and PanAsia-2 lineages), six belonged to PanAsia-2^{ANT10}, and one to and unnamed sub-lineage of PanAsia-2. Of 20 **FMD type A** viruses identified, eight belonged to A/ASIA/Iran-05^{SIS-12} and 12 belonged to a new sub-lineage which we have named A/ASIA/Iran-05^{FAR-11} which had previously been found in the Fars province of Iran in 2011. Nine **FMD type Asia 1** viruses all belonged to the Sindh-08 lineage that is circulating elsewhere in Asia. Two samples contained a mixture of both type A and Asia 1 (and were among the sequences reported) and one additional sample appeared to contain a mixture of two or more type A sequences which could not be resolved.

Russian Federation

Outbreaks of **FMD type A** continue to be reported in the Amur Oblast (28/09/2013 & 27/11/2013) and Zabaykalsky Krai (21/09/2013, 22/09/2013 & 02/10/2013) regions of eastern Russia. It is assumed that these viruses belong to the A/ASIA topotype, Sea-97 lineage as was shown for previous outbreaks in the region.

Saudi Arabia

FMDV type O was isolated from samples collected from two outbreaks in cattle in Saudi Arabia in August (Al-Kharj) and November (Dhurma) 2013, both close to Riyadh. Genotyping revealed the viruses to be closely related to each other and to belong to the O/ME-SA topotype, Ind-2001 lineage. Phylogenetic comparisons that were undertaken at the WRLFMD, Pirbright and Project Directorate on Foot and Mouth Disease (ICAR), Mukteswar, India (PD-FMD), showed that the Saudi Arabian viruses were closely related to a recent sub-lineage of Ind-2001 named KAR-13, which had also been recently identified in Libya (see below and Fig. 1).

Taiwan

A single **FMD type O** virus was sent for vaccine matching and genotyping showed it to belong to the CATHAY topotype. Ambiguities in the VP1 sequence suggested that it was a mixture of closely related viruses.

Vietnam

Forty samples collected from all over Vietnam during 2013 revealed the presence of **FMD types O and A**. **FMDV type O** was identified in 19 samples and genotyping showed these all to belong to the O/ME-SA/PanAsia lineage. **FMDV type A** was identified in 10 samples and genotyping showed them to belong to the A/ASIA/Sea-97 lineage.

AFRICA

Kenya

Fifteen samples collected from cattle in Kenya in 2012-2013 were received by the WRLFMD. **FMDV types A, SAT 1 and SAT 2** were isolated. Two **FMD type A** viruses from Esageri, Koibatek District, Rift Valley Province (collected on 25/09/2013) belonged to the AFRICA topotype, G-I lineage (see below). Seven **FMD SAT 1** viruses from Ngata, Nakuru District, Rift Valley Province (collected on 20/01/2013 to 30/01/2013) belonged to topotype I (aka NWZ) and a single **FMD type SAT 2** virus from Rongai, Nakuru District, Rift Valley Province (collected on 25/09/2013) belonged to topotype IV (see below).

Libya

Samples collected from FMD outbreaks in Libya (collected from cattle between September and December 2013) and sent via Dr. E. Brocchi, Istituto Zooprofilattico Sperimentale della Lombardia e dell'Emilia Romagna (IZSLER), Brescia, Italy, revealed the presence of **FMDV type O**. The first seven samples were from Zliten in Murqub District. Genotyping showed that the virus belonged to the ME-SA topotype, Ind-2001 lineage. Sequence comparisons by the PD-FMD (Mukteswar, India), showed that the Libyan virus was closely related to a newly identified sub-lineage of Ind-2001 which they named KAR-13 (see Fig. 1).

South Africa

Between 30th October and 9th December 2013, three new outbreaks of **FMD type SAT 1** were reported in cattle in the Bushbuckridge, Mpumalanga province adjacent to the Kruger National Park. These are occurred within South Africa's FMD protection zone where vaccination for FMD is performed. Genotyping results are awaited.

SOUTH AMERICA

No new outbreaks of FMD were reported in the region.

Uncharacterised FMD viruses

A number of outbreaks have occurred where samples have not been sent to the WRLFMD. It is probable that the countries involved have performed their own genetic characterisation; however, through the OIE/FAO laboratory network we would also like to encourage the submission of samples (or complete VP1 sequences) to the WRLFMD.

WRLFMD vaccine recommendations are unchanged: however, the spread of the O/ME-SA/Ind-2001 lineage into the Middle East and North Africa needs to be carefully monitored in the coming months.

Summary of sequencing data

An up-to-date list and reports of FMD viruses characterised by sequencing can be found at the following website: http://www.wrlfmd.org/fmd_genotyping/2013.htm.

Results from samples received at WRLFMD (status of samples being tested) are shown in Table 1 and a complete list of clinical sample diagnostics made by the WRLFMD between October and December 2013 is shown in Annex 1 Table A. A summary of these results is shown in Annex 1 Table B.

Table 1: Status of sequencing of samples received by the WRLFMD from October to December 2013.

WRLFMD Batch No.	Date received	Country	Serotype	No. of samples	No. of sequences	Status
WRLFMD/2013/00019*	25/09/2013	Kenya	A	2	2	Completed
WRLFMD/2013/00019*	25/09/2013	Kenya	SAT 1	7	7	Completed
WRLFMD/2013/00019*	25/09/2013	Kenya	SAT 2	1	1	Completed
WRLFMD/2013/00020	28/10/2013	Mongolia	A	3	3	Completed
WRLFMD/2013/00021	29/10/2013	Libya	O	7	7	Completed
WRLFMD/2013/00022	06/11/2013	Taiwan POC	O	1	1	Completed
WRLFMD/2013/00023	07/11/2013	Saudi Arabia	O	3	3	Completed
WRLFMD/2013/00024	07/11/2013	Pakistan	O	11	11	Completed
WRLFMD/2013/00024	07/11/2013	Pakistan	A	19	18†	Completed
WRLFMD/2013/00024	07/11/2013	Pakistan	Asia 1	7	7	Completed
WRLFMD/2013/00024	07/11/2013	Pakistan	A + Asia 1	2	4‡	Completed
WRLFMD/2013/00025	26/11/2013	Vietnam	O	19	19	Completed
WRLFMD/2013/00025	26/11/2013	Vietnam	A§	10	10	Completed
WRLFMD/2013/00026	29/11/2013	Saudi Arabia	O	3	3	Completed
WRLFMD/2013/00028	04/12/2013	Israel	O	3	3	Completed
WRLFMD/2013/00029	04/12/2013	Palestinian AT	O	2	2	Completed
WRLFMD/2013/00030	16/12/2013	Libya	O	2	2	Completed
				102	103	

*, received at the end of the previous reporting period.
†, one isolate appeared to have a mixture of two type A viruses and the sequences could not be determined.
‡, type A and type Asia 1 sequences were determined for each virus isolate.
§, two samples were originally reported as FMDV-GD as not FMDV could be isolated in cell cultures.

Detailed Analysis:

ASIA

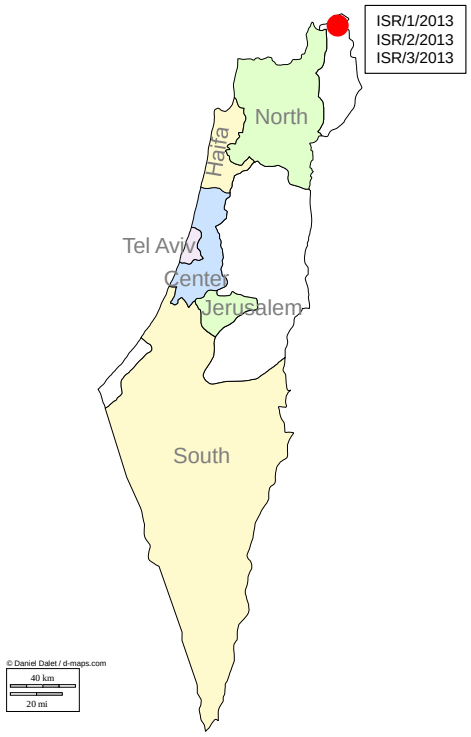
Israel

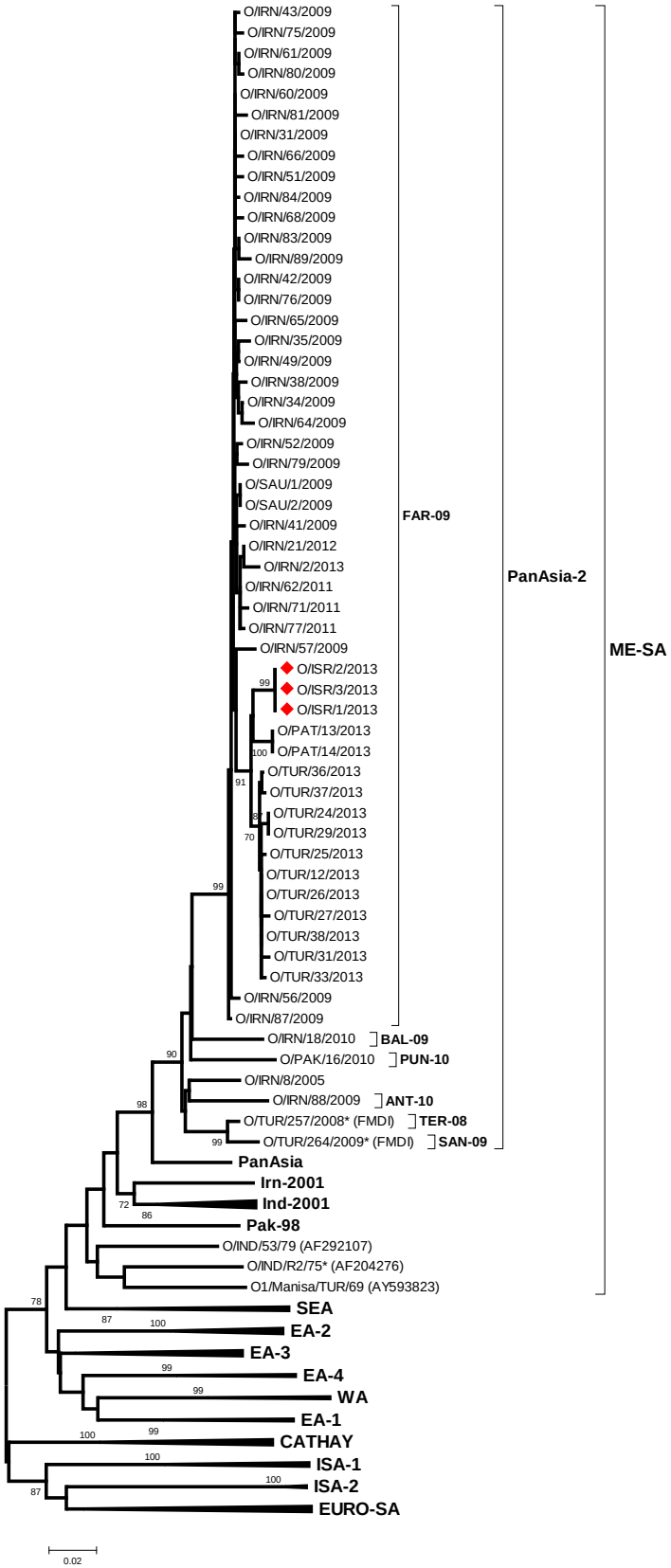
WRLFMD/2013/00028

Date received: 04/12/2013

No. of samples: 3

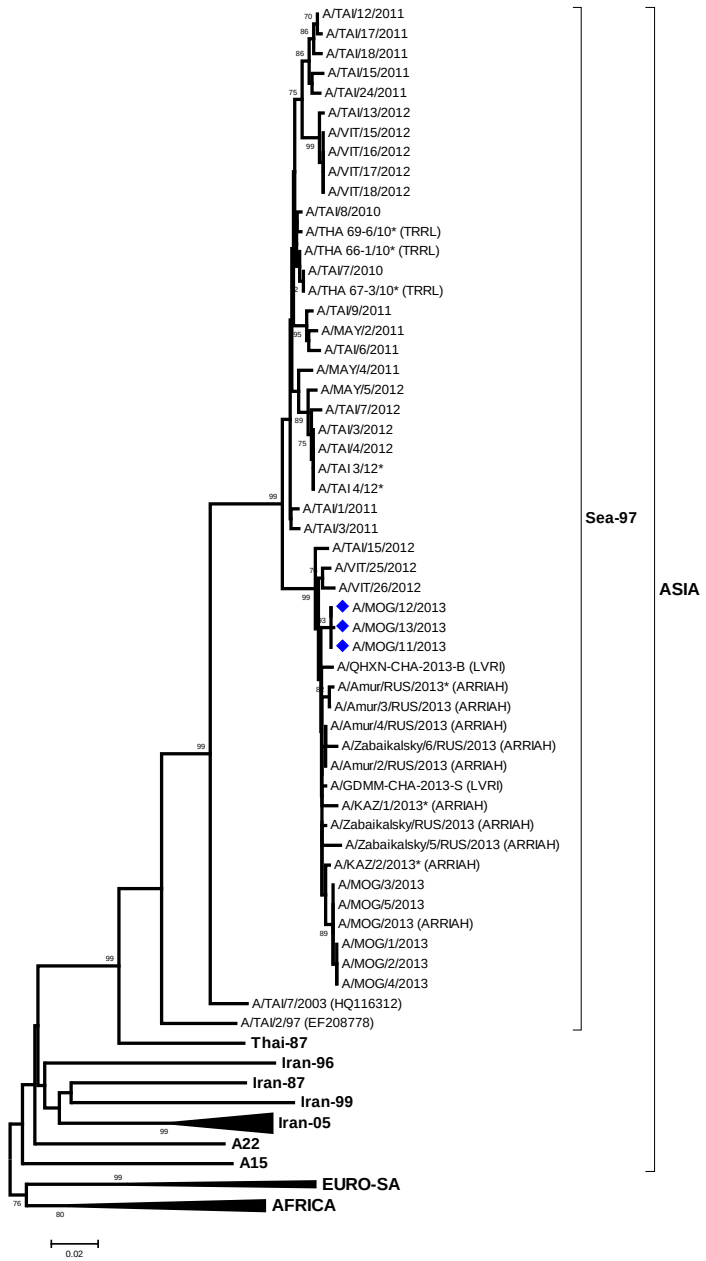
O (ME-SA/PanAsia-2^{FAR-09}): 3





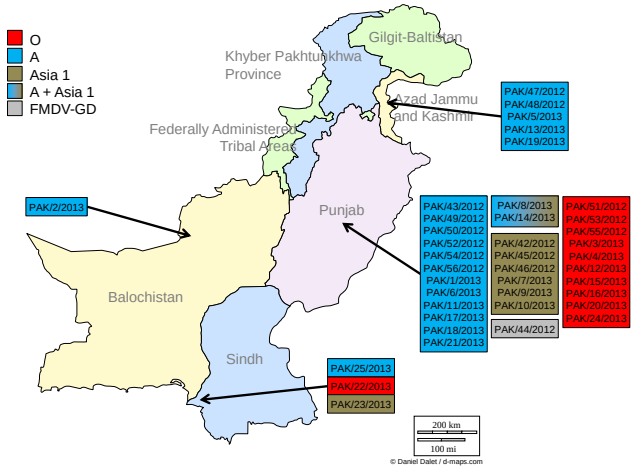
Mongolia
WRLFMD/2013/00020
Date received: 28/10/2013
No. of samples: 3
A (ASIA/Sea-97): 3

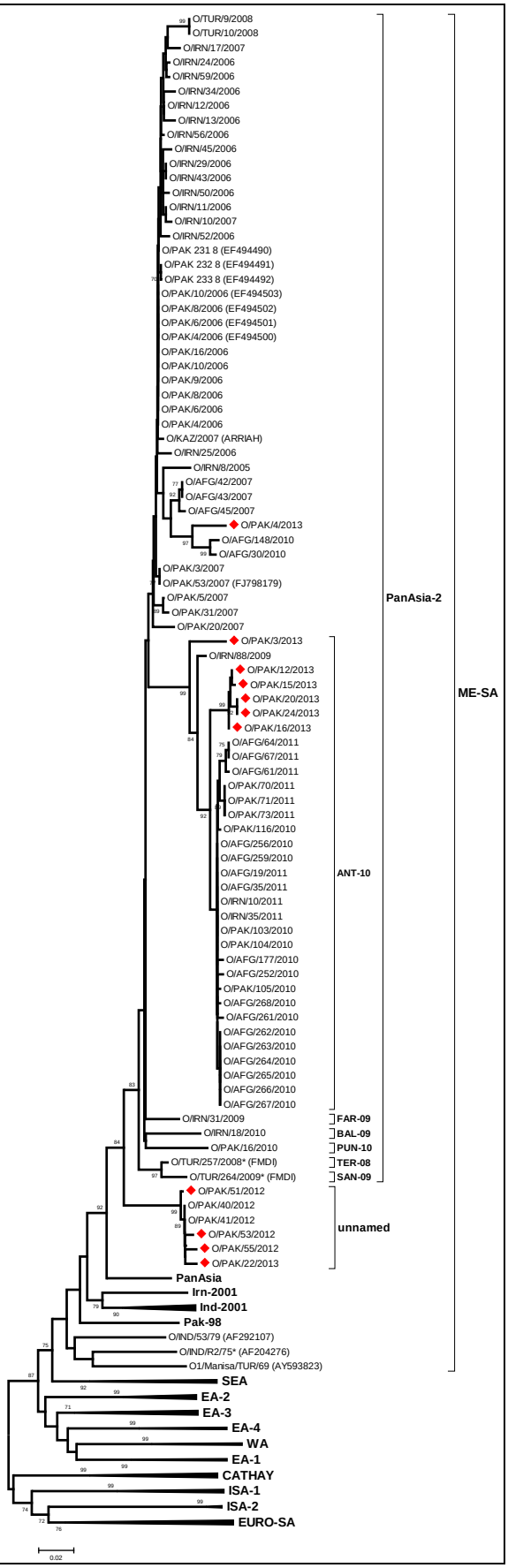
Locations not provided

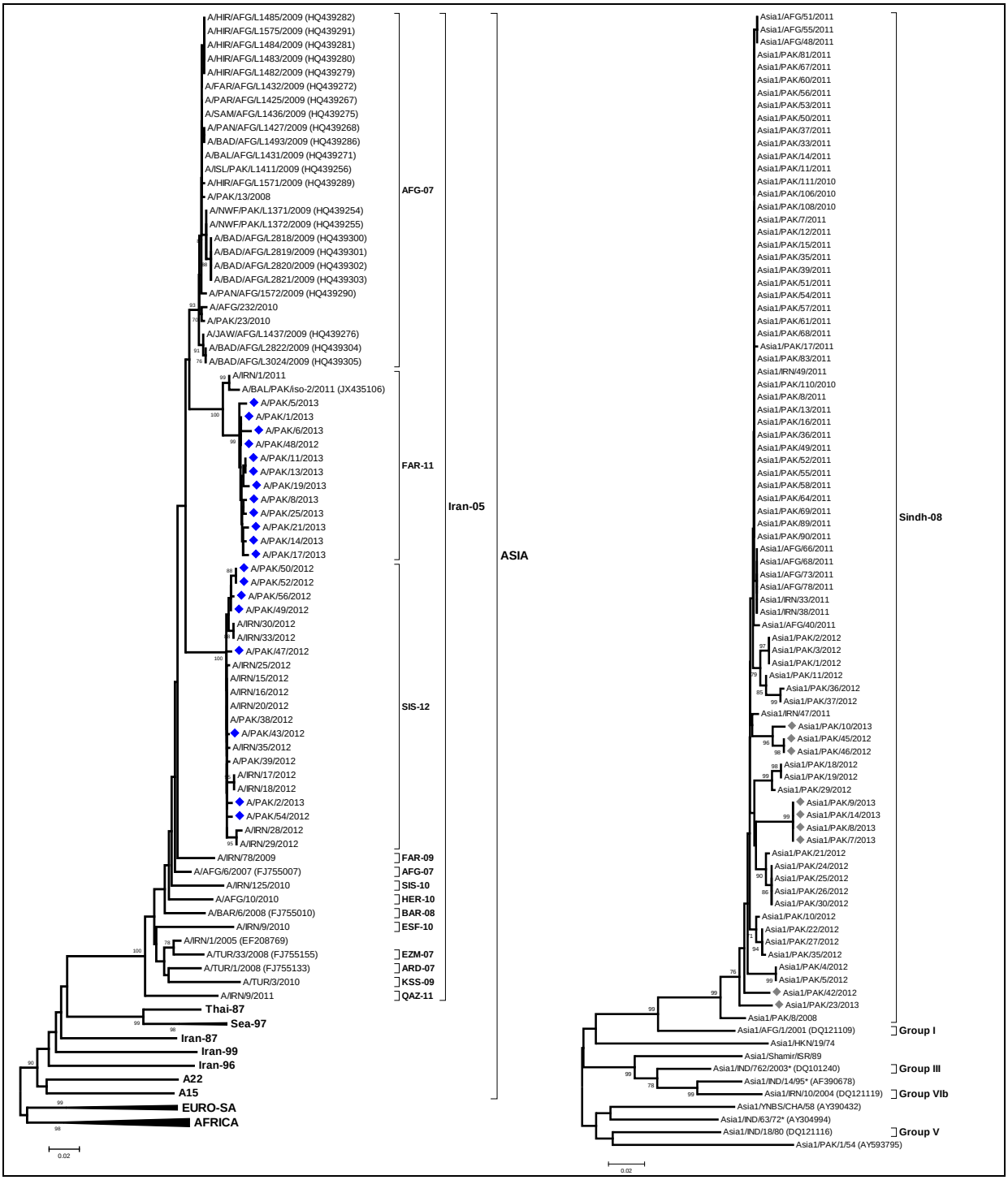


Pakistan

WRLFMD/2013/00024
Date received: 07/11/2013
No. of samples: 40
O (ME-SA/PanAsia-2^{ANT-10}): 6
O (ME-SA/PanAsia-2): 1
O (ME-SA/unnamed): 4
A (ASIA/Iran-05^{SIS-12}): 8
A (ASIA/Iran-05^{FAR-11}): 12
Asia 1 (ASIA/Sindh-08): 9
FMDV-GD: 1



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A/FAR/AFG/L1432/2009 (HQ439272)
A/PAR/AFG/L1425/2009 (HQ439267)
A/SAM/AFG/L1436/2009 (HQ439275)
A/PAN/AFG/L1427/2009 (HQ439268)
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Group III
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Asia1/IRN/10/2004 (DQ121119)
Group VIb
Asia1/YNBS/CHA/58 (AY390432)
Asia1/IND/63/72* (AY304994)
Asia1/IND/18/80 (DQ121116)
Group V
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0.02

Palestinian Autonomous Territories

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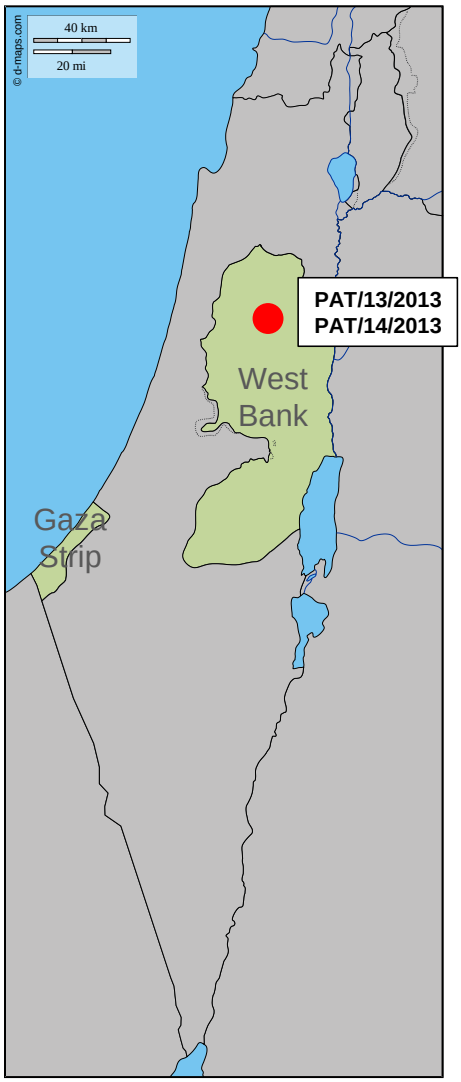
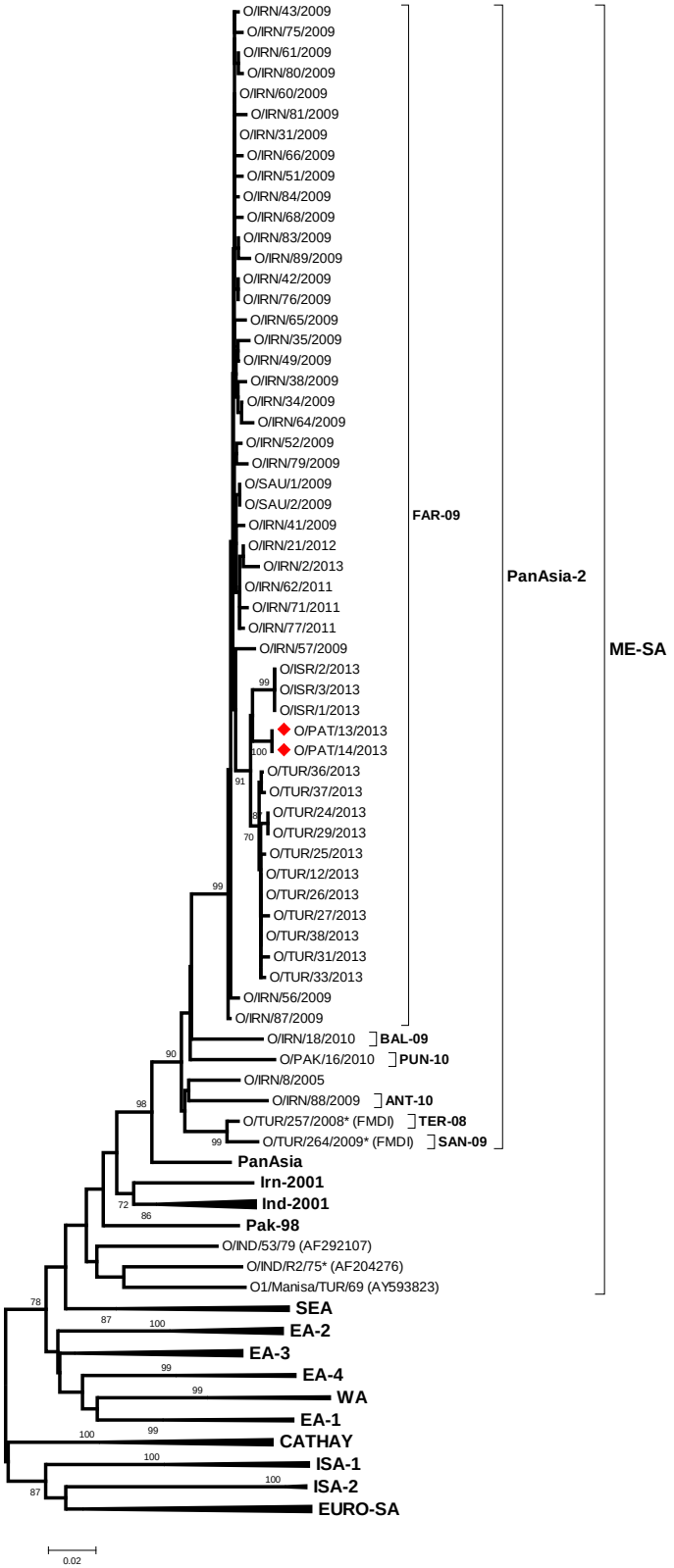
O (ME-SA/PanAsia-2^{FAR-09}): 2

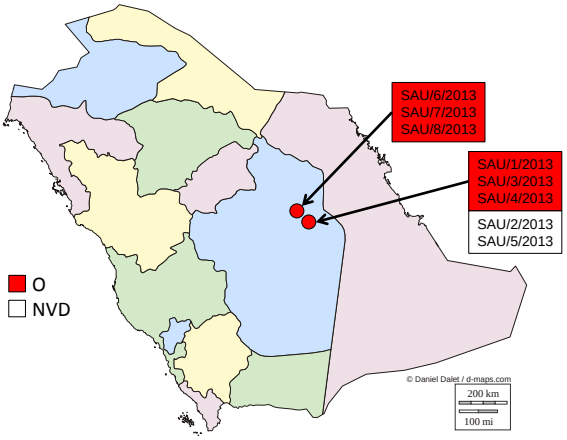


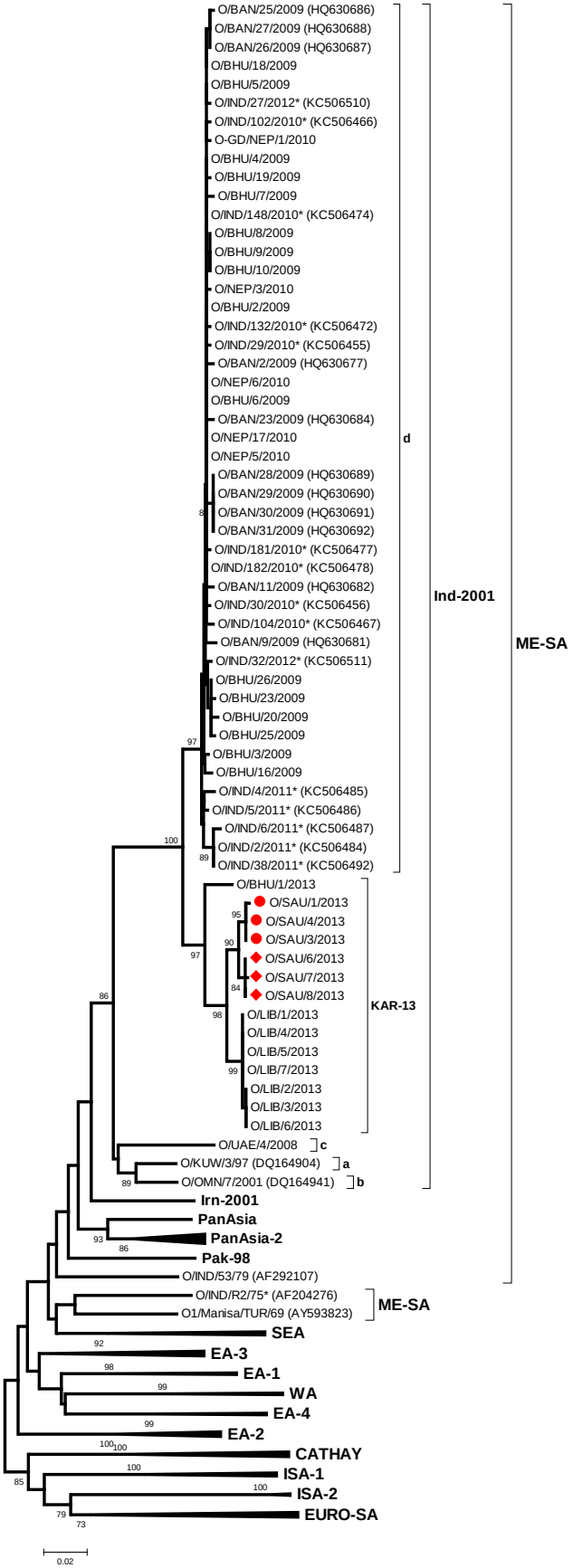


Saudi Arabia

WRLFMD/2013/00023
Date received: 07/11/2013
No. of samples: 3
O (ME-SA/Ind-2001^{KAR-13}): 3

WRLFMD/2013/00026
Date received: 29/11/2013
No. of samples: 3
O (ME-SA/Ind-2001^{KAR-13}): 3

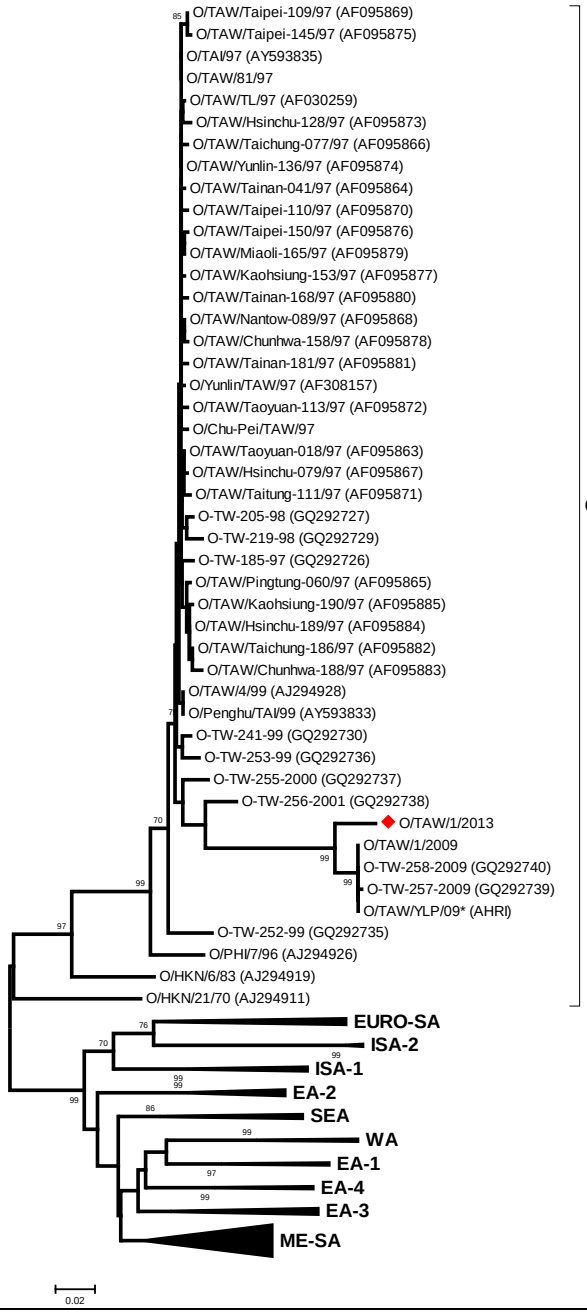




Taiwan POC

WRLFMD/2013/00022
Date received: 06/11/2013
No. of samples: 1
O (CATHAY): 1

Location not provided.



Vietnam

WRLFMD/2013/00025
Date received: 26/11/2013
No. of samples: 40
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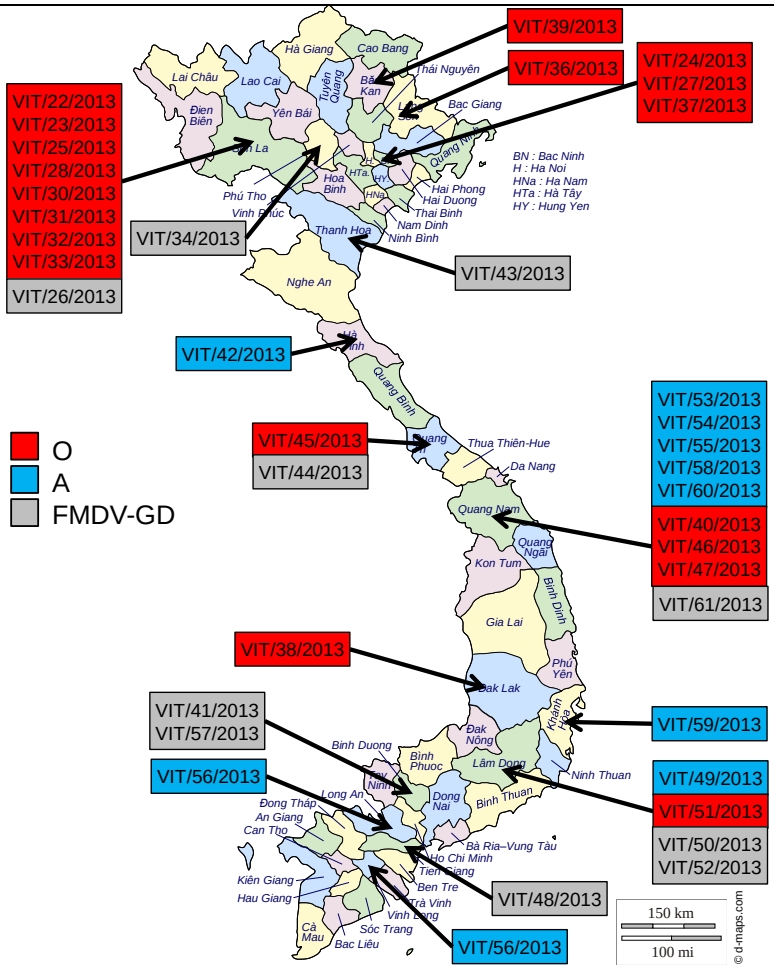
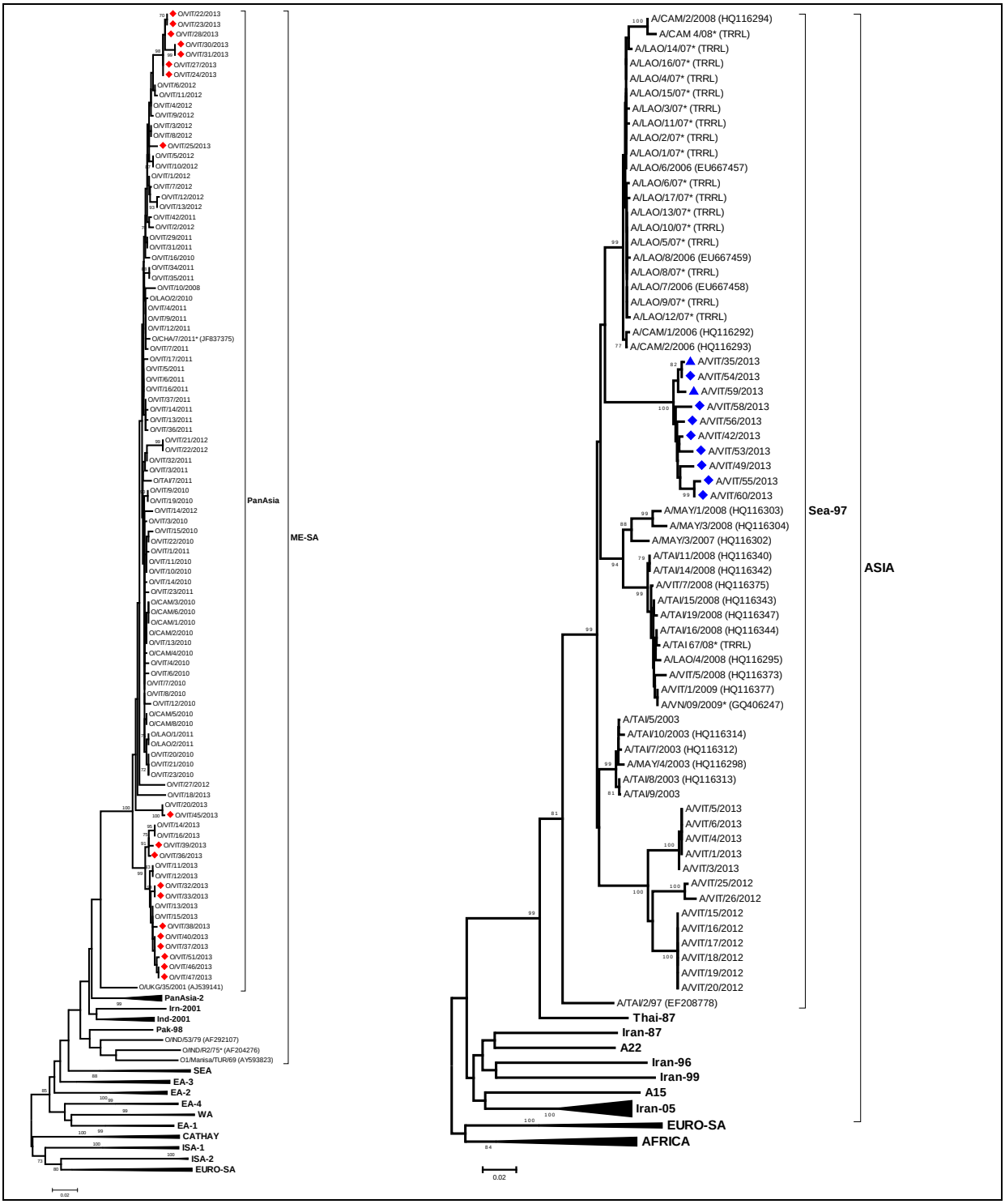
A (ASIA/Sea-97): 8+2
FMDV-GD: 11

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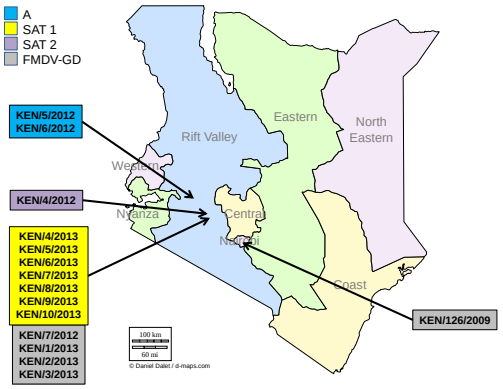
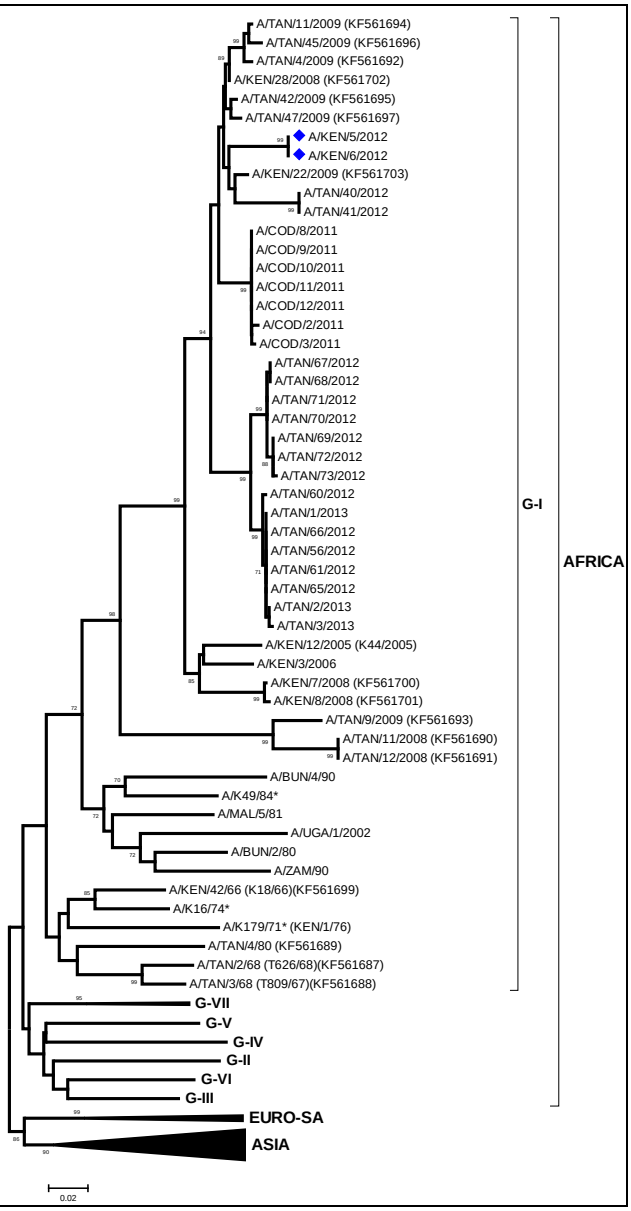
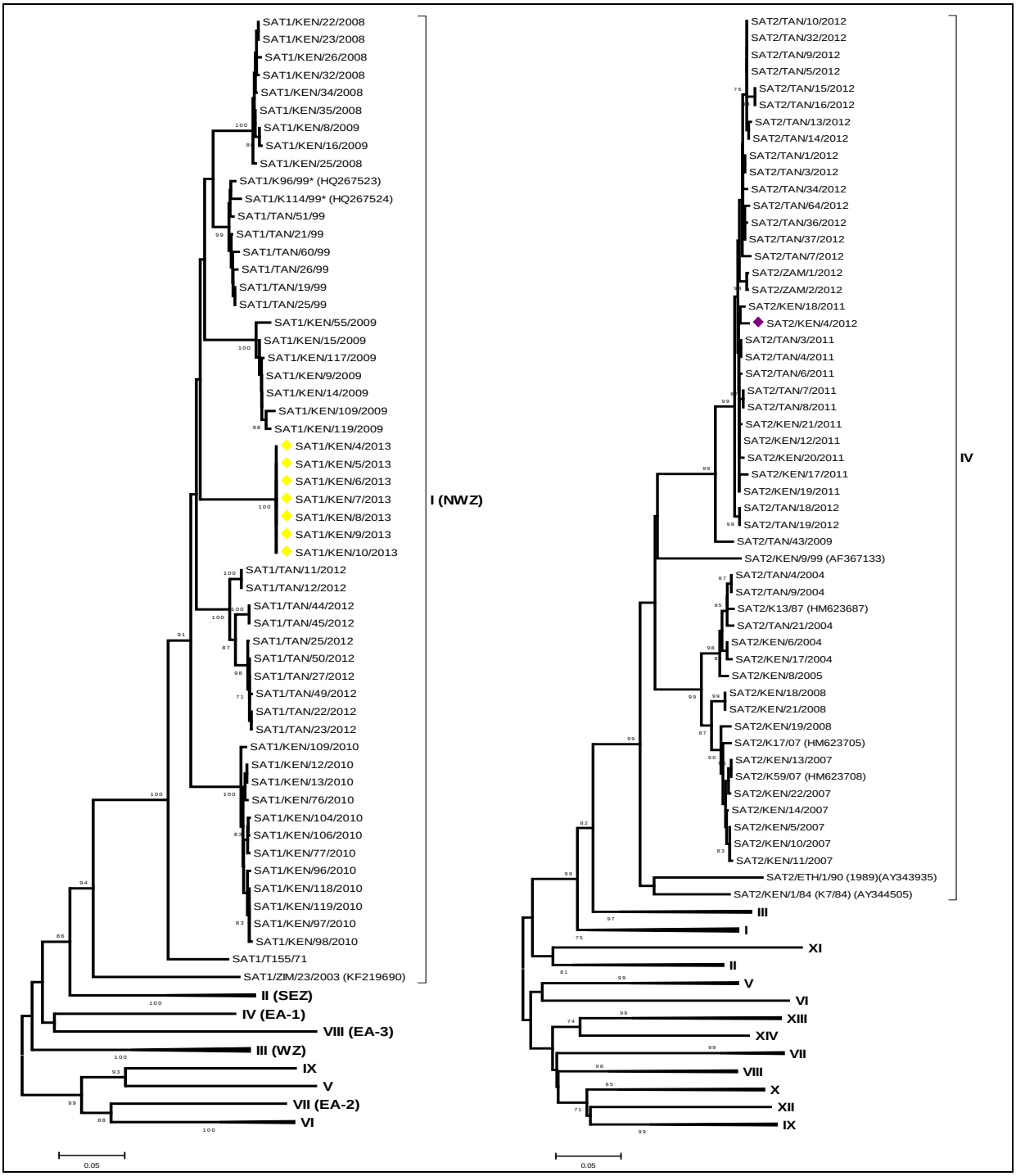
A/LAO/8/07* (TRRL)
A/LAO/7/2006 (EU667458)
A/LAO/9/07* (TRRL)
A/LAO/12/07* (TRRL)
A/CAM/1/2006 (HQ116292)
A/CAM/2/2006 (HQ116293)
A/VIT/35/2013
A/VIT/54/2013
A/VIT/59/2013
A/VIT/58/2013
A/VIT/56/2013
A/VIT/42/2013
A/VIT/53/2013
A/VIT/49/2013
A/VIT/55/2013
A/VIT/60/2013
A/MAY/1/2008 (HQ116303)
A/MAY/3/2008 (HQ116304)
A/MAY/3/2007 (HQ116302)
A/TAI/11/2008 (HQ116340)
A/TAI/14/2008 (HQ116342)
A/VIT/7/2008 (HQ116375)
A/TAI/15/2008 (HQ116343)
A/TAI/19/2008 (HQ116347)
A/TAI/16/2008 (HQ116344)
A/TAI 67/08* (TRRL)
A/LAO/4/2008 (HQ116295)
A/VIT/5/2008 (HQ116373)
A/VIT/1/2009 (HQ116377)
A/VN/09/2009* (GQ406247)
A/TAI/5/2003
A/TAI/10/2003 (HQ116314)
A/TAI/7/2003 (HQ116312)
A/MAY/4/2003 (HQ116298)
A/TAI/8/2003 (HQ116313)
A/TAI/9/2003
A/VIT/5/2013
A/VIT/6/2013
A/VIT/4/2013
A/VIT/1/2013
A/VIT/3/2013
A/VIT/25/2012
A/VIT/26/2012
A/VIT/15/2012
A/VIT/16/2012
A/VIT/17/2012
A/VIT/18/2012
A/VIT/19/2012
A/VIT/20/2012
A/TAI/2/97 (EF208778)
Thai-87
Iran-87
A22
Iran-96
Iran-99
A15
Iran-05
EURO-SA
AFRICA
Sea-97
ASIA
0.02

AFRICA

Kenya
WRLFMD/2013/00019
Date received: 25/09/2013
No. of samples: 15
A (AFRICA/G-I): 2
SAT 1 (I): 7
SAT 2 (IV): 1
FMDV-GD: 5






SAT1/KEN/22/2008
SAT1/KEN/23/2008
SAT1/KEN/26/2008
SAT1/KEN/32/2008
SAT1/KEN/34/2008
SAT1/KEN/35/2008
SAT1/KEN/8/2009
SAT1/KEN/16/2009
SAT1/KEN/25/2008
SAT1/K96/99* (HQ267523)
SAT1/K114/99* (HQ267524)
SAT1/TAN/51/99
SAT1/TAN/21/99
SAT1/TAN/60/99
SAT1/TAN/26/99
SAT1/TAN/19/99
SAT1/TAN/25/99
SAT1/KEN/55/2009
SAT1/KEN/15/2009
SAT1/KEN/117/2009
SAT1/KEN/9/2009
SAT1/KEN/14/2009
SAT1/KEN/109/2009
SAT1/KEN/119/2009
SAT1/KEN/4/2013
SAT1/KEN/5/2013
SAT1/KEN/6/2013
SAT1/KEN/7/2013
SAT1/KEN/8/2013
SAT1/KEN/9/2013
SAT1/KEN/10/2013
SAT1/TAN/11/2012
SAT1/TAN/12/2012
SAT1/TAN/44/2012
SAT1/TAN/45/2012
SAT1/TAN/25/2012
SAT1/TAN/50/2012
SAT1/TAN/27/2012
SAT1/TAN/49/2012
SAT1/TAN/22/2012
SAT1/TAN/23/2012
SAT1/KEN/109/2010
SAT1/KEN/12/2010
SAT1/KEN/13/2010
SAT1/KEN/76/2010
SAT1/KEN/104/2010
SAT1/KEN/106/2010
SAT1/KEN/77/2010
SAT1/KEN/96/2010
SAT1/KEN/118/2010
SAT1/KEN/119/2010
SAT1/KEN/97/2010
SAT1/KEN/98/2010
SAT1/T155/71
SAT1/ZIM/23/2003 (KF219690)
I (NWZ)
II (SEZ)
IV (EA-1)
VIII (EA-3)
III (WZ)
IX
V
VII (EA-2)
VI
0.05
SAT2/TAN/10/2012
SAT2/TAN/32/2012
SAT2/TAN/9/2012
SAT2/TAN/5/2012
SAT2/TAN/15/2012
SAT2/TAN/16/2012
SAT2/TAN/13/2012
SAT2/TAN/14/2012
SAT2/TAN/1/2012
SAT2/TAN/3/2012
SAT2/TAN/34/2012
SAT2/TAN/64/2012
SAT2/TAN/36/2012
SAT2/TAN/37/2012
SAT2/TAN/7/2012
SAT2/ZAM/1/2012
SAT2/ZAM/2/2012
SAT2/KEN/18/2011
SAT2/KEN/4/2012
SAT2/TAN/3/2011
SAT2/TAN/4/2011
SAT2/TAN/6/2011
SAT2/TAN/7/2011
SAT2/TAN/8/2011
SAT2/KEN/21/2011
SAT2/KEN/12/2011
SAT2/KEN/20/2011
SAT2/KEN/17/2011
SAT2/KEN/19/2011
SAT2/TAN/18/2012
SAT2/TAN/19/2012
SAT2/TAN/43/2009
SAT2/KEN/9/99 (AF367133)
SAT2/TAN/4/2004
SAT2/TAN/9/2004
SAT2/K13/87 (HM623687)
SAT2/TAN/21/2004
SAT2/KEN/6/2004
SAT2/KEN/17/2004
SAT2/KEN/8/2005
SAT2/KEN/18/2008
SAT2/KEN/21/2008
SAT2/KEN/19/2008
SAT2/K17/07 (HM623705)
SAT2/KEN/13/2007
SAT2/K59/07 (HM623708)
SAT2/KEN/22/2007
SAT2/KEN/14/2007
SAT2/KEN/5/2007
SAT2/KEN/10/2007
SAT2/KEN/11/2007
SAT2/ETH/1/90 (1989)(AY343935)
SAT2/KEN/1/84 (K7/84) (AY344505)
IV
III
I
XI
II
V
VI
XIII
XIV
VII
VIII
X
XII
IX
0.05

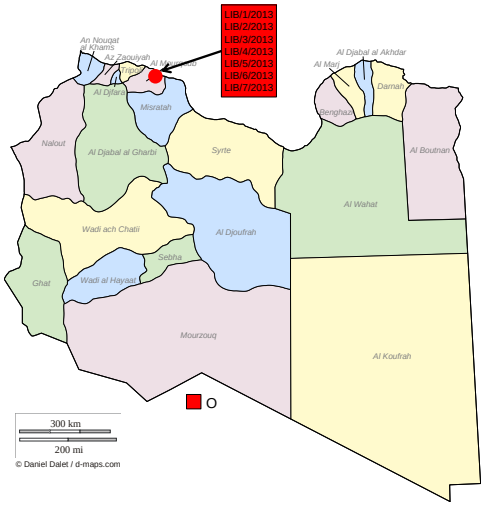
Libya

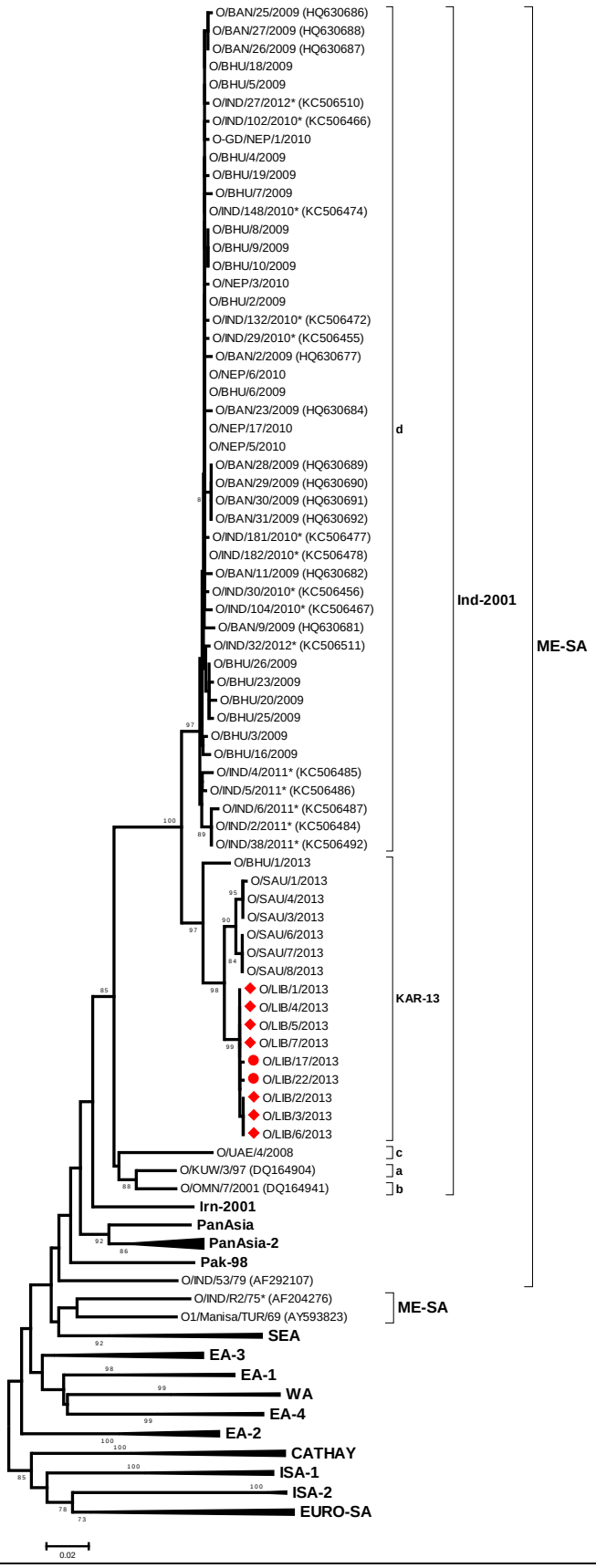
WRLFMD/2013/00021
Date received: 29/10/2013
No. of samples: 7
O (ME-SA/Ind-2001^{KAR-13}): 7 (red diamond)

WRLFMD/2013/00021
Date received: 29/10/2013
No. of samples: 15
O (ME-SA/Ind-2001^{KAR-13}): 2 (red circle)
FMDV-GD: 11
NVD: 2

Samples received via Dr. E. Brocchi, Istituto Zooprofilattico Sperimentale della Lombardia e dell'Emilia Romagna (IZSLER), Brescia, Italy.

Locations were not provided for the second batch of samples.





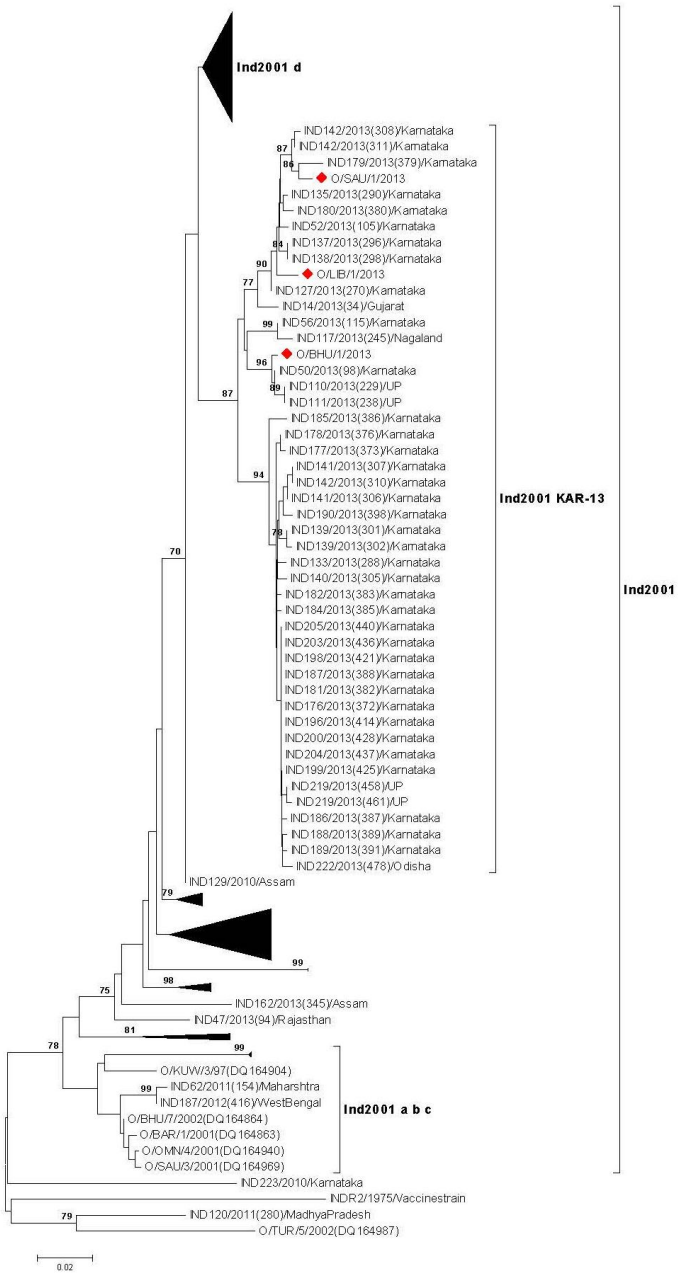


Fig. 1. Phylogenetic comparison of VP1 sequences from O-Ind-2001 from Bhutan, Libya and Saudi Arabia with recent viruses from India. Produced by the Project Directorate on Foot and Mouth Disease (ICAR), Mukteswar, India.

Vaccine matching (for individual data see: Annex 1 Table C)

Serotype O

Two FMDV type O isolates from Libya and 4 FMDV type O isolates from Saudi Arabia were found to be of the ME-SA Ind-2001^{KAR-13} lineage. These were analysed using the two dimensional neutralisation tests (2dm-VNT) and matched with O 3039, O TAW/98, O TUR/5/09. However, only one out of these 6 O/ME-SA/Ind-2001^{KAR-13} isolates matched with O_1 Manisa (r_1-value 0.33).

Three ME-SA isolates from Pakistan collected during 2012 and 2013 (2 of the PanAsia-2^{ANT-10} lineage, and one of an unnamed lineage) were tested by 2dm-VNT and matched with O 3039, O/TAW/98 and O TUR/5/09. They did not match with O_1 Manisa. Similar data were generated using a Palestinian FMD virus isolate which was tested against the same panel of vaccine antisera.

One Taiwanese FMD virus isolate was tested and found to be a match against O 3039, O TUR/5/09 and O PHI/98. It had a borderline r_1-value against O TAW/98 and was not matched against O_1 Manisa. Two viruses from Vietnam (PanAsia lineage) were also tested and found to be a match with O 3039. One of these isolates was not a match to O_1 Manisa while the other was.

Serotype A

During this quarter two viruses were received from Kenya (collected during 2012 and of lineage G-I). On a 2dm-VNT they did not match with A Iran05, A_{22}IRQ or A TUR/06. Work is currently underway to evaluate the in-vitro match of these isolates against vaccine strains provided by the Kenyan Veterinary Vaccines Production Institute (KEVEVAPI).

Two serotype A viruses were received from Mongolia (from A/ASIA/Sea-97 lineage). These viruses were found to be a match to A Iran05, A_{22}IRQ and A TUR/06. Two viruses of the same serotype from Vietnam were also tested and found not to match with A Iran05; however, they did match with A TUR/06. These two Vietnam isolates had borderline r_1-values to A_{22}IRQ and one was matched with A May/97 while the other had a borderline value.

Pakistan submitted two serotype A Iran-05^{SIS-12} viruses from 2012 that were tested by the 2dm VNT and found to be a match against A TUR/06, but not matched to A Iran-05 or A 22 IRQ. For viruses collected during 2013, one isolate (A/PAK/1/2013) from the A Iran-05^{FAR-11} sub-lineage was matched to A_{22}IRQ and A TUR/06 and not to A/Iran05 or A MAY/97. Similar results were generated for a virus of the same sub-lineage (with positive match for A_{22}IRQ and A TUR/06 and a poor match to A MAY/97), but was also matched against A/Iran05.

Serotype Asia1

Four viruses (Asia1 lineage Sind-08) from Pakistan, two isolated from 2012 and two from 2013 were tested by 2dm-VNT and were not matched to Asia1/IND/8/79. However, one had a borderline value against Asia1 Shamir and another was a match.

Serotype SAT1 and SAT2

Two viruses from Kenya were tested and were a match to SAT1/RHO/12/78. One serotype SAT2 virus from Kenya, isolated in 2012, was not a match to ERI 3218 and SAT2/ZIM/7/83.

Annex 1. TABLE A: Clinical sample diagnostics made by the WRLFMD® between October-December 2013

Country	WRL for FMD Sample Identification	Animal	Date of Collection	Results		
				VI/ELISA	RT-PCR	Final report
KENYA (Received in September 2013 - Results pending at the time of previous quarterly report	KEN 126/2009	CATTLE	00-00-09	NVD	POS	FMDV GD
	KEN 4/2012	CATTLE	00-00-12	SAT 2	POS	SAT 2
	KEN 5/2012	CATTLE	23-Dec-12	A	POS	A
	KEN 6/2012	CATTLE	24-Dec-12	A	POS	A
	KEN7/2012	CATTLE	29-Dec-12	NVD	POS	FMDV GD
	KEN 1/2013	CATTLE	00-00-13	NVD	POS	FMDV GD
	KEN 2/2013	CATTLE	15-Jan-13	NVD	POS	FMDV GD
	KEN 3/2013	CATTLE	15-Jan-13	NVD	POS	FMDV GD
	KEN 4/2013	CATTLE	20-Jan-13	SAT 1	POS	SAT 1
	KEN 5/2013	CATTLE	20-Jan-13	SAT 1	POS	SAT 1
	KEN 6/2013	CATTLE	22-Jan-13	SAT 1	POS	SAT 1
	KEN 7/2013	CATTLE	22-Jan-13	SAT 1	POS	SAT 1
	KEN 8/2013	CATTLE	22-Jan-13	SAT 1	POS	SAT 1
	KEN 9/2013	CATTLE	28-Jan-13	SAT 1	POS	SAT 1
	KEN 10/2013	CATTLE	30-Jan-13	SAT 1	POS	SAT 1
HONG KONG	HKN 2/2013	PIG	12-Sep-13	NEG	NEG	NVD
ISRAEL	ISR 1/2013	CATTLE	17-Nov-13	NEG	POS	FMDV GD
	ISR 2/2013	CATTLE	17-Nov-13	NEG	POS	FMDV GD
	ISR 3/2013	CATTLE	17-Nov-13	NEG	POS	FMDV GD
LIBYA	LIB 1/2013	CATTLE	01-Sep-13	O	POS	O
	LIB 2/2013	CATTLE	01-Sep-13	O	POS	O
	LIB 3/2013	CATTLE	01-Sep-13	O	POS	O
	LIB 4/2013	CATTLE	01-Sep-13	O	POS	O
	LIB 5/2013	CATTLE	01-Sep-13	O	POS	O
	LIB 6/2013	CATTLE	01-Sep-13	O	POS	O
	LIB 7/2013	CATTLE	08-Sep-13	O	POS	O
LIBYA	LIB 8/2013	CATTLE	10-Sep-13	NEG	POS	FMDV GD
	LIB 9/2013	CATTLE	10-Sep-13	NEG	POS	FMDV GD
	LIB 10/2013	CATTLE	11-Sep-13	NEG	NEG	NVD
	LIB 11/2013	CATTLE	12-Sep-13	NEG	POS	FMDV GD
	LIB 12/2013	CATTLE	12-Sep-13	NEG	POS	FMDV GD
	LIB 13/2013	CATTLE	14-Sep-13	NEG	POS	FMDV GD
	LIB 14/2013	CATTLE	24-Sep-13	NEG	NEG	NVD
	LIB 15/2013	CATTLE	24-Sep-13	NEG	POS	FMDV GD
	LIB 16/2013	CATTLE	30-Sep-13	NEG	POS	FMDV GD
	LIB 17/2013	CATTLE	01-Oct-13	O	POS	O
	LIB 18/2013	CATTLE	22-Oct-13	NEG	POS	FMDV GD
	LIB 19/2013	CATTLE	25-Oct-13	NEG	POS	FMDV GD
	LIB 20/2013	CATTLE	25-Oct-13	NEG	POS	FMDV GD
	LIB 21/2013	CATTLE	25-Oct-13	NEG	POS	FMDV GD
	LIB 22/2013	CATTLE	01-Dec-13	O	POS	O

MONGOLIA	MOG 11/2013	CATTLE	01-Sep-13	A	POS	A
	MOG 12/2013	CATTLE	01-Sep-13	A	POS	A
	MOG 13/2013	CATTLE	01-Sep-13	A	POS	A
PAKISTAN	PAK 42/2012	BUFFALO	15-Sep-12	ASIA-1	POS	ASIA-1
	PAK 43/2012	BUFFALO	28-Sep-12	A	POS	A
	PAK 44/2012	BUFFALO	28-Oct-12	NEG	POS	FMDV GD
	PAK 45/2012	BUFFALO	02-Nov-12	ASIA-1	POS	ASIA-1
	PAK 46/2012	CATTLE	07-Nov-12	ASIA-1	POS	ASIA-1
	PAK 47/2012	CATTLE	08-Nov-12	A	POS	A
	PAK 48/2012	CATTLE	10-Nov-12	A	POS	A
	PAK 49/2012	BUFFALO	12-Nov-12	A	POS	A
	PAK 50/2012	BUFFALO	22-Nov-12	A	POS	A
	PAK 51/2012	CATTLE	10-Dec-12	O	POS	O
	PAK 52/2012	BUFFALO	11-Dec-12	A	POS	A
	PAK 53/2012	BUFFALO	12-Dec-12	O	POS	O
	PAK 54/2012	CATTLE	13-Dec-12	A	POS	A
	PAK 55/2012	CATTLE	15-Dec-12	O	POS	O
	PAK 56/2012	BUFFALO	19-Dec-12	A	POS	A
	PAK 1/2013	BUFFALO	08-Jan-13	A	POS	A
	PAK 2/2013	CATTLE	10-Jan-13	A	POS	A
	PAK 3/2013	BUFFALO	28-Jan-13	O	POS	O
	PAK 4/2013	CATTLE	29-Jan-13	O	POS	O
	PAK 5/2013	CATTLE	07-Feb-13	A	POS	A
	PAK 6/2013	CATTLE	27-Feb-13	A	POS	A
	PAK 7/2013	BUFFALO	28-Feb-13	ASIA-1	POS	ASIA-1
	PAK 8/2013	CATTLE	06-Mar-13	A, ASIA-1	POS	A, ASIA-1
	PAK 9/2013	BUFFALO	14-Mar-13	ASIA-1	POS	ASIA-1
	PAK 10/2013	CATTLE	14-Mar-13	ASIA-1	POS	ASIA-1
	PAK 11/2013	CATTLE	19-Mar-13	A	POS	A
	PAK 12/2013	CATTLE	26-Mar-13	O	POS	O
	PAK 13/2013	BUFFALO	01-Apr-13	A	POS	A
	PAK 14/2013	CATTLE	01-Apr-13	A, ASIA-1	POS	A, ASIA-1
	PAK 15/2013	CATTLE	10-Apr-13	O	POS	O
	PAK 16/2013	CATTLE	17-Apr-13	O	POS	O
	PAK 17/2013	CATTLE	19-Apr-13	A	POS	A
	PAK 18/2013	CATTLE	25-Apr-13	A	POS	A
	PAK 19/2013	BUFFALO	27-Apr-13	A	POS	A
	PAK 20/2013	CATTLE	16-May-13	O	POS	O
	PAK 21/2013	CATTLE	22-May-13	A	POS	A
	PAK 22/2013	BUFFALO	25-May-13	O	POS	O
	PAK 23/2013	BUFFALO	04-Jun-13	ASIA-1	POS	ASIA-1
	PAK 24/2013	BUFFALO	10-Jun-13	O	POS	O
	PAK 25/2013	BUFFALO	01-Aug-13	A	POS	A
PALESTINIAN AUTONOMOUS TERRITORIES	PAT 13/2013	SHEEP	21-Nov-13	O	POS	O
	PAT 14/2013	SHEEP	24-Nov-13	O	POS	O
SAUDI ARABIA	SAU 1/2013	CATTLE	07-Aug-13	O	POS	O
	SAU 2/2013	CATTLE	07-Aug-13	NEG	NEG	NVD
	SAU 3/2013	CATTLE	07-Aug-13	O	POS	O
	SAU 4/2013	CATTLE	07-Aug-13	O	POS	O
	SAU 5/2013	CATTLE	10-Sep-13	NEG	NEG	NVD
	SAU 6/2013	CATTLE	22-Nov-13	O	POS	O

	SAU 7/2013	CATTLE	27-Nov-13	O	POS	O
	SAU 8/2013	CATTLE	27-Nov-13	O	POS	O
TAIWAN	TAW 1/2013	PIG	29-Oct-13	O	POS	O
VIETNAM	VIT 22/2013	PIG	04-Jan-13	O	POS	O
	VIT 23/2013	PIG	04-Feb-13	O	POS	O
	VIT 24/2013	PIG	23-Feb-13	O	POS	O
	VIT 25/2013	PIG	01-Mar-13	O	POS	O
	VIT 26/2013	BUFFALO	01-Mar-13	NEG	POS	FMDV GD
	VIT 27/2013	PIG	03-Mar-13	O	POS	O
	VIT 28/2013	PIG	08-Apr-13	O	POS	O
	VIT 29/2013	PIG	06-May-13	NEG	POS	FMDV GD
	VIT 30/2013	PIG	23-May-13	O	POS	O
	VIT 31/2013	PIG	25-May-13	O	POS	O
	VIT 32/2013	CATTLE	30-May-13	O	POS	O
	VIT 33/2013	CATTLE	30-Jun-13	O	POS	O
	VIT 34/2013	BUFFALO	27-Jul-13	NEG	POS	FMDV GD
	VIT 35/2013	CATTLE	30-Jul-13	NEG	POS	FMDV GD
	VIT 36/2013	CATTLE	01-Aug-13	O	POS	O
	VIT 37/2013	CATTLE	13-Aug-13	O	POS	O
	VIT 38/2013	CATTLE	17-Aug-13	O	POS	O
	VIT 39/2013	CATTLE	24-Aug-13	O	POS	O
	VIT 40/2013	CATTLE	17-Sep-13	O	POS	O
	VIT 41/2013	CATTLE	07-Oct-13	NEG	POS	FMDV GD
	VIT 42/2013	CATTLE	16-Oct-13	A	POS	A
	VIT 43/2013	CATTLE	23-Oct-13	NEG	POS	FMDV GD
	VIT 44/2013	PIG	23-Oct-13	NEG	POS	FMDV GD
	VIT 45/2013	BUFFALO	23-Oct-13	O	POS	O
	VIT 46/2013	CATTLE	25-Oct-13	O	POS	O
	VIT 47/2013	CATTLE	25-Oct-13	O	POS	O
	VIT 48/2013	CATTLE	25-Oct-13	NEG	POS	FMDV GD
	VIT 49/2013	CATTLE	28-Oct-13	A	POS	A
	VIT 50/2013	CATTLE	28-Oct-13	NEG	POS	FMDV GD
	VIT 51/2013	CATTLE	30-Oct-13	O	POS	O
	VIT 52/2013	CATTLE	30-Oct-13	NEG	POS	FMDV GD
	VIT 53/2013	CATTLE	02-Nov-13	A	POS	A
	VIT 54/2013	BUFFALO	07-Nov-13	A	POS	A
	VIT 55/2013	CATTLE	09-Nov-13	A	POS	A
	VIT 56/2013	CATTLE	11-Nov-13	A	POS	A
	VIT 57/2013	CATTLE	12-Nov-13	NEG	POS	FMDV GD
	VIT 58/2013	CATTLE	14-Nov-13	A	POS	A
	VIT 59/2013	CATTLE	14-Nov-13	NEG	POS	FMDV GD
	VIT 60/2013	CATTLE	16-Nov-13	A	POS	A
	VIT 61/2013	CATTLE	16-Nov-13	NEG	POS	FMDV GD
	TOTAL:	**120**				

FMD(V)	Foot-and-mouth disease (virus)
FMDV GD	Genome detected
VI/ELISA	FMDV serotype identified following virus isolation in cell culture and antigen ELISA
RT-PCR	Reverse transcription polymerase chain reaction on epithelial suspension for FMD (or SVD) viral genome
NVD	No foot-and-mouth disease, swine vesicular disease or vesicular stomatitis virus detected
NT	Not tested

TABLE B: Summary of samples collected and received to The Pirbright Institute (October-December 2013)

Country	No. of samples	Virus isolation in cell culture/ELISA								RT-PCR for FMD (or SVD) virus (where appropriate)	
		FMD virus serotypes							NVD		
		O	A	C	SAT 1	SAT 2	SAT 3	Asia 1		Positive	Negative
HONG KONG	1	-	-	-	-	-	-	-	1	-	1
ISRAEL	3	-	-	-	-	-	-	-	3	3	-
LIBYA	22	9	-	-	-	-	-	-	13	20	2
MONGOLIA	3	-	3	-	-	-	-	-	-	3	-
PAKISTAN[a]	40	11	21	-	-	-	-	9	1	40	-
PALESTINIAN AUTONOMOUS TERRITORIES	2	2	-	-	-	-	-	-	-	2	-
SAUDI ARABIA	8	6	-	-	-	-	-	-	2	6	2
TAIWAN	1	1	-	-	-	-	-	-	-	1	-
VIETNAM	40	19	8	-	-	-	-	-	13	40	-
TOTAL	**120**	**48**	**32**	**-**	**-**	**-**	**-**	**9**	**33**	**115**	**5**

VI/ELISA FMD (or SVD) virus serotype identified following virus isolation in cell culture and antigen detection ELISA
FMD foot-and-mouth disease
SVD swine vesicular disease
NVD no FMD, SVD or vesicular stomatitis virus detected
NT not tested
RT-PCR reverse transcription polymerase chain reaction for FMD (or SVD) viral genome
[a] 2 samples from Pakistan contained a mixture of FMDVs of types A and Asia 1

TABLE C: Antigenic characterisation of FMD field isolates by matching with vaccine strains by 2dmVNT from 1st October to 31th December 2013.

Type O:

Vaccine Matching studies for Serotype O FMDV by VNT

Sample Reference	O 3039	O1 Manisa	O TAW/98	O TUR/5/09
O/LIB/1/2013	M	N	M	M
O/LIB/7/2013	M	N	M	M
O/PAK/55/2012	M	N	M	M
O/PAK/3/2013	M	N	M	M
O/PAK/24/2013	M	N	M	M
O/PAT/14/2013	M	N	M	M
O/SAU/1/2013	M	N	M	M
O/SAU/4/2013	M	N	M	M
O/SAU/6/2013	M	N	M	M
O/SAU/7/2013	M	M	M	M
O/TAW/1/2013	M	N	borderline	M
O/VIT/22/2013	M	N	M/N*	NT
O/VIT/51/2013	M	M	M	NT

M/N* - two sera were tested. One resulted in a vaccine match while the other did not.

O/TAW/01/2013 was also tested against O Campos (borderline r_1-value) and O PHI/98 (vaccine match).

Type A:

Vaccine Matching studies for Serotype A FMDV by VNT

Sample Reference	A Iran05	A 22IRQ	A MAY/97	A TUR/06
A/KEN/5/2012	N	N	NT	N
A/KEN/6/2012	N	N	NT	N
A/MOG/11/2013	M	M	NT	M
A/MOG/13/2013	M	M	NT	M
A/PAK/43/2012	N	N	borderline	M
A/PAK/56/2012	N	N	N	M
A/PAK/1/2013	N	M	N	M
A/PAK/25/2013	M	M	N	M
A/VIT/42/2013	N	borderline	M	M
A/VIT/60/2013	N	borderline	borderline	M

A/KEN/05/2012 was also tested against A ERI 98 and found not to be a vaccine match. A/KEN/06/2012 was tested against A/ERI/98 and found to be a vaccine match.

Vaccine Matching studies for Serotype Asia1 FMDV by VNT

Sample Reference	Asia1/IND/8/79	Asia1 Shamir
Asia1/PAK/42/2012	N	N
Asia1/PAK/56/2012	N	N
Asia1/PAK/7/2013	N	borderline
Asia1/PAK/23/2013	N	M

Type SAT1:

Vaccine Matching studies for Serotype SAT1 FMDV by VNT	
Sample Reference	SAT1 RHO/12/78
SAT1/KEN/4/2013	M
SAT1/KEN/10/2013	M

Type SAT2:

Vaccine Matching studies for Serotype SAT2 FMDV by VNT		
Sample Reference	ERI 3218	SAT2/ZIM/7/83
SAT 2/KEN/04/2012	N	N

Results Descriptor:

M : = Vaccine Match- $r_1 = \geq 0.3$. Suggests that there is a close relationship between field isolate and vaccine strain. A potent vaccine containing the vaccine strain is likely to confer protection.

N : = No Vaccine Match - $r_1 = < 0.3$. Suggests that the field isolate is so different from the vaccine strain that the vaccine is unlikely to protect

Borderline = Any r_1 values between 0.28 to 0.32

☐ = Not tested against this vaccine

Annex 2. Recent FMD Publications (October – December) cited by PubMed (Pirbright Institute papers are highlighted in **BOLD**)

- **Hall MD, Knowles NJ, Wadsworth J, Rambaut A, Woolhouse ME. Reconstructing geographical movements and host species transitions of foot-and-mouth disease virus serotype SAT 2. MBio. 2013 Oct 22;4(5):e00591-13.**
- **Ludi A, Horton D, Li Y, Mahapatra M, King D, Knowles N, Russell C, Paton D, Wood J, Smith D, Hammond J. Antigenic variation of foot-and-mouth disease virus serotype A. J Gen Virol. 2013 Nov 1. doi: 10.1099/vir.0.057521-0. [Epub ahead of print]**
- **Wright CF, Knowles NJ, Di Nardo A, Paton DJ, Haydon DT, King DP. Reconstructing the origin and transmission dynamics of the 1967-68 foot-and-mouth disease epidemic in the United Kingdom. Infect Genet Evol. 2013 Dec;20:230-8.**
- **Midgley R, Moffat K, Berryman S, Hawes P, Simpson J, Fullen D, Stephens DJ, Burman A, Jackson T. A role for endoplasmic reticulum exit sites in foot-and-mouth disease virus infection. J Gen Virol. 2013 Dec;94(Pt 12):2636-46.**
- **Knight-Jones TJ, Rushton J. The economic impacts of foot and mouth disease - what are they, how big are they and where do they occur? Prev Vet Med. 2013 Nov 1;112(3-4):161-73.**
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Annex 3. RECOMMENDATIONS FROM WRLFMD® ON FMD VIRUS STRAINS TO BE INCLUDED IN FMDV ANTIGEN BANKS – December 2013

High Priority

O Manisa
O PanAsia-2
O BFS or Campos
A24 Cruzeiro
Asia 1 Shamir
A Iran-05 (or A TUR 06)
A22 Iraq
SAT 2 Saudi Arabia *(or equivalent i.e. SAT 2 Eritrea)*

(not in order of importance)

Medium Priority

A Eritrea
SAT 2 Zimbabwe
SAT 1 South Africa
A Malaysia 97 *(or Thai equivalent such as A/NPT/TAI/86)*
A Argentina 2001
O Taiwan 97 *(pig-adapted strain or Philippine equivalent)*

(not in order of importance)

Low Priority

A Iran '96
A Iran '99
A Iran 87 or A Saudi Arabia 23/86 *(or equivalent)*
A15 Bangkok related strain
A87 Argentina related strain
C Noville
SAT 2 Kenya
SAT 1 Kenya
SAT 3 Zimbabwe