

# WRLFMD Quarterly Report April to June 2019

Foot-and-Mouth Disease





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# 1. Summary of samples tested and reported FMD outbreaks

## 1.1. Global Overview of samples received and tested

The location of all samples detailed in this report can be seen on the map below. More detailed maps and sample data, on a country by country basis, can be found in the following sections of this report.

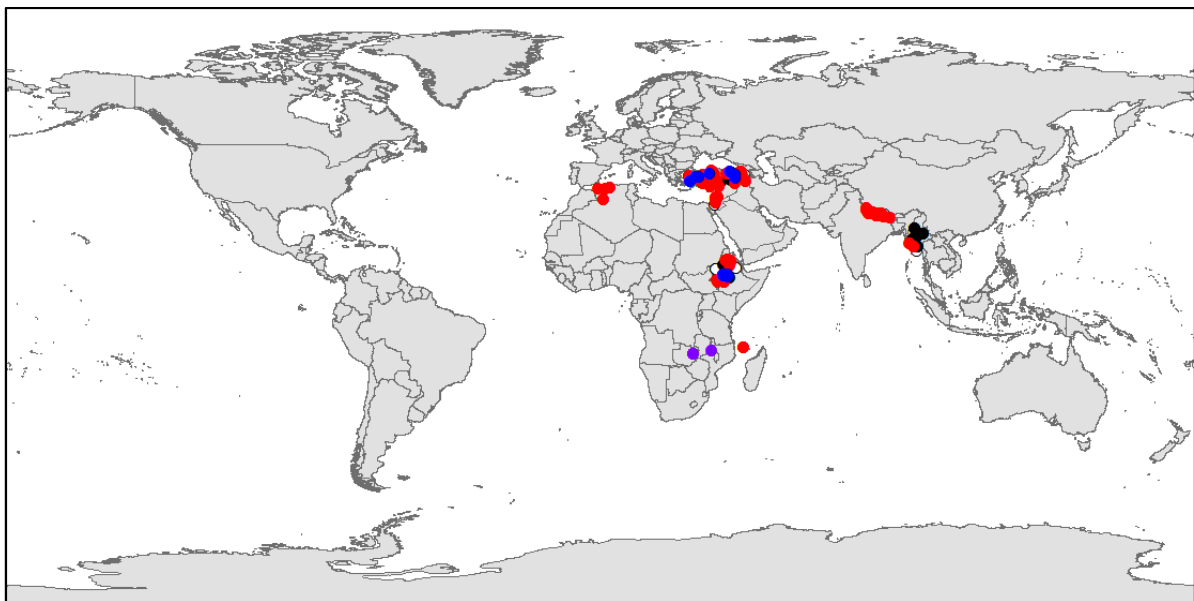


Figure 1: Samples tested by WRLFMD in this quarter (coloured spots define serotypes detected (O, A, C, Asia 1, SAT 1, SAT 2, SAT 3, untyped, negative))

## 1.2. Asia

### China, People's Republic of

Two further outbreaks of **FMD type O** were reported in cattle in the Xinjiang Autonomous Region on 26<sup>th</sup> March 2019 and 19<sup>th</sup> May 2019. No genotyping has been reported.

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## Israel

One outbreak of **FMD type O** was reported in cattle in Haifa. The VP1 sequence of an isolate from nearby Tamra was submitted to the WRLFMD by the Kimron Veterinary Institute (KVI) and genotyped as O/ME-SA/PanAsia-2<sup>QOM-15</sup> (see below). A batch of 27 samples, collected between January and May 2019 (collected in Hatzafon and Haifa), was received on 12<sup>th</sup> June 2019. Twenty-three of the samples were identified as **FMD type O**, two as FMDV-GD and two as NVD. Genotyping showed all to belong to O/ME-SA/PanAsia-2<sup>QOM-15</sup> (see below).

## Palestine, State of

A single **FMD type O** VP1 sequence, from a sample collected from a goat in Bani Naim, Hebron District, West Bank (26/03/2019), was received from the KVI on 11<sup>th</sup> April 2019. Genotyping showed it to belong to O/ME-SA/PanAsia-2<sup>QOM-15</sup> lineage (see below). Four samples were received from the KVI on 12/06/2019. Two, from cattle in Jenin, West Bank (26<sup>th</sup> February 2019), were NVD and two from goats in Hebron (4<sup>th</sup> April 2019) were typed as **FMDV O**; genotyping showed them also to belong to O/ME-SA/PanAsia-2<sup>QOM-15</sup> lineage (see below).

## Myanmar

On the 23<sup>rd</sup> May 2019, a batch of 15 samples was received by the WRLFMD. They had been collected from cattle between 2013 and December 2018 in various locations. Despite five samples having good Ct values in real-time RT-PCR tests, only one grew in cell culture (MYA/1/2013) and was typed as **FMDV O**. Conventional RT-PCR was used to try and amplify the VP1 region, but this only succeeded for MYA/2/2018; which was also **FMDV O**. Genotyping revealed that O/MYA/1/2013 belonged to the SEA toponotype, Mya-98 lineage and O/MYA/2/2018 belonged to the ME-SA toponotype, Ind-2001 lineage, 'e' sublineage (see below).

## Nepal

On 9<sup>th</sup> April 2019, a batch of 50 samples was received by the WRLFMD. They had been collected from cattle (n=45), water buffalo (n=2), goats (n=2) and pigs (n=1) between April 2018 and March 2019. Forty-four were identified as **FMD type O**, five as FMDV-GD and one as NVD. Genotyping reveals all the type O's to belong to ME-SA/Ind-2001e (see below).

## Turkey

On 23<sup>rd</sup> April 2019, a batch of 40 samples was received by the WRLFMD. They had been collected from cattle between October 2016 and April 2019 from various parts of

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the country. Twenty were identified as FMD type O, eight a FMD type A, six as FMDV-GD and 6 as NVD. Genotyping revealed all the type O's as ME-SA/PanAsia-2<sup>QOM-15</sup> and the A's as ASIA/G-VII (see below).

### 1.3. Africa

#### Algeria

Between 2<sup>nd</sup> January 2019 and 31<sup>st</sup> March 2019, a further 171 outbreaks due to **FMD type O** were reported in cattle, sheep and goats across northern Algeria. On 23<sup>rd</sup> April 2019, six **FMD type O** VP1 sequences were submitted to the WRLFMD by IZSLER (Brescia, Italy); genotyping confirmed them to belong to the EA-3 toptotype.

#### Comoros

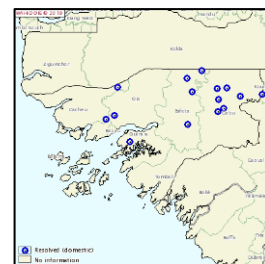
An outbreak of **FMD type O** was reported to have occurred in cattle at Fomboni on the island of Mwali (aka Moheli). On 19<sup>th</sup> April 2019, four VP1 sequences were received from ANSES (European Union Reference Laboratory, FAO Reference Centre & OIE Reference Laboratory for FMD); genotyping showed them to belong to the EA-2 toptotype, being most closely related to viruses collected in Tanzania in 2017 (kindly provided by Sokoine University of Agriculture, Tanzania; see below).

#### Ethiopia

A batch of 36 samples collected from cattle between March 2018 and March 2019 were received on the 5<sup>th</sup> April 2019. Typing/virus isolation results were as follows: 13 **FMD type O**, 12 **FMD type A**, 4 FMDV-GD and 7 NVD. Genotyping showed 12 the type O's to be toptotype EA-3 and one was EA-4 while all the type A's were AFRICA/G-IV (see below).

#### Guinea-Bissau

Between 7<sup>th</sup> July 2018 and 23<sup>rd</sup> December 2018, 46 outbreaks due to **FMD type O** occurred in cattle across the country. No genotyping has been reported.



**Figure 2: FMD type O in Guinea-Bissau**

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## Libya

Between 25<sup>th</sup> April 2019 and 20<sup>th</sup> May 2019, nine outbreaks due to **FMD type O** occurred in sheep and cattle mainly in the north-west of the country. Data provided by IZSLER (OIE/FAO FMD and SVD Reference Laboratory) indicates that samples collected in Misrata and Tajoura were positive for the O/EA-3 lineage using an EA-3-specific real-time RT-PCR indicating the probable involvement of this toptotype in these cases.

## Malawi

On 21<sup>st</sup> February 2019, an outbreak of **FMD type SAT 2** was reported in cattle at Zioni, Mzimba (Northern Region). A VP1 sequence was submitted to the WRLFMD by the SSARRL (BVI). Genotyping showed this to belong to toptotype I and to be most closely related to viruses previously collected from Zambia (see below).

## Morocco

Between 21<sup>st</sup> April 2019 and 21<sup>st</sup> May 2019, 11 outbreaks due to **FMD type O** occurred. No new genotyping has been reported, but previously O/EA-3 was identified by ANSES (see last Quarterly Report).

## Mozambique

Between 9<sup>th</sup> February 2019 and 24<sup>th</sup> May 2019, eight outbreaks of **suspected FMD** were reported to have occurred in cattle in the Tete area between Zimbabwe and Malawi in the north-western part of the country.

## Zambia

Twelve samples were received by the WRLFMD on 10<sup>th</sup> April 2019; they were collected from cattle between January and April 2019, but no locations were given. Six samples were typed as **FMDV O**, four as **FMDV SAT 2** and two were NVD. Genotyping showed the O's to belong to the EA-2 toptotype and the SAT 2's to toptotype I (see below). A single **FMD type A** VP1 sequence (from a sample collected in 2018) was received from the SSARRL (BVI); genotyping showed it to belong to A/AFRICA/G-I and to be closely related to sequences of samples received by the WRLFMD in 2018 (see below).

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## Zimbabwe

Three sets of outbreaks have occurred in cattle: i) **FMD type SAT 2** (x 8) at Beatrice, Seke, Mashonaland East, in March 2019; ii) **FMD type SAT 2** (x 14) in Mashonaland Central in March/April 2019; and iii) FMD type SAT 1 in Midlands in March/April. No genotyping results have been reported.

### 1.4. South America

No new outbreaks of FMD were reported in the continent.

### 1.5. 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.

An up-to-date list and reports of FMD viruses characterised by sequencing can be found at the following website: <http://www.wrlfmd.org/country-reports/country-reports-2019>.

Results from samples or sequences 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 from April to June 2019 is shown in Annex 1 (Summary of Submissions). A record of all samples received by WRLFMD is shown in Annex 1 (Clinical Samples).

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**Table 1:** Status of sequencing of samples or sequences received by the WRLFMD from April to June 2019 (\* indicates a batch carried over from the previous quarter).

WRLFMD Batch No.	Date received	Country	Serotype	No. of samples	No. of sequences	Sequencing status
WRLFMD/2019/00020	05/04/2019	Ethiopia	O	13	13	completed
			A	12	12	completed
WRLFMD/2019/00021	19/04/2019	Nepal	O	44	44	completed
WRLFMD/2019/00022	10/04/2019	Zambia	O	6	6	completed
			SAT 2	4	4	completed
WRLFMD/2019/00023	23/04/2019	Turkey	O	20	20	completed
			A	8	8	completed
WRLFMD/2019/00024	23/05/2019	Myanmar	O	2	2	completed
WRLFMD/2019/00026	12/06/2019	Palestine, State of	O	2	2	completed
WRLFMD/2019/00027	12/06/2019	Israel	O	23	23	completed
<b>Total</b>				<b>134</b>	<b>134</b>	

**Table 2:** VP1 sequences submitted by other FMD Network laboratories to the WRLFMD from April to June 2019.

WRLFMD Batch No.	Date received	Country	Serotype	No. of sequences	Submitting laboratory
WRLMEG/2019/00027	11/04/2019	Israel	O	1	KVI
WRLMEG/2019/00028	11/04/2019	Palestine, State of	O	1	KVI
WRLMEG/2019/00030	19/04/2019	Comoros and Tanzania	O	4	ANSES SUA
WRLMEG/2019/00031	23/04/2019	Algeria	O	6	IZSLER
WRLMEG/2019/00034	14/06/2019	Malawi	SAT 2	1	BVI
WRLMEG/2019/00035	17/06/2019	Zambia	A	1	BVI
<b>Total</b>				<b>14</b>	

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## 2. Detailed Analysis

Key for maps and trees:

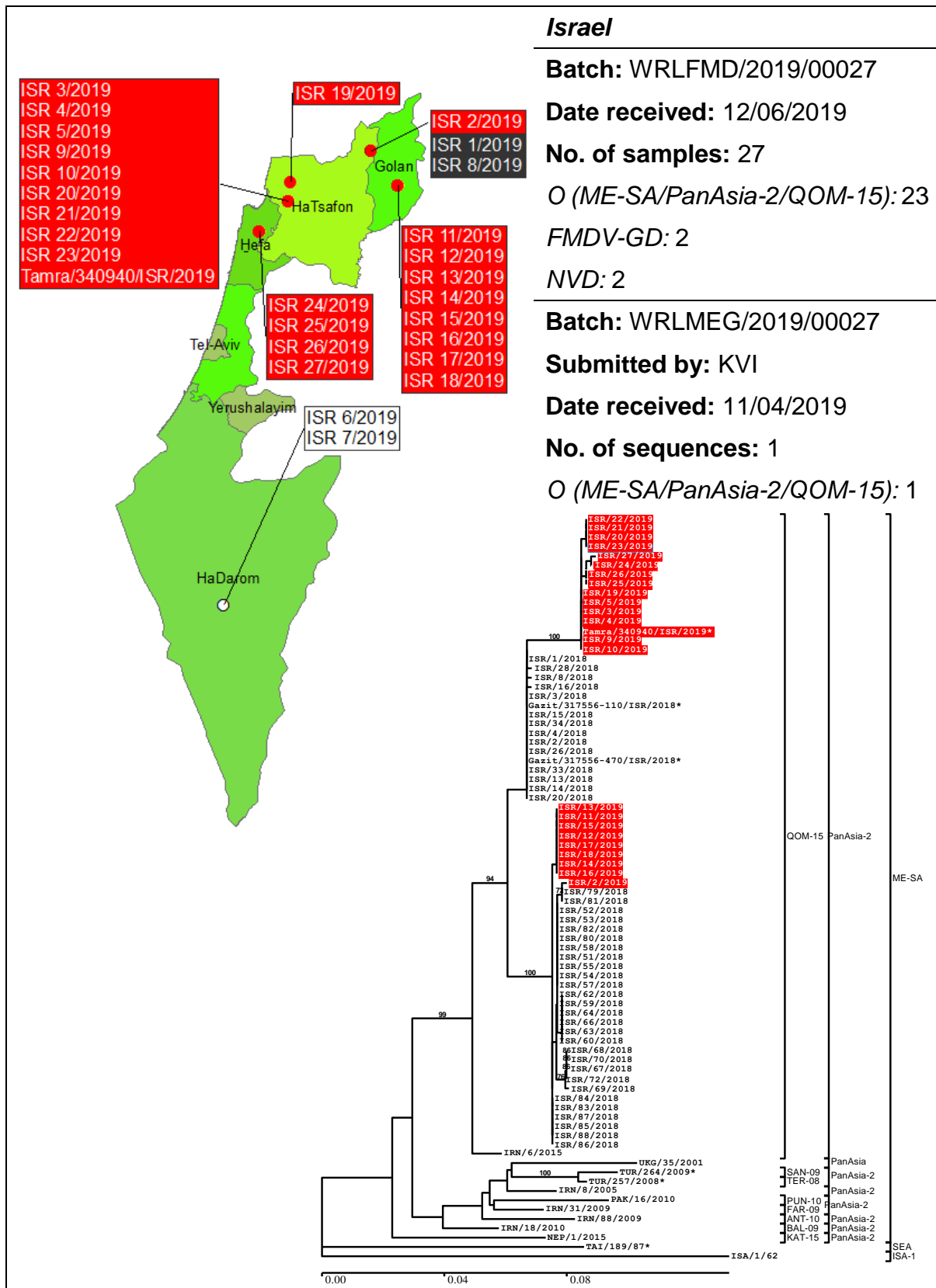
<b>Serotype O</b>	<b>Serotype Asia-1</b>	<b>Serotype SAT 3</b>
<b>Serotype A</b>	<b>Serotype SAT 1</b>	<b>FMDV Genome Detected</b>
<b>Serotype C</b>	<b>Serotype SAT 2</b>	<b>No Virus Detected</b>

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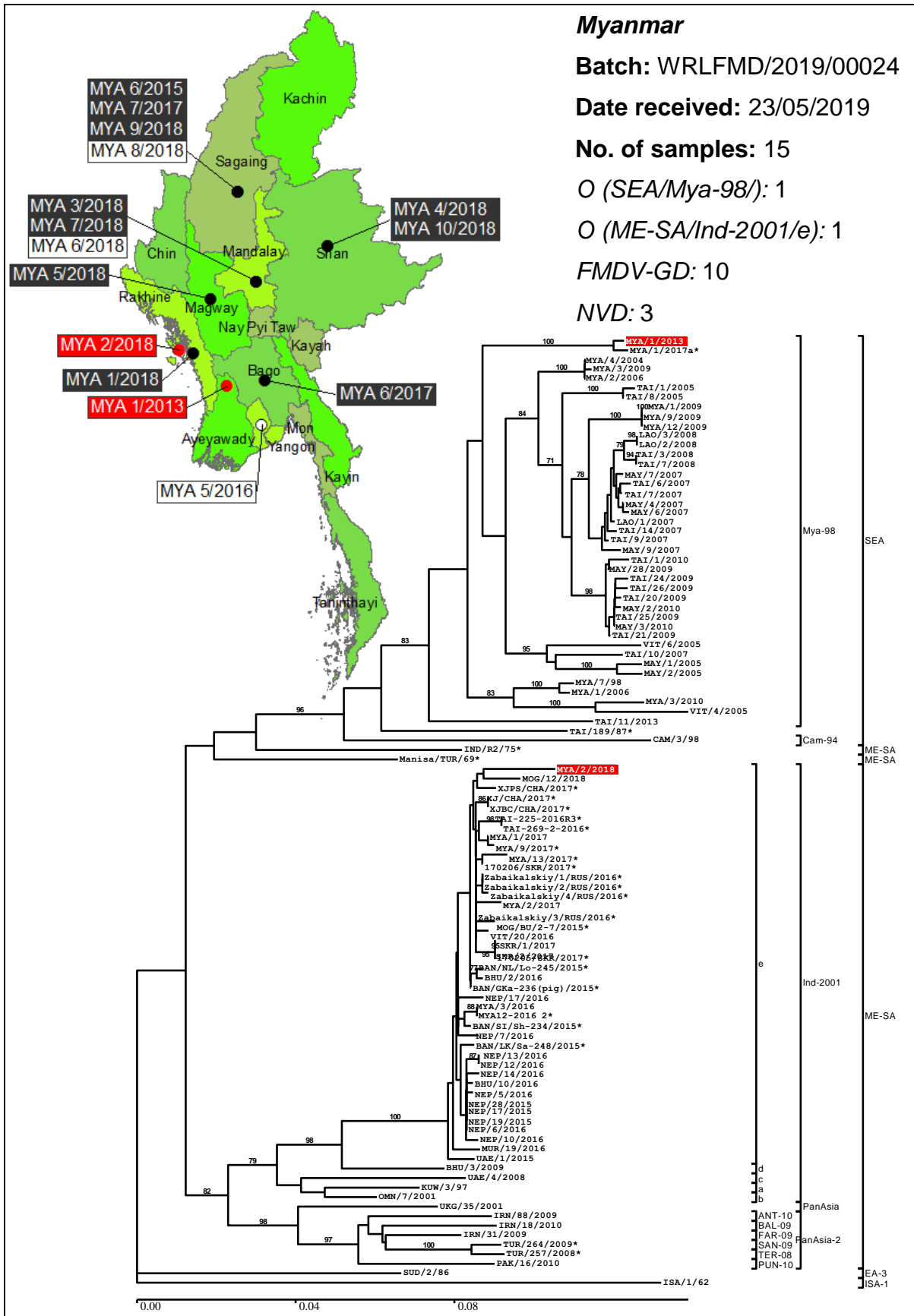


## 2.2. Asia



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**Nepal**

**Batch:** WRLFMD/2019/00021

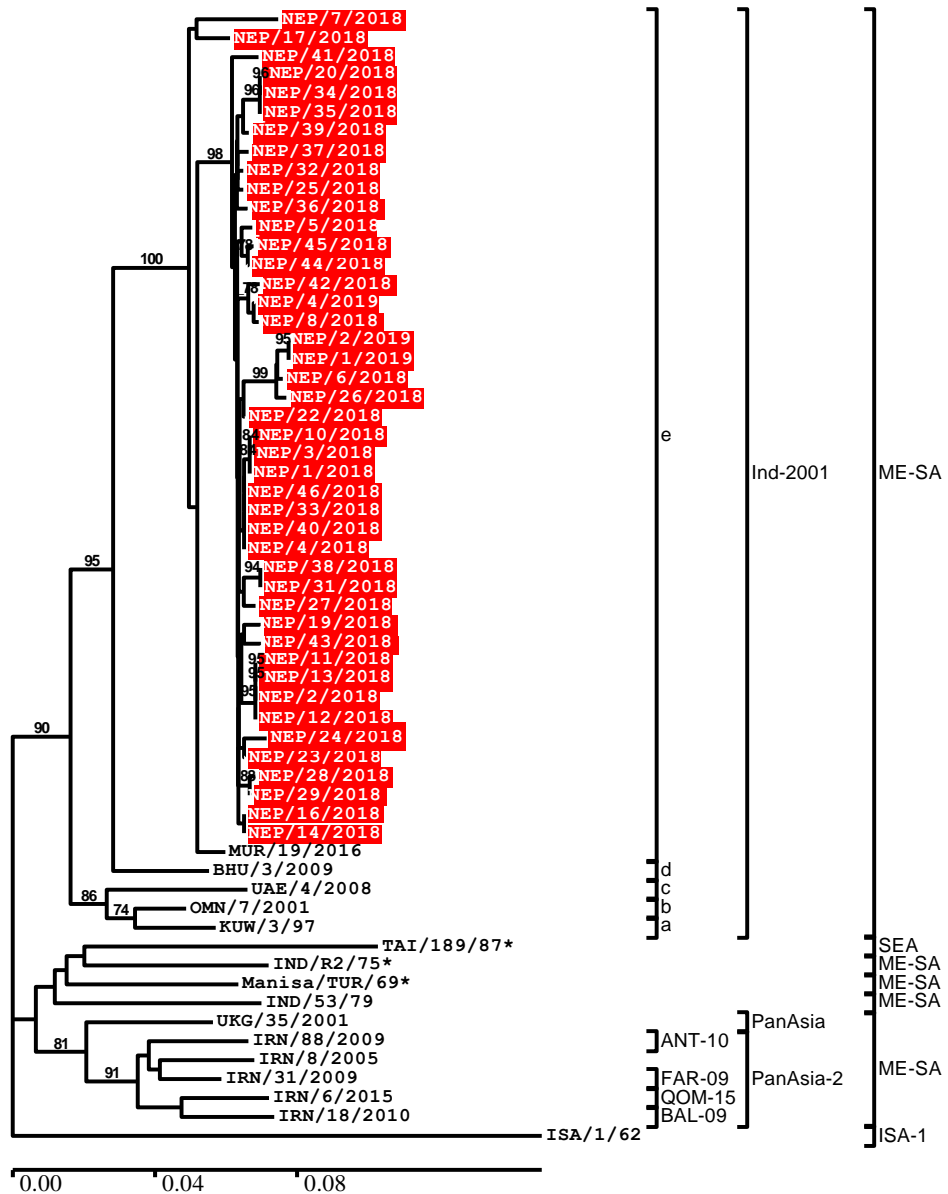
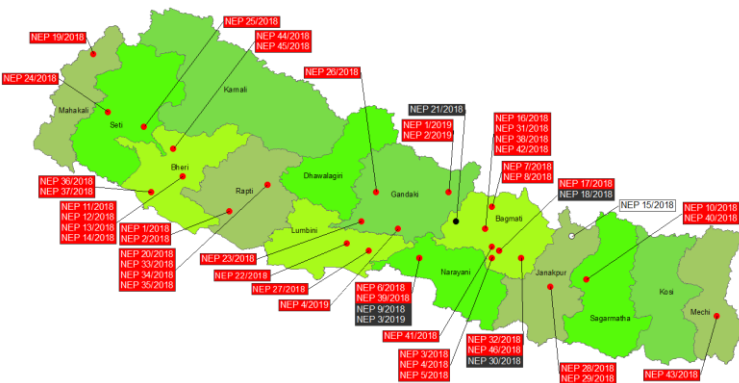
**Date received:** 19/04/2019

**No. of samples:** 50

**O (ME-SA/Ind-2001e):** 44

**FMDV-GD:** 5

**NVD:** 1



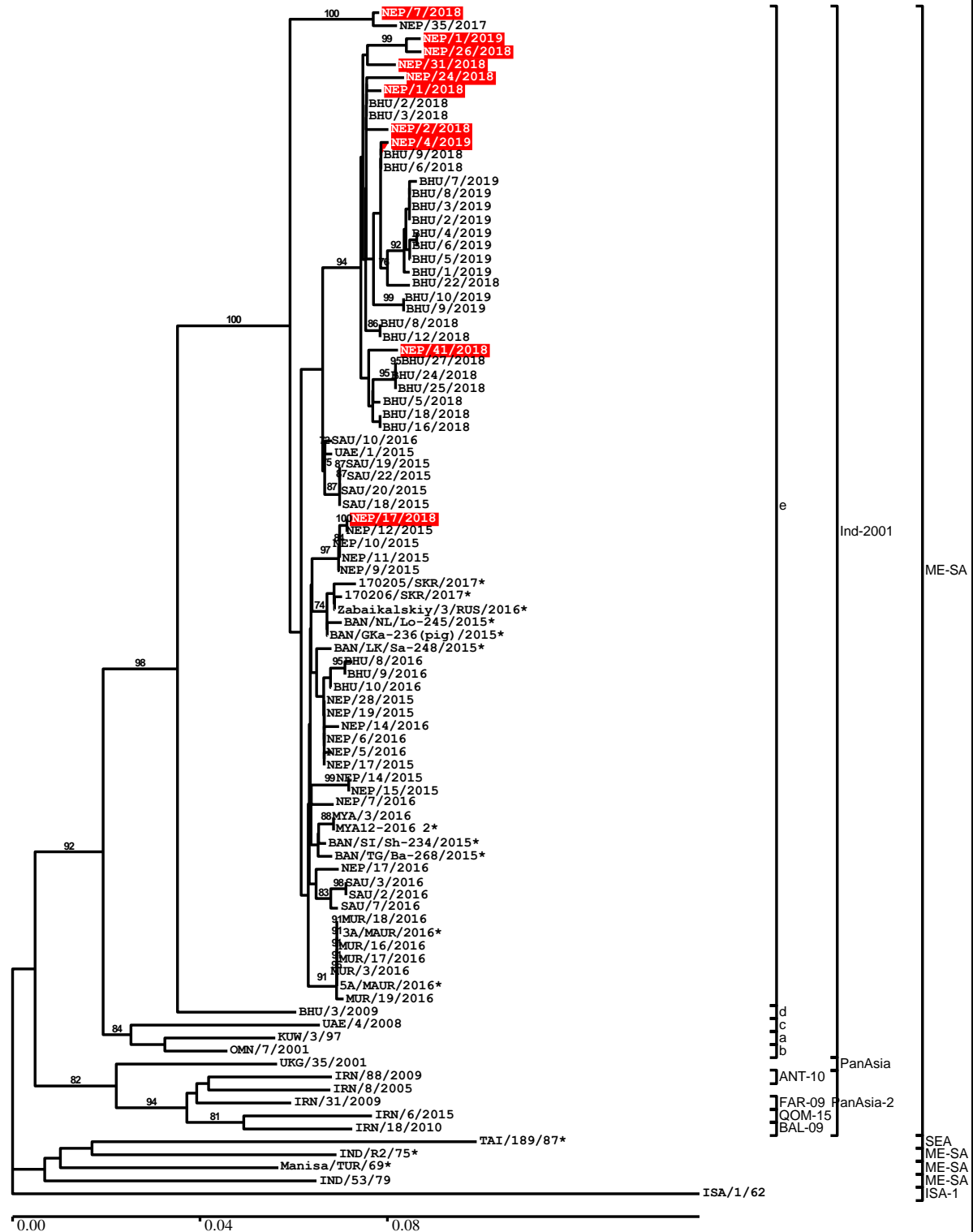
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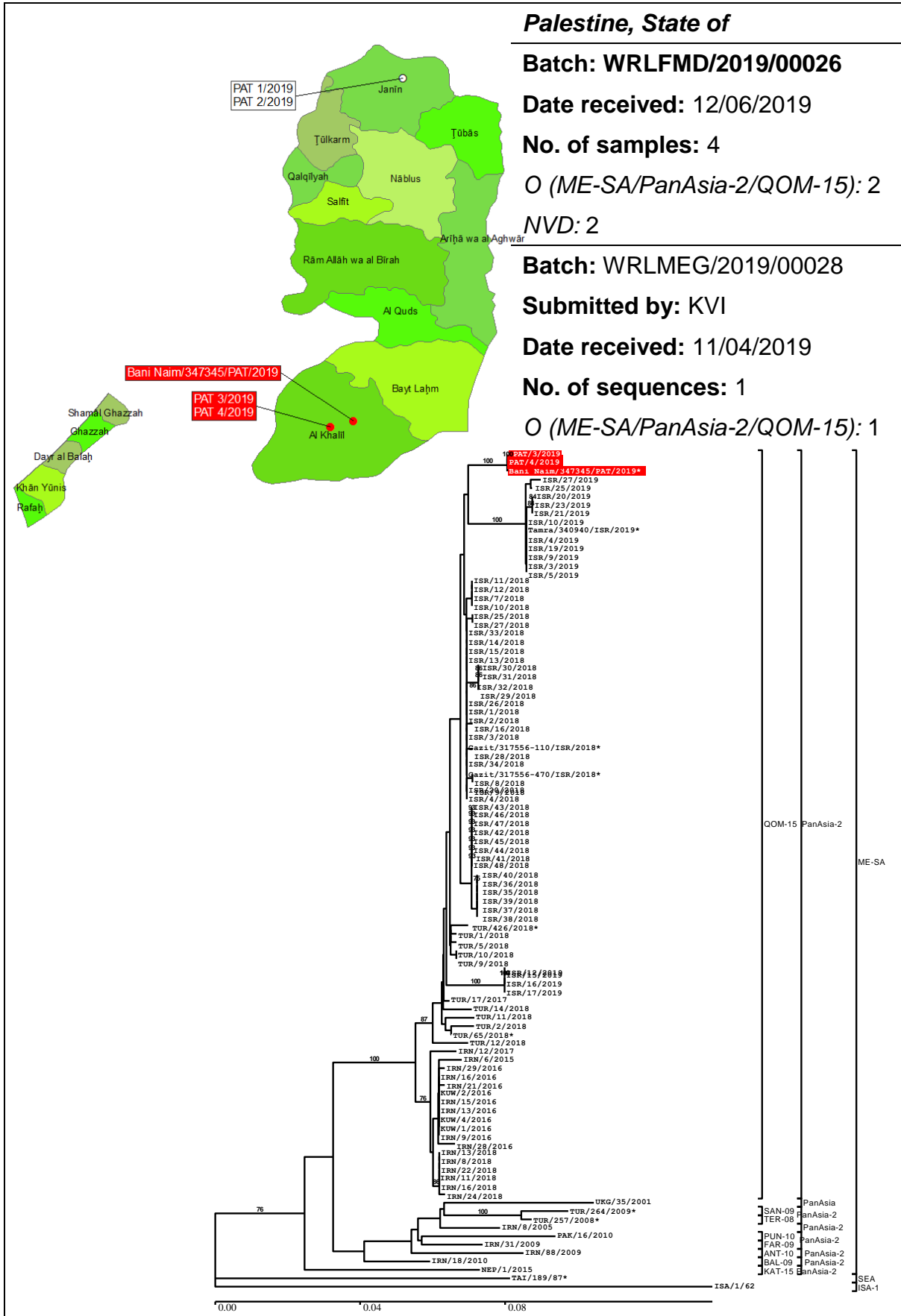


Nepal continued



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## Turkey

Batch: WRLFMD/2019/00023

Date received: 23/04/2019

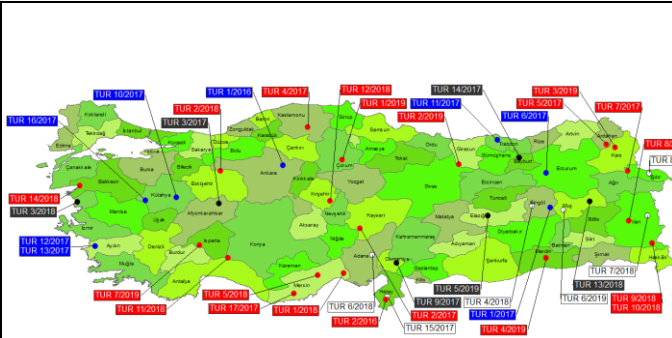
No. of samples: 40

O (ME-SA/PanAsia-2/QOM-15): 20

A (ASIA/G-VII): 8

FMDV-GD: 6

NVD: 6



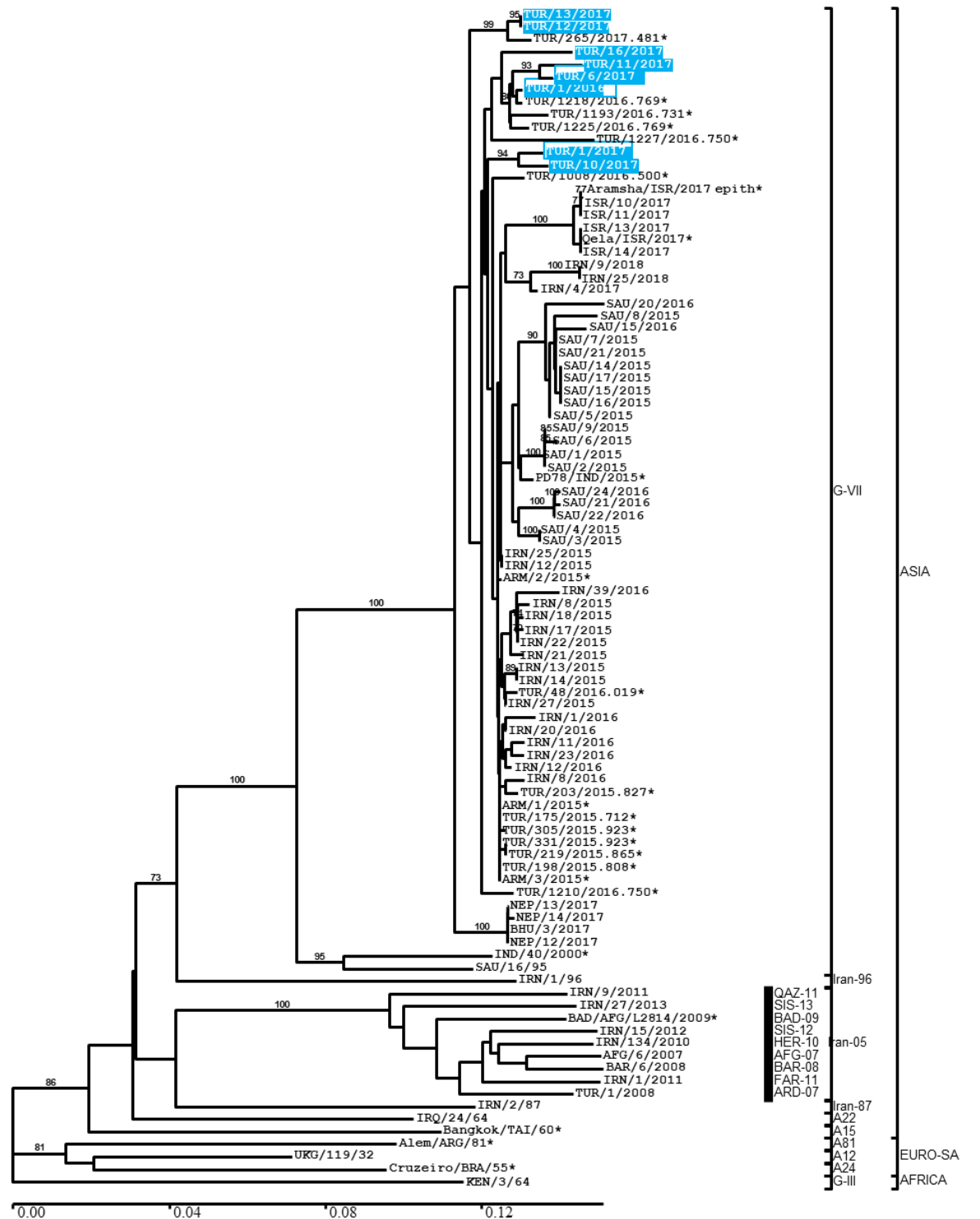
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Turkey continued



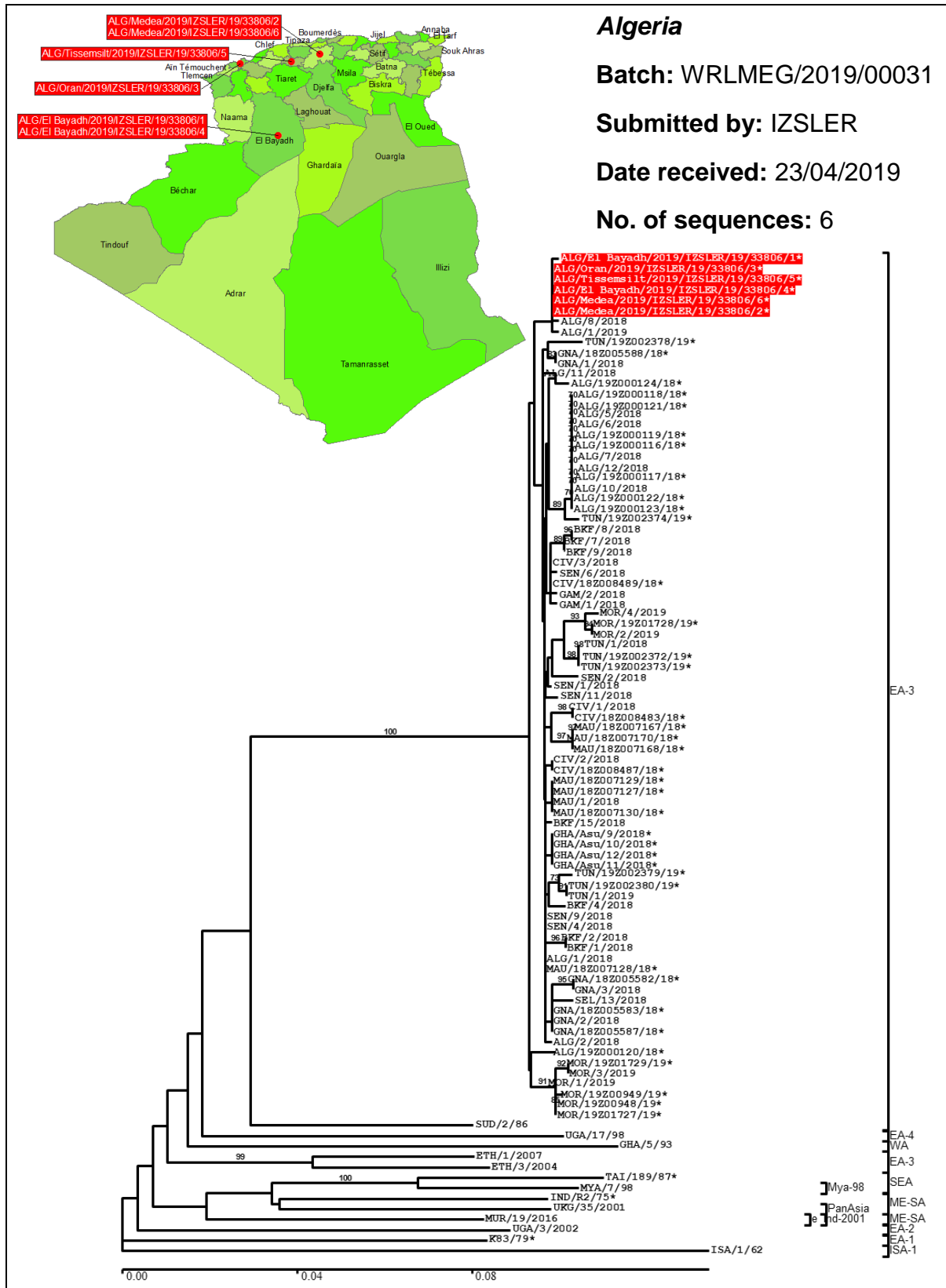
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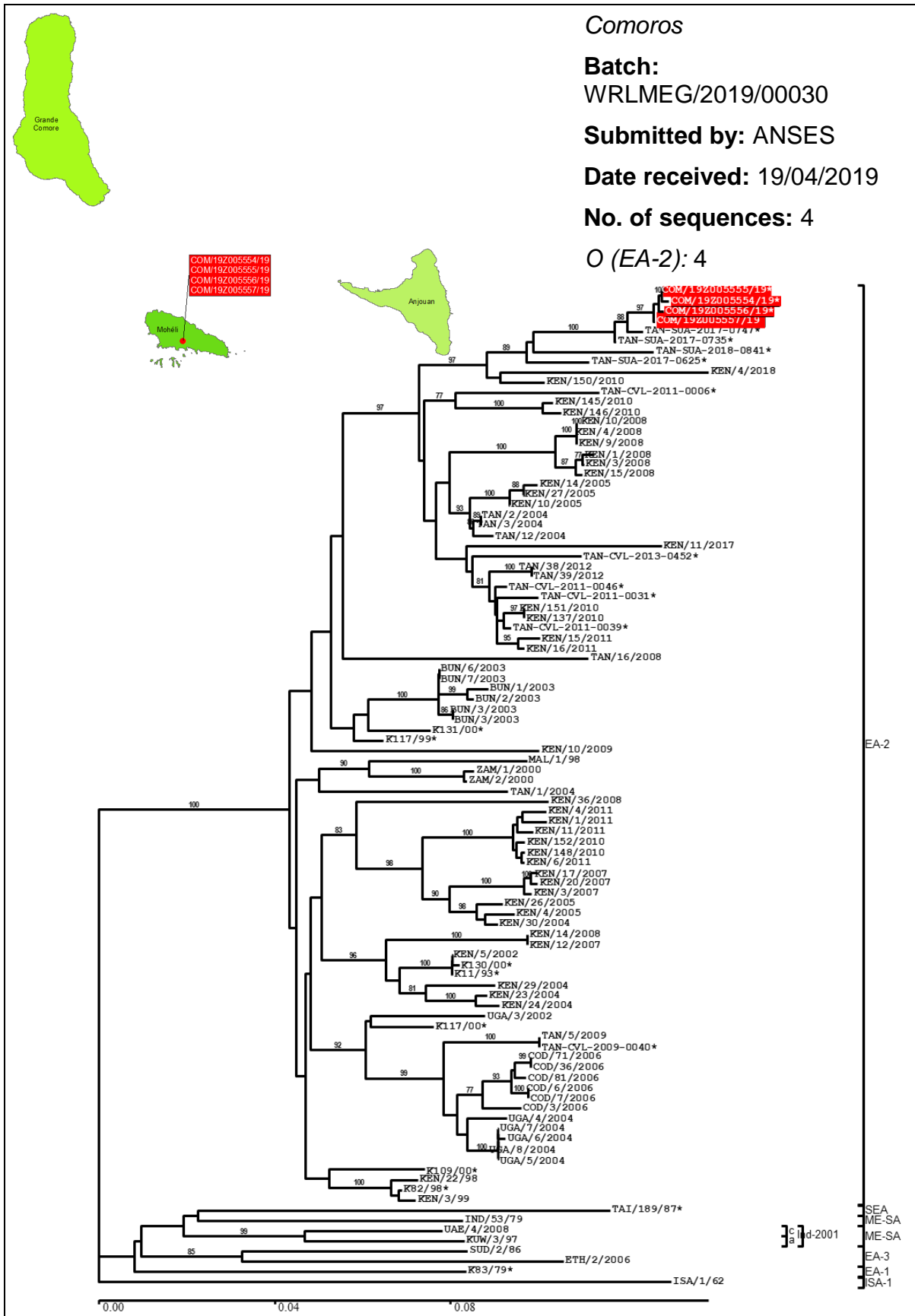


### 2.3. Africa



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**Malawi**

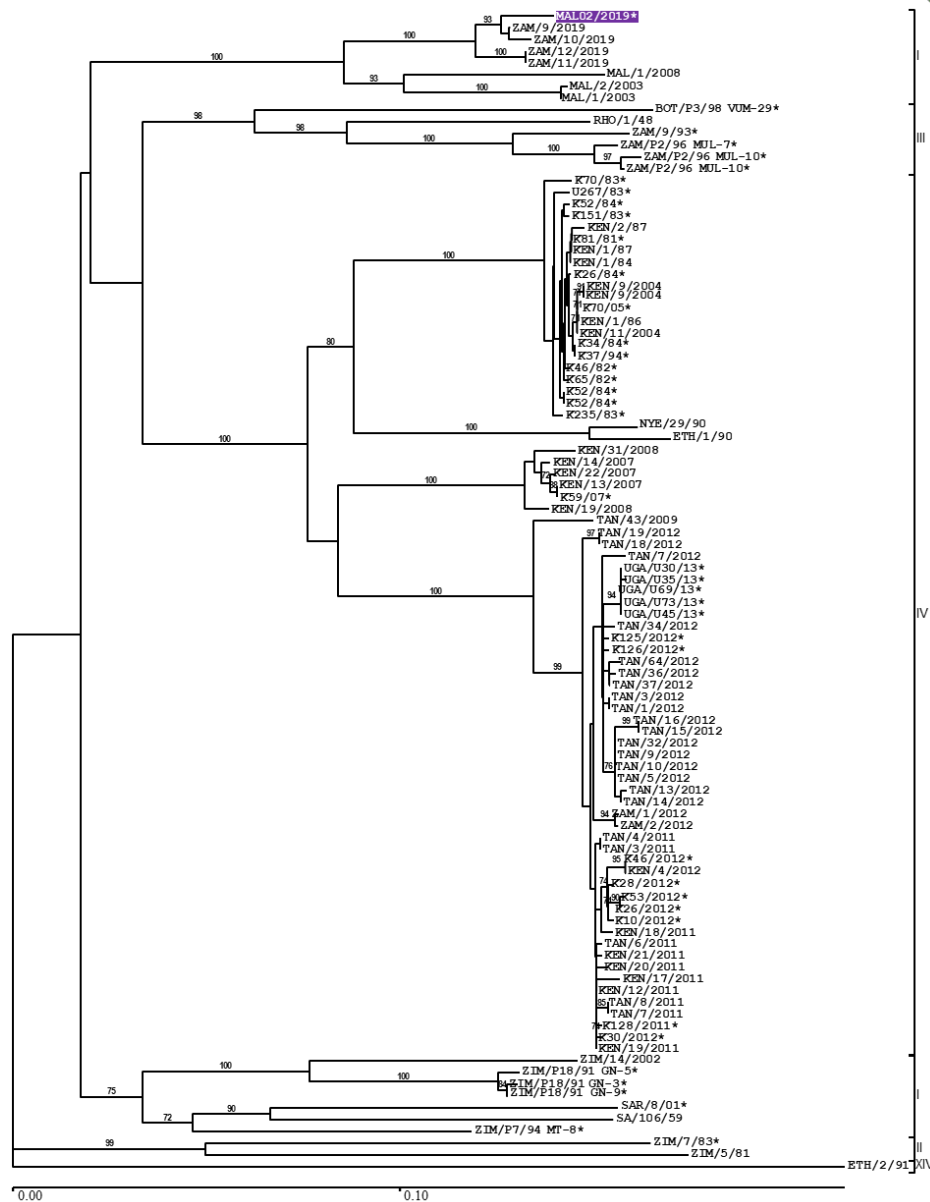
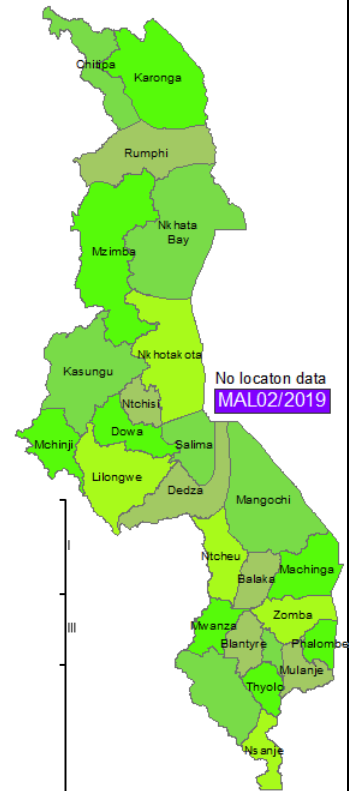
**Batch:** WRLMEG/2019/00034

**Submitted by:** SSARRL (BVI)

**Date received:** 14/06/2019

**No. of sequences:** 1

**SAT 2 (I):** 1

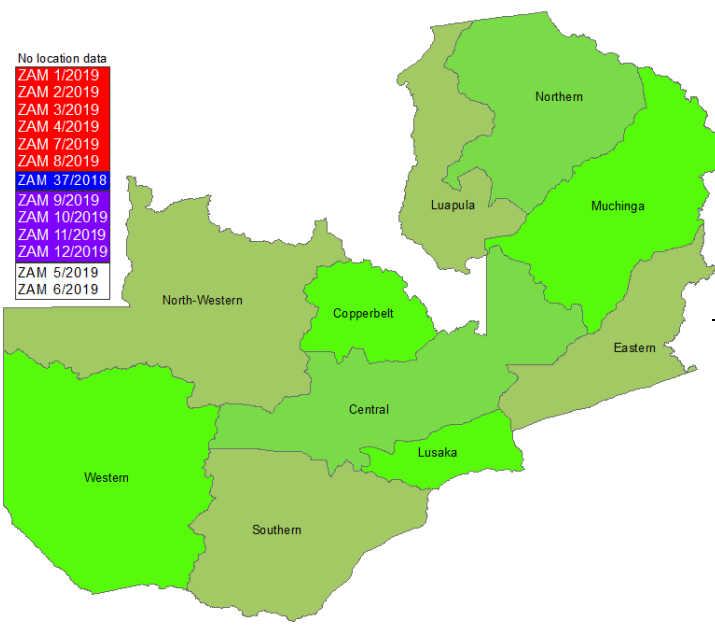


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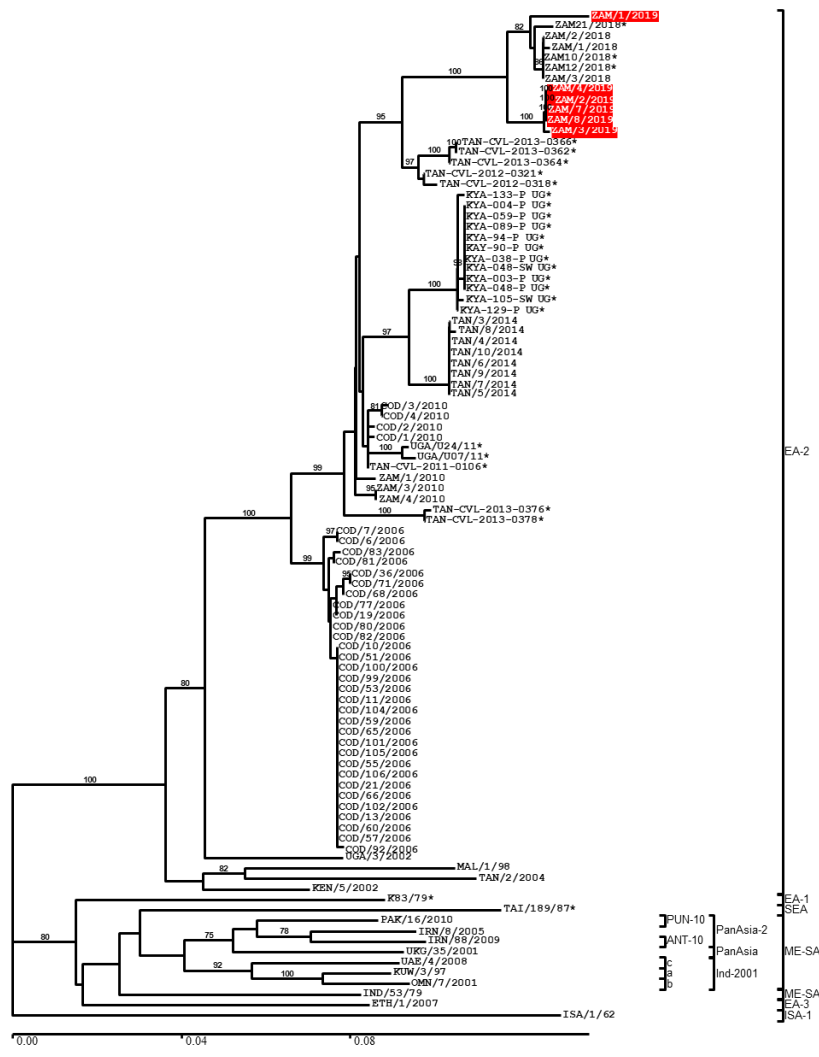


No location data  
 ZAM 1/2019  
 ZAM 2/2019  
 ZAM 3/2019  
 ZAM 4/2019  
 ZAM 7/2019  
 ZAM 8/2019  
 ZAM 37/2018  
 ZAM 9/2019  
 ZAM 10/2019  
 ZAM 11/2019  
 ZAM 12/2019  
 ZAM 5/2019  
 ZAM 6/2019



**Zambia**  
 Batch: WRLFMD/2019/00022  
 Date received: 10/04/2019  
 No. of samples: 12  
 O (EA-2): 6  
 SAT 2 (I): 4  
 NVD: 2

Batch: WRLMEG/2019/00035  
 Submitted by: SSARRL (BVI)  
 Date received: 17/06/2019  
 No. of sequences: 1  
 A (AFRICA): 1



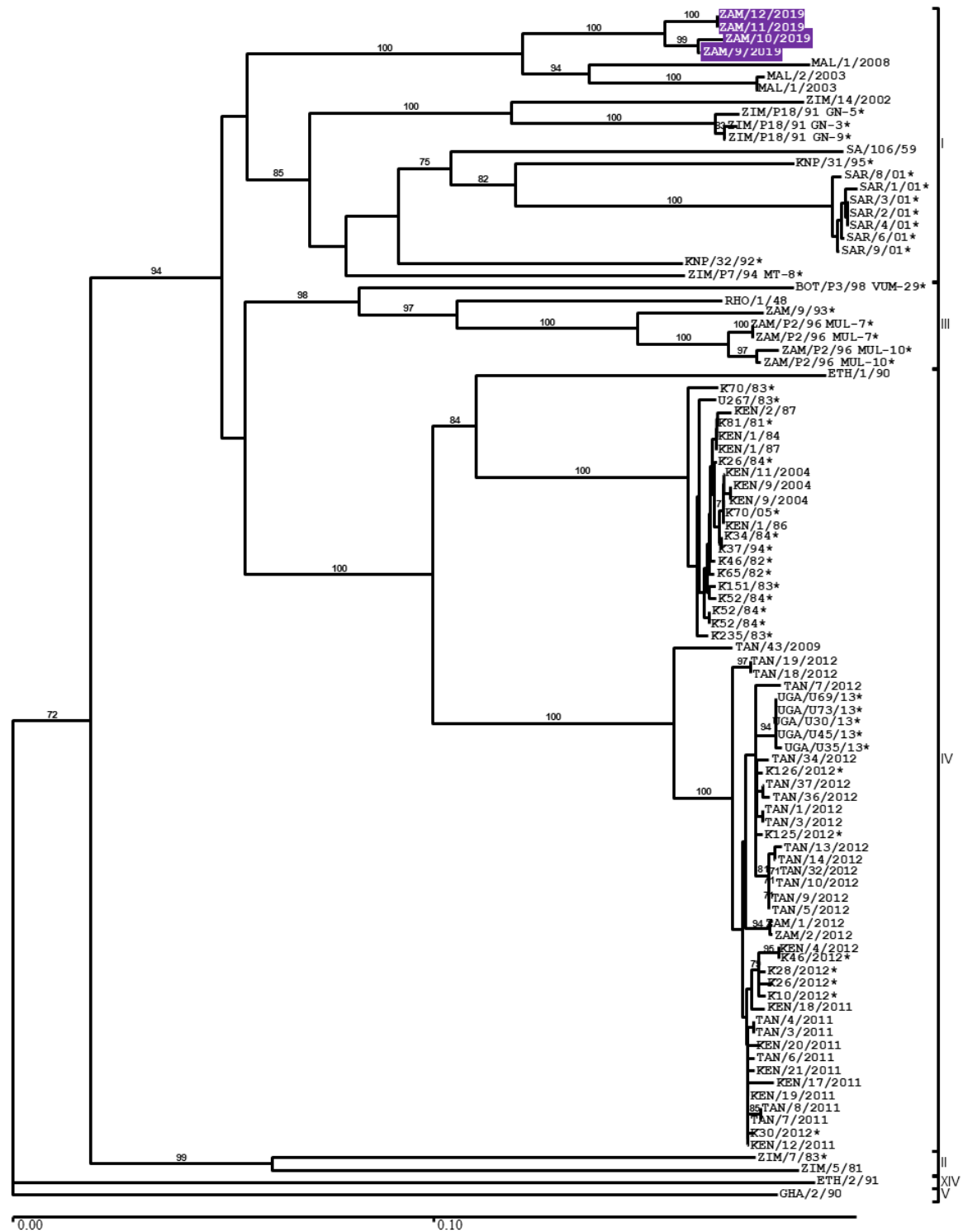
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Zambia continued



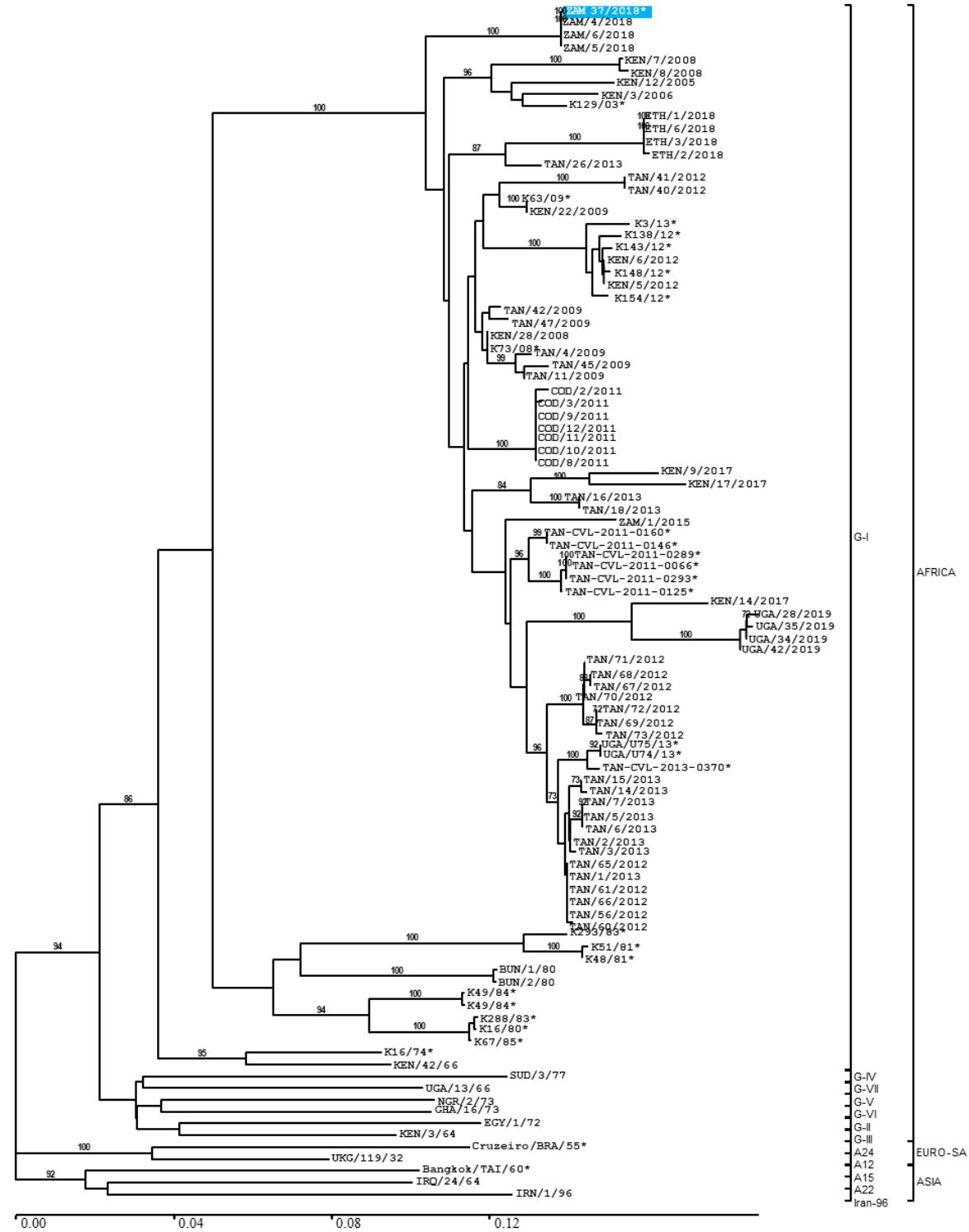
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Zambia continued



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## 2.4. Vaccine matching

During this reporting period vaccine matching has been undertaken for 24 FMD virus field isolates

**Table 3: Summary of samples tested by vaccine matching.**

<b>Serotype</b>	<b>O</b>	<b>A</b>	<b>C</b>	<b>Asia-1</b>	<b>SAT 1</b>	<b>SAT 2</b>	<b>SAT 3</b>
Algeria	1	-	-	-	-	-	-
Bhutan	2	-	-	-	-	-	-
Côte d'Ivoire	1	-	-	-	-	-	-
Egypt	1	1	-	-	-	1	-
Ethiopia	2	2	-	-	-	-	-
Guinea	1	-	-	-	-	-	-
Saudi Arabia	2	-	-	-	-	-	-
Tunisia	1	-	-	-	-	-	-
Uganda	1	2	-	-	-	-	-
Vietnam	3	-	-	-	-	-	-
Zambia	1	-	-	-	-	2	-

For individual data see Annex 1, section 2.7 (Antigenic Characterisation).

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# Annex 1: Sample data

## 2.5. Summary of Submissions

Table 4: Summary of samples collected and received to WRLFMD (April to June 2019)

Country	N <sup>o</sup> of samples	Virus isolation in cell culture/ELISA								No Virus Detected	RT-PCR for FMD	
		FMD virus serotypes									Positive	Negative
		O	A	C	SAT 1	SAT 2	SAT 3	ASIA -1				
Algeria	3	3	-	-	-	-	-	-	-	-	3	-
Bhutan	34	21	-	-	-	-	-	-	-	13	31	3
Côte d'Ivoire	3	3	-	-	-	-	-	-	-	-	3	-
Ethiopia	36	13	11	-	-	-	-	-	-	12	29	7
Guinea	3	3	-	-	-	-	-	-	-	-	3	-
Israel	27	23	-	-	-	-	-	-	-	4	25	2
Mauritania	1	1	-	-	-	-	-	-	-	-	1	-
Morocco	4	4	-	-	-	-	-	-	-	-	4	-
Myanmar	15	1	-	-	-	-	-	-	-	14	12	3
Nepal	50	44	-	-	-	-	-	-	-	6	48	2
Palestinian Autonomous Territories	4	2	-	-	-	-	-	-	-	2	2	2
Tunisia	2	2	-	-	-	-	-	-	-	-	2	-
Turkey	40	20	8	-	-	-	-	-	-	12	34	6
Zambia	12	6	-	-	-	4	-	-	-	2	10	2
<b>TOTAL</b>	<b>234</b>	<b>146</b>	<b>19</b>	<b>-</b>	<b>-</b>	<b>4</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>65</b>	<b>207</b>	<b>27</b>

### Abbreviations used in table

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
rRT-PCR	Real-time reverse transcription polymerase chain reaction for FMD (or SVD) viral genome

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## 2.6. Clinical Samples

Please note that in Table 5 below the samples ETH 13/2019 and MYA 2/2018 were detected and reported as FMDV GD. Subsequent sequence analysis has allowed the serotype of the samples to be determined.

**Table 5: Clinical sample diagnostics made by the WRLFMD® April to June 2019**

Country	Date		WRL for FMD Sample Identification	Animal	Date of Collection	Results		
	Received	Reported				VI/ELISA	RT-PCR	Final report
Algeria	27-Mar-19	03-Apr-19	ALG 10/2018	Sheep	17-Jul-18	O	POS	O
			ALG 11/2018	Goat	19-Dec-18	O	POS	O
			ALG 12/2018	Cattle	30-Dec-18	O	POS	O
Bhutan	15-Mar-19	11-Apr-19	BHU 5/2018	Bovine	09-May-18	O	POS	O
			BHU 6/2018	Cattle	11-Jul-18	O	POS	O
			BHU 7/2018	Cattle	11-Jul-18	NEG	POS	FMDV GD
			BHU 8/2018	Cattle	12-Jul-18	O	POS	O
			BHU 9/2018	Goat	12-Jul-18	O	POS	O
			BHU 10/2018	Cattle	15-Jul-18	NEG	POS	FMDV GD
			BHU 11/2018	Cattle	25-Jul-18	NEG	POS	FMDV GD
			BHU 12/2018	Cattle	09-Aug-18	O	POS	O
			BHU 13/2018	Cattle	13-Aug-18	NEG	POS	FMDV GD
			BHU 14/2018	Cattle	13-Aug-18	NEG	POS	FMDV GD
			BHU 15/2018	Cattle	13-Aug-18	NEG	NEG	NVD
			BHU 16/2018	Cattle	03-Sep-18	O	POS	O
			BHU 17/2018	Cattle	03-Sep-18	NEG	POS	FMDV GD
			BHU 18/2018	Cattle	03-Sep-18	O	POS	O
			BHU 19/2018	Cattle	03-Sep-18	NEG	NEG	NVD
			BHU 20/2018	Cattle	03-Sep-18	NEG	POS	FMDV GD
			BHU 21/2018	Cattle	21-Sep-18	NEG	POS	FMDV GD
			BHU 22/2018	Cattle	21-Sep-18	O	POS	O
			BHU 23/2018	Cattle	21-Sep-18	NEG	NEG	NVD
			BHU 24/2018	Cattle	14-Dec-18	O	POS	O
			BHU 25/2018	Cattle	14-Dec-18	O	POS	O
			BHU 26/2018	Cattle	14-Dec-18	NEG	POS	FMDV GD
			BHU 27/2018	Cattle	14-Dec-18	O	POS	O
			BHU 28/2018	Cattle	14-Dec-18	NEG	POS	FMDV GD
			BHU 1/2019	Cattle	16-Jan-19	O	POS	O
			BHU 2/2019	Cattle	16-Jan-19	O	POS	O
			BHU 3/2019	Cattle	16-Jan-19	O	POS	O
			BHU 4/2019	Cattle	16-Jan-19	O	POS	O
			BHU 5/2019	Cattle	16-Jan-19	O	POS	O
			BHU 6/2019	Cattle	16-Jan-19	O	POS	O
			BHU 7/2019	Cattle	16-Jan-19	O	POS	O
			BHU 8/2019	Cattle	16-Jan-19	O	POS	O
			BHU 9/2019	Cattle	18-Jan-19	O	POS	O
BHU 10/2019	Cattle	18-Jan-19	O	POS	O			
			CIV 1/2018	Pig	30-Jun-18	O	POS	O

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Country	Date		WRL for FMD Sample Identification	Animal	Date of Collection	Results		
	Received	Reported				VI/ELISA	RT-PCR	Final report
Côte d'Ivoire	27- Mar- 19	03- Apr- 19	CIV 2/2018	Pig	30-Jun-18	O	POS	O
			CIV 3/2018	Pig	30-Jun-18	O	POS	O
Ethiopia	05-Apr-19	10-May-19	ETH 72/2018	Bovine	15-Mar-18	O	POS	O
			ETH 73/2018	Bovine	20-Mar-18	O	POS	O
			ETH 74/2018	Bovine	26-Mar-18	NEG	POS	FMDV GD
			ETH 75/2018	Bovine	02-Apr-18	NEG	POS	FMDV GD
			ETH 76/2018	Bovine	10-Apr-18	NEG	NEG	NVD
			ETH 77/2018	Bovine	10-Apr-18	NEG	NEG	NVD
			ETH 78/2018	Bovine	24-Sep-18	NEG	NEG	NVD
			ETH 79/2018	Bovine	24-Sep-18	NEG	NEG	NVD
			ETH 80/2018	Bovine	24-Sep-18	NEG	NEG	NVD
			ETH 81/2018	Bovine	11-Oct-18	O	POS	O
			ETH 82/2018	Bovine	11-Oct-18	O	POS	O
			ETH 83/2018	Bovine	11-Oct-18	O	POS	O
			ETH 84/2018	Bovine	11-Oct-18	O	POS	O
			ETH 85/2018	Bovine	02-Dec-18	A	POS	A
			ETH 86/2018	Bovine	03-Dec-18	A	POS	A
			ETH 87/2018	Bovine	03-Dec-18	A	POS	A
			ETH 1/2019	Bovine	06-Feb-19	A	POS	A
			ETH 2/2019	Bovine	06-Feb-19	A	POS	A
			ETH 3/2019	Bovine	06-Feb-19	A	POS	A
			ETH 4/2019	Bovine	07-Feb-19	O	POS	O
ETH 5/2019	Bovine	07-Feb-19	O	POS	O			
ETH 6/2019	Bovine	19-Feb-19	O	POS	O			
ETH 7/2019	Bovine	19-Feb-19	O	POS	O			
ETH 8/2019	Bovine	19-Feb-19	O	POS	O			
ETH 9/2019	Bovine	19-Feb-19	O	POS	O			
ETH 10/2019	Bovine	19-Feb-19	NEG	POS	FMDV GD			
ETH 11/2019	Bovine	28-Feb-19	A	POS	A			
ETH 12/2019	Bovine	28-Feb-19	A	POS	A			
ETH 13/2019	Bovine	28-Feb-19	NEG	POS	A *			
ETH 14/2019	Bovine	28-Feb-19	O	POS	O			
ETH 15/2019	Bovine	28-Feb-19	NEG	NEG	NVD			
ETH 16/2019	Bovine	09-Mar-19	A	POS	A			
ETH 17/2019	Bovine	09-Mar-19	NEG	NEG	NVD			
ETH 18/2019	Bovine	09-Mar-19	A	POS	A			
ETH 19/2019	Bovine	09-Mar-19	A	POS	A			
ETH 20/2019	Bovine	19-Mar-19	NEG	POS	FMDV GD			
Guinea	27- Mar- 19	03- Apr- 19	GNA 1/2018	Cattle	10-Jul-18	O	POS	O
			GNA 2/2018	Cattle	10-Jul-18	O	POS	O
			GNA 3/2018	Cattle	12-Jul-18	O	POS	O
Israel	12-Jun-19	20-Jun-19	ISR 1/2019	Cattle	28-Jan-19	NEG	POS	FMDV GD
			ISR 2/2019	Cattle	28-Jan-19	O	POS	O
			ISR 3/2019	Cattle	30-Jan-19	O	POS	O
			ISR 4/2019	Cattle	30-Jan-19	O	POS	O
			ISR 5/2019	Cattle	30-Jan-19	O	POS	O
			ISR 6/2019	Cattle	31-Jan-19	NEG	NEG	NVD
			ISR 7/2019	Cattle	31-Jan-19	NEG	NEG	NVD

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Country	Date		WRL for FMD Sample Identification	Animal	Date of Collection	Results		
	Received	Reported				VI/ELISA	RT-PCR	Final report
			ISR 8/2019	Cattle	01-Feb-19	NEG	POS	FMDV GD
			ISR 9/2019	Cattle	02-Feb-19	O	POS	O
			ISR 10/2019	Cattle	02-Feb-19	O	POS	O
			ISR 11/2019	Cattle	05-Feb-19	O	POS	O
			ISR 12/2019	Cattle	05-Feb-19	O	POS	O
			ISR 13/2019	Cattle	05-Feb-19	O	POS	O
			ISR 14/2019	Cattle	05-Feb-19	O	POS	O
			ISR 15/2019	Cattle	05-Feb-19	O	POS	O
			ISR 16/2019	Cattle	07-Feb-19	O	POS	O
			ISR 17/2019	Cattle	07-Feb-19	O	POS	O
			ISR 18/2019	Cattle	07-Feb-19	O	POS	O
			ISR 19/2019	Cattle	26-Feb-19	O	POS	O
			ISR 20/2019	Cattle	28-Feb-19	O	POS	O
			ISR 21/2019	Cattle	28-Feb-19	O	POS	O
			ISR 22/2019	Cattle	03-Mar-19	O	POS	O
			ISR 23/2019	Cattle	03-Mar-19	O	POS	O
			ISR 24/2019	Cattle	07-May-19	O	POS	O
			ISR 25/2019	Cattle	07-May-19	O	POS	O
			ISR 26/2019	Cattle	09-May-19	O	POS	O
			ISR 27/2019	Cattle	09-May-19	O	POS	O
Mauritania	27- Mar- 19	03- Apr- 19	MAU 1/2018	Cattle	07-Aug-18	O	POS	O
Morocco	27- Mar- 19	03- Apr- 19	MOR 1/2019	Cattle	15-Jan-19	O	POS	O
			MOR 2/2019	Cattle	15-Jan-19	O	POS	O
			MOR 3/2019	Cattle	15-Jan-19	O	POS	O
			MOR 4/2019	Cattle	15-Jan-19	O	POS	O
Myanmar	23-May-19	20-May-19	MYA 1/2013	Cattle	11-Nov-13	O	POS	O
			MYA 6/2015	Cattle	29-Sep-15	NEG	POS	FMDV GD
			MYA 5/2016	Cattle	21-Nov-16	NEG	NEG	NVD
			MYA 6/2017	Cattle	17-Aug-17	NEG	POS	FMDV GD
			MYA 7/2017	Cattle	24-Oct-17	NEG	POS	FMDV GD
			MYA 1/2018	Cattle	20-May-18	NEG	POS	FMDV GD
			MYA 2/2018	Cattle	24-May-18	NEG	POS	O *
			MYA 3/2018	Cattle	18-Sep-18	NEG	POS	FMDV GD
			MYA 4/2018	Cattle	06-Oct-18	NEG	POS	FMDV GD
			MYA 5/2018	Cattle	18-Oct-18	NEG	POS	FMDV GD
			MYA 6/2018	Cattle	24-Oct-18	NEG	NEG	NVD
			MYA 7/2018	Cattle	01-Nov-18	NEG	POS	FMDV GD
			MYA 8/2018	Cattle	15-Nov-18	NEG	NEG	NVD
			MYA 9/2018	Cattle	03-Dec-18	NEG	POS	FMDV GD
MYA 10/2018	Cattle	06-Dec-18	NEG	POS	FMDV GD			
Nepal	09-Apr-19	22-May-19	NEP 1/2018	Cattle	02-Apr-18	O	POS	O
			NEP 2/2018	Cattle	02-Apr-18	O	POS	O
			NEP 3/2018	Cattle	02-May-18	O	POS	O
			NEP 4/2018	Cattle	02-May-18	O	POS	O
			NEP 5/2018	Cattle	02-May-18	O	POS	O
			NEP 6/2018	Cattle	20-May-18	O	POS	O
			NEP 7/2018	Cattle	02-Jun-18	O	POS	O

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Country	Date		WRL for FMD Sample Identification	Animal	Date of Collection	Results		
	Received	Reported				V/ELISA	RT-PCR	Final report
			NEP 8/2018	Cattle	03-Jun-18	O	POS	O
			NEP 9/1018	Cattle	06-Jun-18	NEG	POS	FMDV GD
			NEP 10/2018	Cattle	12-Jun-18	O	POS	O
			NEP 11/2018	Cattle	15-Jun-18	O	POS	O
			NEP 12/2018	Cattle	15-Jun-18	O	POS	O
			NEP 13/2018	Cattle	15-Jun-18	O	POS	O
			NEP 14/2018	Cattle	15-Jun-18	O	POS	O
			NEP 15/2018	Goat	20-Jun-18	NEG	NEG	NVD
			NEP 16/2018	Cattle	10-Jul-18	O	POS	O
			NEP 17/2018	Goat	16-Jul-18	O	POS	O
			NEP 18/2018	Cattle	18-Jul-18	NEG	POS	FMDV GD
			NEP 19/2018	Cattle	25-Jul-18	O	POS	O
			NEP 20/2018	Cattle	25-Jul-18	O	POS	O
			NEP 21/2018	Cattle	27-Jul-18	NEG	POS	FMDV GD
			NEP 22/2018	Cattle	24-Aug-18	O	POS	O
			NEP 23/2018	Cattle	09-Sep-18	O	POS	O
			NEP 24/2018	Cattle	10-Sep-18	O	POS	O
			NEP 25/2018	Cattle	17-Sep-18	O	POS	O
			NEP 26/2018	Cattle	24-Sep-18	O	POS	O
			NEP 27/2018	Cattle	24-Sep-18	O	POS	O
			NEP 28/2018	Cattle	26-Sep-18	O	POS	O
			NEP 29/1018	Cattle	26-Sep-18	O	POS	O
			NEP 30/2018	Cattle	26-Sep-18	NEG	POS	FMDV GD
			NEP 31/2018	Cattle	08-Oct-18	O	POS	O
			NEP 32/2018	Pig	09-Oct-18	O	POS	O
			NEP 33/2018	Cattle	09-Oct-18	O	POS	O
			NEP 34/2018	Cattle	09-Oct-18	O	POS	O
			NEP 35/2018	Cattle	11-Oct-18	O	POS	O
			NEP 36/2018	Cattle	14-Oct-18	O	POS	O
			NEP 37/2018	Cattle	14-Oct-18	O	POS	O
			NEP 38/2018	Cattle	18-Oct-18	O	POS	O
			NEP 39/1018	Cattle	28-Oct-18	O	POS	O
			NEP 40/2018	Cattle	18-Nov-18	O	NEG	O
			NEP 41/2018	Cattle	27-Nov-18	O	POS	O
			NEP 42/2018	Cattle	04-Dec-18	O	POS	O
			NEP 43/2018	Cattle	05-Dec-18	O	POS	O
			NEP 44/2018	Cattle	21-Dec-18	O	POS	O
			NEP 45/2018	Cattle	21-Dec-18	O	POS	O
			NEP 46/2018	Cattle	26-Dec-18	O	POS	O
			NEP 1/2019	Cattle	15-Jan-19	O	POS	O
			NEP 2/2019	Buffalo	15-Jan-19	O	POS	O
			NEP 3/2019	Cattle	17-Mar-19	NEG	POS	FMDV GD
			NEP 4/2019	Buffalo	17-Mar-19	O	POS	O
Palestine, State of	12-Jun- 19	20-Jun- 19	PAT 1/2019	Cattle	26-Feb-19	NEG	NEG	NVD
			PAT 2/2019	Cattle	26-Feb-19	NEG	NEG	NVD
			PAT 3/2019	Goat	04-Apr-19	O	POS	O
			PAT 4/2019	Goat	08-Apr-19	O	POS	O
Tunisia			TUN 1/2018	Cattle	17-Dec-18	O	POS	O

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Country	Date		WRL for FMD Sample Identification	Animal	Date of Collection	Results		
	Received	Reported				VI/ELISA	RT-PCR	Final report
	27- Mar- 19	03- Apr- 19	TUN 1/2019	Cattle	13-Jan-19	O	POS	O
Turkey	23-Apr-19	22-May-19	TUR 1/2016	Cattle	04-Oct-16	A	POS	A
			TUR 2/2016	Cattle	30-Dec-16	O	POS	O
			TUR 1/2017	Cattle	02-Jan-17	A	POS	A
			TUR 2/2017	Cattle	30-Jan-17	O	POS	O
			TUR 3/2017	Cattle	31-Jan-17	NEG	POS	FMDV GD
			TUR 4/2017	Cattle	01-Mar-17	O	POS	O
			TUR 5/2017	Cattle	16-Jul-17	O	POS	O
			TUR 6/2017	Cattle	07-Aug-17	A	POS	A
			TUR 7/2017	Cattle	20-Sep-17	O	POS	O
			TUR 8/2017	Cattle	21-Sep-17	NEG	NEG	NVD
			TUR 9/2017	Cattle	28-Sep-17	NEG	POS	FMDV GD
			TUR 10/2017	Cattle	28-Sep-17	A	POS	A
			TUR 11/2017	Cattle	02-Oct-17	A	POS	A
			TUR 12/2017	Cattle	20-Oct-17	A	POS	A
			TUR 13/2017	Cattle	20-Oct-17	A	POS	A
			TUR 14/2017	Cattle	20-Oct-17	NEG	POS	FMDV GD
			TUR 15/2017	Cattle	23-Oct-17	NEG	NEG	NVD
			TUR 16/2017	Cattle	24-Oct-17	A	POS	A
			TUR 17/2017	Cattle	21-Dec-17	O	POS	O
			TUR 1/2018	Cattle	02-May-18	O	POS	O
			TUR 2/2018	Cattle	09-May-18	O	POS	O
			TUR 3/2018	Cattle	15-May-18	NEG	POS	FMDV GD
			TUR 4/2018	Cattle	18-May-18	NEG	NEG	NVD
			TUR 5/2018	Cattle	24-May-18	O	POS	O
			TUR 6/2018	Cattle	14-Jun-18	NEG	NEG	NVD
			TUR 7/2018	Cattle	03-Jul-18	NEG	NEG	NVD
			TUR 8/2018	Cattle	18-Jul-18	O	POS	O
			TUR 9/2018	Cattle	20-Jul-18	O	POS	O
			TUR 10/2018	Cattle	20-Jul-18	O	POS	O
			TUR 11/2018	Cattle	13-Aug-18	O	POS	O
			TUR 12/2018	Cattle	03-Sep-18	O	POS	O
			TUR 13/2018	Cattle	06-Sep-18	NEG	POS	FMDV GD
TUR 14/2018	Cattle	30-Oct-18	O	POS	O			
TUR 1/2019	Cattle	06-Feb-19	O	POS	O			
TUR 2/2019	Cattle	07-Feb-19	O	POS	O			
TUR 3/2019	Cattle	25-Feb-19	O	POS	O			
TUR 4/2019	Cattle	25-Feb-19	O	POS	O			
TUR 5/2019	Cattle	11-Mar-19	NEG	POS	FMDV GD			
TUR 6/2019	Cattle	01-Apr-19	NEG	NEG	NVD			
TUR 7/2019	Cattle	03-Apr-19	O	POS	O			
Zambia	10	02	ZAM 1/2019	Bovine	18-Jan-19	O	POS	O

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Country	Date		WRL for FMD Sample Identification	Animal	Date of Collection	Results		
	Received	Reported				VI/ELISA	RT-PCR	Final report
			ZAM 2/2019	Bovine	11-Feb-19	O	POS	O
			ZAM 3/2019	Bovine	11-Feb-19	O	POS	O
			ZAM 4/2019	Bovine	11-Mar-19	O	POS	O
			ZAM 5/2019	Bovine	24-Mar-19	NEG	NEG	NVD
			ZAM 6/2019	Bovine	25-Mar-19	NEG	NEG	NVD
			ZAM 7/2019	Bovine	30-Mar-19	O	POS	O
			ZAM 8/2019	Bovine	30-Mar-19	O	POS	O
			ZAM 9/2019	Bovine	02-Apr-19	SAT 2	POS	SAT 2
			ZAM 10/2019	Bovine	02-Apr-19	SAT 2	POS	SAT 2
			ZAM 11/2019	Bovine	03-Apr-19	SAT 2	POS	SAT 2
			ZAM 12/2019	Bovine	03-Apr-19	SAT 2	POS	SAT 2
			TOTAL	319				

### Abbreviations used in table

FMD(V)	Foot-and-mouth disease (virus)
FMDV GD	Genome detected
FMDV NGD	Genome not detected (samples submitted in Trizol, only rRT-PCR carried out)
VI/ELISA	FMDV serotype identified following virus isolation in cell culture and antigen ELISA
rRT-PCR	Real-time 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

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## 2.7. Antigenic Characterisation

Antigenic characterisation of FMD field isolates by matching with vaccine strains by 2dmVNT from April to June 2019.

### Abbreviations used in tables

M	<p>Vaccine Match</p> <p><math>r_1 = \geq 0.3</math>. 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.</p>
N	<p>No Vaccine Match</p> <p><math>r_1 = &lt; 0.3</math>. Suggests that the field isolate is so different from the vaccine strain that the vaccine is unlikely to protect</p>
B	<p>Borderline</p> <p>Any <math>r_1</math> values between 0.28 to 0.32</p>
NT	<p>Not tested against this vaccine</p>

**Table 6: Vaccine matching studies for A FMDV by VNT**

Strain	Serotype	Topotype	Lineage	A/IRN/05	A/TUR/20/06	A22 IRAQ	A/ERI/3/98	A/ASIA/GVII
EGY 2/2018	A	AFRICA	G-IV	0.03	0.11	0.12	0.42	0
ETH 35/2018	A	AFRICA	G-IV	0.04	0.00	0.09	0.25	0
ETH 48/2018	A	AFRICA	G-IV	0.04	0.00	0.17	0.21	0
UGA 28/2019	A	AFRICA	G-I	0.05			0.15	0
UGA 42/2019	A	AFRICA	G-I	0.06	0.17	0.17	0.28	0

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**Table 7: Vaccine matching studies for O FMDV by VNT**

Strain	Serotype	Topotype	Lineage	O 3039	O1 Manisa	O/TUR/5/2009
ALG 11/2018	O	EA-3	n/a	0.81	0.58	0.81
BHU 1/2019	O	ME-SA	Ind-2001e	0.38	0.49	0.49
BHU 9/2019	O	ME-SA	Ind-2001e	0.38	0.34	0.47
CIV 3/2018	O	EA-3	n/a	0.59	0.46	0.76
EGY 34/2017	O	EA-3	n/a	0.69	0.47	0.50
ETH 20/2018	O	EA-3		0.41	0.46	0.36
ETH 23/2018	O	EA-3		0.47	0.56	0.56
GNA 3/2018	O	EA-3	n/a	0.55	0.40	0.50
SAU 11/2018	O	ME-SA	Ind-2001e	0.43	0.62	0.54
SAU 8/2018	O	ME-SA	Ind-2001e	0.41	0.71	0.40
TUN 1/2019	O	EA-3	n/a	0.51	0.46	0.47
UGA 10/2019	O	EA-2	n/a	0.10	0.09	0.28
VIT 6/2018	O	CATHAY	n/a	0.11	0.08	0.13
VIT 10/2018	O	ME-SA	PanAsia	0.33	0.38	0.56
VIT 1/2019	O	SEA	Mya-98	0.27	0.24	0.30
ZAM 2/2019	O	EA-2	n/a	0.62	0.31	0.44

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**Table 8: Vaccine matching studies for SAT 2 FMDV by VNT**

Strain	Serotype	Topotype	Lineage	SAT 2 ERI	SAT 2 ZIM
EGY 1/2018	SAT 2	VII	Ghb-12	0.28	0.11
ZAM 10/2019	SAT 2	I	n/a	0.66	0.35
ZAM 12/2019	SAT 2	I	n/a	0.72	0.17

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## Annex 2: FMD publications

Recent FMD Publications (April to June 2019) cited by Web of Science (Pirbright Institute papers and authors are highlighted in **BOLD AND GREY**)

1. (2019). Study: pigs spread FMD prior to illness. *Journal of the American Veterinary Medical Association*, **254**(9): 1013-1013.
2. (2019). United States has short supply of FMD vaccine, report says. *Journal of the American Veterinary Medical Association*, **254**(11): 1244-1245.
3. Al-Hosary, A.A., A. Kandeil, A.N. El-Taweel, A. Nordengrahn, M. Merza, R. Badra, G. Kayali, and M.A. Ali (2019). Co-infection with different serotypes of FMDV in vaccinated cattle in Southern Egypt. *Virus Genes*, **55**(3): 304-313.
4. Al-Salihi, K.A. (2019). The epidemiology of Foot-and-mouth disease outbreaks and its history in Iraq. *Veterinary World*, **12**(5): 706-712.
5. Arzt, J., I. Fish, S.J. Pauszek, S.L. Johnson, P.S. Chain, D.K. Rai, E. Rieder, T.L. Goldberg, L.L. Rodriguez, and C. Stenfeldt (2019). The evolution of a super-swarm of *Foot-and-mouth disease virus* in cattle. *Plos One*, **14**(4): 22.
6. Bai, M.Y., H. Dong, X. Su, Y. Jin, S.Q. Sun, Y.P. Zhang, Y.S. Yang, and H.C. Guo (2019). Hollow mesoporous silica nanoparticles as delivery vehicle of *Foot-and-mouth disease virus*-like particles induce persistent immune responses in guinea pigs. *Journal of Medical Virology*, **91**(6): 941-948.
7. Bai, X.W., H.F. Bao, P.H. Li, X.Q. Ma, P. Sun, Q.F. Bai, M. Zhang, H. Yuan, D.D. Chen, K. Li, Y.L. Chen, Y.M. Cao, Y.F. Fu, J. Zhang, D. Li, Z.J. Lu, Z.X. Liu, and J.X. Luo (2019). Engineering responses to amino acid substitutions in the VP0-and VP3-coding regions of PanAsia-1 strains of *Foot-and-mouth disease virus* serotype O. *Journal of Virology*, **93**(7): 14.
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10. Dill, V., A. Zimmer, M. Beer, and M. Eschbaumer (2019). Investigation of cell culture conditions for optimal *Foot-and-mouth disease virus* production. *BMC Biotechnology*, **19**: 10.
11. Elgioushy, M., M.A. Rizk, M. El-Adl, M. Elhadidy, and S. El-Khodery (2019). The first molecular detection of *Clostridium perfringens* from pneumonic cases associated with Foot-and-mouth disease in cattle and buffalo in Egypt. *Tropical Animal Health and Production*, **51**(4): 847-852.
12. Fernandez-Sainz, I., T.D. Gavitt, M. Koster, E. Ramirez-Medina, Y.Y. Rodriguez, P. Wu, L.K. Silbart, T. de Los Santos, and S.M. Szczepanek (2019). The VP1 G-H loop hypervariable epitope contributes to protective immunity against *Foot-and-mouth disease virus* in swine. *Vaccine*, **37**(26): 3435-3442.
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- imported from Sudan to Egypt. *Journal of Advanced Veterinary and Animal Research*, **6**(1): 92-99.
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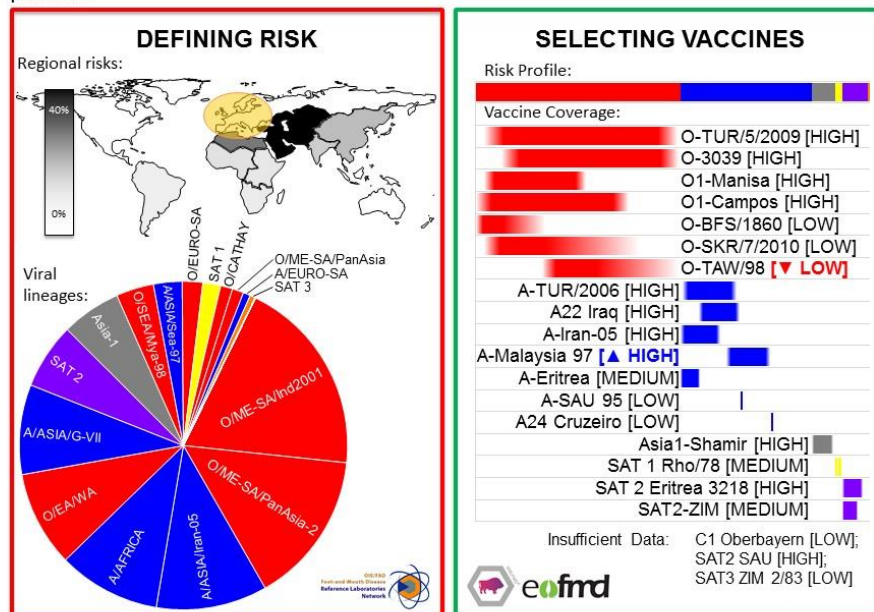
## Annex 3: Vaccine Recommendations

This report provides recommendations of FMDV vaccines to be included in antigen banks. These outputs are generated with a new tool (called PRAGMATIST) that has been developed in partnership between WRLFMD® and EuFMD. These analyses accommodate the latest epidemiological data collected by the OIE FAO FMD Laboratory Network regarding FMDV lineages that are present in different *source regions* (see Table below), as well as available *in vitro*, *in vivo* and field data to score the ability of vaccines to protect against these FMDV lineages.

Lineage	West Eurasia	East Asia	North Africa	India and Southern Asia	East Africa	West and Central Africa	Southern Africa	South America
O ME-SA PanAsia-2	35	-	-	-	-	-	-	-
O ME-SA PanAsia	-	10	-	-	-	-	-	-
O SEA Mya-98	-	33	-	-	-	-	-	-
O ME-SA Ind2001	6	20	35	80	-	-	-	-
O EA or O WA	3	-	20	-	45	37	-	-
O EURO-SA	-	-	-	-	-	-	-	74
O CATHAY	-	10.5	-	-	-	-	-	-
A ASIA Sea-97	-	25	-	-	-	-	-	-
A ASIA Iran-05	25.5	-	-	-	-	-	-	-
A ASIA G-VII	17.5	-	-	16	-	-	-	-
A AFRICA	-	-	35	-	24	25	-	-
A EURO-SA	-	-	-	-	-	-	-	26
Asia-1	12.5	1.5	-	4	-	-	-	-
SAT 1	-	-	-	-	10	10	27	-
SAT 2	0.5	-	10	-	20	28	57	-
SAT 3	-	-	-	-	1	-	16	-
C	-	-	-	-	-	-	-	-

### Vaccine Antigen Prioritisation: Europe

April 2019



NB: Analyses uses best available data, however there are gaps in surveillance and vaccine coverage data

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The table defines the relative distribution of FMDV lineages in each of the eight *source regions*, while the figure highlights the importance of these *source regions* for **Europe** (using data collected at the EU-RL Workshop); please contact WRLFMD EuFMD for assistance to tailor these outputs to other geographical regions. NB: Vaccine-coverage data presented is based on available data and may under-represent the true performance of individual vaccines.

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## Annex 4: Brief round-up of WRLFMD activities

### Proficiency test scheme organised by WRLFMD:

Phase XXXI: Feedback letters are being drafted for those laboratories that participated in this phase of the proficiency test scheme.

Phase XXXII (available in late 2019 or early 2020): Sample panels (including “live” and inactivated samples for virology assays, and validated sera for FMDV-specific antibody tests) are currently being prepared at the WRLFMD. We anticipate that two panels will be prepared and dispatched to participating laboratories: Panel 1 (available as either “live” FMDV or inactivated FMDV) will test virological methods, while Panel 2 will evaluate serological assays. We are proposing that this proficiency test focusses on laboratory confirmation of FMDV virus infection using different laboratory methods, and that laboratories will be scored according to expectations defined by the PCP status of their country, or their international reference laboratory status (see Table below). Please contact WRLFMD if you have any comments on this proposal, or if you would like more information about participating in this phase of the proficiency test scheme.

**Table** Minimum diagnostic testing capabilities for laboratories location in countries at different stages of the PCP (scored using common panels of identical samples sent to all participating laboratories – irrespective of their status).

Level	VIROLOGY (Panel 1)		SEROLOGY (Panel 2)	
	Minimum test requirements	Expected lab capability	Minimum test requirements	Expected lab capability
PCP 0	-	n/a	NSP ELISA	Define infection history (FMDV+/-)
PCP 1	either AgELISA or RT-PCR	<ul style="list-style-type: none"> <li>FMD virus present</li> <li>FMDV serotype</li> </ul>	NSP ELISA	Define infection history (FMDV+/-)
PCP 2	either AgELISA or RT-PCR	<ul style="list-style-type: none"> <li>FMD virus present</li> <li>FMDV serotype</li> </ul>	NSP ELISA SP ELISA	<ul style="list-style-type: none"> <li>Define infectious status</li> <li>vaccination status</li> <li>serotype</li> <li>+/- PVM</li> </ul>
PCP 3 PCP 4+	AgELISA rRT-PCR +/- sequencing +/- VI*	<ul style="list-style-type: none"> <li>FMD virus present</li> <li>FMDV serotype</li> <li>topotype, lineage</li> </ul>	NSP ELISA SP ELISA +/- VNT*	<ul style="list-style-type: none"> <li>Define infectious status</li> <li>vaccination status</li> <li>serotype</li> <li>+/- PVM</li> </ul>
OIE/FAO Reference Laboratories	Enhanced genome sequencing*	<ul style="list-style-type: none"> <li>FMD virus present</li> <li>FMDV serotype</li> <li>topotype, lineage, and relationship between FMDV positive samples in panel</li> </ul>	NSP ELISA SP ELISA +/- VNT*	<ul style="list-style-type: none"> <li>Define infectious status</li> <li>vaccination status</li> <li>serotype</li> <li>PVM</li> <li>identify cross-reactivity</li> </ul>

\* If able to receive the infectious panel

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### **Residential Training Course:**

Delegates from Oman and New Zealand attended a two-week practical training course covering FMD diagnostic methods which was held at Pirbright during May 2019. Information about the residential course that will run in 2020 will be posted on the website below; <https://www.pirbright.ac.uk/training-courses/diagnosis-foot-and-mouth-disease>

### **Summary of Meetings attended by WRLFMD Scientists**

- 43<sup>rd</sup> EuFMD General Session at FAO HQ, Rome, 16<sup>th</sup>-18<sup>th</sup> April 2019.
- International Alliance for Biological Standardization (IABS) meeting (Diagnostics in the Veterinary Field: The Role in Health Surveillance and Disease Identification), Wiesbaden, Germany (15-17<sup>th</sup> May 2019)
- OIE SEACFMD (22<sup>nd</sup> National Coordinators Meeting) in Ulaanbaatar, Mongolia (25<sup>th</sup> June – via SKYPE)

### **OIE/FAO FMD Reference Laboratory Network Activities**

The framework agreement for the Network has been signed and circulated to all 15 laboratories (and partner organisations: OIE, FAO and EuFMD) and was included as a recent item in the OIE Bulletin (<https://oiebulletin.com/?official=2019-1-oie-fao-fmd-reflab-network-en>). Dates for this year's meeting have been agreed for w/c 2<sup>nd</sup> December 2019 and the meeting will be kindly hosted by Dr Park and colleagues from APQA, South Korea (please contact [donald.king@pirbright.ac.uk](mailto:donald.king@pirbright.ac.uk) for further information). A draft of Annual report for 2018 activities will be circulated for comments shortly.

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