Food and Agriculture Organization of the United Nations

eufmd
european commission for the control of foot-and-mouth disease

OIE/FAO Foot-and-Mouth Disease Reference Laboratories Network

Foot-and-Mouth Disease

January-March 2020
Quarterly report

FAST Reports
Foot-and-mouth And Similar Transboundary animal diseases

European Commission for the Control of Foot-and-Mouth Disease

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CONTENTS

Abbreviations and acronyms

BVI – Botswana Vaccine Institute

EIDRA – Emerging Infectious Disease Research Association

EuFMD – European Commission for the Control of Foot-and-Mouth Disease

FAST reports: Foot-and-mouth and similar transboundary animal diseases reports

FGBI “ARRIAH” – Federal Governmental Budgetary Institution “Federal Centre for Animal Health”

FMD – Foot-and-Mouth Disease

FMDV – Foot-and-Mouth Disease Virus

FMDV GD – Genome detected

FMDV NGD – Genome not detected (samples submitted in Trizol, only rRT-PCR carried out)

GF-TAD – Global Framework for the Progressive Control of Transboundary Animal Diseases

MEVAC – International Facility For Veterinary Vaccines Production

NT – Not tested

NVD – No FMD, SVD or vesicular stomatitis virus detected

OIE – World Organisation for Animal Health

PIADC – Plum Island Animal Disease Center

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

SAARC – South Asian Association for Regional Cooperation

SADC – Southern Africa in collaboration with the Southern African Development Community

SAT – Southern African Territories

SSARRL - Sub-Saharan Africa Regional Reference Laboratory

SVD – Swine vesicular disease

VETBIS – Veterinary Information System of Turkey

VI/ELISA – FMDV serotype identified following virus isolation in cell culture and antigen ELISA

WAHIS – World Animal Health Information System (of the OIE)

WRLFMD – World Reference Laboratory for Foot-and-Mouth Disease

1. Highlights and headlines

Welcome to the first "Quarterly Report" for 2020 which is also the first Joint report between European Commission for the Control of Foot-and-Mouth Disease (EuFMD) and the World Reference Laboratory for Foot-and-Mouth Disease (WRLFMD), replacing the former Global Monthly Report (GMR) which had been issued by the EuFMD for eight years. It is hoped that with time, more analysis of trends and developments will be provided in this format and new online tools are also planned to assist users to select and display results of most interest to them.

Twenty years ago, the work of the WRLFMD highlighted threats posed by the O-PanAsia strain, named for its history of unprecedented spread across Asia in the 1990s. This strain originated in South Asia (Pool 2), and subsequently spread to Pool 3 (West/Eurasia and the Middle-East) and Pool 1 (East Asia). The jumps from Pool 1 to Foot-and-mouth disease (FMD) free countries raised concerns that this virus could be the first global "pandemic" strain, and countries were warned by EuFMD to review preparedness and increase stringency of controls. In 2000, outbreaks affected South Africa, and in February 2001, the United Kingdom of Great Britain and Northern Ireland, from where it spread to three other European Union countries. The story has remarkable parallels to the COVID-19 emergence; from the warning signs to the overwhelming speed of the epidemic and demands upon health systems. The WRLFMD services, in tracking the emergence of new viruses provide vital information as well as critical thinking on why some viruses elude biosecurity barriers. Since 2001, with the formation of the World Organisation for Animal Health (OIE)/Food and Agriculture Organization of the United Nations (FAO) FMD Laboratory Network, international capacity to detect the signals of pandemic spread are stronger; but only still as good as the quality of surveillance and adequacy of sample submission and speed of the network to share vital viral intelligence.

This report highlights new FMD outbreaks in North Africa (Libya), from where the disease threatens the Maghreb countries; the detection of new serotype O lineages in Pool 2 (Sri Lanka) and the complexities of multiple serotype and topotype co-circulations in Pool 4 (East Africa) that indicate that more frequent and timely virus typing is required. Despite the enhanced surveillance work of the OIE/FAO FMD Laboratory Network, Figure 3 in this report highlights significant and concerning gaps in submissions from Pool 3 (countries in Middle-East and parts of Central Asia), Pool 5 countries in West Africa (Mali, Chad, Niger) and Pool 1 countries (Myanmar and Cambodia). There is also concern for the lack of typing of samples from Malawi given the southerly spread of FMDV from Pool 4 into Pool 3 during 2018–19 and potential for involvement with risk populations in southern Africa. This report also highlights technical improvements in the use of environmental sampling (swabbing) which enabled virus typing of Foot-and-mouth disease virus (FMDV) from Cameroon. Further use of these approaches is encouraged as they allow sequence data to be generated from environments such as markets in the absence of reported disease. All colleagues reading this report are encouraged to assist to increase the submissions from these gap areas. We also welcome feedback on this new report format.

Best wishes,

Keith Sumption (Rome) and

Don King (Pirbright)

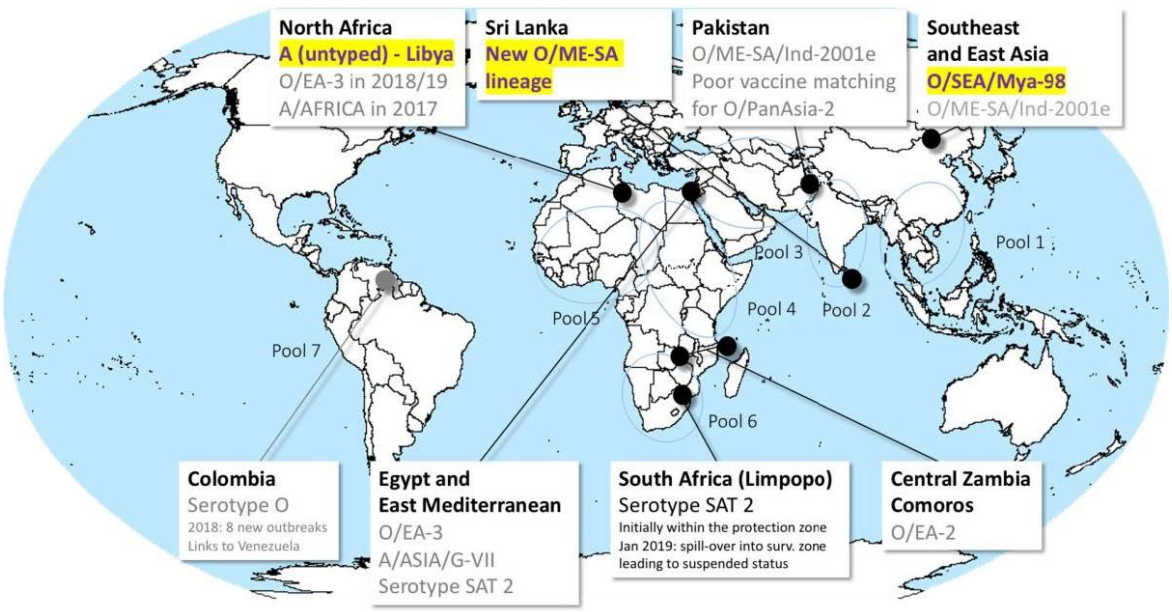


Figure 1: Recent and new headline events (January to March 2020)
Source: WRLFMD. Map conforms to the United Nations World map, February 2020

2. General overview

Endemic Pools represent independently circulating and evolving foot-and-mouth disease virus (FMDV) genotypes; within the pools, cycles of emergence and spread occur that usually affect multiple countries in the region. In the absence of specific reports, it should be assumed that the serotypes indicated below are continuously circulating in parts of the pool area and would be detected if sufficient surveillance was in place.

POOL	REGION/COUNTRIES	SEROTYPES PRESENT
1	**SOUTHEAST ASIA/CENTRAL ASIA/EAST ASIA** Cambodia, China, China (Hong Kong SAR), Taiwan Province of China, Democratic People's Republic of Korea, Republic of Korea, Lao People's Democratic Republic, Malaysia, Mongolia, Myanmar, Russian Federation, Thailand, Viet Nam	A, Asia 1 and O
2	**SOUTH ASIA** Bangladesh, Bhutan, India, Mauritius, Nepal, Sri Lanka	A, Asia 1 and O
3	**WEST EURASIA & MIDDLE EAST** Afghanistan, Armenia, Azerbaijan, Bahrain, Georgia, Iran (Islamic Republic of), Iraq, Israel, Jordan, Kazakhstan, Kuwait, Kyrgyzstan, Lebanon, Oman, Pakistan, Palestine, Qatar, Saudi Arabia, Syrian Arab Republic, Tajikistan, Turkey, Turkmenistan, United Arab Emirates, Uzbekistan	A, Asia 1 and O (SAT 2)*
4	**NORTH AFRICA** Algeria, Egypt, Libya, Morocco, Tunisia	A, O and SAT 2
	EASTERN AFRICA Burundi, Comoros, Djibouti, Eritrea, Ethiopia, Kenya, Rwanda, Somalia, South Sudan, Sudan, Uganda, United Republic of Tanzania, Yemen	O, A, SAT 1, SAT 2 and SAT 3
5	**WEST/CENTRAL AFRICA** Benin, Burkina Faso, Cabo Verde, Cameroon, Central African Republic, Chad, Congo, Côte d'Ivoire, Democratic Republic of the Congo, Equatorial Guinea, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Mauritania, Niger, Nigeria, Sao Tome and Principe, Senegal, Sierra Leone, Togo	O, A, SAT 1 and SAT 2
6	**SOUTHERN AFRICA** Angola, Botswana, Malawi, Mozambique, Namibia, South Africa, Zambia, Zimbabwe	SAT 1, SAT 2 and SAT 3 (O, A)†
7	**SOUTH AMERICA** Colombia, Venezuela (Bolivarian Republic of)	O and A

** Reported only in Oman in 2017*

† only in Angola and north Zambia as spill-over from pool 4

3. Summary of FMD outbreaks and intelligence

3.1. 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 2: Samples tested by WRLFMD or reported in this quarter (coloured spots define serotypes detected (O, A, C, Asia 1, SAT 1, SAT 2, SAT 3, untyped, negative). ● indicates samples analysed; X indicates new outbreaks reported to the OIE, but where results to define the genotype have not been reported; ■ indicated reports of FMD from other sources.

Source: WRLFMD. Map conforms to the United Nations World map, February 2020.

3.2. Pool 1 (Southeast Asia/Central Asia/East Asia)

People's Republic of China

An outbreak of **FMD type O** was reported in cattle on 30 December 2019 at Yandun Animal Health Inspection and Disinfection Station along Highway G30, Yizhou District, Hami, Xinjiang. No genotyping has been reported.

The Russian Federation

An outbreak due to **FMD type O** was reported in cattle on 27January 2020 at Novotsurukhajtuj, Priargunsky, Zabajkal`Skij Kray. The suspected source of infection was a communal cattle watering point on the Argun river along which the national boundary between the Russian Federation and China runs. The VP1 sequence was received from the Federal Governmental Budgetary Institution "Federal Centre for Animal Health" (FGI-ARRIAH) and genotyping showed that it belonged to the SEA topotype, Mya-98 lineage (see below). Immediate Notification and Follow up reports on the World Animal Health Information System (WAHIS, OIE)

3.3. Pool 2 (South Asia)

The Democratic Socialist Republic of Sri Lanka

On 9 January 2020, 23 samples were received. They were collected from cattle (and one water buffalo) between May 2018 and December 2019. **FMD type O** virus was isolated from 15 of the samples, FMDV genome was detected in a further four samples and four were no FMD, SVD or vesicular stomatitis virus detected (NVD). VP1 genotyping showed all 15 belonged to the ME-SA topotype. Twelve of these belonged to the Ind-2001d sublineage, while three were unable to be subgrouped (see below).

3.4. Pool 3 (West Eurasia and Middle East)

The Republic of Turkey

Fifty-two outbreaks were reported in the Anatolia region between January and March 2020 (January: 24 outbreaks, February: 21 outbreaks, March: 7 outbreaks); 82 outbreaks were reported in 2019. FMD is endemic in Anatolia. Currently, only serotype O (O/ME-SA/PanAsia-2/Qom-15) is circulating. Serotypes A and Asia-1 have not been detected since January 2018 and July 2015, respectively. The Thrace Region of Turkey has been free from FMD (with vaccination) since May 2010.

Reported by Turkish Veterinary Authority and Veterinary Information System of Turkey (VETBIS).

The Islamic Republic of Pakistan

A batch of 50 samples was received on the 16 March 2020. Testing is in progress and results will be reported in the next quarterly report.

3.5. Pool 4 (North and Eastern Africa)

The Arab Republic of Egypt

Eleven **FMD type SAT 2** VP1 sequences were retrieved from GenBank. They were submitted by International Facility For Veterinary Vaccines Production (MEVAC)Cairo, Egypt, and consist of viruses from three locations, Alexandria, Ismailia and Sharqia, collected in 2018. Genotyping showed them all to belong to topotype VII, lineage Lib-12 (see below).

The State of Eritrea

A batch of 47 samples was received on 18 December 2019. Samples were collected from cattle, sheep and pigs between October 2015 and November 2019, but no locations were given. **FMD type O** virus was isolated from six samples, **FMD type A** virus from one sample and **FMD type SAT 2** virus from 15 samples. FMDV genome was detected in a further 16 samples and the remaining nine were NVD. VP1 genotyping reveals that the type O viruses belonged to the EA-3 topotype; the single type A virus belonged to the AFRICA topotype, G-IV lineage; and the SAT 2 viruses all belonged to topotype VII, Lib-12 lineage (see below).

State of Libya

An outbreak of FMD type A was reported to have occurred on 11 February 2020 in sheep in the Tarabulus Governorate. No genotyping has been reported. Immediate Notification and Follow up reports on WAHIS, OIE

The Republic of Uganda

On 18 January 2020, 158 FMDV VP1 sequences were retrieved from GenBank. They had been submitted by the Plum Island Animal Disease Center (PIADC) and were from probang samples collected from cattle in 2016 and 2017. There were 67 **FMD type O**, 4 **FMD type A**, 54 **FMD type SAT 1** and 33 **FMD type SAT 2**. Sixty-five of the type O viruses belonged to the EA-2 topotype and two belonged to the EA-4 topotype. All four type A viruses belonged to the G-I lineage of the AFRICA topotype. The 54 SAT 1 viruses belonged to topotype I and are the first description of this topotype in Uganda. Two of the SAT 2 viruses belonged to topotype IV and 31 to topotype VII (see below).

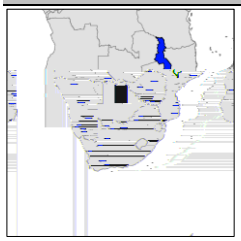
3.6. Pool 5 (West/Central Africa)

The Republic of Cameroon

An environmental sample, collected in Bertoua on 20 June 2019, was processed at the Pirbright Institute. The sample was taken as part of an EuFMD-funded project awarded to the Emerging Infectious Disease Research Association (EIDRA), based at the University of Buea, Cameroon. It was submitted to the WRLFMD for sequence analysis. Generation of sequence data using an Illumina MiSeq allowed the VP1 genotyping to be undertaken. The sample was shown to contain **FMD type O** virus which belonged to the EA-3 topotype (see below).

3.7. Pool 6 (Southern Africa)

The Republic of Malawi



An outbreak of **FMD** (so far untyped) was reported to have occurred on 6 February 2020 in cattle in the Ntcheu district, Central Region.

The Republic of Namibia

A single **FMD type SAT 3** VP1 sequence was submitted by the Sub-Saharan Africa Regional Reference Laboratory (SSARRL) Botswana Vaccine Institute (BVI) on 15 January 2020. This was derived from a sample collected from cattle in the Zambezi Region in 2019. Genotyping showed that the causal virus belonged to topotype II (see below).

The Republic of South Africa

During January 2020, a further four outbreaks due to **FMD type SAT 2** were reported in cattle in the municipalities of Polokwane, Makhado and Ba-Phalaborwa (Limpopo Province: Immediate Notification and Follow up reports on WAHIS, OIE). In March 2020, six outbreaks due to **FMD type SAT 2** were reported in cattle in Bushbuckridge, Mpumalanga Province Immediate Notification and Follow up reports on WAHIS, OIE. All these outbreaks occurred in South Africa's FMD Protection Zone. Although detailed genotyping has not been reported, the OVI has stated that the two sets of outbreaks were caused by different FMD viruses.

3.8. Pool 7 (South America)

No new outbreaks of FMD were reported in the continent.

3.9. Extent of global surveillance

Figure 3: Samples received during 2019 from FMD outbreaks. Draft data for sample testing undertaken by laboratories within the OIE/FAO FMD Reference Laboratory Network (www.foot-and-mouth.org)
Source: WRLFMD. Map conforms to the United Nations World map, February 2020

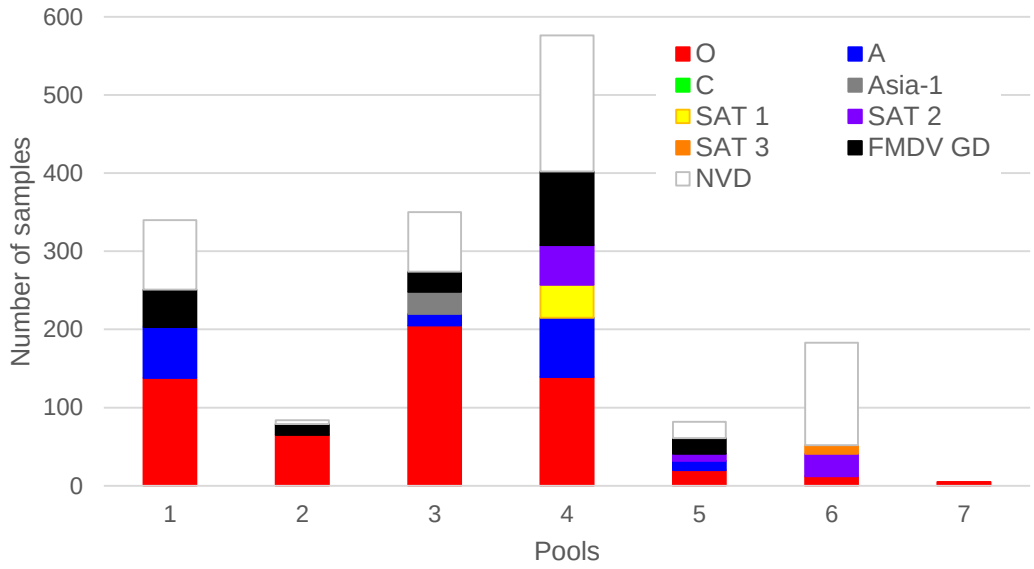


Figure 4: Representation of different FMDV serotypes detected in samples tested from the FMD endemic pools by the OIE/FAO FMD Laboratory Network during 2019 (draft data)

In regions where FMD is endemic, continuous evolution of the virus generates geographically discrete lineages that are genetically distinct from FMD viruses found elsewhere. This report displays how different FMD lineages circulate in different regions; these analyses accommodate the latest epidemiological intelligence to assess the relative importance of the viral strains circulating within each regions (see Table 1, sotto).

Table 1: Conjectured relative prevalence of circulating FMD viral lineages in each Pool. For each of the regions, data represent the relative importance of each viral lineage [prevalence score estimated as a proportion (%) of total FMD cases that occur in domesticated hosts].

Lineage	Southeast / Central / East Asia [Pool 1]	South Asia [Pool 2]	West Eurasia & Middle East [Pool 3]	North Africa	Eastern Africa [Pool 4]	West / Central Africa [Pool 5]	Southern Africa [Pool 6]	South America [Pool 7]
O ME-SA PanAsia-2			35					
O ME-SA PanAsia	10							
O SEA Mya-98	33							
O ME-SA Ind2001	20	80	6	10				
O EA or O WA			3	55	55	70		
O EURO-SA								80
O CATHAY	10.5							
A ASIA Sea-97	25							
A ASIA Iran-05	0		25.5					
A ASIA G-VII		16	17.5					
A AFRICA				25	22	15		
A EURO-SA								20
Asia-1	1.5	4	12.5					
SAT 1				0	8	5	27	
SAT 2			0.5	10	14	10	57	
SAT 3					1		16	
C								

A number of outbreaks have occurred where samples have not been sent to the WRLFMD or other laboratories in the OIE/FAO FMD Laboratory Network. 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-2020.

Results from samples or sequences received at WRLFMD (status of samples being tested) are shown in Table 2 and a complete list of clinical sample diagnostics made by the WRLFMD from January to March 2020 is shown in Annex 1: (Summary of submissions). A record of all samples received by WRLFMD is shown in Annex 1: (Clinical samples).

Table 2: Status of sequencing of samples or sequences received by the WRLFMD from January to March 2020 (* 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/2019/00031	18/12/2019	Eritrea	O	6	6	completed
			A	1	1	completed
			SAT2	15	15	completed
WRLMEG/2019/00044	28/10/2019	Cameroon	O	1	1	completed
WRLFMD/2020/00001	09/01/2020	Sri Lanka	O	15	15	completed
WRLFMD/2020/00002	16/03/2020	Pakistan	pending	50		pending
			Total	**88**	**38**	

Table 3: VP1 sequences submitted by other FMD Network laboratories to the WRLFMD from January to March 2020 (* indicates sequences retrieved from GenBank).

WRLFMD Batch No.	Date received	Country	Serotype	Date Collected	No. of sequences	Submitting laboratory
WRLMEG/2020/00002	15/01/2020	Namibia	SAT3	2019	1	BVI
WRLMEG/2020/00003	18/01/2020	Uganda	O	2016	67	PIADC*
			A	2016	4	
			SAT1	2016	54	
			SAT2	2016-2017	33	
WRLMEG/2020/00004	28/01/2020	Egypt	SAT2	2018	11	MEVAC*
WRLMEG/2020/00009	04/02/2020	Russian Federation	O	2020	1	ARRIAH
				Total	**171**	

4. Detailed analysis

Key for maps and trees

Result of analysis	Symbol	
Serotype O	●	UKG 99/9999
Serotype A	●	UKG 99/9999
Serotype C	●	UKG 99/9999
Serotype Asia-1	●	UKG 99/9999
Serotype SAT 1	●	UKG 99/9999
Serotype SAT 2	●	UKG 99/9999
Serotype SAT 3	●	UKG 99/9999
FMDV Genome Detected (FMD GD)	●	UKG 99/9999
No Virus Detected (NVD)	○	UKG 99/9999

4.1. Pool 1 (Southeast Asia/Central Asia/East Asia)

The Russian Federation

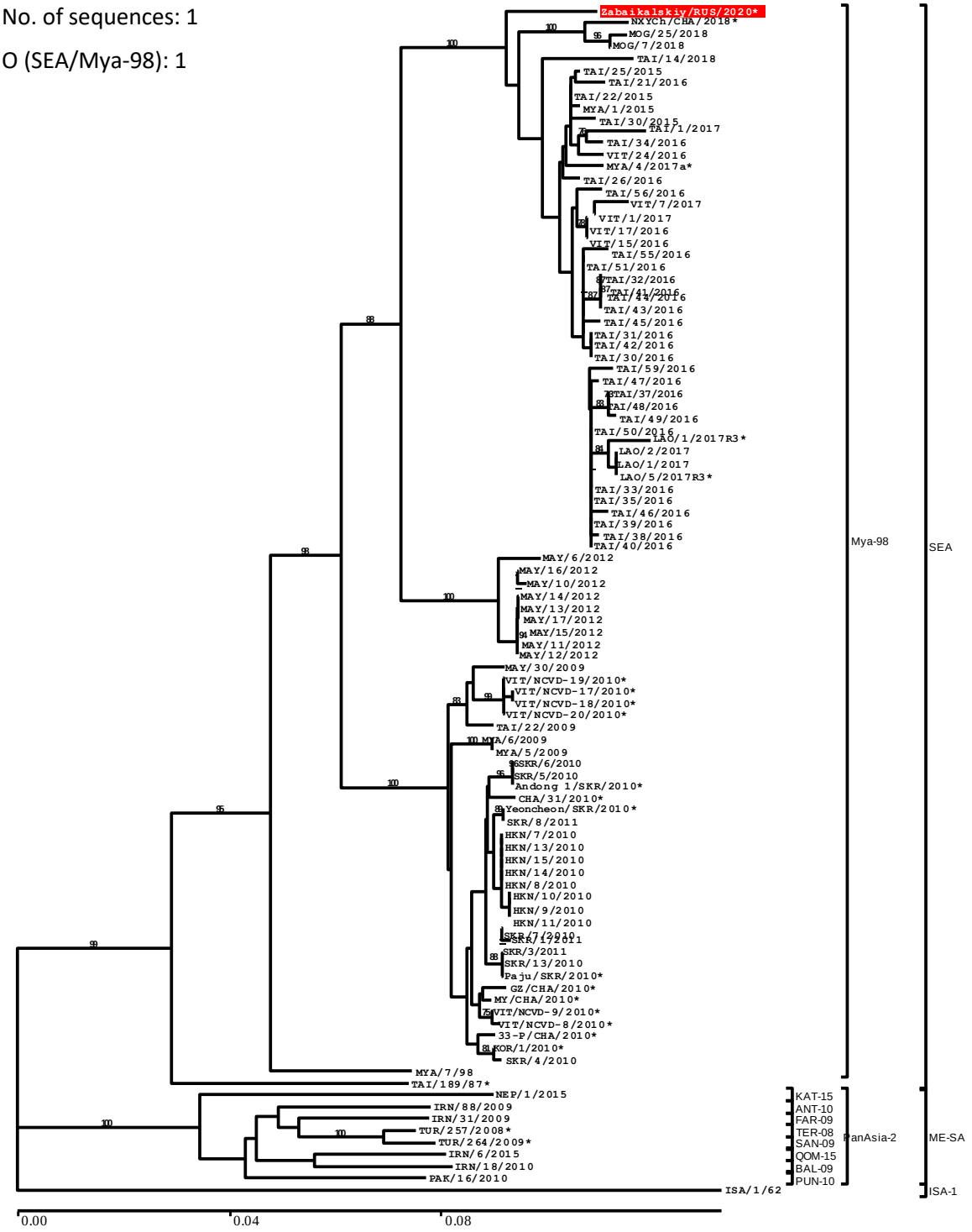
Batch: WRLMEG/2020/00009

Submitted by: ARRIAH

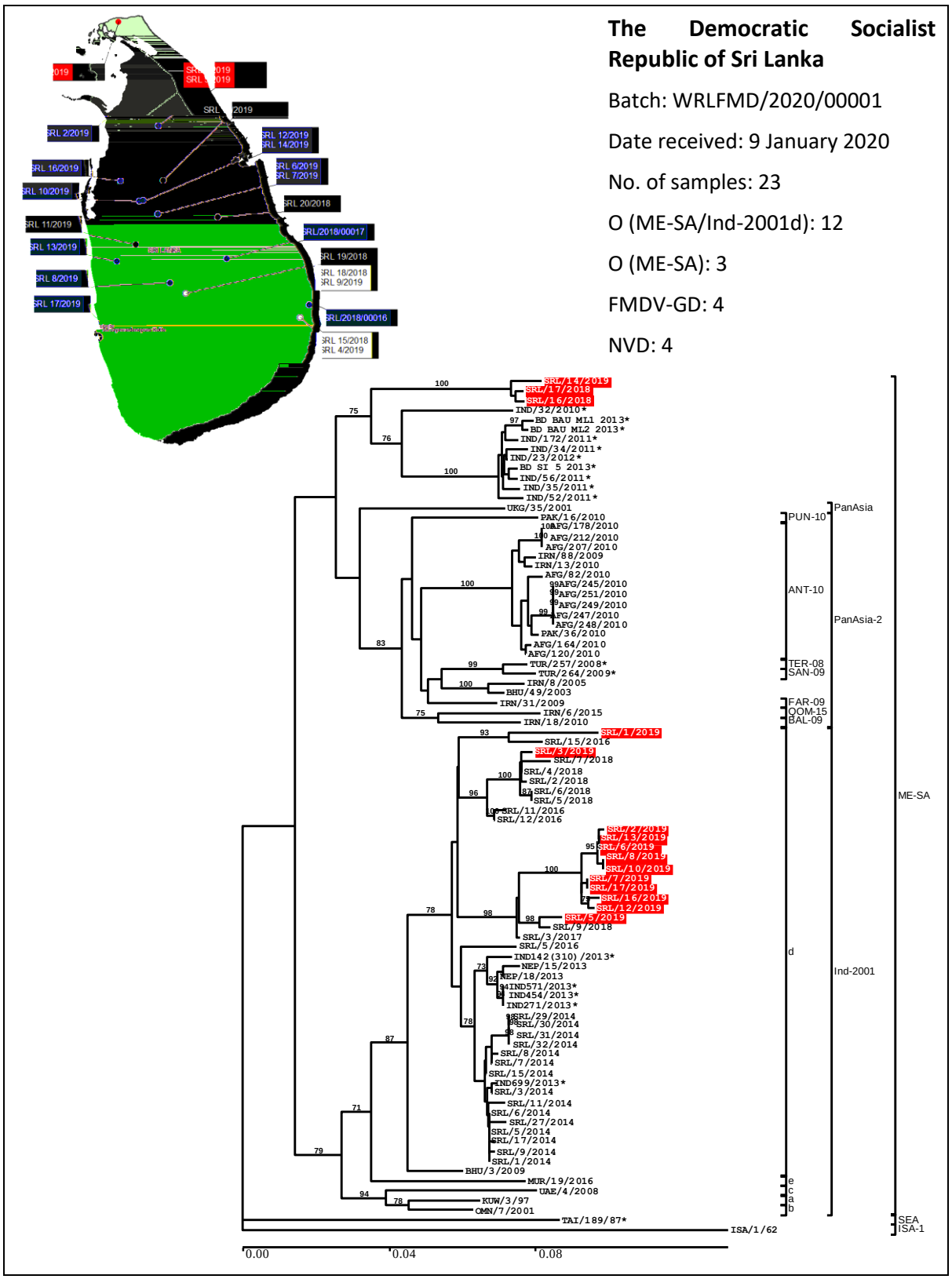
Date received: 4 February 2020

No. of sequences: 1

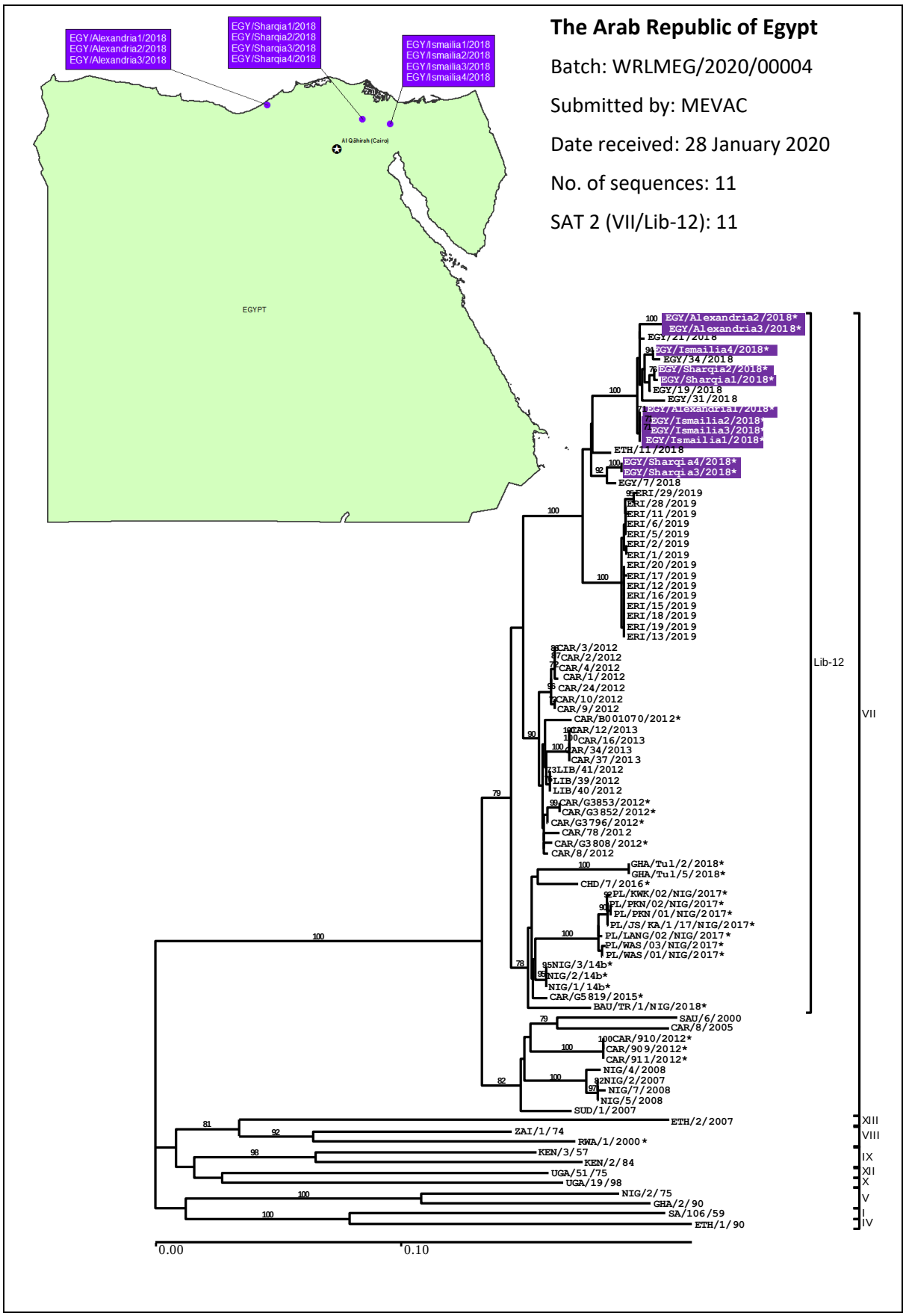
O (SEA/Mya-98): 1

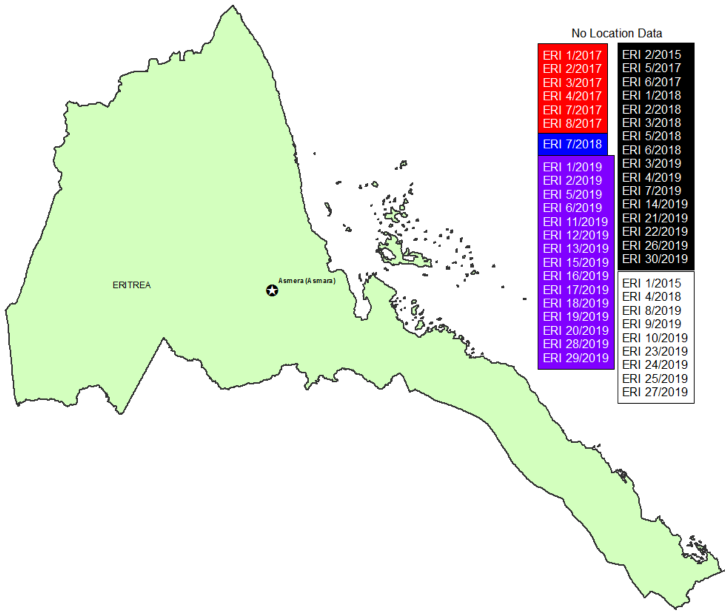


4.2. Pool 2 (South Asia)



4.3. Pool 4 (North and Eastern Africa)





The State of Eritrea

Batch: WRLFMD/2019/00031

Date received: 18 December 2019

No. of Samples: 47

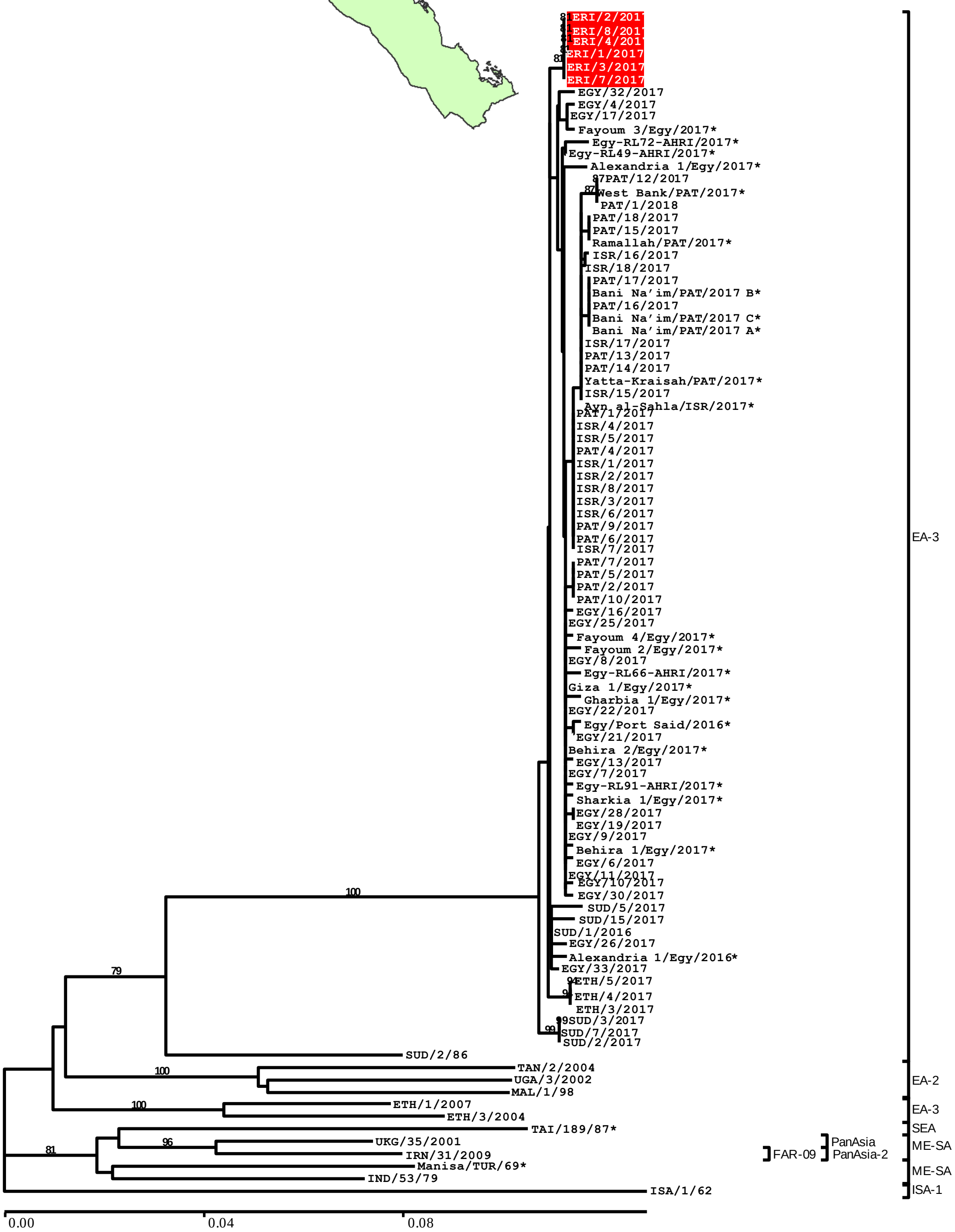
O (EA-3): 6

A (AFRICA/G-IV): 1

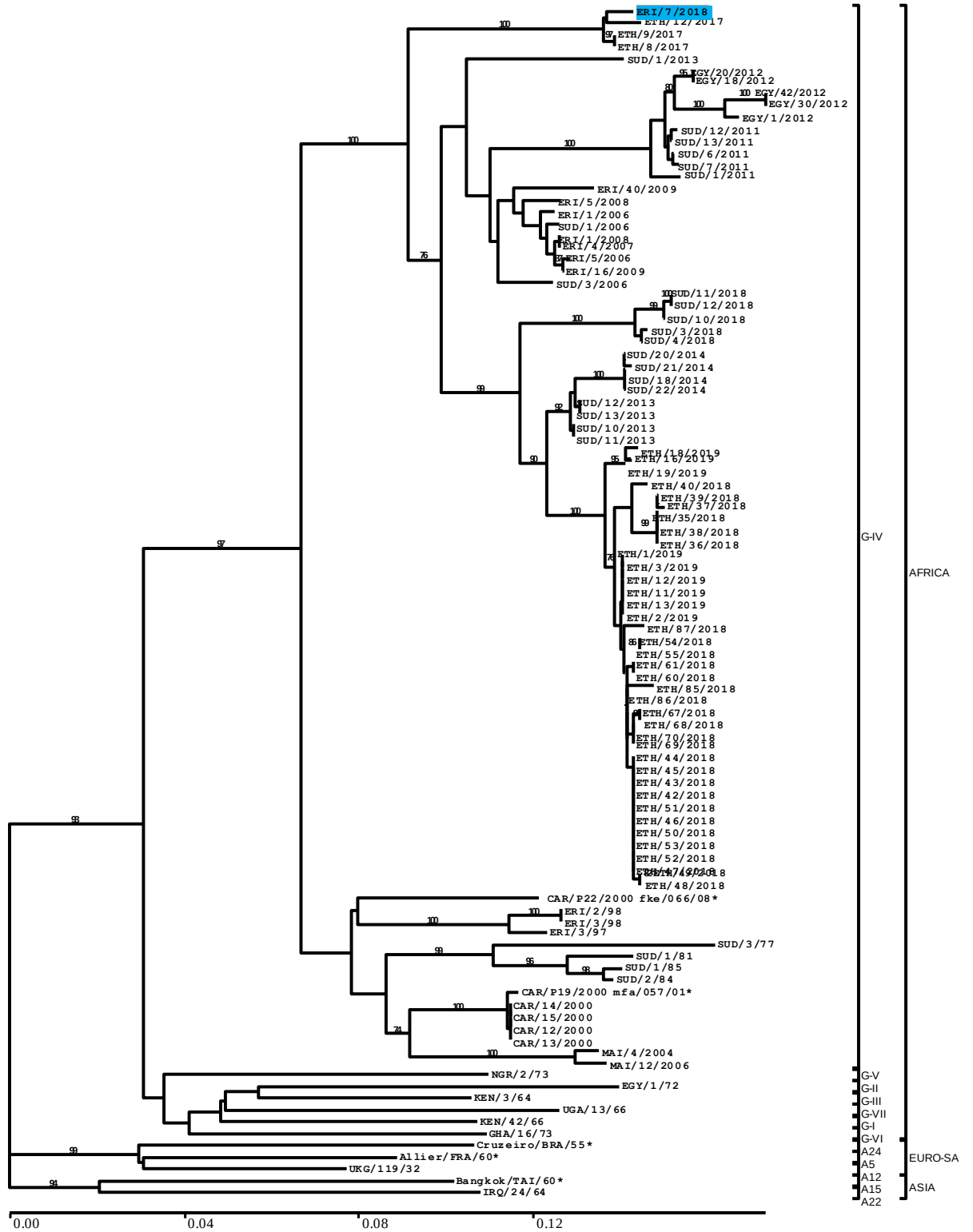
SAT 2 (VII/Lib-12): 15

FMDV-GD: 16

NVD: 9



Eritrea contiunued



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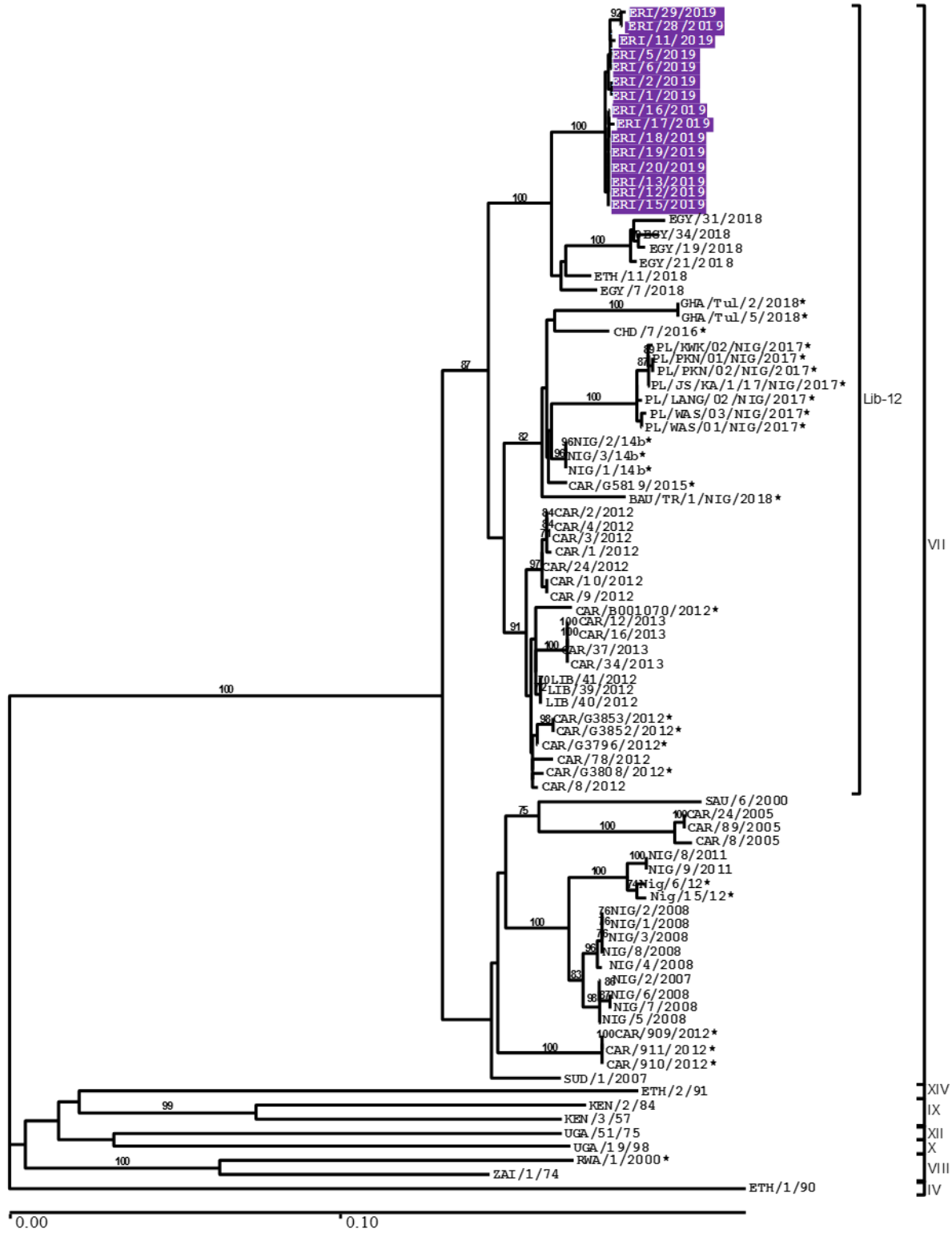
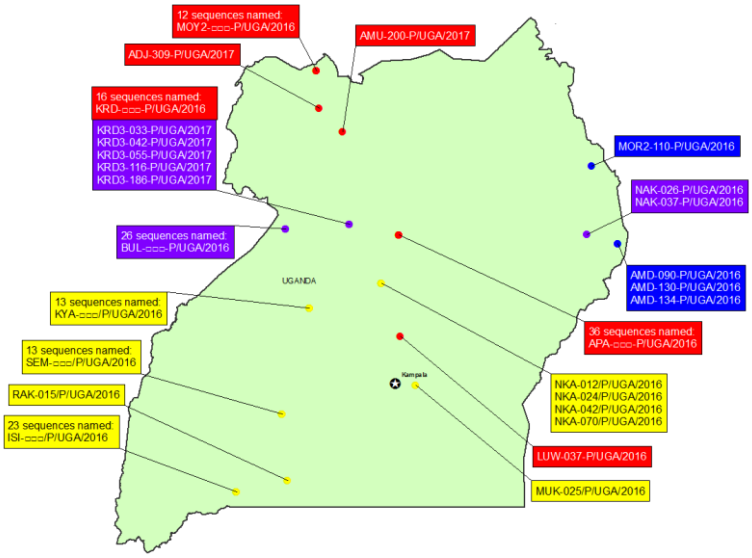
Eritrea contiunued





The Republic of Uganda

Batch: WRLMEG/2020/00003

Submitted by: PIADC

Date received: 18 January 2020

No. of sequences: 158

O (EA-2): 65

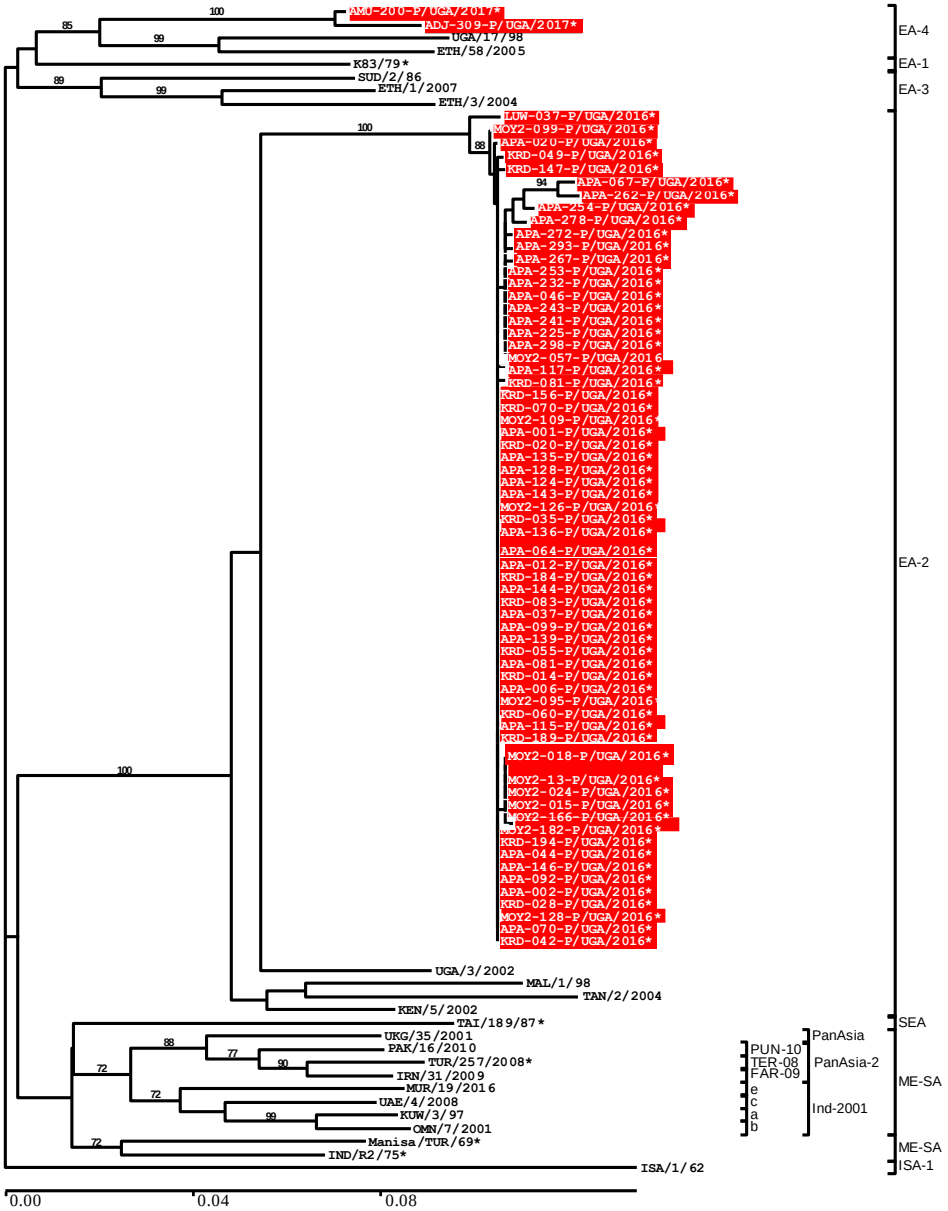
O (EA-4): 2

A (AFRICA/G-I): 4

SAT 1 (I (NWZ)): 54

SAT 2 (IV): 2

SAT 2 (VII): 31



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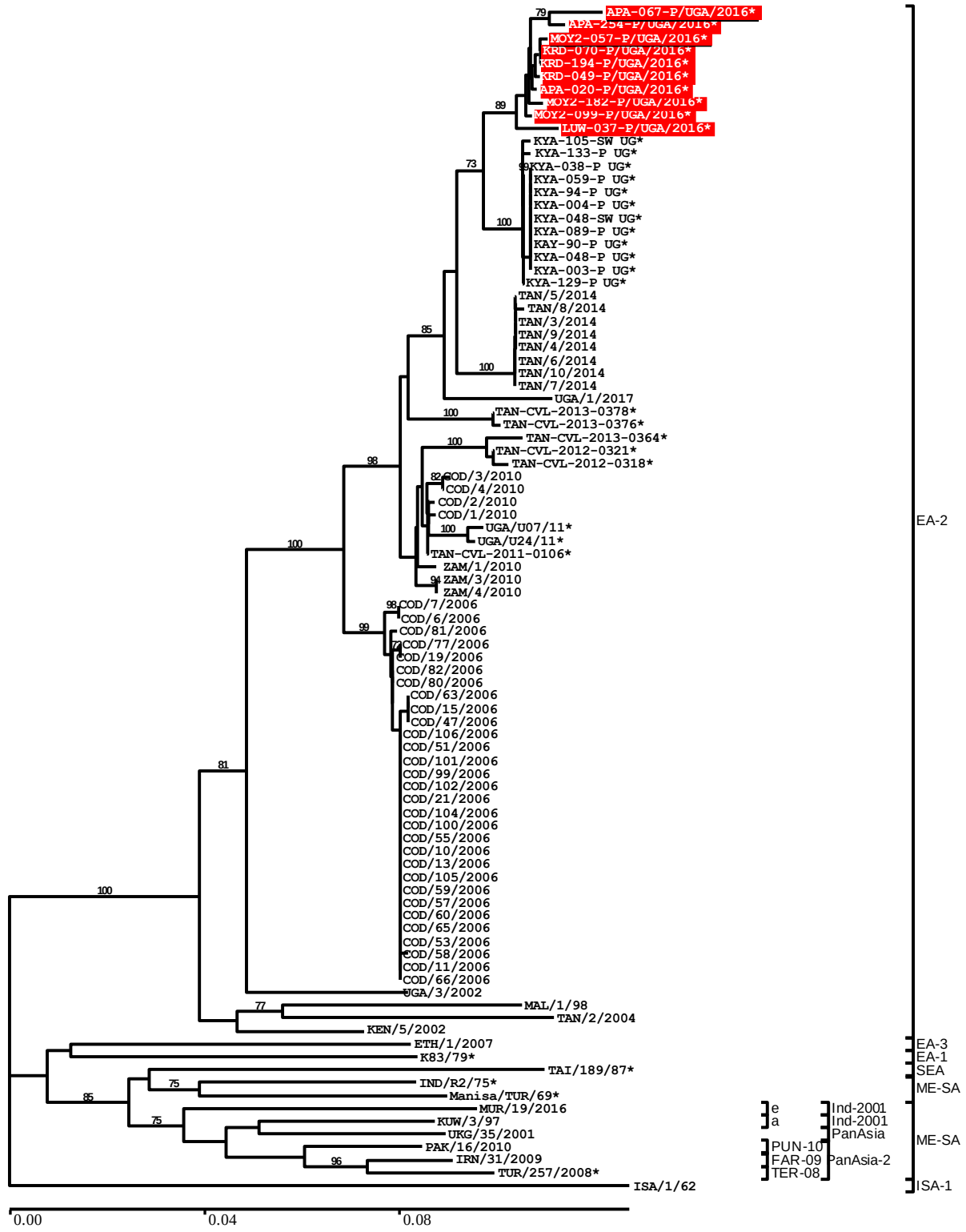

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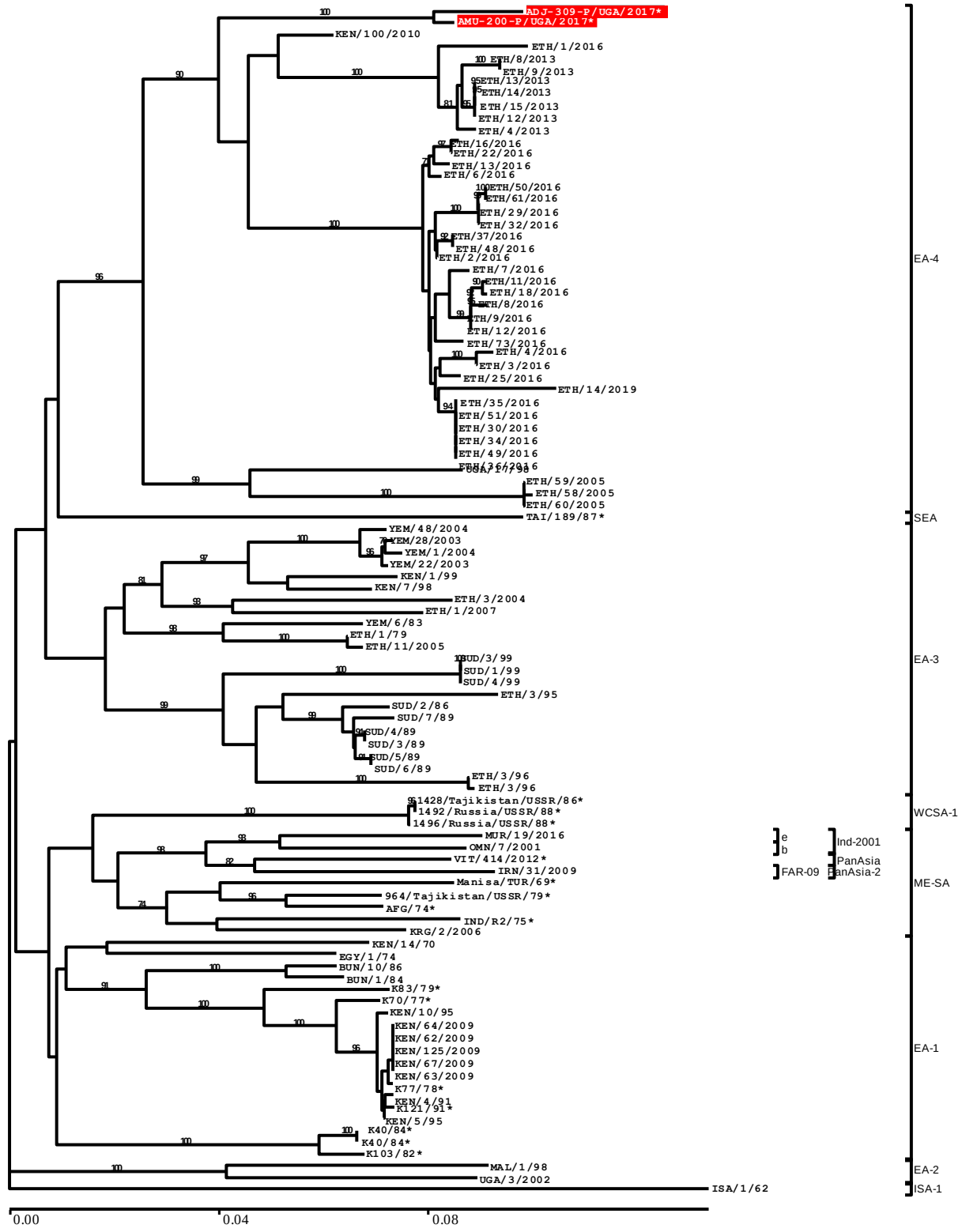

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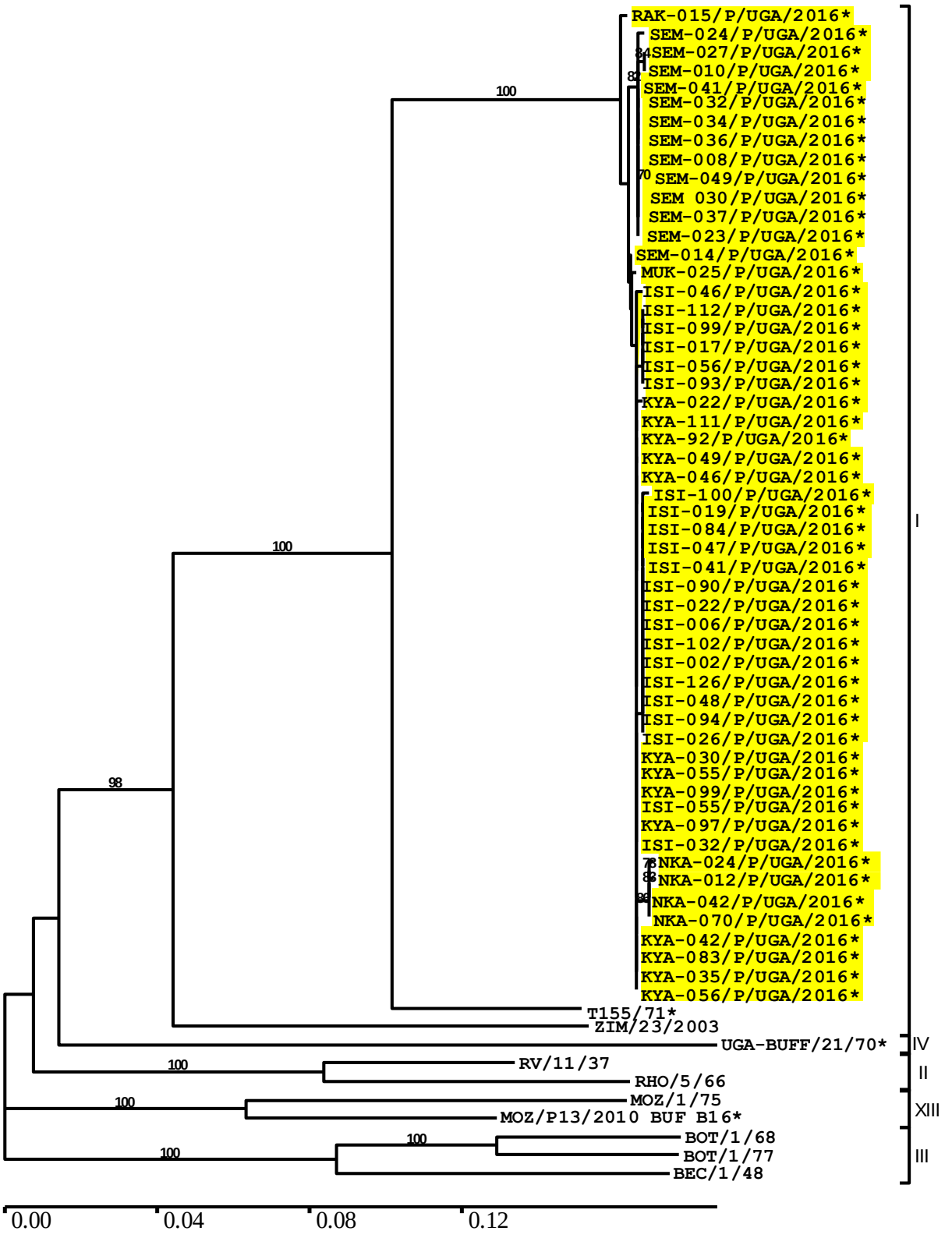

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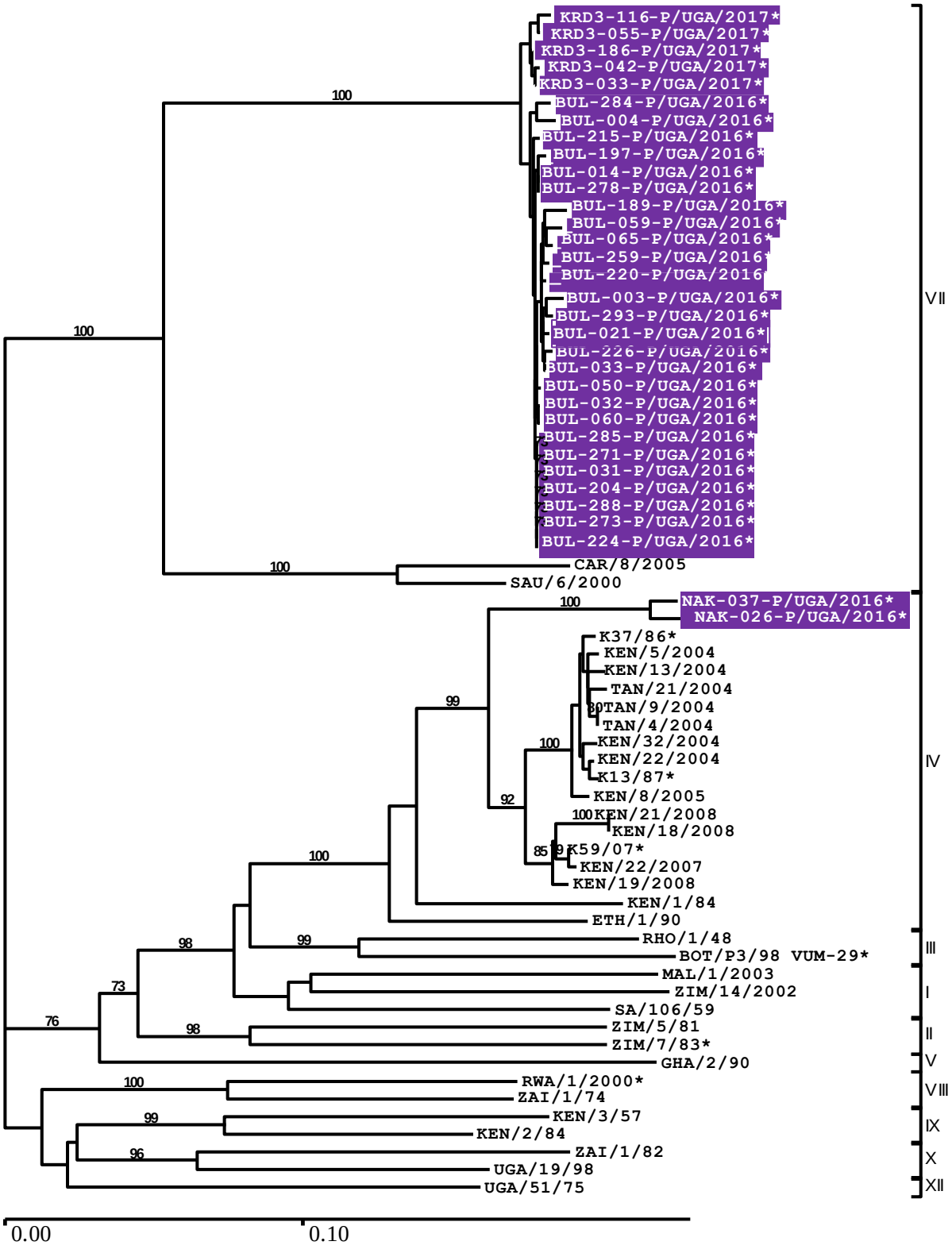

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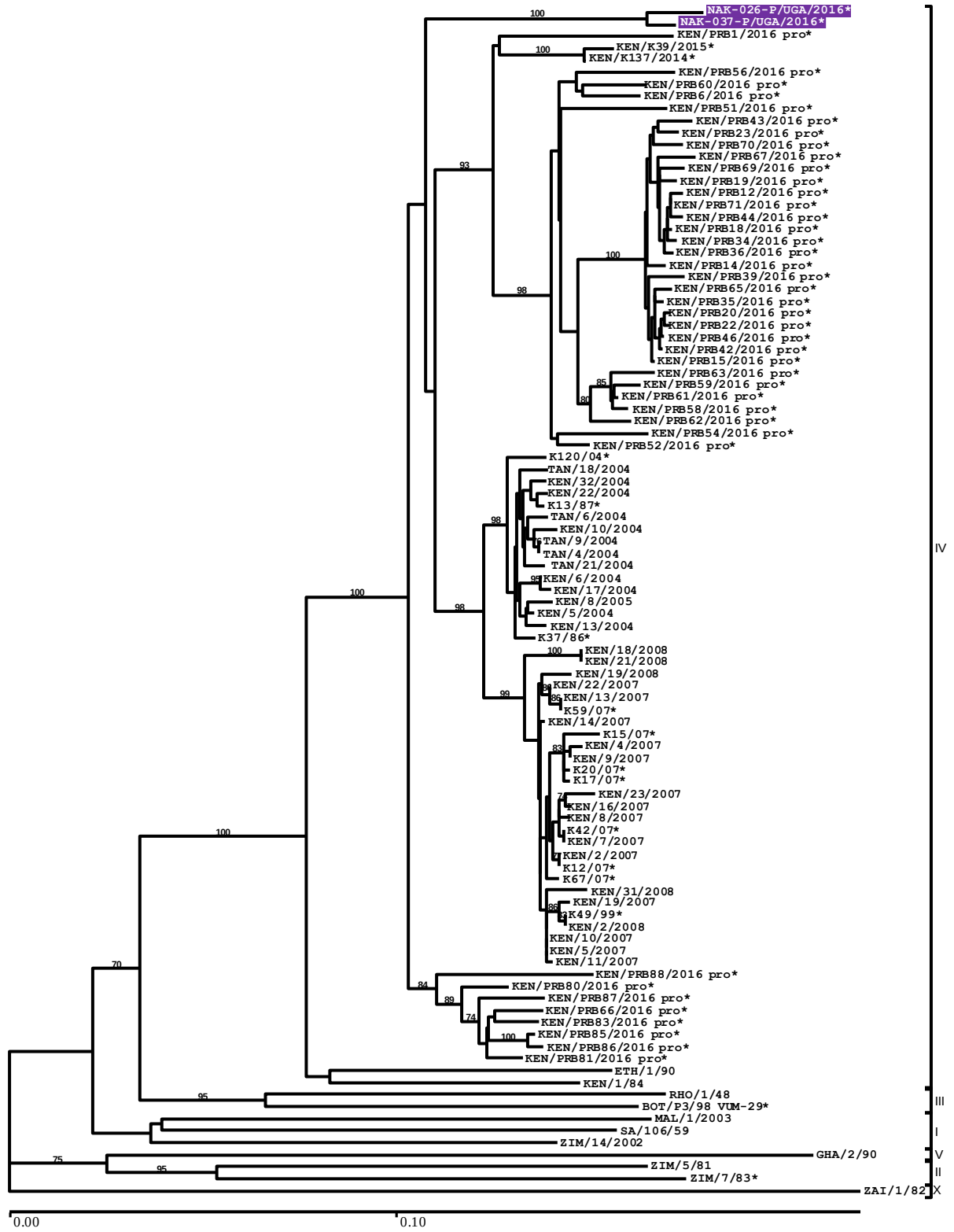
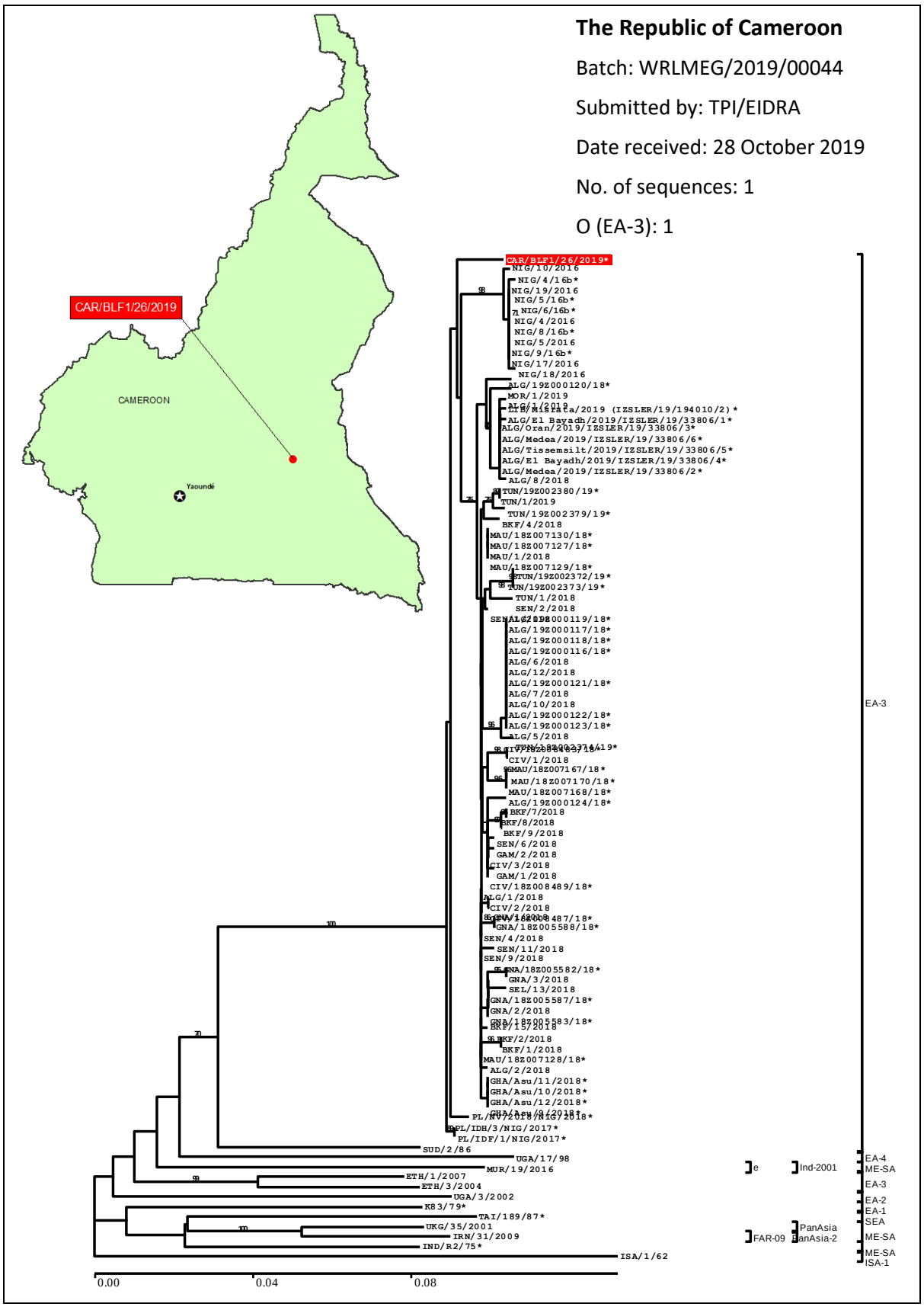
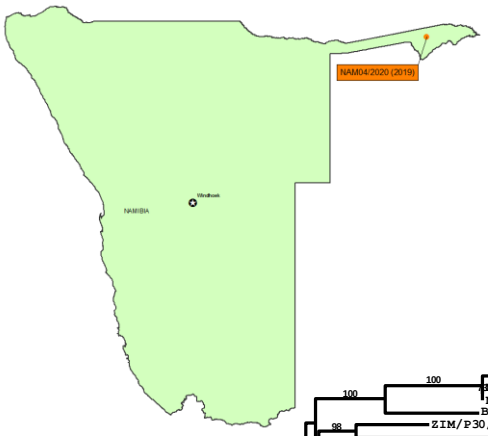


4.4. Pool 5 (West/Central Africa)



4.5. Pool 6 (Southern Africa)



The Republic of Namibia

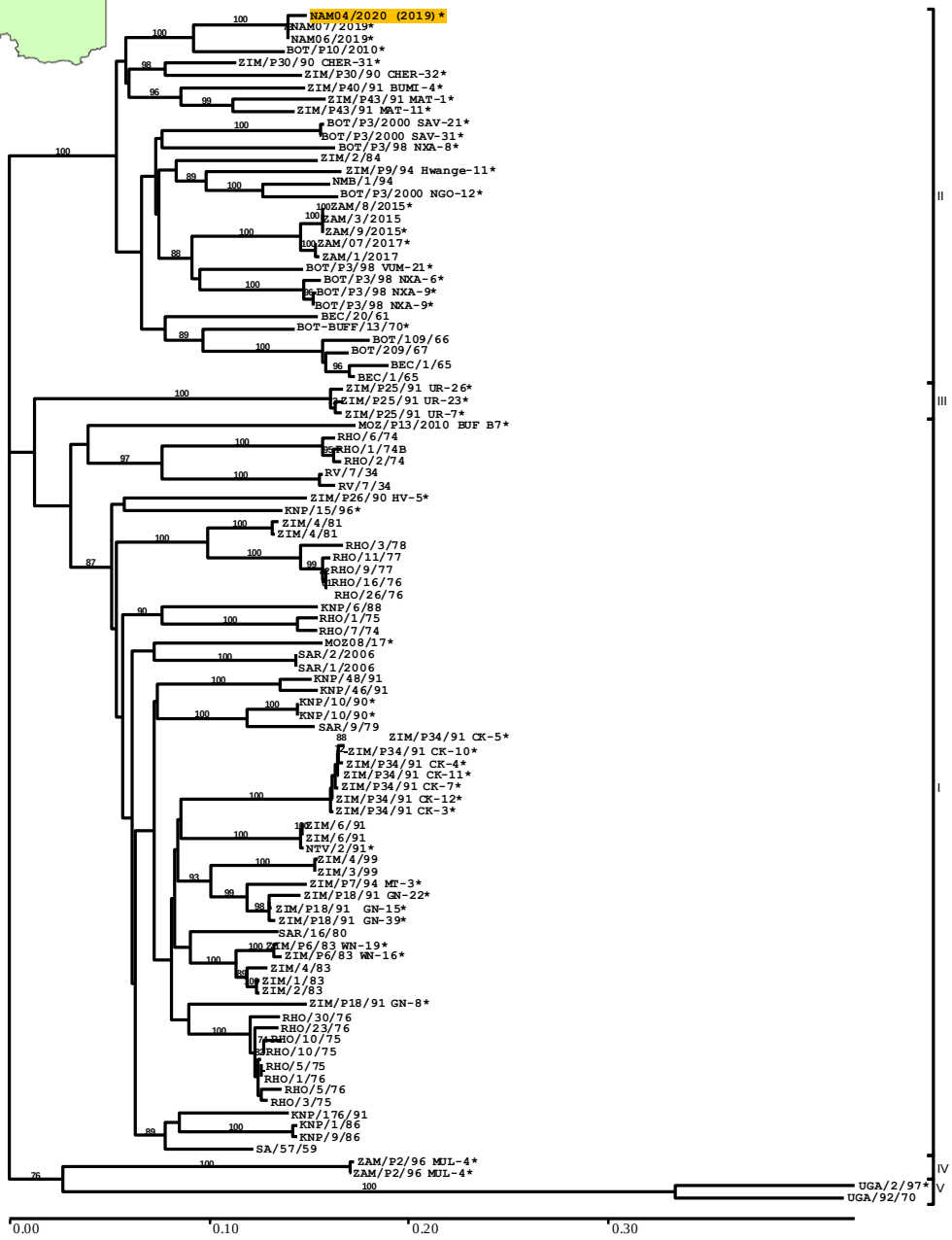
Batch: WRLMEG/2020/00002

Submitted by: BVI

Date received: 15 January 2020

No. of sequences: 1

SAT 3 (II): 1



4.6. Vaccine matching

Antigenic characterisation of FMD field isolates by matching with vaccine strains by 2dmVNT from January to March 2020. During this reporting period vaccine matching has been undertaken for 14 FMD virus field isolates. In addition, vaccine antigen A SAU/95, has been tested against recent isolates from Africa (Table 8, sotto).

Table 4: Summary of samples tested by vaccine matching

Serotype	O	A	C	Asia-1	SAT 1	SAT 2	SAT 3
Egypt	1	1				3	
Eritrea	2	1				2	
Sri Lanka	4						
Total	**7**	**2**	**0**	**0**	**0**	**5**	**0**

Abbreviations used in tables

M	Vaccine Match *r_1 = ≥ 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*
B	Borderline *Any r_1 values between 0.28 to 0.32*
NT	Not tested against this vaccine

Table 5: 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/G-VII		A/SAU/95	
				neut	r1 value	neut	r1 value	neut	r1 value	neut	r1 value	neut	r1 value	neut	r1 value
EGY 2/2018	A	AFRICA	G-IV	1.46	0.03	0.96	0.11	1.51	0.12	2.18	0.42	0.00	0.00		
ERI 7/2018	A	AFRICA	G-IV	1.45	0.10	0.77	0.07	1.79	0.23					1.26	0.08

Table 6: Vaccine matching studies for O FMDV by VNT

Strain	Serotype	Topotype	Lineage	O 3039		O1 Manisa		O/TUR/5/2009	
				neut	r1 value	neut	r1 value	neut	r1 value
EGY 34/2017	O	EA-3	-	1.80	0.69	2.21	0.47	1.88	0.50
ERI 3/2017	O	EA-3	-	1.81	0.54	2.02	0.42	1.93	0.39
ERI 8/2017	O	EA-3	-	1.93	0.71	2.02	0.49	1.95	0.45
SRL 16/2018	O	ME-SA	-	1.75	0.59	1.94	0.34	2.04	0.62
SRL 14/2019	O	ME-SA	-	1.79	0.79	2.12	0.49	2.11	0.83
SRL 1/2019	O	ME-SA	Ind-2001	1.77	0.76	2.03	0.40	2.10	0.81
SRL 17/2019	O	ME-SA	Ind-2001	1.80	0.66	2.08	0.47	2.15	0.79

Table 7: Vaccine matching studies for SAT 2 FMDV by VNT

Strain	Serotype	Topotype	Lineage	SAT 2/ERI		SAT 2/ZIM	
				neut	r1 value	neut	r1 value
EGY 1/2018	SAT 2	VII	Ghb-12	1.34	0.28	1.37	0.11
EGY 7/2018	SAT 2	VII	Lib-12	1.72	0.83	1.96	0.32
EGY 34/2018	SAT 2	VII	Lib-12	1.71	0.81		
ERI 19/2019	SAT 2	VII	Lib-12	1.57	0.68	1.80	0.25
ERI 28/2019	SAT 2	VII	Lib-12	1.62	0.76	1.80	0.25

Table 8: Additional vaccine-matching undertaken for the A SAU/95 vaccine antigen with 14 recent serotype A viruses from Africa

			A SAU 95	
Serotype	**Lineage**	**Sample**	**neut.**	**r_1**
A	G-I	KEN 14/17	1.76	0.24
A	G-I	KEN 17/17	1.92	0.36
A	G-I	ZAM 04/18	1.58	0.16
A	G-I	ZAM 05/18	1.57	0.16
A	G-I	UG28/19	1.67	0.21
A	G-I	UG42/19	1.64	0.18
A	G-IV	ALG 02/17	2.16	0.70
A	G-IV	ALG 03/17	2.13	0.62
A	G-IV	EGY 19/16	1.62	0.19
A	G-IV	EGY 02/18	1.55	0.16
A	G-IV	SUD 09/18	0.81	0.09
A	G-IV	SUD 10/18	1.79	0.28
A	G-IV	ETH 35/18	1.30	0.09
A	G-IV	ETH 48/18	0.67	0.05

Annex 1: Sample data

Summary of submissions

Table 9: Summary of samples collected and received to WRLFMD (January to March 2020)

Country	Nº of samples	Virus isolation in cell culture/ELISA								RT-PCR for FMD	
		FMD virus serotypes							No Virus Detected		
		O	*A*	*C*	*SAT 1*	*SAT 2*	*SAT 3*	*ASIA-1*		*Positive*	*Negative*
Eritrea	47	6	1	-	-	15	-	-	25	38	9
Sri Lanka	23	15	-	-	-	-	-	-	8	19	4
TOTAL	**70**	**21**	**1**	**0**	**0**	**15**	**0**	**0**	**33**	**57**	**13**

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

Clinical samples

Table 10: Clinical sample diagnostics made by the WRLFMD January to March 2020

Country	Date		WRL for FMD Sample Identification	Animal	Date of Collection	Results		
	Received	Reported				VI/ELISA	RT-PCR	Final report
Eritrea	18/12/2019	27/01/2020	ERI 1/2015	Bovine	19/10/2015	NEG	NEG	NVD
			ERI 2/2015	Bovine	19/10/2015	NEG	POS	FMDV GD
			ERI 1/2017	Bovine	22/03/2017	O	POS	O
			ERI 2/2017	Bovine	22/03/2017	O	POS	O
			ERI 3/2017	Bovine	22/03/2017	O	POS	O
			ERI 4/2017	Bovine	22/03/2017	O	POS	O
			ERI 5/2017	Swine	27/03/2017	NEG	POS	FMDV GD
			ERI 6/2017	Swine	27/03/2017	NEG	POS	FMDV GD
			ERI 7/2017	Swine	27/03/2017	O	POS	O
			ERI 8/2017	Swine	27/03/2017	O	POS	O

Country	Date		WRL for FMD Sample Identification	Animal	Date of Collection	Results		
	Received	Reported				VI/ELISA	RT-PCR	Final report
			ERI 1/2018	Bovine	13/01/2018	NEG	POS	FMDV GD
			ERI 2/2018	Bovine	13/01/2018	NEG	POS	FMDV GD
			ERI 3/2018	Bovine	17/10/2018	NEG	POS	FMDV GD
			ERI 4/2018	Bovine	17/10/2018	NEG	NEG	NVD
			ERI 5/2018	Bovine	17/10/2018	NEG	POS	FMDV GD
			ERI 6/2018	Bovine	17/10/2018	NEG	POS	FMDV GD
			ERI 7/2018	Bovine	17/10/2018	A	POS	A
			ERI 1/2019	Bovine	18/09/2019	SAT 2	POS	SAT 2
			ERI 2/2019	Bovine	18/09/2019	SAT 2	POS	SAT 2
			ERI 3/2019	Bovine	24/09/2019	NEG	POS	FMDV GD
			ERI 4/2019	Bovine	24/09/2019	NEG	POS	FMDV GD
			ERI 5/2019	Bovine	25/09/2019	SAT 2	POS	SAT 2
			ERI 6/2019	Bovine	25/09/2019	SAT 2	POS	SAT 2
			ERI 7/2019	Bovine	27/09/2019	NEG	POS	FMDV GD
			ERI 8/2019	Bovine	27/09/2019	NEG	NEG	NVD
			ERI 9/2019	Bovine	27/09/2019	NEG	NEG	NVD
			ERI 10/2019	Ovine	29/09/2019	NEG	NEG	NVD
			ERI 11/2019	Bovine	29/09/2019	SAT 2	POS	SAT 2
			ERI 12/2019	Bovine	29/10/2019	SAT 2	POS	SAT 2
			ERI 13/2019	Bovine	29/10/2019	SAT 2	POS	SAT 2
			ERI 14/2019	Bovine	29/10/2019	NEG	POS	FMDV GD
			ERI 15/2019	Bovine	29/10/2019	SAT 2	POS	SAT 2
			ERI 16/2019	Bovine	29/10/2019	SAT 2	POS	SAT 2
			ERI 17/2019	Bovine	29/10/2019	SAT 2	POS	SAT 2
			ERI 18/2019	Bovine	29/10/2019	SAT 2	POS	SAT 2
			ERI 19/2019	Bovine	29/10/2019	SAT 2	POS	SAT 2
			ERI 20/2019	Bovine	29/10/2019	SAT 2	POS	SAT 2
			ERI 21/2019	Bovine	19/11/2019	NEG	POS	FMDV GD
			ERI 22/2019	Bovine	19/11/2019	NEG	POS	FMDV GD
			ERI 23/2019	Bovine	19/11/2019	NEG	NEG	NVD
			ERI 24/2019	Bovine	19/11/2019	NEG	NEG	NVD
			ERI 25/2019	Bovine	19/11/2019	NEG	NEG	NVD
			ERI 26/2019	Bovine	25/11/2019	NEG	POS	FMDV GD
			ERI 27/2019	Bovine	25/11/2019	NEG	NEG	NVD
			ERI 28/2019	Bovine	25/11/2019	SAT 2	POS	SAT 2
			ERI 29/2019	Bovine	25/11/2019	SAT 2	POS	SAT 2
			ERI 30/2019	Bovine	25/11/2019	NEG	POS	FMDV GD
Sri Lanka	9/01/2020	24/01/2020	SRL 15/2018	Cattle	09/05/2018	NEG	NEG	NVD
			SRL 16/2018	Cattle	23/05/2018	O	POS	O
			SRL 17/2018	Cattle	25/05/2018	O	POS	O
			SRL 18/2018	Cattle	02/08/2018	NEG	NEG	NVD
			SRL 19/2018	Cattle	02/08/2018	NEG	POS	FMDV GD
			SRL 20/2018	Cattle	08/11/2018	NEG	POS	FMDV GD
			SRL 1/2019	Cattle	10/01/2019	O	POS	O
			SRL 2/2019	Cattle	14/02/2019	O	POS	O

Country	Date		WRL for FMD Sample Identification	Animal	Date of Collection	Results		
	Received	Reported				VI/ELISA	RT-PCR	Final report
			SRL 3/2019	Cattle	01/03/2019	O	POS	O
			SRL 4/2019	Cattle	09/10/2019	NEG	NEG	NVD
			SRL 5/2019	Cattle	04/11/2019	O	POS	O
			SRL 6/2019	Cattle	13/11/2019	O	POS	O
			SRL 7/2019	Cattle	13/11/2019	O	POS	O
			SRL 8/2019	Cattle	21/11/2019	O	POS	O
			SRL 9/2019	Buffalo	21/11/2019	NEG	NEG	NVD
			SRL 10/2019	Cattle	22/11/2019	O	POS	O
			SRL 11/2019	Cattle	22/11/2019	NEG	POS	FMDV GD
			SRL 12/2019	Swine	22/11/2019	O	POS	O
			SRL 13/2019	Cattle	24/11/2019	O	POS	O
			SRL 14/2019	Cattle	26/11/2019	O	POS	O
			SRL 15/2019	Cattle	16/12/2019	NEG	POS	FMDV GD
			SRL 16/2019	Cattle	16/12/2019	O	POS	O
			SRL 17/2019	Cattle	17/12/2019	O	POS	O
TOTAL					**70**			

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

Annex 2: FMD publications

Recent FMD Publications (January to March 2020) cited by Web of Science.

1. **Abd El-Rhman, M.M., D.G.A. El-Hassan, W.S. Awad & S.A.H. Salem** 2020. Serological evaluation for the current epidemic situation of foot-and-mouth disease among cattle and buffaloes in Egypt. *Veterinary World*, 13(1): 1-9. DOI: 10.14202/vetworld.2020.1-9.

2. **Abdel-Aziz, A.I., A. Romey, A. Relmy, K. Gorna, E. Laloy, R. Metras, F. Munoz, S. Blaise-Boisseau, S. Zientara, R. Lancelot & L.B. Kassimi** . Seroprevalence and molecular characterization of *Foot-and-mouth disease virus* in Chad. *Veterinary Medicine and Science*: 8. DOI: 10.1002/vms3.206.

3. **Abodayeh, K., M.S. Arif, A. Raza, M. Rafiq, M. Bibi & A. Nazeer** 2020. Numerical techniques for stochastic foot-and-mouth disease epidemic model with the impact of vaccination. *Advances in Difference Equations*, 2020(1): 14. DOI: 10.1186/s13662-020-2503-8.

4. **Alvarez, C.J.** 2019. The US-Mexico border and the 1947 Foot-and-mouth-disease outbreak in Mexico. *Journal of the Southwest*, 61(4): 691-724. DOI: 10.1353/jsw.2019.0039.

5. **Armson, B., A. Di Nardo, D.M. Nyaguthii, B. Sanz-Bernardo, P.M. Kitala, E. Chepkwony, V. Mioulet, D.P. King % N.A. Lyons** . Utilizing milk from pooling facilities as a novel approach for foot-and-mouth disease surveillance. *Transboundary and Emerging Diseases*: 11. DOI: 10.1111/tbed.13487.

6. **Auty, H., D. Mellor, G. Gunn & L.A. Boden** 2019. The risk of foot-and-mouth disease transmission posed by public access to the countryside during an outbreak. *Frontiers in Veterinary Science*, 6: 12. DOI: 10.3389/fvets.2019.00381.

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8. **Barman, N.N., S.S. Patil, R. Kurli, P. Deka, D.P. Bora, G. Deka, K.M. Ranjitha, C. Shivaranjini, P. Roy & K.P. Suresh** 2020. Meta-analysis of the prevalence of livestock diseases in North Eastern Region of India. *Veterinary World*, 13(1): 80-91. DOI: 10.14202/vetworld.2020.80-91.

9. **Bertram, M.R., S. Dickmu, R.M. Palinski, S.J. Pauszek, E.J. Hartwig, G.R. Smoliga, D. Vierra, S. Abdoulkadiri & J. Arzt** 2019. Genome sequences of four *Foot-and-mouth disease virus* SAT 1 topotype X isolates from Cameroon. *Microbiology Resource Announcements*, 8(49): 2. DOI: 10.1128/mra.01243-19.

10. **Biswal, J.K., S. Subramaniam, R. Ranjan, K. VanderWaal, A. Sanyal, B. Pattnaik & R.K. Singh** 2020. Differential antibody responses to the major antigenic sites of FMD virus serotype O after primo-vaccination, multiply-vaccination and after natural exposure. *Infection Genetics and Evolution*, 78: 9. DOI: 10.1016/j.meegid.2019.104105.

11. **Blanchard, A., J.L. Grandmaison, I.H. Kim & Y.M. Kim** 2019. Standardized phytomolecules improve foot-and-mouth disease vaccine response in grower pigs. *Journal of Animal Science*, 97: 16-17.

12. **Blignaut, B., J. van Heerden, B. Reininghaus, G.T. Fosgate & L. Heath**. Characterization of SAT2 foot-and-mouth disease 2013/2014 outbreak viruses at the wildlife-livestock interface in South Africa. *Transboundary and Emerging Diseases*: 12. DOI: 10.1111/tbed.13493.

13. **Canas-Arranz, R., M. Forner, S. Defaus, M. Rodriguez-Pulido, P. de Leon, E. Torres, M.J. Bustos, B. Borrego, M. Saiz, E. Blanco, D. Andreu & F. Sobrino** . A bivalent B-cell epitope dendrimer peptide can confer long-lasting immunity in swine against foot-and-mouth disease. *Transboundary and Emerging Diseases*: 9. DOI: 10.1111/tbed.13497.

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15. **Cho, J., E.Y. Ko, K. Jo, S. Lee, S. Jang, M. Song & S. Jung** 2020. Reducing lesion incidence in pork carcasses by heating foot-and-mouth disease vaccine before injection. *Asian-Australasian Journal of Animal Sciences*, 33(4): 634-639. DOI: 10.5713/ajas.19.0237.

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20. **Du, P., R.H. Liu, S.Q. Sun, H. Dong, R.B. Zhao, R.K. Tang, J.W. Dai, H. Yin, J.X. Luo, Z.X. Liu & H.C. Guo** 2019. Biomineralization improves the thermostability of *Foot-and-mouth disease virus*-like particles and the protective immune response induced. *Nanoscale*, 11(47): 22748-22761. DOI: 10.1039/c9nr05549e.

21. **Ehizibolo, D.O., I.H. Fish, B. Brito, M.R. Bertram, A. Ardo, H.G. Ularamu, D.D. Lazarus, Y.S. Wungak, C.I. Nwosuh, G.R. Smoliga, E.J. Hartwig, S.J. Pauszek, S. Dickmu, S. Abdoulkadiri & J. Arzt** . Characterization of transboundary foot-and-mouth disease viruses in Nigeria and Cameroon during 2016. *Transboundary and Emerging Diseases*: 14. DOI: 10.1111/tbed.13461.

22. **Eschbaumer, M., V. Dill, J.C. Carlson, J. Arzt, C. Stenfeldt, P.W. Krug, J.M. Hardham, J.E. Stegner, L.L. Rodriguez & E. Rieder** 2020. *Foot-and-mouth disease virus* lacking the leader protein and containing two negative DIVA markers (FMDV LL3B3D A(24)) is highly attenuated in pigs. *Pathogens*, 9(2): 8. DOI: 10.3390/pathogens9020129.

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31. **Horsington, J., M. Eschbaumer, N.B. Singanallur & W. Vosloo** 2020. Inactivation of *Foot-and-mouth disease virus* in epithelium samples for safe transport and processing in low-containment laboratories. *Journal of Virological Methods*, 276: 5. DOI: 10.1016/j.jviromet.2019.113770.

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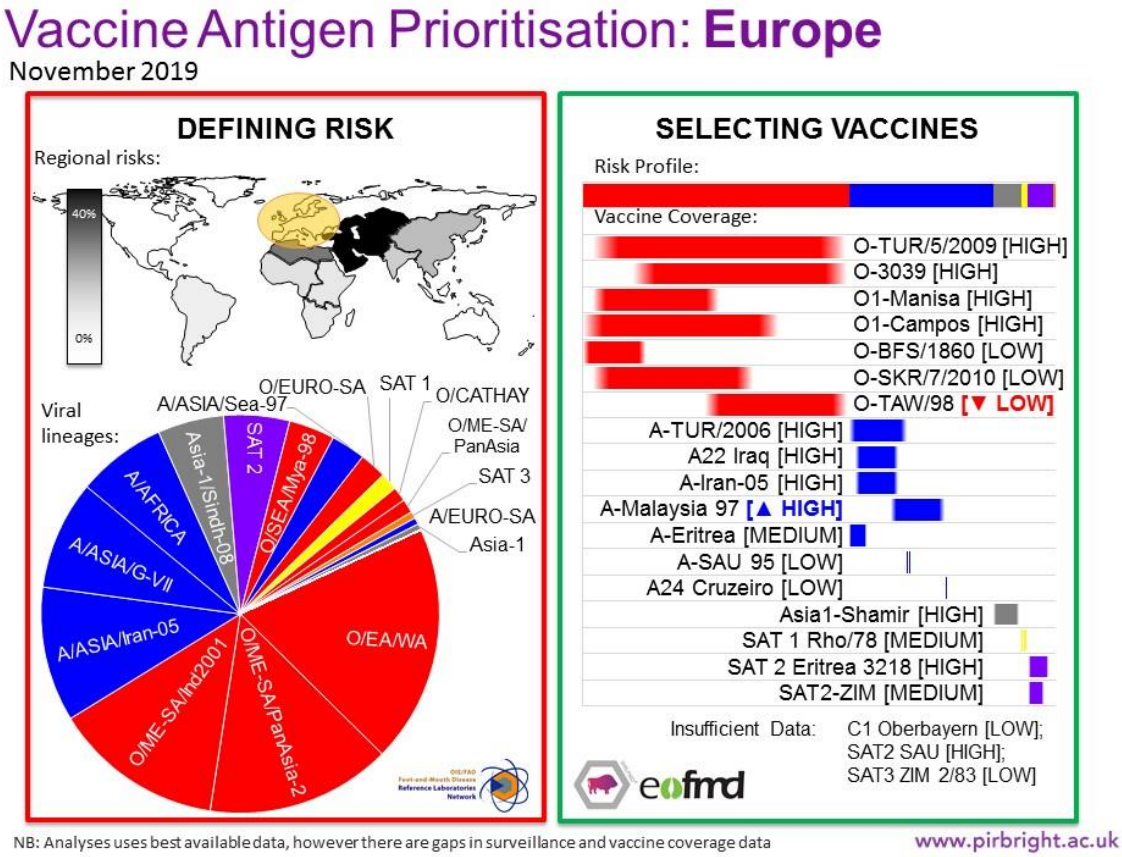
Annex 3: Vaccine recommendations

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 1 in Section 3.9, sopra), as well as available *in vitro, in vivo* and field data to score the ability of vaccines to protect against these FMDV lineages.



Source: WRLFMD.

Please contact WRLFMD or 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.

Annex 4: Brief round-up of EuFMD and WRLFMD activities

Open Session of the EuFMD OS20

"Livelihoods @ risk in a FASTer world"

27-30 October 2020. Marseille, France. https://www.eufmd.info/os20faster

The OS20 will be a multi-day meeting, with two distinct parts. The first focuses on Foot-and-mouth disease. The second considers how best we can use the intelligence on animal movements and drivers of disease spread for smarter and FASTer risk mitigation.

Courses

- EuFMD's open access online courses provide convenient self-paced training which you may study anytime, anywhere, free of charge. There are currently 4 courses in English and 1 in Arabic:
    - Introduction to Foot-and-Mouth Disease
    - What is the Progressive Control Pathway?
    - Public Private Partnerships in the Veterinary Domain
    - Introduction to the Progressive Control Pathway

  https://eufmdlearning.works/mod/page/view.php?id=13130
- The WRLFMD residential training course on FMD diagnostics (https://www.pirbright.ac.uk/instructor-led-training/diagnosis-foot-and-mouth-disease) scheduled for May 2020 has been postponed until later in the year

Podcasts

We have a constantly updated series of short podcasts relating to the FAST world, available here: http://www.fao.org/eufmd/resources/podcasts/en/

Meetings

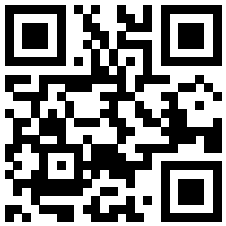
Reports of the 2nd FMD Roadmap Meeting for the Foot-and-Mouth Disease Progressive Control Pathway in West Africa (Dakar, Senegal, 04–06 September 2019) and of the 8th West Eurasia Roadmap Meeting (Shiraz, Iran, 04–06 March 2019) have been published online on the Global Framework for the Progressive Control of Transboundary Animal Diseases (GF-TADs) website (available at: http://www.gf-tads.org/fmd/fmd/en/)

Three FMD Roadmap Meetings (RMMs) were originally planned in 2020 in Eastern Africa, in South Asia in collaboration with the South Asian Association for Regional Cooperation (SAARC) Secretariat, and in Southern Africa in collaboration with the Southern African Development Community (SADC) Secretariat. Due to the current global SARS-CoV-2

pandemic, the organization of these international events is being postponed and innovative strategies to support collaborative events at the regional levels are under development.

Proficiency test scheme organised by WRLFMD

Sample panels for the Phase XXXII exercise are ready for dispatch and will be sent when international shipping resumes after the COVID-19 crisis. We will write to inform participating laboratories about any other changes that may be required to accommodate these events, and please feel free to contact WRLFMD if you have any questions.



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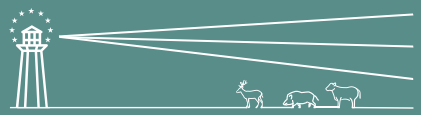

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Hold-FAST tools

GET PREPARED, E-learning, FMD-PCP, EuFMDiS, Pragmatist, Impact Risk Calculator, Virtual Learning Center, SMS Disease reporting, Global Vaccine Security, Outbreak Investigation app, PCP-Support Officers, PCP Self-Evaluation tool, AESOP, Telegram, Whatssap, Quarterly Global Reports, Real Time Traning.

EuFMD Committees

Executive Committee, Standing Technical Committee, Special Committee for Surveillance and Applied Research (SCSAR), Special Committee on Biorisk Management (SCBRM), Tripartite Groups.