

Foot-and-Mouth Disease

January-March 2021
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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Sudan and South Sudan: *Final boundary between the Republic of Sudan and the Republic of South Sudan has not yet been determined.*

Abyei: *Final status of the Abyei area is not yet determined.*

Falkland Islands (Malvinas): *A dispute exists between the Governments of Argentina and the United Kingdom of Great Britain and Northern Ireland concerning sovereignty over the Falkland Islands (Malvinas).*

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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	Foot-and-mouth disease Virus Genome detected
FMDV NGD	Foot-and-mouth disease Virus Genome not detected
GF-TAD	Global Framework for the Progressive Control of Transboundary Animal Diseases
LVRI	The National Reference Laboratory for FMD, The Lanzhou Veterinary Research Institute, Chinese Academy of Agricultural Sciences
MEVAC	International Facility for Veterinary Vaccines Production (Egypt)
NT	Not tested
NVD	No virus detected
OIE	World Organisation for Animal Health
PIADC	Plum Island Animal Disease Center
rRT-PCR	Real-time reverse transcription polymerase chain reaction
SAARC	South Asian Association for Regional Cooperation
SADC	Southern Africa in collaboration with the Southern African Development Community
SAT	Southern African Territories
SEACFMD	South-East Asia and China FMD campaign
SSARRL	Sub-Saharan Africa Regional Reference Laboratory
SVD	Swine vesicular disease
VETBIS	Veterinary Information System of Turkey
VI	Virus Isolation
WAHIS	World Animal Health Information System (of the OIE)
WRLFMD	World Reference Laboratory for Foot-and-Mouth Disease

1. Highlights and headlines

Welcome to this new issue of the FMD Quarterly Report where we describe results for samples received from Bahrain, Cambodia, Israel, Laos, Nigeria, Thailand and Uganda. New sequence data has also been shared from Burkina Faso (via ANSES), India (via ICAR-DFMD), Israel (via KVI), Mauritius (via ANSES), Namibia (via SSARL at BVI, Botswana) and Niger (via ANSES). Sample submissions to International FMD Reference Laboratories have been impacted by the on-going COVID-19 pandemic: despite these current difficulties, the OIE/FAO FMD Laboratory Network (<https://www.foot-and-mouth.org>) welcomes countries to submit appropriate clinical samples for laboratory analyses – testing is free-of-charge, for further information or assistance with shipments, please contact donald.king@pirbright.ac.uk.

These data highlight two new events:

[1] **Samples from Mauritius:** In recent years, particular attention has focused on FMD viruses that circulate in Pool 2 (South Asia) and the frequency by which these viruses can seed new outbreaks elsewhere. Previous examples of viruses that have spread from Pool 2 include O/ME-SA/Ind-2001 (d and e sub-lineages) and A/ASIA/G-VII. In this report, we describe new sequence data that have been provided by ANSES (France) for samples collected on the Island of Rodriguez in Mauritius during March 2021. Analyses demonstrate that these new sequences belong to the O/ME-SA/Ind-2001e lineage – however, they appear to be distinct from sequences that were detected in Mauritius during 2016.

[2] **Samples from Bahrain:** FMDV sequence data for the samples collected in Bahrain have been characterised as belonging to two East African viral lineages (O/EA-3 and A/AFRICA/G-I). We understand that these samples are from cattle that have been recently imported from Somalia which explains the unexpected origin of these viruses.

A new review article published by the OIE/FAO FMD Laboratory Network provides an overview of the history of serotype C and evidence that this serotype is no long circulating in susceptible hosts (see: <https://academic.oup.com/ve/advance-article/doi/10.1093/ve/veab009/6178807>). Now that more than sixteen years have passed since the last serotype C outbreak (in Kenya and Brazil in 2004), this paper also makes recommendations to reduce the possibility that this serotype is reintroduced into the field.

Don King, Pirbright April 2021

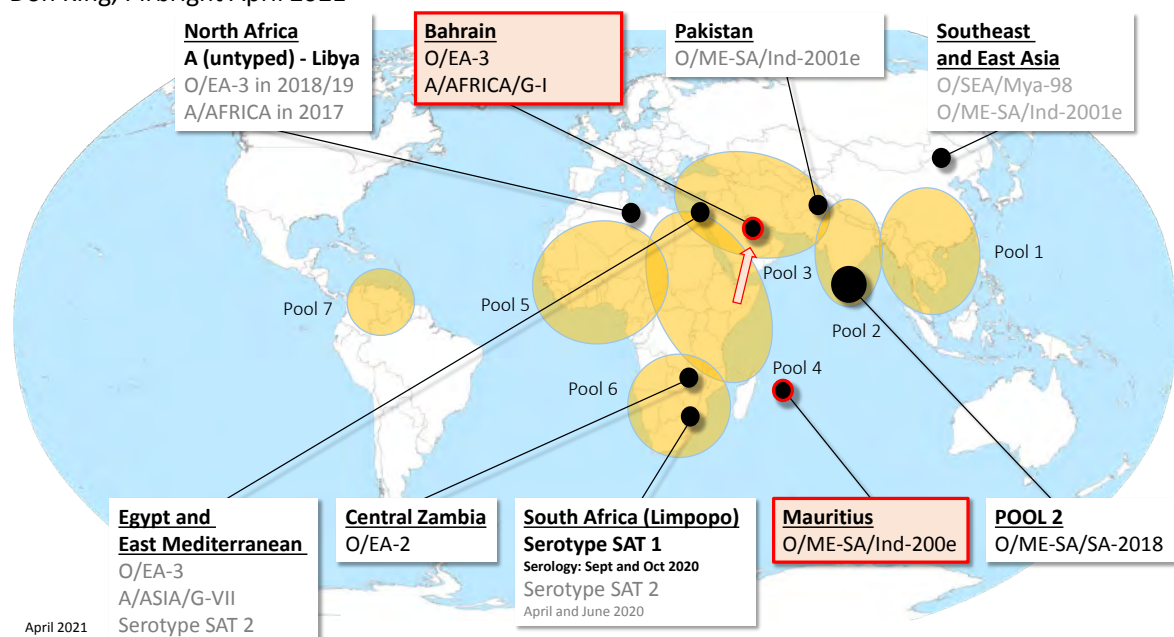


Figure 1: Recent FMD global outbreaks (new headline events reported **January-March 2021** are highlighted) with endemic pools highlighted in orange. Source: WRLFMD. Map conforms to the United Nations World Map, June 2020.

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
	<u>SOUTHEAST ASIA/CENTRAL ASIA/EAST ASIA</u>	
1	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
	<u>SOUTH ASIA</u>	
2	Bangladesh, Bhutan, India, Mauritius, Nepal, Sri Lanka	A, Asia 1 and O
	<u>WEST EURASIA & MIDDLE EAST</u>	
3	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)
	<u>NORTH AFRICA</u>	
4	Algeria, Egypt, Libya, Morocco, Tunisia	A, O and SAT 2
	<u>EASTERN AFRICA</u>	
	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
	<u>WEST/CENTRAL AFRICA</u>	
5	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
	<u>SOUTHERN AFRICA</u>	
6	Angola, Botswana, Malawi, Mozambique, Namibia, South Africa, Zambia, Zimbabwe	SAT 1, SAT 2 and SAT 3 (O, A) [†]
	<u>SOUTH AMERICA</u>	
7	Colombia, Venezuela (Bolivarian Republic of)	O and A

[†] 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.

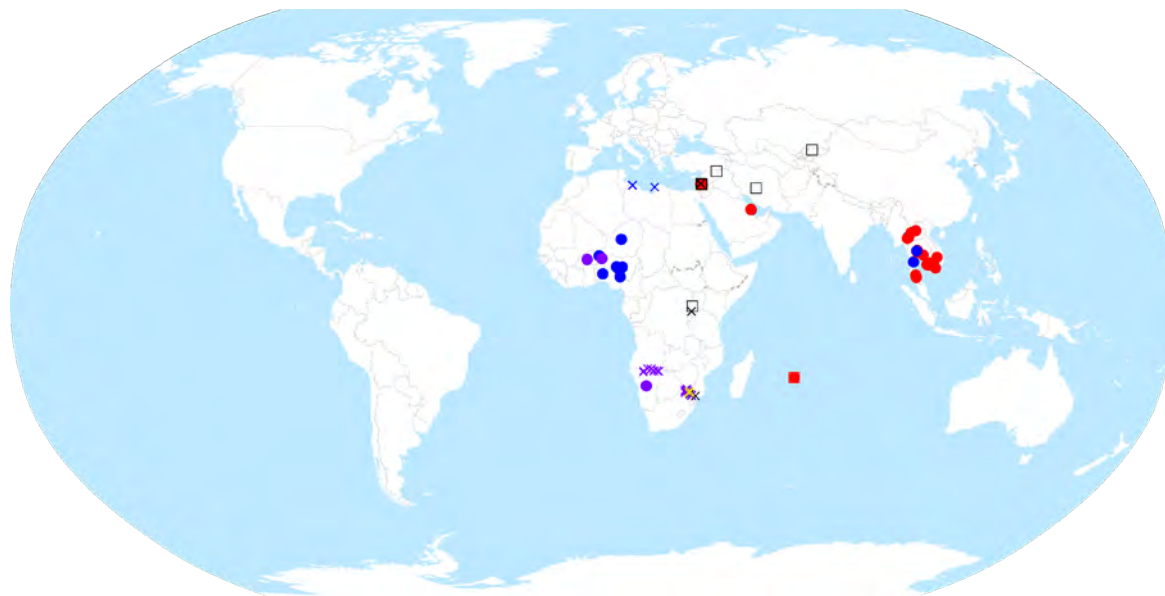
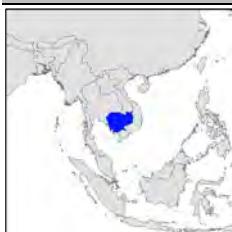


Figure 2: Samples tested by WRLFMD or reported in this quarter. ● indicates samples analysed; × indicates new outbreaks reported to the OIE, but where results to define the genotype have not been reported; □ indicates reports of FMD from other sources. Shape colours define the serotype detected ● O; ● A; ● C; ● Asia1, ● SAT1, ● SAT2, ● SAT3, ○ FMD not detected, ● serotype undetermined/not given in the report.

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

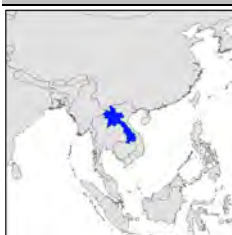
3.2. Pool 1 (Southeast Asia/Central Asia/East Asia)

The Kingdom of Cambodia



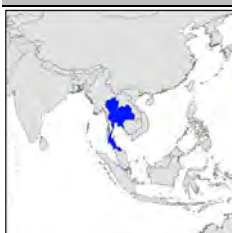
A batch of nine samples was received to WRLFMD on 22 December 2020. All were confirmed as serotype O and genotyping showed them all to belong to the ME-SA/PanAsia lineage.

The Lao People's Democratic Republic



A batch of five samples was received to WRLFMD on 22 December 2020. All samples were confirmed as serotype O and genotyping showed all to belong to the ME-SA/Ind-2001e sublineage.

The Kingdom of Thailand



A batch of 16 samples was received to WRLFMD on 22 December 2020. Twelve samples were confirmed as serotype O and the remaining four were serotype A. Genotyping showed the type O viruses to belong to the ME-SA/Ind-2001e sublineage and the type A viruses to the ASIA/Sea-97 lineage.

3.3. Pool 2 (South Asia)

No new outbreaks of FMD were reported in South Asia.

3.4. Pool 3 (West Eurasia and Middle East)

Kingdom of Bahrain



A batch of 40 samples was received on 9 March 2021. FMD type O was identified in three samples, type A in one sample and FMDV genome was detected in one additional sample; 36 samples were NVD. Genotyping showed the type O viruses to belong to the EA-3 topotype and the type A virus to the AFRICA/G-I lineage.

The Islamic Republic of Iran



The first instance of naturally acquired FMDV infection in dogs has been reported (see Waters et al., 2021). The sample was from one of 5 young dogs that had died after being fed the carcasses of lambs which died during an FMD outbreak on a farm in Iran in 2016.

The report contains no evidence that dogs are able to contract the disease from live infected animals or that they are capable of spreading the disease as a result of being infected. ProMED post: [20210225.8212791](https://www.promed.org/post/20210225.8212791)

According to the Iran Veterinary Organization (IVO) 1,405,493 large ruminants and 16,009,422 small ruminants were vaccinated against FMD between 1st January and 1st April 2021 with trivalent vaccines (O, A, Asia1) which were either locally produced or imported. The vaccination of nomadic animals was done free of charge

State of Israel



On the 8 January 2021, three VP1 sequences were received from the Kimron Veterinary Institute and on 01/03/2021, six samples were received. All sequences/samples belonged to FMD type O and genotyping showed them to belong to the ME-SA/PanAsia-2^{QOM-15} sublineage.

FMD was reported to the OIE in January and February (OIE event ID: 37437).

[OIE World Animal Health Information System](#)

FMD was reported in northern Israel in January and March by the OIE and Israel's Veterinary Services (VSAH).

ProMed posts: [20210107.8079606](#) and [20210127.8141870](#) and [20210312.8243802](#)

The Kyrgyz Republic



An anonymous source has reported observations of suspected foot and mouth disease on a farm in Chuyskaya Oblast.

ProMED post: [20210110.8090048](#)

The Lebanese Republic



The National News Agency reported that a vaccination campaign has started against Foot-and-Mouth Disease in cattle in the district of Caza de Bent Jbaïl, Mohafazat Nabatîyé.

ProMED post: [20210219.8201498](#)

The Syrian Arab Republic



According to an unofficial/media report, there is a widespread outbreak of Foot-and-Mouth Disease in northeastern Syria.

ProMED post: [20210216.8194894](#)

The Republic of Turkey



Turkey reported 26 outbreaks in cattle (n=19) and small ruminants (7). FMD is endemic in Anatolia and the identified sublineages are still O PanAsia-2^{Qom15} and O PanAsia-2^{ANT10}. Both are well matched to the vaccines currently in use. Serotypes A and Asia1 have not been detected since January 2018 and July 2015, respectively.

The Thrace region has been free with vaccination since May 2010

Update from the Transcaucasus region:

The 2021 spring vaccination campaigns are currently underway in Georgia, Azerbaijan, and Armenia, following a risk-based approach according to their respective national FMD control strategies.

Georgia has conducted risk-based vaccination since 2017. The entire population of cattle and small ruminants of eastern Georgia is considered at high risk of FMD and therefore regularly vaccinated. In western Georgia, villages are targeted based on their proximity to live animal markets, migrating animals, and borders with Turkey and non-controlled territories.

Azerbaijan plans to conduct a post-vaccination serological survey for large and small ruminants after this spring vaccination

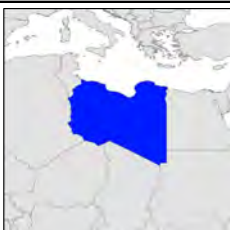
3.5. Pool 4 (North and Eastern Africa)

The Arab Republic of Egypt



About 3.03 million large and small ruminants were vaccinated against FMD within the context of a massive campaign launched on 6 February 2021 by the Egyptian veterinary services with locally produced vaccine recently modified by adding the serotype A lineage (A/AFRICA/G-IV) to the vaccine as a response to the outbreak reported in October 2020 caused by this lineage. (Source: GOVS)

The State of Libya



FMD was reported to the OIE in January (OIE event ID: 33808)

[OIE World Animal Health Information System](#)

Recently, the NCAH has launched a FMD mass vaccination campaign targeting all cattle populations (~25000 doses are available), where currently 94,000 doses have been distributed to 43 animal health offices in the east, west, and south of Libya. In parallel blood samples are being collected to be tested against FMD and other transboundary animal diseases.

The Republic of Rwanda



FMD was reported to the OIE in January (OIE event ID: 37581)

[OIE World Animal Health Information System](#)

The Republic of Uganda



A batch of 11 samples was received to WRLFMD on 16 December 2020. FMD viral genome was detected in 9 samples but no serotype confirmed. Genotyping is underway and results will be reported shortly.

Foot-and-Mouth Disease has been affecting Animals in Kiruhuura District (sub-counties of Kikatsi, Kenshunga, Kashongi, Kinoni and

From 57 cases in dairy and mixed-breed cattle, 16 deaths were recorded.

ProMED post: [20210314.8247240](#) and [20210327.8273130](#)

The Republic of Mozambique



FMD was reported to the OIE in January (OIE event ID: 35436)

[OIE World Animal Health Information System](#)

The Republic of Namibia



FMD was reported to the OIE in January (OIE event ID: 36008)

[OIE World Animal Health Information System](#)

The Republic of South Africa



FMD was reported to the OIE in January and March (OIE event IDs: 33576, 36933, 28323, 32311 and 36933)

[OIE World Animal Health Information System](#)

3.8. Pool 7 (South America)

No new outbreaks of FMD were reported in South America.

3.9. Extent of global surveillance

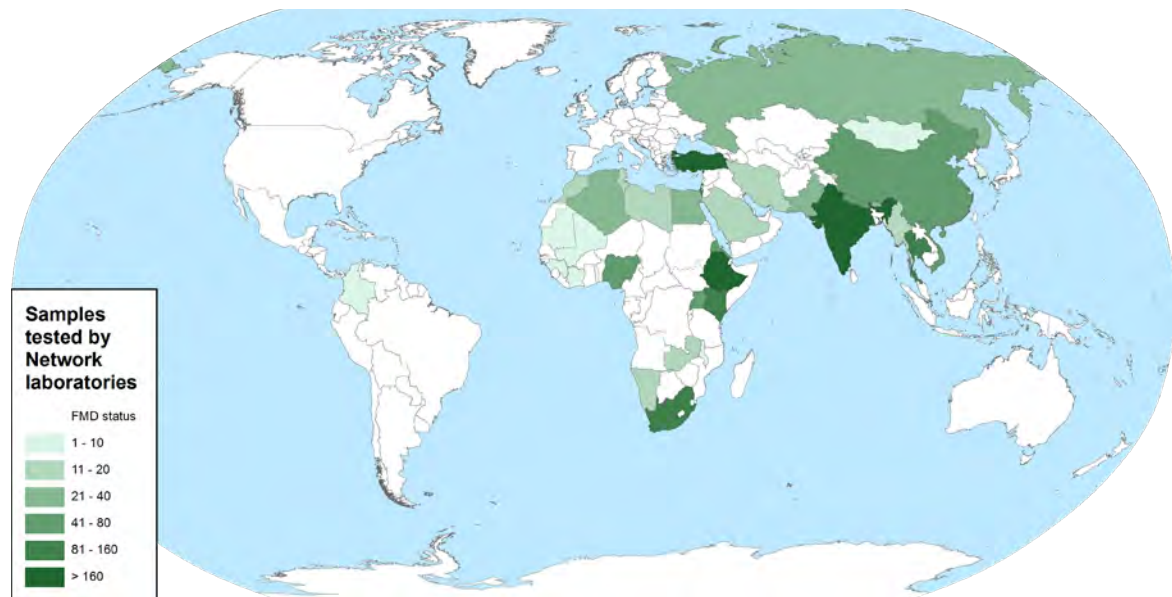


Figure 3: Samples received during 2019 from FMD outbreaks (routine surveillance that is undertaken in countries that are FMD-free without vaccination is not shown). Data from presentations given at the OIE/FAO Reference laboratory Network annual meeting (<https://www.foot-and-mouth.org/Ref-Lab-Network/Network-Annual-Meeting>)

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

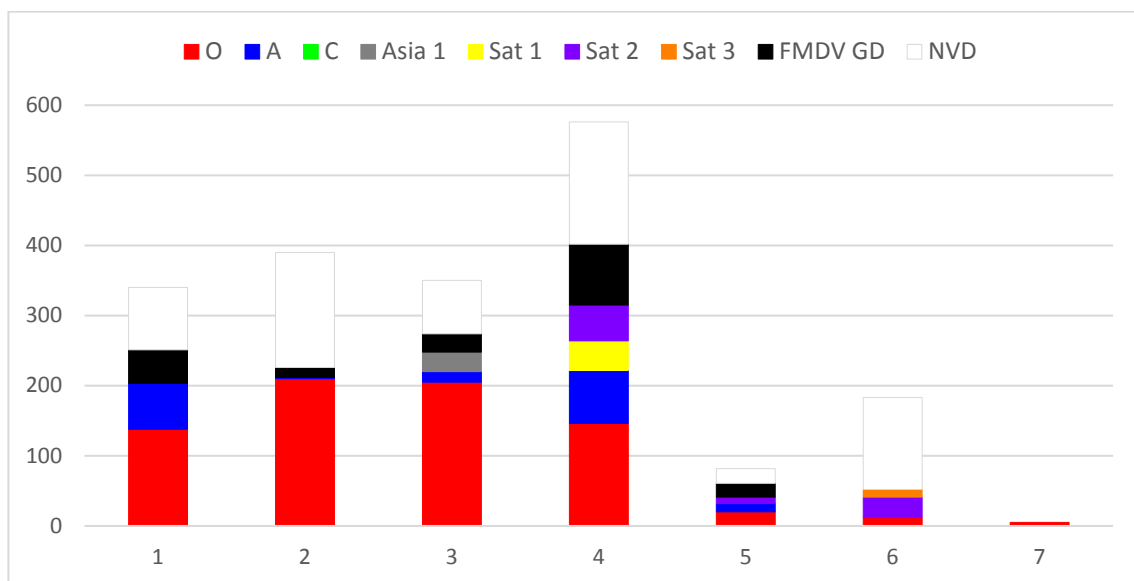


Figure 4: Representation of different FMDV serotypes detected in samples tested from the FMD endemic pools by the OIE/FAO FMD Laboratory Network during 2019 (NVD = no virus detected; GD = genome detected)

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, below).

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 percentage (%) of total FMD cases that occur in domesticated hosts]. These scores (reviewed at the OIE/FAO FMD Laboratory Network meeting in December 2020) can be used to inform the PRAGMATIST tool (see Annex 3). Recent changes to increase risks are shown in red, while a reduction in risk is shown in green.

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	7	10				
O EA or O WA			3	55	55	70		
O EURO-SA								80
O CATHAY	10.5							
A ASIA Sea-97	26							
A ASIA Iran-05	0		27					
A ASIA G-VII		16	15					
A AFRICA				25	22	15		
A EURO-SA								20
Asia-1	0.5	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 2021 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 2021 (* indicates a batch carried over from the previous quarter).

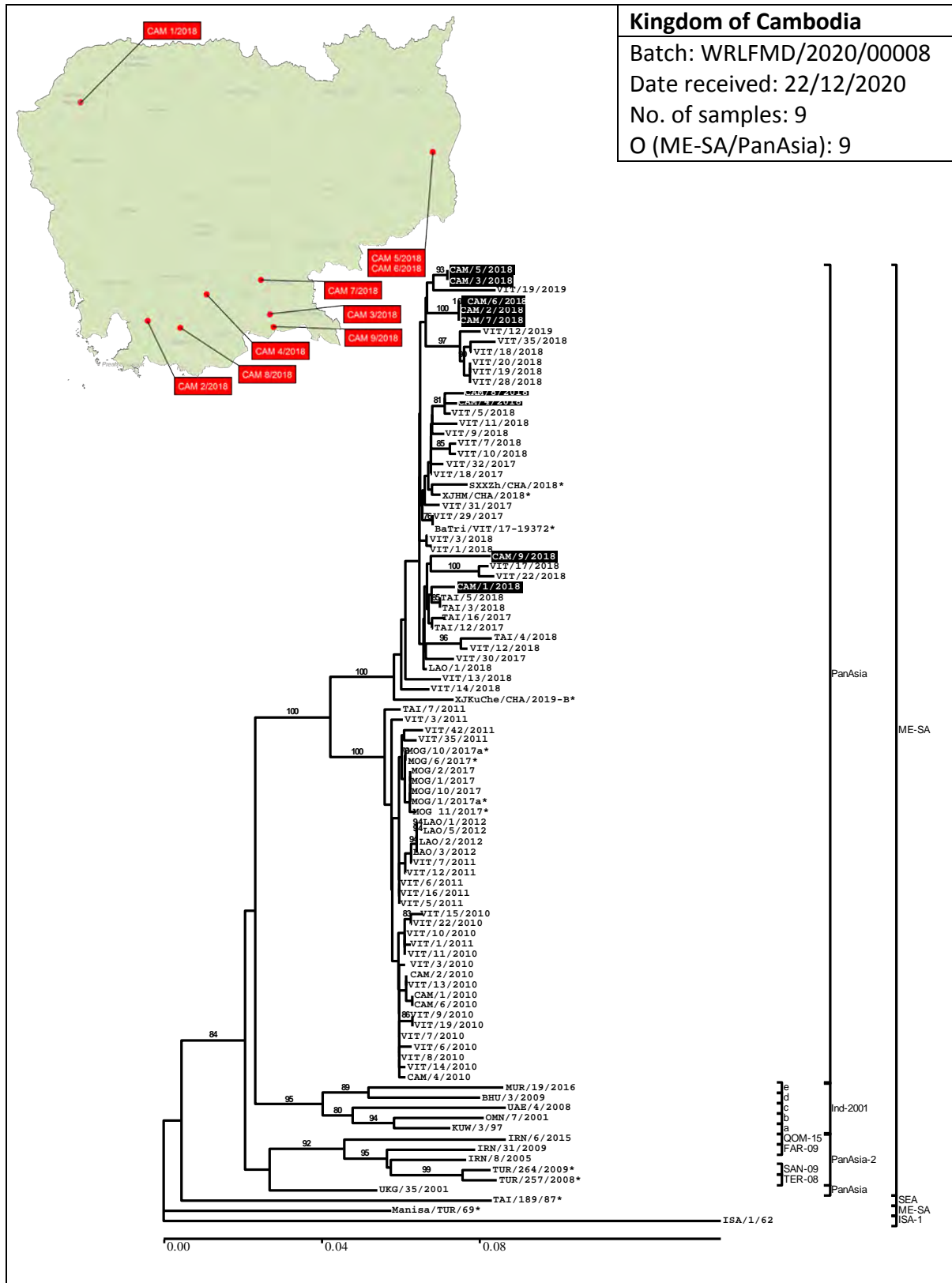
WRLFMD Batch No.	Date received	Country	Serotype	No. of samples	No. of sequences	Sequencing status
WRLFMD/2020/00006*	16/12/2020	Uganda	pending	11	-	pending
WRLFMD/2020/00007*	22/12/2020	Thailand	O	12	12	completed
			A	4	4	completed
WRLFMD/2020/00008*	22/12/2020	Cambodia	O	9	9	completed
WRLFMD/2020/00009*	22/12/2020	Lao P.D.R.	O	5	5	completed
WRLFMD/2021/00002	01/02/2021	Nigeria	A	7	7	completed
WRLFMD/2021/00003	24/02/2021	Nigeria	SAT2	6	6	completed
WRLFMD/2021/00004	01/03/2021	Israel	O	6	6	completed
WRLFMD/2021/00005	09/03/2021	Bahrain	O	3	3	completed
			A	1	1	completed
Total				53	53	

Table 3: VP1 sequences submitted by other FMD Network laboratories to the WRLFMD from January to March 2021.

WRLFMD Batch No.	Date received	Country	Serotype	Date Collected	No. of sequences	Submitting laboratory
WRLMEG/2021/00001	08/01/2021	Israel	O	2021	3	KVI
WRLMEG/2021/00002	18/02/2021	Vietnam	O	2020	4	RAHO6
WRLMEG/2021/00003	25/02/2021	Namibia	SAT2	2020	2	BVI
WRLMEG/2021/00004	26/03/2021	Mauritius	O	2021	2	ANSES
WRLMEG/2021/00005	30/03/2021	Niger	A	2019-2020	18	ANSES
			SAT2	2019	1	
WRLMEG/2021/00006	30/03/2021	Burkina Faso	SAT2	2021	4	ANSES
Total					34	

4. Detailed analysis

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



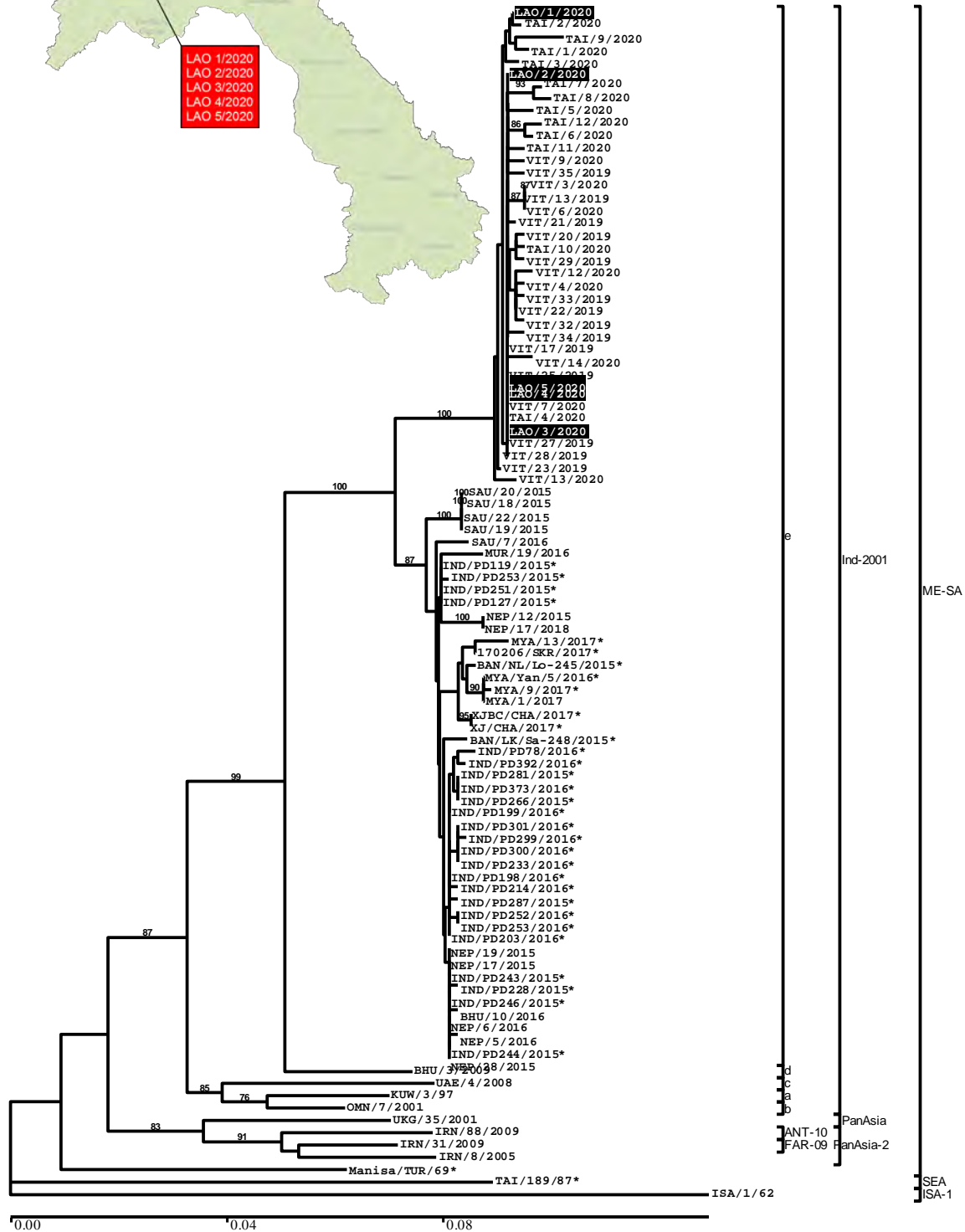
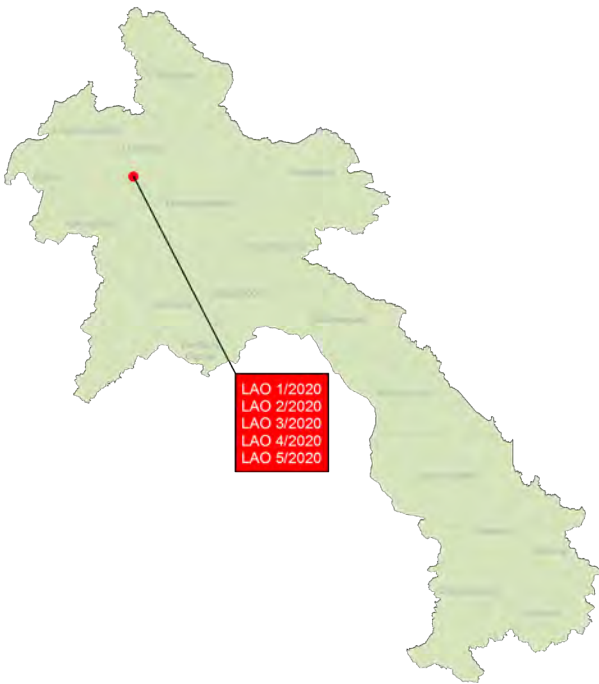
Lao People's Democratic Republic

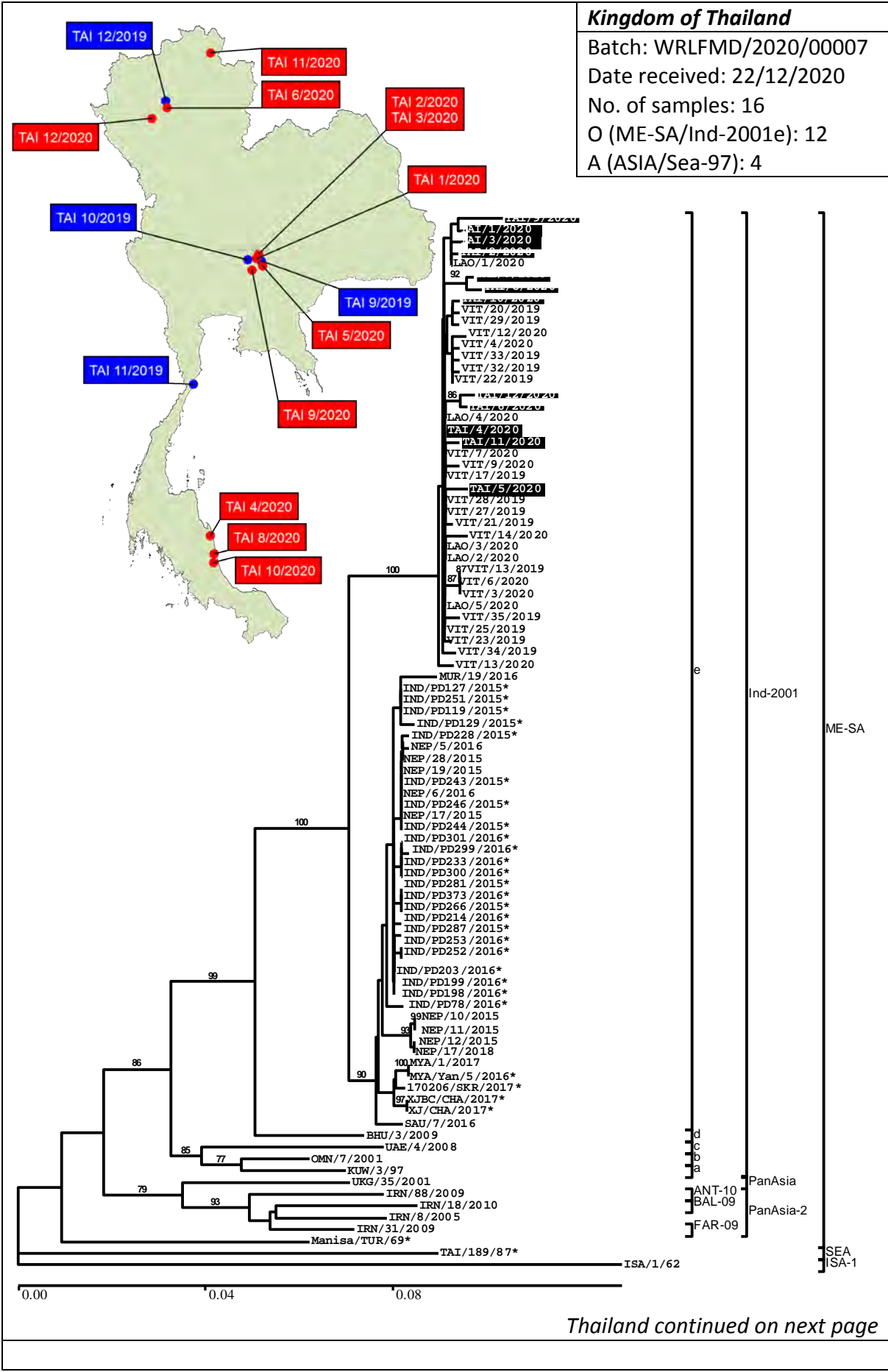
Batch: WRLFMD/2020/00009

Date received: 22/12/2020

No. of samples: 5

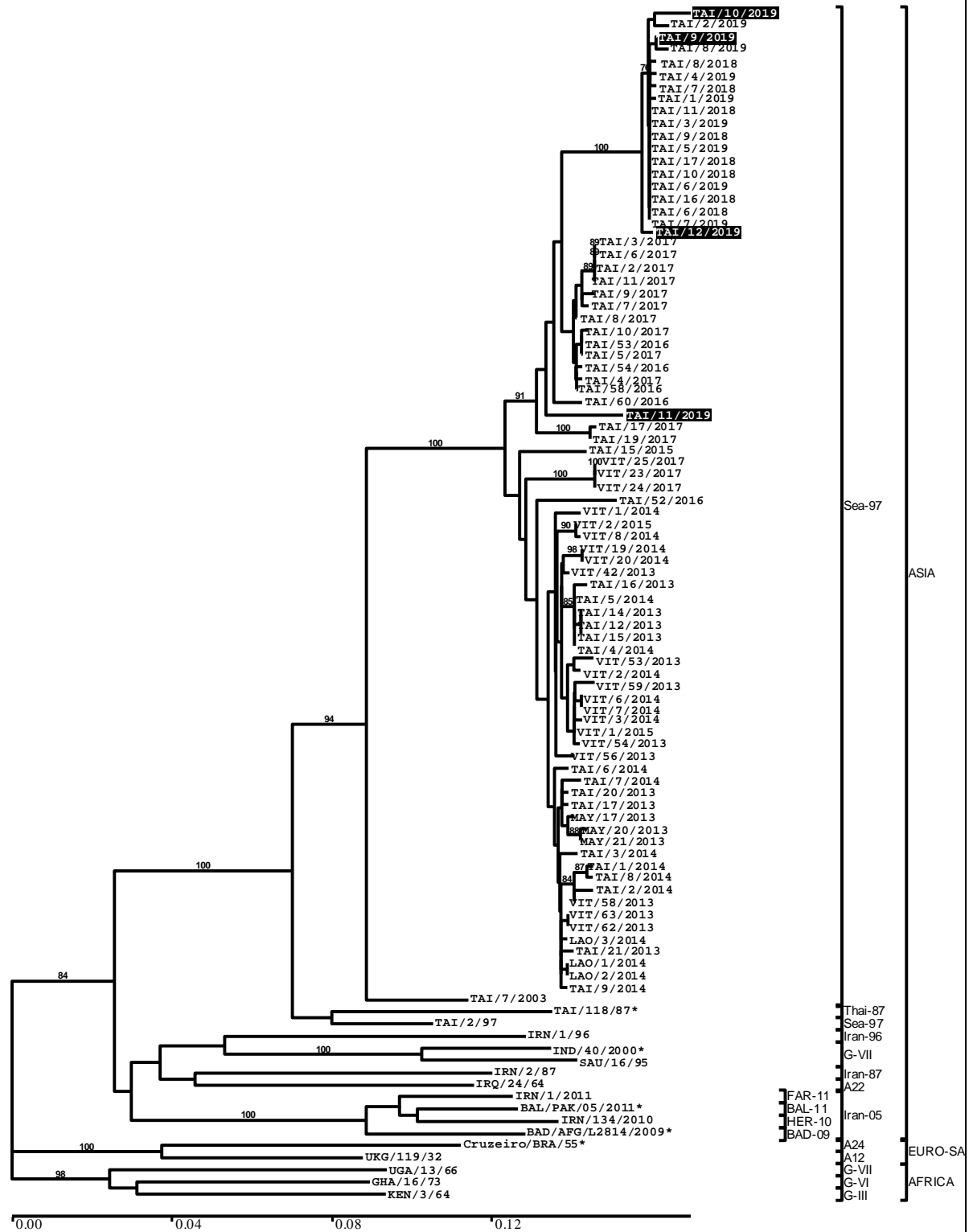
O (ME-SA/Ind-2001e): 5





Thailand continued on next page

Thailand continued



Socialist Republic of Vietnam

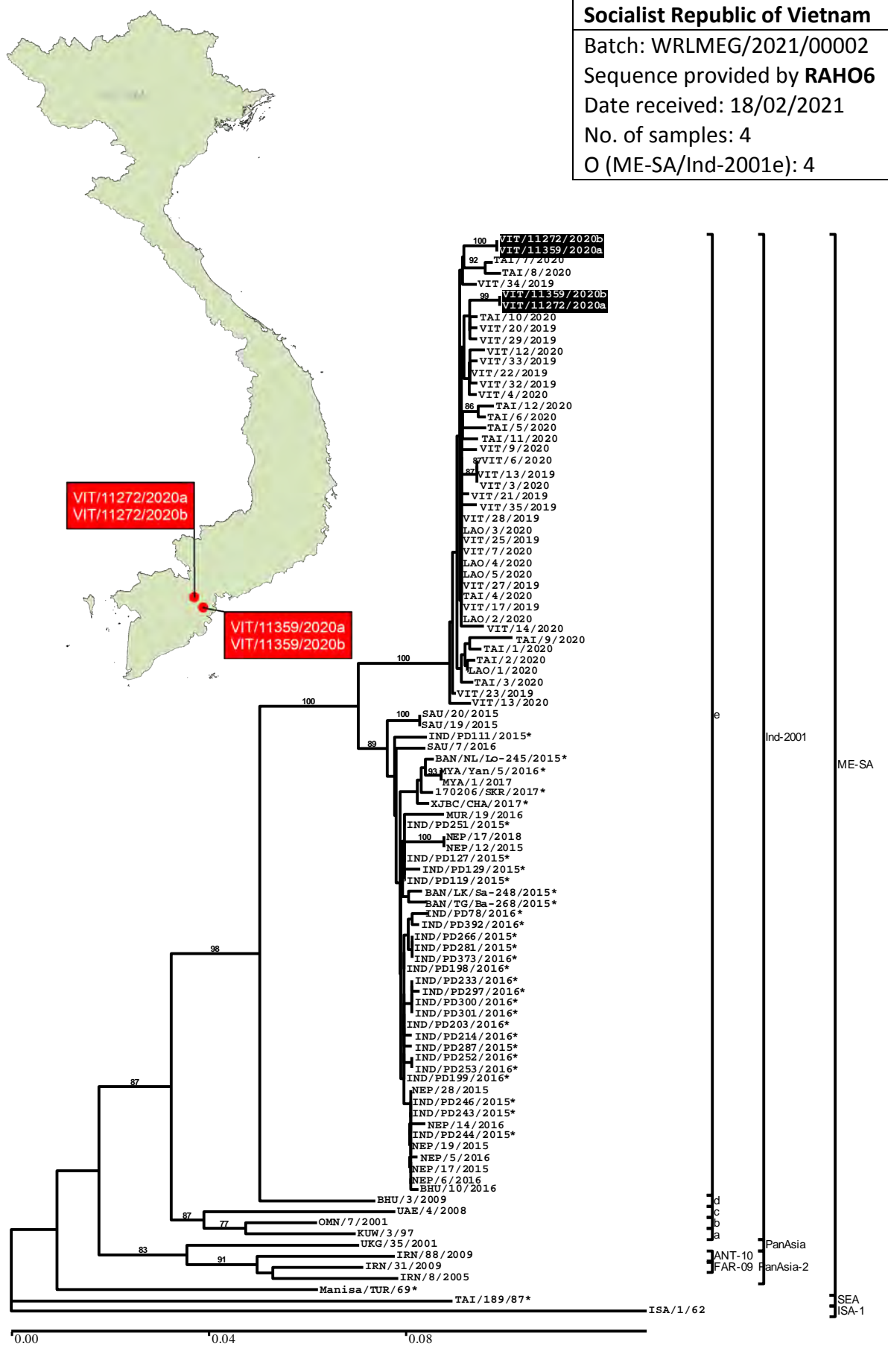
Batch: WRLMEG/2021/00002

Sequence provided by RAH06

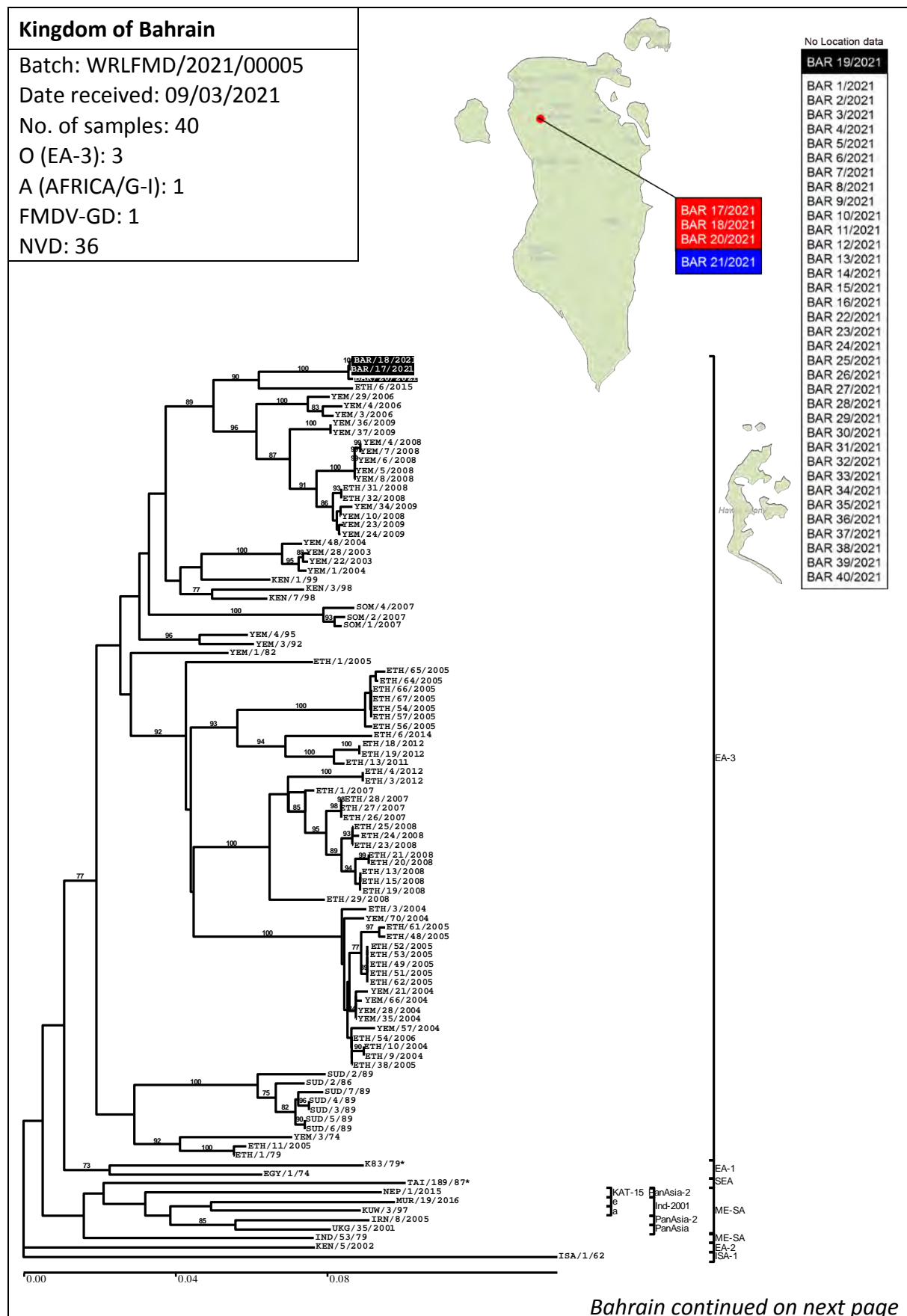
Date received: 18/02/2021

No. of samples: 4

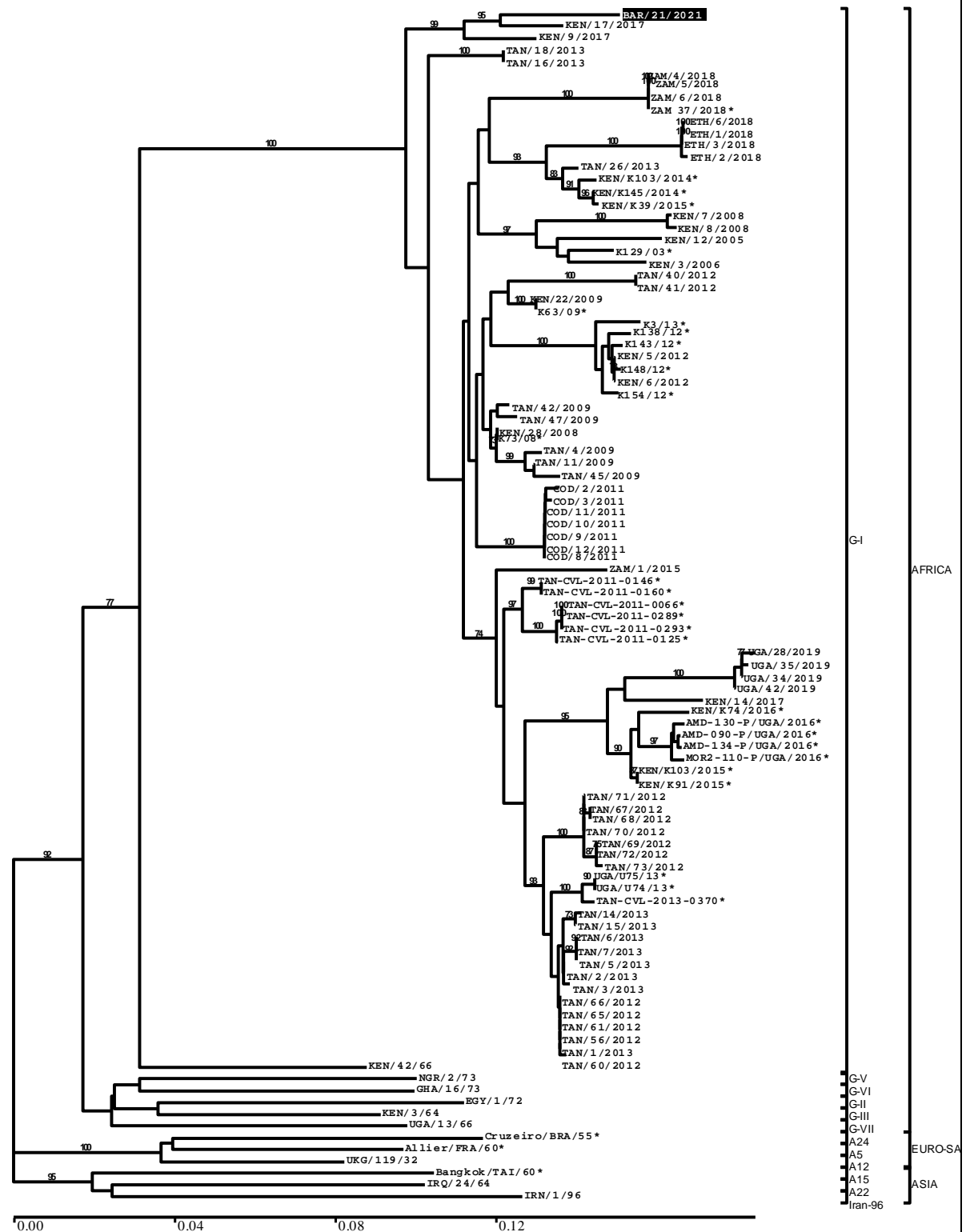
O (ME-SA/Ind-2001e): 4

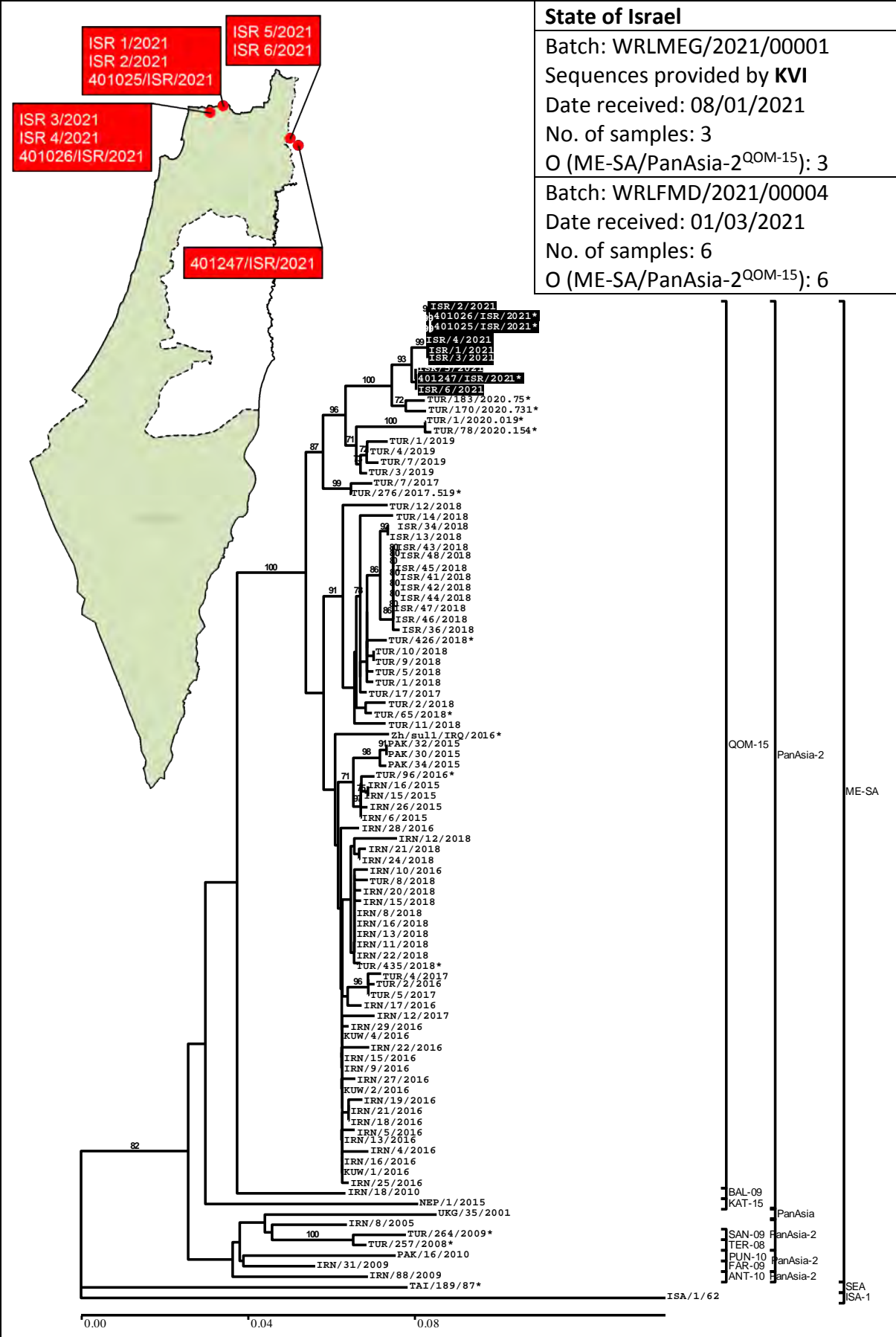


4.2. Pool 3 (West Eurasia and Middle East)

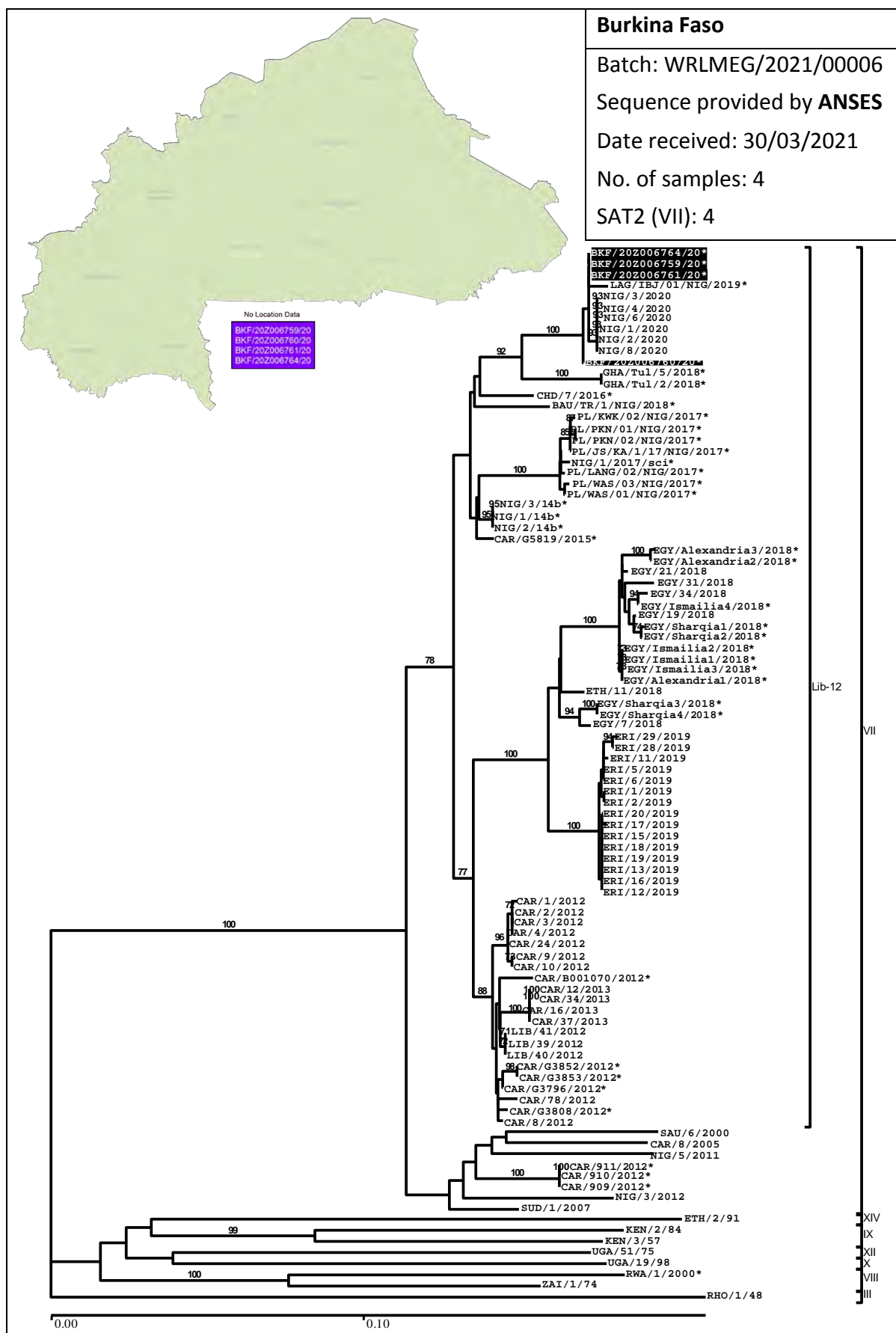


Bahrain continued





4.3. Pool 5 (West/Central Africa)



Republic of the Niger

Batch: WRLMEG/2021/00005

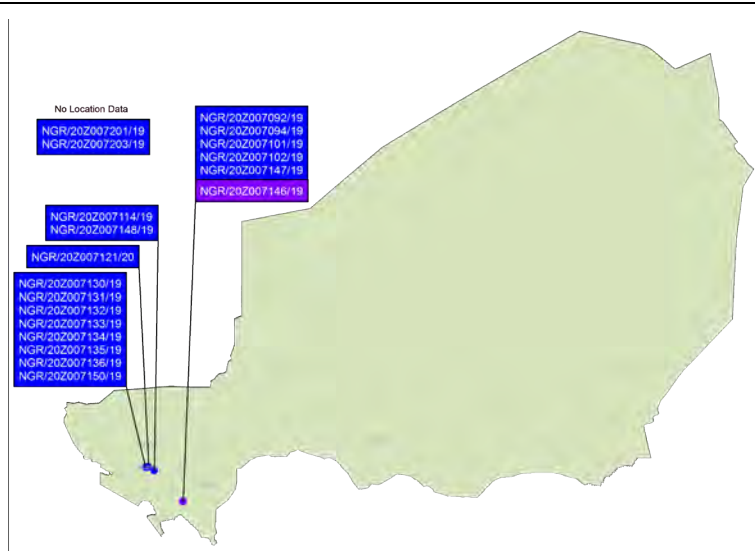
Sequence provided by ANSES

Date received: 30/03/2021

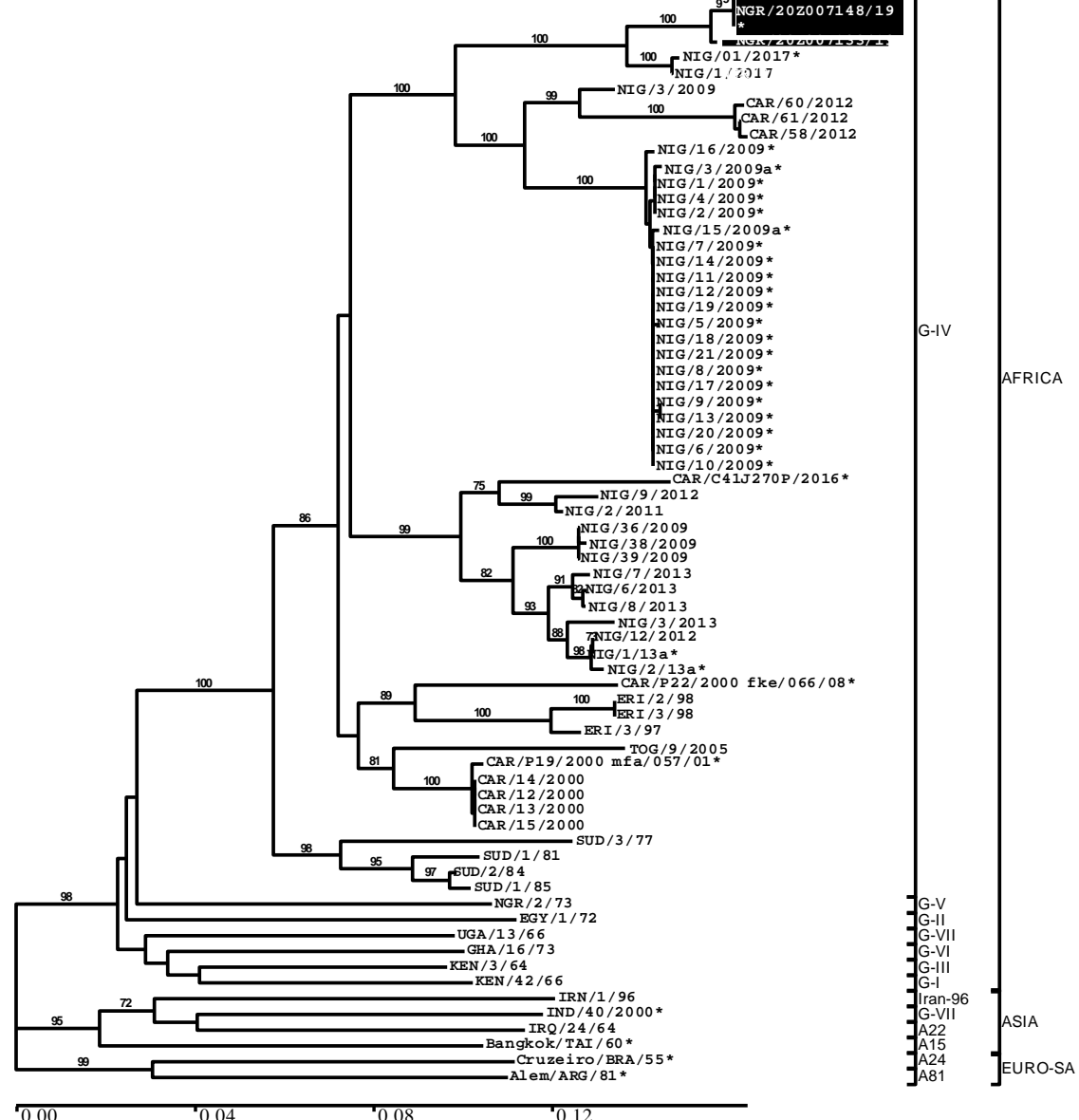
No. of samples: 19

A (AFRICA/G-IV): 18

SAT2 (VII): 1

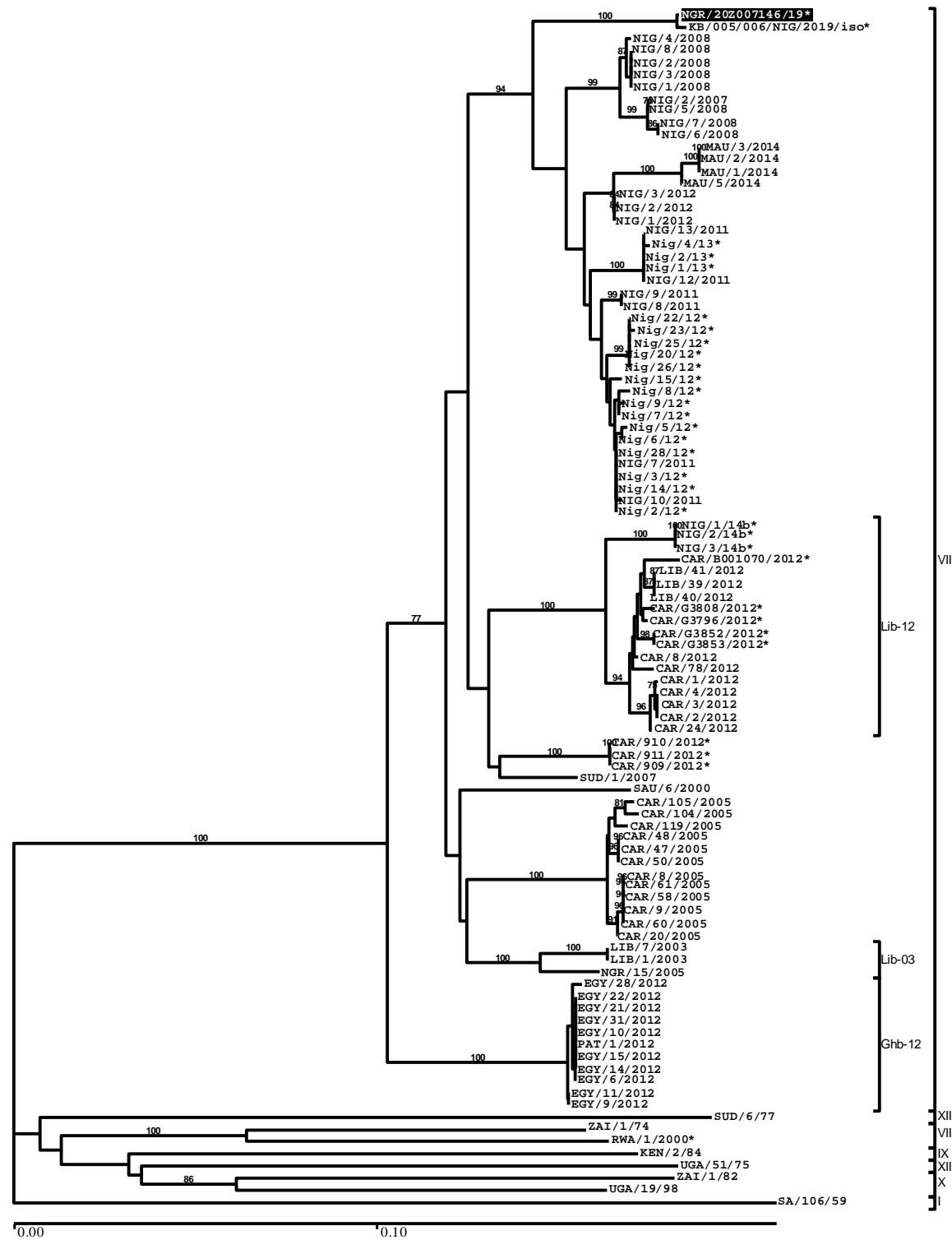


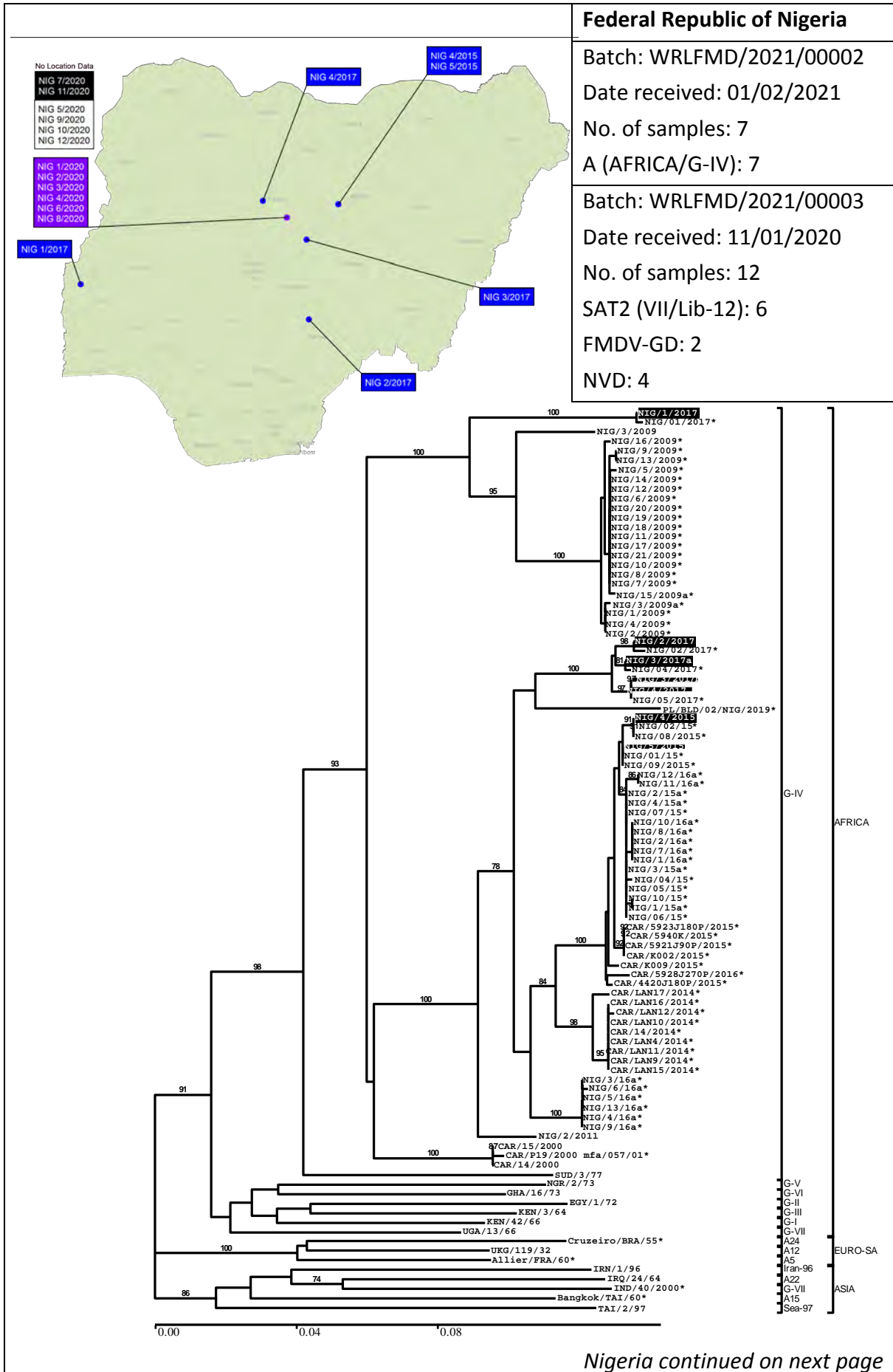
- 1 NGR/202007114/19*
- 2 NGR/202007134/19*
- 3 NGR/202007201/19*
- 4 NGR/202007092/19*
- 5 NGR/202007102/19*
- 6 NGR/202007203/19*
- 7 NGR/202007101/19*
- 8 NGR/202007130/19*
- 9 NGR/202007147/19*
- 10 NGR/202007131/19*
- 11 NGR/202007135/19*
- 12 NGR/202007121/20*
- 13 NGR/202007132/19*
- 14 NGR/202007094/19*
- 15 NGR/202007148/19*



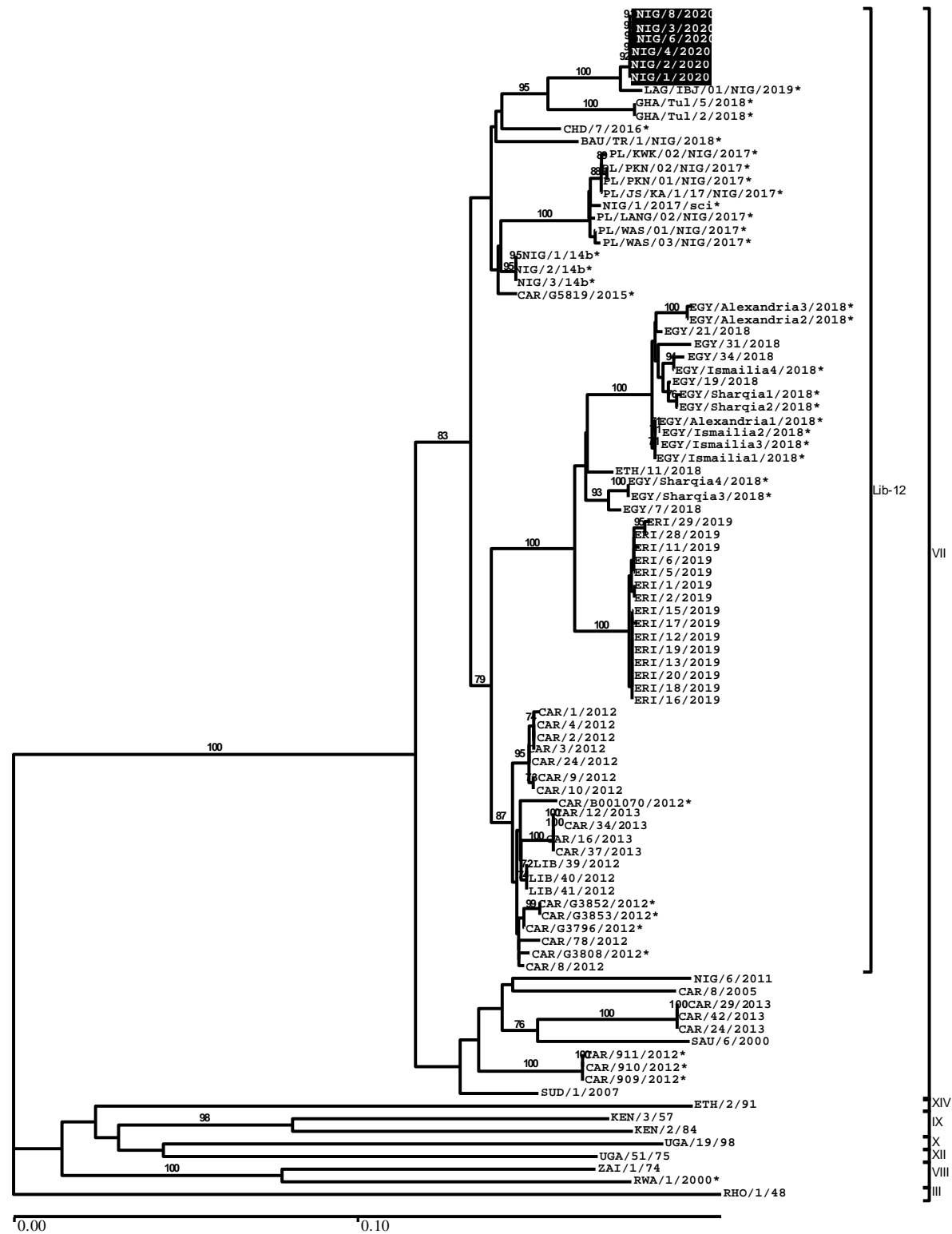
Niger continued on next page

Niger Continued

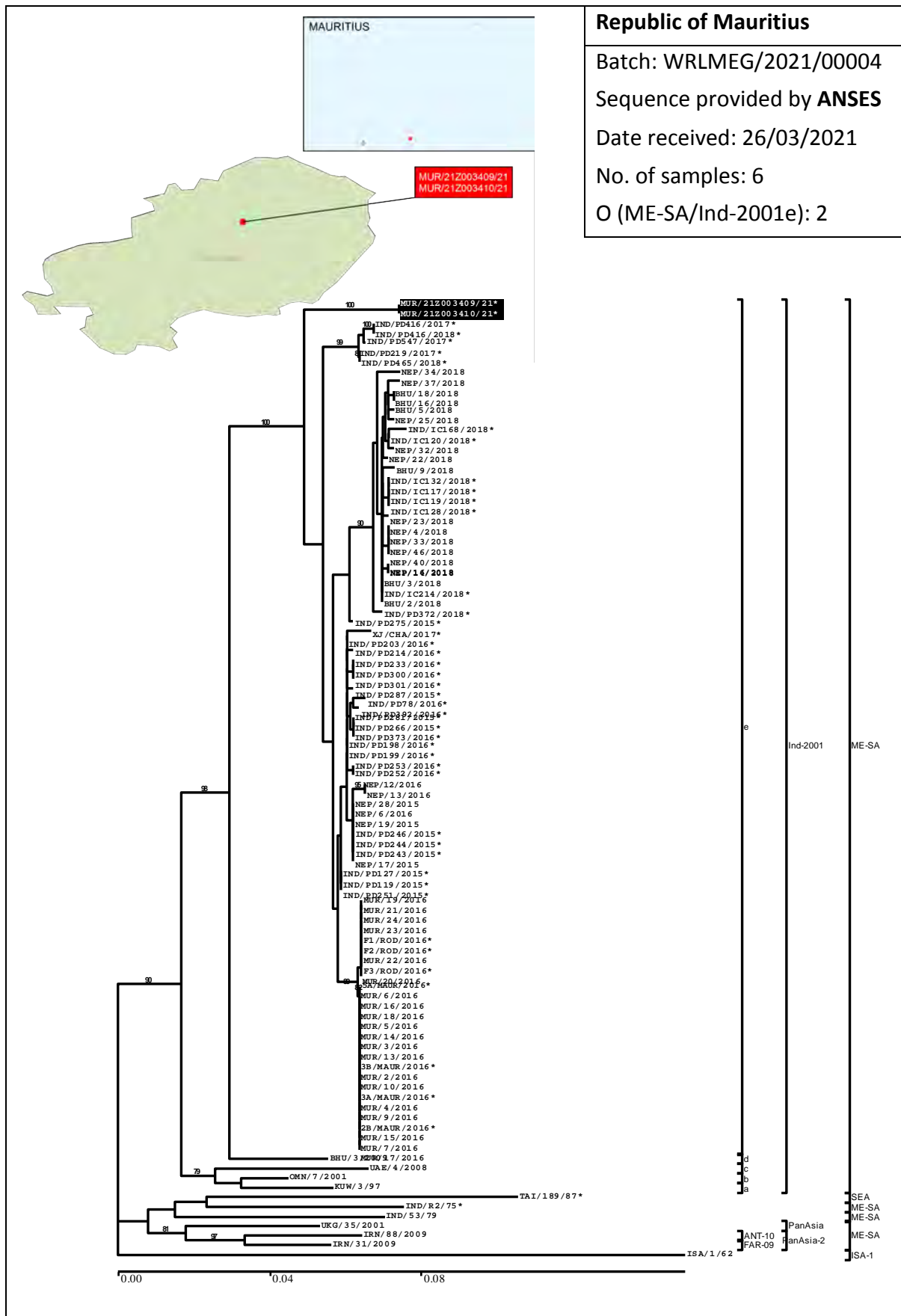


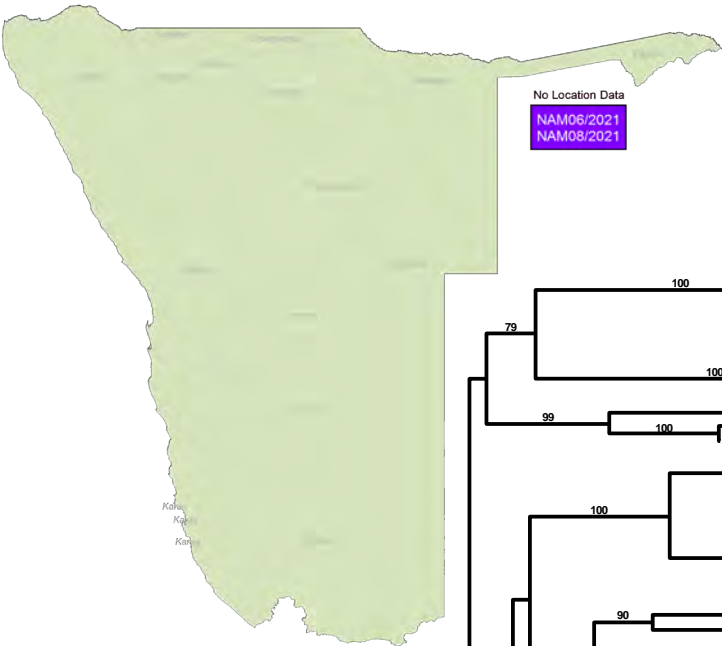


Nigeria continued

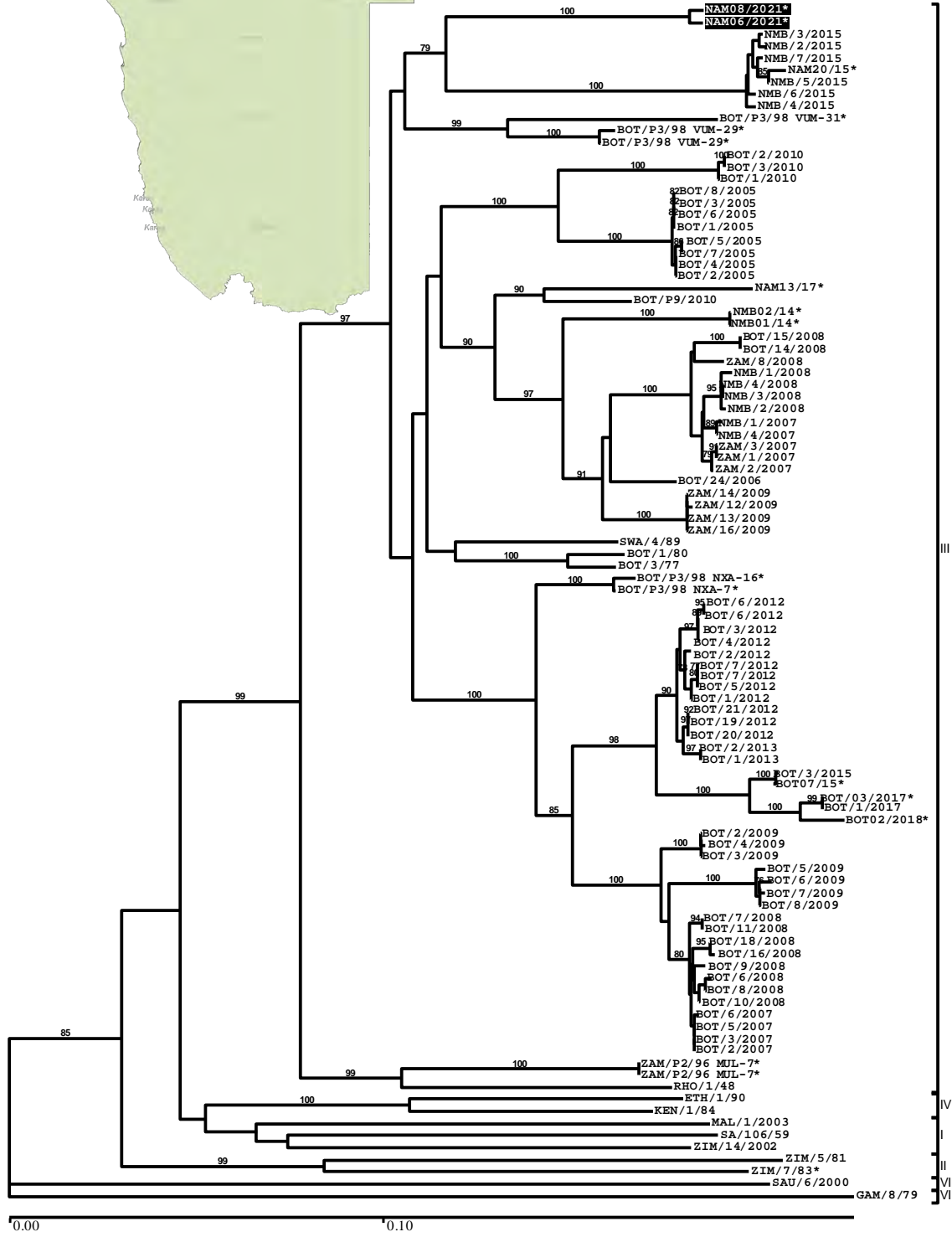


4.4. Pool 6 (Southern Africa)





Republic of Namibia
 Batch: WRLMEG/2021/00003
 Sequence provided by BVI
 Date received: 25/02/2021
 No. of samples: 2
 SAT2 (III): 2



4.5. Vaccine matching

Antigenic characterisation of FMD field isolates by matching with vaccine strains by 2dmVNT from January to March 2021.

NOTES:

1. Vaccine efficacy is influenced by vaccine potency, antigenic match and vaccination regime. Therefore, it is possible that a less than perfect antigenic match of a particular antigen may be compensated by using a high potency vaccine and by administering more than one vaccine dose at suitable intervals. Thus, a vaccine with a weak antigenic match to a field isolate, as determined by serology, may nevertheless afford some protection if it is of sufficiently high potency and is administered under a regime to maximise host antibody responses (Brehm, 2008).
2. Vaccine matching data generated in this report only considers antibody responses in cattle after a single vaccination (typically 21 days after vaccination). The long-term performance of FMD vaccines after a second or multiple doses of vaccine should be monitored using post-vaccination serological testing.

Table 4: Summary of samples tested by vaccine matching

Serotype	O	A	C	Asia-1	SAT 1	SAT 2	SAT 3
Nigeria	-	3	-	-	-	-	-
Israel*	3	-	-	-	-	-	-
Total	3	3	0	0	0	0	0

* Supplementary vaccine matching reports including O1 Campos from Biogénesis Bagó

Abbreviations used in tables

For each field isolate the r1 value is shown followed by the heterologous neutralisation titre (r1-value / titre). The r1 values shown below, represent the one-way serological match between vaccine strain and field isolate, calculated from the comparative reactivity of antisera raised against the vaccine in question. Heterologous neutralisation titres for vaccine sera with the field isolates are included as an indicator of cross-protection.

M	<p>Vaccine Match</p> <p>$r_1 = \geq 0.3$ - suggests that there is a close antigenic 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>$r_1 < 0.3$ - suggest that the field isolate is antigenically different to the vaccine strain. Where there is no alternative, the use of this vaccine should carefully consider vaccine potency, the possibility to use additional booster doses and monitoring of vaccinated animals for heterologous responses.</p>
NT	<p>Not tested against this vaccine</p>

NOTE: A “0” in the neutralisation columns indicates that for that particular field virus no neutralisation was observed at a virus dose of a 100 TCID₅₀.

NOTE: This report includes the source of the vaccine virus and bovine vaccinal serum. Vaccines from different manufactures may perform differently and caution should be taken when comparing the data.

Table 5: Vaccine matching studies for A FMDV

Isolate	Serotype A		A Iran 05 Boehringer Ingelheim		A Saudi 95 Boehringer Ingelheim		A/TUR/20/06 MSD Animal Health		A Malaysia 97 Boehringer Ingelheim		A22 Iraq Boehringer Ingelheim	
	Topotype	Lineage	r_1	Titre	r_1	Titre	r_1	Titre	r_1	Titre	r_1	Titre
NIG/1/2017	Africa	G-IV	0.00	0.00	0.16	1.72	0.15	1.00	0.12	1.44	0.18	1.75
NIG/3/2017	Africa	G-IV	0.04	1.11	0.37	2.08	0.21	1.15	0.17	1.58	0.23	1.86
NIG/5/2015	Africa	G-IV	0.05	1.17	0.35	2.05	0.20	1.13	0.19	1.63	0.30	1.98

Table 6: Supplementary vaccine matching studies for O1 Campos (Biogénesis Bagó)

Isolate	Serotype O		O1 Campos Biogénesis Bagó	
	Topotype	Lineage	r_1	Titre
ISR/15/2017	EA-3	-	0.21	2.13
ISR/12/2019	ME-SA	PanAsia-2 ^{QOM-15}	0.29	2.28
ISR/27/2019	ME-SA	PanAsia-2 ^{QOM-15}	0.42	2.25

Annex 1: Sample data

Summary of submissions

Table 6: Summary of samples collected and received to WRLFMD (January to March 2021)

Country	N ^o of samples	Virus isolation in cell culture/ELISA									
		FMD virus serotypes							No Virus Detected	RT-PCR for FMD	
		O	A	C	SAT 1	SAT 2	SAT 3	ASIA-1		Positive	Negative
BAHRAIN	40	3	1	-	-	-	-	-	36	5	35
CAMBODIA	9	9	-	-	-	-	-	-	-	9	-
ISRAEL	6	6	-	-	-	-	-	-	-	6	-
LAOS	5	5	-	-	-	-	-	-	-	5	-
NIGERIA	18	-	6	-	-	6	-	-	6	14	4
THAILAND	16	12	4	-	-	-	-	-	-	16	-
UGANDA	11	-	-	-	-	-	-	-	11	9	2
TOTAL	105	35	11	0	0	6	0	0	53	64	41

Clinical samples

Table 7: Clinical sample diagnostics made by the WRLFMD[®] January to March 2021

Country	Date		WRL for FMD Sample Identification	Animal	Date of Collection	VI/ELISA	Results	
	Received	Reported					RT-PCR	Final report
BAHRAIN	09-Mar-21	23-Mar-21	BAR 1/2021	Goat	01-Feb-21	NEG	NEG	NVD
			BAR 2/2021	Goat	01-Feb-21	NEG	NEG	NVD
			BAR 3/2021	Cattle	01-Feb-21	NEG	NEG	NVD
			BAR 4/2021	Cattle	01-Feb-21	NEG	NEG	NVD
			BAR 5/2021	Cattle	01-Feb-21	NEG	NEG	NVD
			BAR 6/2021	Cattle	01-Feb-21	NEG	NEG	NVD
			BAR 7/2021	Cattle	01-Feb-21	NEG	NEG	NVD
			BAR 8/2021	Cattle	01-Feb-21	NEG	NEG	NVD
			BAR 9/2021	Cattle	01-Feb-21	NEG	NEG	NVD
			BAR 10/2021	Cattle	01-Feb-21	NEG	NEG	NVD
			BAR 11/2021	Cattle	01-Feb-21	NEG	NEG	NVD
			BAR 12/2021	Sheep	01-Feb-21	NEG	NEG	NVD
			BAR 13/2021	Sheep	01-Feb-21	NEG	NEG	NVD

Country	Date		WRL for FMD Sample Identification	Animal	Date of Collection	VI/ELISA	Results	
	Received	Reported					RT-PCR	Final report
			BAR 14/2021	Cattle	01-Feb-21	NEG	NEG	NVD
			BAR 15/2021	Cattle	01-Feb-21	NEG	NEG	NVD
			BAR 16/2021	Cattle	01-Feb-21	NEG	NEG	NVD
			BAR 17/2021	Cattle	02-Feb-21	O	POS	O
			BAR 18/2021	Cattle	02-Feb-21	O	POS	O
			BAR 19/2021	Cattle	02-Feb-21	NEG	POS	FMDV GD
			BAR 20/2021	Cattle	02-Feb-21	O	POS	O
			BAR 21/2021	Cattle	02-Feb-21	A	POS	A
			BAR 22/2021	Sheep	09-Feb-21	NEG	NEG	NVD
			BAR 23/2021	Sheep	09-Feb-21	NEG	NEG	NVD
			BAR 24/2021	Sheep	09-Feb-21	NEG	NEG	NVD
			BAR 25/2021	Sheep	09-Feb-21	NEG	NEG	NVD
			BAR 26/2021	Sheep	09-Feb-21	NEG	NEG	NVD
			BAR 27/2021	Sheep	09-Feb-21	NEG	NEG	NVD
			BAR 28/2021	Sheep	09-Feb-21	NEG	NEG	NVD
			BAR 29/2021	Sheep	09-Feb-21	NEG	NEG	NVD
			BAR 30/2021	Sheep	09-Feb-21	NEG	NEG	NVD
			BAR 31/2021	Cattle	09-Feb-21	NEG	NEG	NVD
			BAR 32/2021	Cattle	09-Feb-21	NEG	NEG	NVD
			BAR 33/2021	Cattle	09-Feb-21	NEG	NEG	NVD
			BAR 34/2021	Cattle	09-Feb-21	NEG	NEG	NVD
			BAR 35/2021	Cattle	09-Feb-21	NEG	NEG	NVD
			BAR 36/2021	Cattle	09-Feb-21	NEG	NEG	NVD
			BAR 37/2021	Cattle	09-Feb-21	NEG	NEG	NVD
			BAR 38/2021	Cattle	09-Feb-21	NEG	NEG	NVD
			BAR 39/2021	Cattle	09-Feb-21	NEG	NEG	NVD
			BAR 40/2021	Cattle	09-Feb-21	NEG	NEG	NVD
CAMBODIA	22-Dec-20	29-Jan-21	CAM 1/2018	Cattle	01-Jan-18	O	POS	O
			CAM 2/2018	Cattle	03-May-18	O	POS	O
			CAM 3/2018	Cattle	17-May-18	O	POS	O
			CAM 4/2018	Cattle	30-May-18	O	POS	O
			CAM 5/2018	Cattle	10-Aug-18	O	POS	O
			CAM 6/2018	Buffalo	10-Aug-18	O	POS	O
			CAM 7/2018	Cattle	15-Aug-18	O	POS	O
			CAM 8/2018	Cattle	05-Sep-18	O	POS	O
			CAM 9/2018	Cattle	14-Sep-18	O	POS	O
ISRAEL	01-Mar-21	08-Mar-21	ISR 1/2021	Goat	03-Jan-21	O	POS	O
			ISR 2/2021	Goat	05-Jan-21	O	POS	O
			ISR 3/2021	Cattle	03-Jan-21	O	POS	O
			ISR 4/2021	Cattle	04-Jan-21	O	POS	O
			ISR 5/2021	Cattle	05-Jan-21	O	POS	O

Country	Date		WRL for FMD Sample Identification	Animal	Date of Collection	Results		
	Received	Reported				VI/ELISA	RT-PCR	Final report
LAOS	22-Dec-20	29-Jan-21	ISR 6/2021	Cattle	06-Jan-21	O	POS	O
			LAO 1/2020	Cattle	30-Jan-20	O	POS	O
			LAO 2/2020	Cattle	30-Jan-20	O	POS	O
			LAO 3/2020	Cattle	30-Jan-20	O	POS	O
			LAO 4/2020	Cattle	30-Jan-20	O	POS	O
NIGERIA	28-Jan-21	09-Feb-21	NIG 4/2015	Cattle	11-Sep-15	A	POS	A
			NIG 5/2015	Cattle	11-Sep-15	A	POS	A
			NIG 1/2017	Cattle	22-Mar-17	A	POS	A
			NIG 2/2017	Cattle	29-May-17	A	POS	A
			NIG 3/2017	Cattle	04-Jul-17	A	POS	A
			NIG 4/2017	Cattle	21-Sep-17	A	POS	A
	24-Feb-21	08-Mar-21	NIG 1/2020	Cattle	11-Jan-20	SAT 2	POS	SAT 2
			NIG 2/2020	Cattle	11-Jan-20	SAT 2	POS	SAT 2
			NIG 3/2020	Cattle	11-Jan-20	SAT 2	POS	SAT 2
			NIG 4/2020	Cattle	11-Jan-20	SAT 2	POS	SAT 2
			NIG 5/2020	Cattle	11-Jan-20	NEG	NEG	NVD
			NIG 6/2020	Cattle	11-Jan-20	SAT 2	POS	SAT 2
			NIG 7/2020	Cattle	11-Jan-20	NEG	POS	FMDV GD
THAILAND	22-Dec-20	29-Jan-21	TAI 9/2019	Cattle	23-Jan-19	A	POS	A
			TAI 10/2019	Cattle	04-Mar-19	A	POS	A
			TAI 11/2019	Cattle	28-Mar-19	A	POS	A
			TAI 12/2019	Cattle	30-Jul-19	A	POS	A
			TAI 1/2020	Cattle	07-Jan-20	O	POS	O
UGANDA	16-Dec-20	29-Jan-21	TAI 2/2020	Cattle	23-Jan-20	O	POS	O
			TAI 3/2020	Cattle	31-Jan-20	O	POS	O
			TAI 4/2020	Cattle	05-Feb-20	O	POS	O
			TAI 5/2020	Cattle	07-Feb-20	O	POS	O
			TAI 6/2020	Cattle	18-Feb-20	O	POS	O
			TAI 7/2020	Cattle	05-Mar-20	O	POS	O
			TAI 8/2020	Cattle	09-Mar-20	O	POS	O
			TAI 9/2020	Cattle	07-Apr-20	O	POS	O
			TAI 10/2020	Cattle	15-Apr-20	O	POS	O
			TAI 11/2020	Cattle	20-Apr-20	O	POS	O
			TAI 12/2020	Cattle	20-Apr-20	O	POS	O
			UGANDA	16-Dec-20	29-Jan-21	UGA 1/2020	Cattle	13-Feb-20

Country	Date		WRL for FMD Sample Identification	Animal	Date of Collection	VI/ELISA	Results	
	Received	Reported					RT-PCR	Final report
			UGA 2/2020	Cattle	13-Feb-20	NEG	POS	FMDV GD
			UGA 3/2020	Cattle	02-Jul-20	NEG	POS	FMDV GD
			UGA 4/2020	Cattle	02-Jul-20	NEG	NEG	NVD
			UGA 5/2020	Cattle	02-Jul-20	NEG	NEG	NVD
			UGA 6/2020	Cattle	02-Jul-20	NEG	POS	FMDV GD
			UGA 7/2020	Cattle	02-Jul-20	NEG	POS	FMDV GD
			UGA 8/2020	Cattle	10-Jul-20	NEG	POS	FMDV GD
			UGA 9/2020	Cattle	10-Jul-20	NEG	POS	FMDV GD
			UGA 10/2020	Cattle	10-Jul-20	NEG	POS	FMDV GD
			UGA 11/2020	Cattle	10-Jul-20	NEG	POS	FMDV GD
TOTAL					105			

Annex 2: FMD publications

Recent FMD Publications (January to March 2021) cited by Web of Science.

1. Ali, M.Z. and M. Giasuddin (2020). Detection of an emerging novel sublineage Ind2001BD1 and lineage PanAsia of *Foot-and-mouth disease virus* serotype O in cattle in Manikgonj district of Bangladesh, 2018. *Open Veterinary Journal*, **10**(3): 347-353. DOI: 10.4314/ovj.v10i3.14.
2. Athambawa, M.J., S. Kubota, and H. Kono (2021). Knowledge affecting Foot-and-mouth disease vaccination behavior: traditional dairy farmers in the dry zone of Sri Lanka. *Tropical Animal Health and Production*, **53**(1): 8. DOI: 10.1007/s11250-020-02501-5.
3. Bergmann, I.E., V. Malirat, A. Pedemonte, and E. Maradei (2021). Challenges in *Foot-and-mouth disease virus* strain selection as an input to attain broad vaccine intraserotype cross-protection. *Expert Review of Vaccines*, **20**(1): 13-22. DOI: 10.1080/14760584.2021.1877137.
4. Bertram, M.R., B. Brito, R.M. Palinski, I.H. Fish, S.J. Pauszek, E.J. Hartwig, G.R. Smoliga, L.T. Vu, B.H. Hoang, N.T. Phuong, V.V. Hung, P.P. Vu, N.K. Dung, N.N. Tien, P.V. Dong, D.H. Dung, and J. Arzt (2021). Novel recombinant *Foot-and-mouth disease virus* circulating in Vietnam. *Microbiology Resource Announcements*, **10**(1): 3. DOI: 10.1128/mra.01263-20.
5. Brown, E., N. Nelson, S. Gubbins, and C. Colenutt (2021). Environmental and air sampling are efficient methods for the detection and quantification of *Foot-and-Mouth Disease virus*. *Journal of Virological Methods*, **287**: 8. DOI: 10.1016/j.jviromet.2020.113988.
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9. Diaz-San Segundo, F., G.N. Medina, E. Spinard, A. Kloc, E. Ramirez-Medina, P. Azzinaro, S. Mueller, E. Rieder, and T. de los Santos (2021). Use of synonymous deoptimization to derive modified live attenuated strains of *Foot-and-mouth disease virus*. *Frontiers in Microbiology*, **11**: 17. DOI: 10.3389/fmicb.2020.610286.
10. Dill, V., A. Zimmer, M. Beer, and M. Eschbaumer (2020). Targeted modification of the *Foot-and-mouth disease virus* genome for quick cell culture adaptation. *Vaccines*, **8**(4): 14. DOI: 10.3390/vaccines8040583.
11. Dong, H., P. Liu, M.Y. Bai, K. Wang, R. Feng, D.D. Zhu, Y. Sun, S.Y. Mu, H.Z. Li, M. Harmsen, S.Q. Sun, X.X. Wang, and H.C. Guo. Structural and molecular basis for *Foot-and-mouth disease virus* neutralization by two potent protective antibodies. *Protein & Cell*: 8. DOI: 10.1007/s13238-021-00828-9.
12. Duffy, S., N. Fondevila, S.G. Novo, M. Aznar, C. Garro, E. Smitsaart, and G. Monti (2020). Reduction of *Foot-and-mouth disease virus* transmission in cattle vaccinated one or two weeks before challenge using a commercial polyvalent vaccine. *Vaccine: X*, **5**: 8. DOI: 10.1016/j.jvacx.2020.100063.
13. El Nahas, A.F., W.S.H. Abd El Naby, S.A. Khatab, A.A. Fergany, and R.R. Rashed (2021). Comparative expression analysis of inflammatory and immune-related genes in cattle during acute infection with *Foot-and-mouth disease virus* in Egypt. *Journal of Veterinary Research*, **65**(1): 39-44. DOI: 10.2478/jvetres-2021-0005.

14. Fukai, K., K. Inoue, A. Takeuchi, and M. Yamakawa (2021). New possibilities for egg white lysozyme: heat-denatured lysozyme partially inactivates select *Foot-and-mouth disease virus* strains. *Scientific Reports*, **11**(1): 5. DOI: 10.1038/s41598-020-80239-8.
15. Gashirai, T.B., S.D. Hove-Musekwa, and S. Mushayabasa (2021). Dynamical analysis of a fractional-order Foot-and-mouth disease model. *Mathematical Sciences*, **15**(1): 65-82. DOI: 10.1007/s40096-020-00372-3.
16. Hao, J.H., C.C. Shen, N.N. Wei, M.H. Yan, X.G. Zhang, G.W. Xu, D. Zhang, J. Hou, W.J. Cao, Y. Jin, K.S. Zhang, H.X. Zheng, and X.T. Liu (2021). *Foot-and-mouth disease virus* Capsid Protein VP1 capsid protein vp1 antagonizes TPL2-mediated activation of the IRF3/IFN- β signaling pathway to facilitate the virus replication. *Frontiers in Immunology*, **11**: 14. DOI: 10.3389/fimmu.2020.580334.
17. Jo, H., B.Y. Kim, S.H. Park, H.M. Kim, S.H. Shin, S.Y. Hwang, S.M. Kim, B. Kim, J.H. Park, and M.J. Lee (2021). The HSP70-fused foot-and-mouth disease epitope elicits cellular and humoral immunity and drives broad-spectrum protective efficacy. *NPJ Vaccines*, **6**(1): 14. DOI: 10.1038/s41541-021-00304-9.
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19. Kim, A.Y., H. Kim, S.Y. Park, S.H. Park, J.M. Lee, J.S. Kim, J.W. Park, C.K. Park, J.H. Park, and Y.J. Ko. Investigation of the optimal medium and application strategy for Foot-and-mouth disease vaccine antigen production. *Journal of Applied Microbiology*: 10. DOI: 10.1111/jam.15024.
20. Kim, A.Y., H. Kim, S.Y. Park, S.H. Park, J.S. Kim, J.W. Park, J.H. Park, and Y.J. Ko (2021). Development of a potent stabilizer for long-term storage of Foot-and-mouth disease vaccine antigens. *Vaccines*, **9**(3): 10. DOI: 10.3390/vaccines9030252.
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24. Kushwaha, A., S. Behera, M. Saminathan, K. Sreedharan, S. Basagoudanavar, G.B.M. Reddy, and M. Hosamani (2021). Monoclonal antibodies against *Foot-and-mouth disease virus* RNA polymerase for detection of virus infection. *Microbiology and Immunology*, **65**(2): 95-98. DOI: 10.1111/1348-0421.12860.
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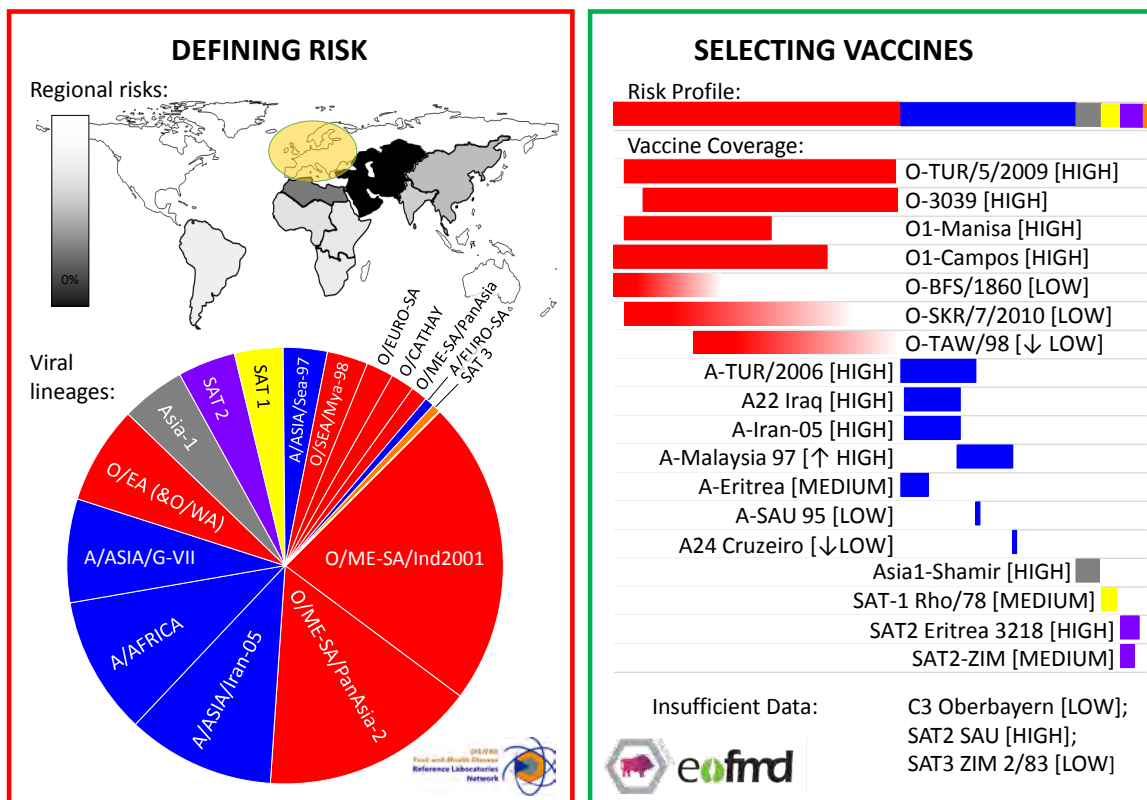
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Annex 3: Vaccine recommendations

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 (<http://www.fao.org/3/cb1799en/cb1799en.pdf>). 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, above), as well as available *in vitro*, *in vivo* and field data to score the ability of vaccines to protect against these FMDV lineages.

Vaccine Antigen Prioritisation: Europe

March 2021



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

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

Courses

- The [EuFMD Virtual Learning platform](#) provides convenient self-paced training which you may study anytime, anywhere, free of charge. Open access courses currently offered are:
 - [Simulation Exercises for Animal Disease Emergencies](#) aiming at building your understanding of simulation exercises and their value as part of the emergency preparedness cycle.
 - [Introduction to the Risk-Based Strategic Plan](#) introducing the Risk-Based Strategic Plan (RBSP).
 - [What is the Progressive Control Pathway](#) providing an overview of the Progressive Control Pathway for Foot-and-Mouth Disease (PCP-FMD), the tool used to FMD control under the GF-TADs Global Strategy.
 - For anyone who is new to the PCP-FMD, a short e-learning module is also available in [Arabic](#).
 - [Introduction to FMD](#) course, available in English and [French](#), introducing foot-and-mouth disease (FMD), its importance, diagnosis, outbreak investigation and the control measure that might apply in a previously free country experiencing an outbreak.
 - [Introduction to Lumpy Skin Disease](#), a short open-access module made available to support countries in Asia and the Pacific face this rapidly emerging threat.
 - [Public Private Partnerships in the Veterinary Domain](#) course, developed in partnership with the World Organisation for Animal Health OIE, applying public-private partnerships to the control of FMD and similar transboundary animal diseases.
- The WRLFMD residential training course on FMD diagnostic methods (<https://www.pirbright.ac.uk/instructor-led-training/diagnosis-foot-and-mouth-disease>) scheduled for May 2021 has been postponed.

Other resources

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

Emergency Preparedness Network <http://www.fao.org/eufmd/network/en/>

The Emergency Preparedness Network is a forum for emergency preparedness experts to share information and experience. You will regularly receive the latest information on topics related to prevention and control of foot-and-mouth and other similar transboundary animal diseases ("FAST" diseases).

Meetings

- A Meeting of Laboratory and Epidemiology Networks for the West Eurasia Region is planned for June 2021 (virtual).
- The 4th Regional Roadmap Meeting on PCP-FMD for SAARC Member States is planned for July 2021 (virtual) and will also include a meeting of the Laboratory and Epidemiology networks.

Proficiency test scheme organised by WRLFMD

Sample panels for the Phase XXXII exercise have shipped to international laboratories; however, this is still ongoing as the disruption to air travel continues. Results have been received from laboratories and feedback has been sent out to those laboratories that have submitted results (see table below for a summary of the current status of the exercise).

Status	Number of Labs
Invitations	75*
Declined to take part	21
PTS shipped	37
Destroyed in transit	1
Results returned	33
Feedback returned	30

* This table includes self-funded countries.

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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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, Whatsapp, Quarterly Global Reports, Real Time Training.

EuFMD Committees

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



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