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

2022

Quarterly report

April-June

Funded by the European Union

EuFMD's programme, tools and initiatives

FAST
Foot-and-mputh And Similar Transboudary animal diseases

Dt
eufmd digital transformation

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vlearning
eufmd virtual learning centre

microLearning
eufmd virtual learning

vlc EA
virtual learning centre for East Africa

Tom
eufmd training management system

SimExOn
simulation exercises online

KnowBank
eufmd knowledge bank

GetPrepared
emergency preparedness toolbox

RiskComms
risk communications

SQRA
a method for spatial qualitative risk analysis applied to fmd.

Pragmatist
prioritization of antigen management with international surveillance tool

EuFMDiS
european foot-and-mouth disease spread model

Vademos
fmd vaccine demand estimation model

GVS
global vaccine security

PQv
vaccine prequalification

PCP
progressive control pathway

PSO
pcp practicioner officers

VPP
veterinary paraprofessionals

PPP
public private partnership

Sustainable development goals, UN-SDGs. EuFMD's programme has a focus on

Together against wasting resources, think twice before printing.

Foot-and-Mouth Disease

Quarterly Report

April-June 2022

Food and Agriculture Organization of the United Nations

Rome, 2022

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Jammu and Kashmir: *Dotted line represents approximately the Line of Control in Jammu and Kashmir agreed upon by India and Pakistan. The final status of Jammu and Kashmir has not yet been agreed upon by the parties.*

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).*

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	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)
MNFMDL	Malaysian National Foot-and-Mouth Disease Laboratory
NT	Not tested
NVD	No virus detected
OIE	Office International des Epizooties
PIADC	Plum Island Animal Disease Center
Pusvetma	Pusat Veteriner Farma
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 Türkiye
VI	Virus Isolation
WAHIS	World Animal Health Information System (of the WOAH)
WOAH	World Organisation for Animal Health (founded as OIE)

1. Highlights and headlines

Welcome to this new quarterly report covering FMD activities for April-June 2022. During the past three months, the WRLFMD has reported test results for samples received from Algeria, Botswana, Israel, Malawi, Namibia, Palestine, Tunisia, United Arab Emirates and Zambia. There have also been sequence submissions from Indonesia (Pusvetma), Malawi (BVI), Malaysia (MNFMDL), Mali (ANSES), Mozambique (BVI) and Thailand (Pakchong).

During this busy period, greatest attention has been placed on the further expansion of the O/ME-SA/Ind-2001e lineage in Indonesia which had previously maintained an FMD-free status (without vaccination) since 1990. FMD has spread very rapidly and there are now official reports of outbreaks on four main islands (Sumatra, Java, Kalimantan, and Lombok) as well on the Island of Bali (via media sources). Analyses of sequence data reveals a close genetic relationship to FMD viruses collected in Thailand and Malaysia during 2021 and 2022; findings which may help to understand the origin of this incursion. During this quarter, further outbreaks due to the O/EA-3 topotype have been characterised in Algeria, which in addition to earlier cases in Tunisia, pose immediate threats to countries in southern Europe. In southern Africa, the O/EA-2 topotype has continued to spread into new locations (Malawi and Mozambique). In the Middle East a new virus lineage (called O/ME-SA/SA-2018) previously detected in India and Sri Lanka has been detected for the first time (in UAE). Elsewhere, a recent peer-reviewed paper from Egyptian scientists has provided evidence that viruses from the O/EURO-SA topotype are circulating in the country (see: https://pubmed.ncbi.nlm.nih.gov/35679058/). This report has not been officially confirmed, but if true would represent the introduction of a completely new viral lineage with a South American origin into North Africa.

Further published information including the Quarterly report published by WRLFMD in partnership with EuFMD can be retrieved from the following website (http://www.wrlfmd.org/).

Don King, Pirbright, July 2022

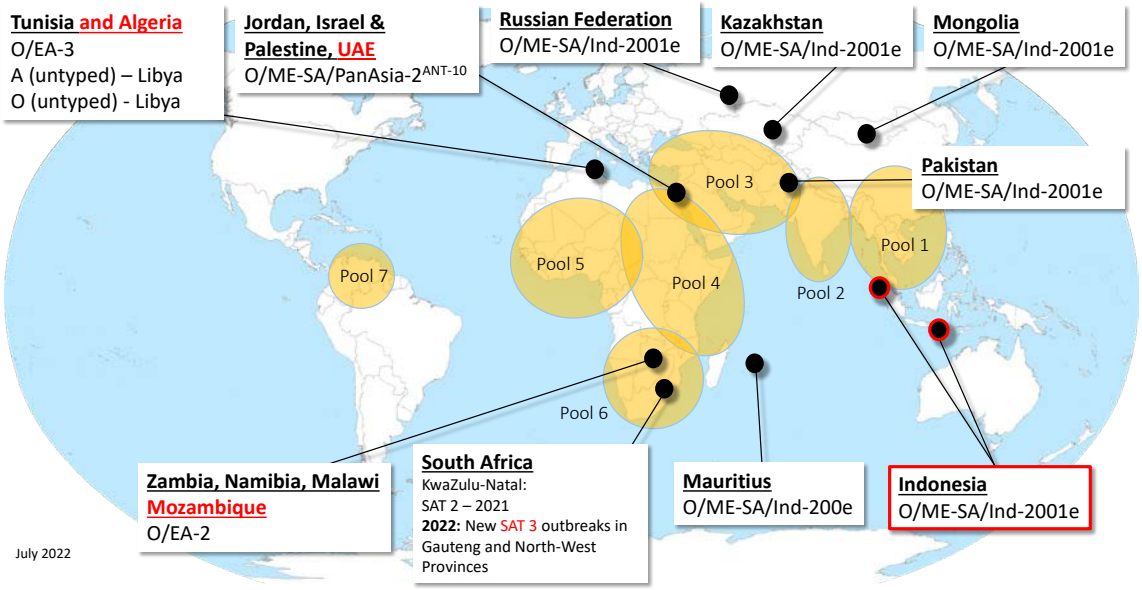


Figure 1: Recent FMD global outbreaks (new headline events reported April to June 2022 are highlighted) with endemic pools highlighted in orange. NB: the figure has been updated to correct the serotype of FMD outbreaks in Gauteng and North-West Provinces of South Africa that were mistakenly identified as SAT2 in the last report. 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
1	**SOUTHEAST ASIA/CENTRAL ASIA/EAST ASIA** Cambodia, China, China (Hong Kong SAR), Taiwan Province of China, Indonesia, 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[1], 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, Türkiye, Turkmenistan, United Arab Emirates, Uzbekistan	A, Asia 1 and O (SAT 2)
4	**EASTERN AFRICA** Burundi, Comoros, Djibouti, Egypt[3], Eritrea, Ethiopia, Kenya, Rwanda, Somalia, South Sudan, Sudan, Uganda, United Republic of Tanzania, Yemen	O, A, SAT 1, SAT 2 and SAT 3
	NORTH AFRICA[2] Algeria, Libya, Morocco, Tunisia	A, O and SAT 2
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)[4]
7	**SOUTH AMERICA** Venezuela (Bolivarian Republic of)	O and A

[1]FMD outbreaks in 2016/21 due to O/ME-SA/Ind-2001 demonstrate close epidemiological links between Pool 2 and Mauritius

[2]Long-term maintenance of FMDV lineages has not been documented in North Africa and therefore this region does not constitute an Endemic Pool, but data is segregated here since FMD circulation in this region poses a specific risk to FMD-free countries in Southern Europe

[3]Egypt represents a crossroads between East African Pool 4 and the Middle East (Pool 3). NB: Serotypes SAT 1 and SAT 3 have not been detected in this country

[4]Detection of O/EA-2 in southern/western Zambia (2018-2021), Namibia (2021) and Malawi (2022) represent a new incursion into Pool 6

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.

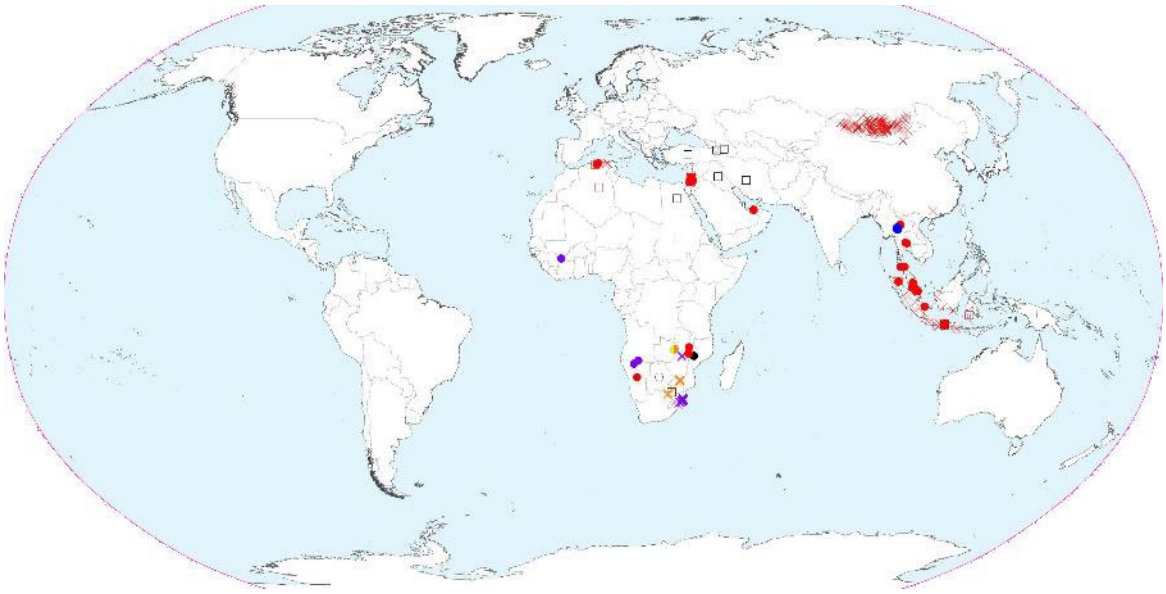


Figure 2: Samples tested by WRLFMD or reported in this quarter. ● indicates samples analysed; × indicates new outbreaks reported to the WOAH; □ indicates reports of FMD from other sources. Shape colours define the serotype detected ●O; ●A; ●C; ●Asia1, ●SAT1, ●SAT2, ●SAT3, ○ FMD not detected, ● serotype 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 People's Republic of China

On 23 May 2022, a single outbreak was reported in pigs in a slaughterhouse in Changzhou District, Guangxi Zhuang Autonomous Region. No genotyping has been reported.

WOAH World Animal Health Information System (event ID: evt_4481)

ProMED post: 20220614.8703855

The Republic of the Indonesia

On the 9 May 2022, 80 outbreaks of **FMD type O** were reported to have occurred in cattle on the islands of Sumatra (n=1) and in four provinces in East Java (n=79). Subsequently, in May and June, outbreaks were reported in many areas including the Bangka Belitung Islands, Central, North, South and West Sumatra, Lampung, Banten, Central, South and West Java, Central, South and West Kalimantan and West Nusa Tenggara.

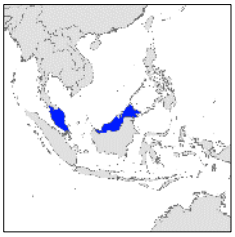
On the 9 May 2022, a single VP1 sequence was received from the Pusvetma laboratory. Subsequently, on the 21 May 2022, four further sequences were received from the same laboratory. Genotyping showed they belonged to the **O/ME-SA/Ind-2001e** sublineage (see below).

On the 18 June 2022, six samples were received from the Pusvetma laboratory. Results are pending.

WOAH World Animal Health Information System (event ID: evt_4448)

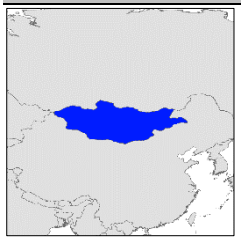
ProMED posts: 20220508.8703115, 20220511.8703175, 20220512.8703203, 20220516.8703290, 20220519.8703361, 20220524.8703437, 20220525.8703456, 20220613.8703827, 20220618.8703940 and 20220625.8704074

Malaysia



On the 11 June 2022, a batch of 14 **FMD type O** VP1 sequences were received from the Malaysian National FMD Laboratory (MNFMDL). The samples from which they were obtained were collected from water buffalo, cattle & goats in various locations between Jan 2021 and Mar 2022. All were genotyped as **O/ME-SA/Ind-2001e** (see below).

Mongolia

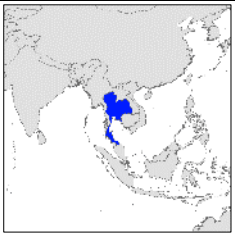


On 16 May 2022, a batch of 17 samples, collected from cattle in 15 different provinces between August 2021 and February 2022. Results are pending.

Mongolia is plans to launch a month-long vaccination campaign starting in mid-April. There has been an outbreak of O/ME-SA/Ind-2001e ongoing since August 2021. As of 13 April 2022, a quarantine regime is in place at 145 locations spread across 15 provinces.

ProMED post: 20220414.8702596

The Kingdom of Thailand



On 10 May 2022, 20 FMDV VP1 sequences were received from the Thailand Regional Reference Laboratory (TRRL) at Pakchong. The samples from which the sequences were derived were collected from cattle in seven provinces (Chiang Mai, Chiang Rai, Krabi, Lamphun, Lopburi, Nakhon Ratchasima and Nakhon Si Thammarat) between January and November 2021. Genotyping showed eight belonged to **FMD type O ME-SA/Ind-2001e** and 12 to **FMD type A ASIA/Sea-97** (see below).

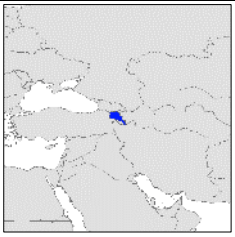
On 6 May 2022, a batch of 48 samples were received. Results are pending.

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)

The Republic of Armenia



Passive surveillance is being used and over 260 000 animals were vaccinated in April and May 2022.

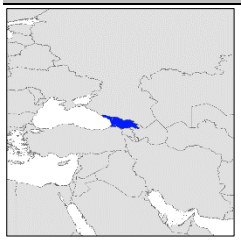
FAO Eu-FMD FAST report Apr-Jun 2022

The Republic of Azerbaijan

Passive and active surveillance are being used in Azerbaijan. Over 6 500 serum samples have been tested in the Central Veterinary Laboratory. Almost 2.25 million animals were vaccinated in April and May 2022.

FAO Eu-FMD FAST report Apr-Jun 2022

Georgia



500 serum samples were collected and submitted for testing for spring prophylatic surveillance 2022. The results are pending

FAO Eu-FMD FAST report Apr-Jun 2022

The Islamic Republic of Iran

153 outbreaks have been reported in this quarter. The circulating strains are O/PanAsia-2^{ANT-10} and A/Iran-05^{FAR-11}.

Passive and (risk-based) active surveillance activities are on-going.

Over 10.5 million animals have been vaccinated using trivalent vaccines (O, A & Asia-1) and post-vaccination monitoring has been completed.

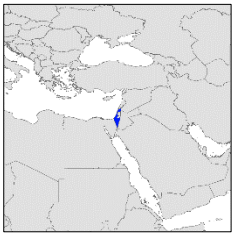
FAO Eu-FMD FAST report Apr-Jun 2022

The Republic of Iraq

77 reported FMD outbreaks (9503 cases with 23 deaths) from provinces across the country - O, A and Asia-1 serotypes. There has been no vaccination campaign since July 2021.

FAO Eu-FMD FAST report Apr-Jun 2022

The State of Israel



Between April and June 2022, 51 outbreaks of **FMD type O** were reported in cattle, sheep, goats and pigs in many locations throughout the country.

On 12 May 2022, ten samples were received from the Kimron Veterinary Institute (Israel). They were collected from cattle in three regions [Hazafon (Northern district), Hamerkaz (Central district) and Jerusalem] in February and March 2022. Nine samples were identified as **FMD type O**, while one was FMDV genome detected. Genotyping revealed that all nine belonged to the **O/ME-SA/PanAsia-2^{ANT-10}** sublineage (see below).

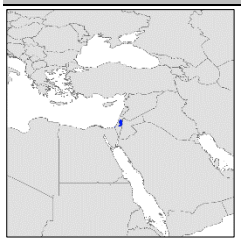
WOAH World Animal Health Information System (event ID: evt_evt_4305)

ProMED posts: 20220421.8702742 and 20220429.8702934

There are reports in the media that a vaccine used by the veterinary service is not protecting animals against the circulating strain.

ProMED posts: 20220512.8703213

Palestine



In April and May 2022, two outbreaks of **FMD type O** were reported in sheep at Dura and cattle at Qilqis, both located in the Hebron Governorate in the West Bank.

On 12 May 2022, 12 samples were received from the Kimron Veterinary Institute (Israel). All were **FMD type O**. Genotyping revealed that eight of viruses (from the West Bank) belonged to the **O/ME-SA/PanAsia-2^{ANT-10}** sublineage, while four (from the Gaza Strip) belonged to the **EA-3** topotype (see below).

WOAH World Animal Health Information System (event ID: evt_4176)

The Republic of Türkiye

During this quarter there were 14 outbreaks of FMD in the Anatolia region. These were typed as O/ME-SA/PanAsia-2^{QOM-15}.

Across Türkiye more than 260 000 animals were clinically examined for signs of FMD and over 1 000 serum samples collected as part of the Thrace RBSP. The spring preventative-vaccination campaign was completed and an additional vaccination campaign for the buffer zone (13 provinces throughout the cross border in Eastern and Southeastern of Anatolia) was started in June.

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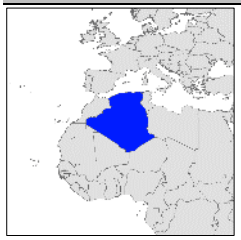
The United Arab Emirates

On 6 May 2022, a batch of 15 samples were received. Two were collected from Arabian oryx (*Oryx leucoryx*) in April 2021 and 13 were from cattle, sheep and goats sampled between July and December 2021. Typing revealed seven to be **FMD type O**, while FMDV genome was detected in a further three samples and five were NVD. Genotyping revealed that the viruses from the oryx belonged to **O/ME-SA/PanAsia-2^{ANT-10}**, while the remaining viruses belonged to a relatively new lineage, **O/ME-SA/SA-2018**, previously found in India (2018) and Sri Lanka (2019) (see below).

3.5. Pool 4 (North and Eastern Africa)

The People's Democratic Republic of Algeria



Between April and May 2022, five outbreaks of **FMD type O** were reported in sheep and goats in three provinces (El Taref, Guelma and Skikda).

On 11 May 2022, five samples were received from ANSES. They were collected from cattle in Béjaïa province in March 2022. Four were identified as **FMD type O** and one was FMDV-GD. Genotyping revealed the four viruses belonged to the **O/EA-3** topotype (see below).

WOAH World Animal Health Information System (event ID: evt_4432)

ProMED post: 20220503. 8702983, 20220509.8703156 and 20220601.8703608

The Arab Republic of Egypt

Media have been reporting on the spread of FMD in Egypt and the variable uptake of vaccines made available by the government in June

ProMED post: 20220627.8704110

The Federal Democratic Republic of Ethiopia

On 18 May 2022, a batch of 48 samples were received. Results are pending.

The Republic of the Sudan

Four FMD outbreaks were reported between March and May 2022. Passive surveillance is active in the country, with active surveillance in quarantine areas. While vaccination is targeting the dairy sector.

FAO Eu-FMD FAST report Apr-Jun 2022

3.6. Pool 5 (West/Central Africa)

The Republic of Mali

On 13 May 2022, two VP1 sequences were received from ANSES. The samples had been collected from cattle and sheep at Fakola on 14 August 2021. Genotyping revealed they belonged to **FMD SAT 2 topotype VII** (see below).

3.7. Pool 6 (Southern Africa)

Malawi

On 13 April 2022, a single VP1 sequence was received from the BVI. The sequence was derived from a sample collected from cattle in Mchinji District (Central region) close to the border with Zambia. Genotyping revealed that it belonged to the **FMD type O EA-2** topotype and was closely related to type O viruses from Zambia (see below).

WOAH World Animal Health Information System (event ID: evt_evt_4325)

The Republic of Mozambique

On 29 June 2022, a single VP1 sequence was received from the BVI. The sequence was derived from a sample collected from cattle in Tete Province close to the borders with Zambia and Malawi. Genotyping revealed that it belonged to the **FMD type O EA-2** topotype and was closely related to viruses from Zambia and Malawi (see below).

WOAH World Animal Health Information System (event ID: evt_4413)

The Republic of South Africa

During April and May 2022, a further 23 outbreaks of **FMD type SAT 2** were reported in cattle in KwaZulu-Natal. Additionally, FMD virus was detected in seven wild African buffalo by real time RT-PCR. Genotyping at the Onderstepoort Veterinary Institute (OVI) has previously shown the virus to belong to **SAT 2 topotype I**.

WOAH World Animal Health Information System (event ID: evt_3738)

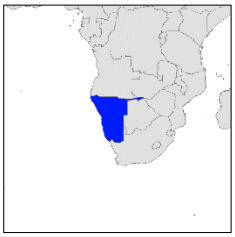
During April and June 2022, a further seven outbreaks of **FMD type SAT 3** were reported in cattle in Limpopo (n=2) and North West (n=5) provinces. Genotyping at the OVI has previously shown the virus to belong to **SAT 3 topotype I**.

WOAH World Animal Health Information System (event ID: evt_4368)

An isolated case of FMD was detected in the Viljoenskroon area of the Free State following an investigation after suspicions were raised about of movement of cattle from North-West and Gauteng Provinces. FMD has also been detected in the Randfontein area of Gauteng Province.

ProMED post: 20220408.8702476 and 20220403.870236

The Republic of Zimbabwe



During May 2022, ten outbreaks of **FMD type SAT 2** (diagnosed serologically by a solid phase blocking ELISA) were reported in cattle in ten villages in Mbire District, Mashonaland Central Province, close to the border with Mozambique. Further laboratory investigations on epithelial samples are recommended to exclude the involvement of FMD type O which has recently caused outbreaks in nearby countries (Mozambique, Malawi and Zambia).

WOAH World Animal Health Information System (event ID: evt_4465)

3.8. Pool 7 (South America)

No new outbreaks of FMD were reported in South America.

3.9. Extent of global surveillance

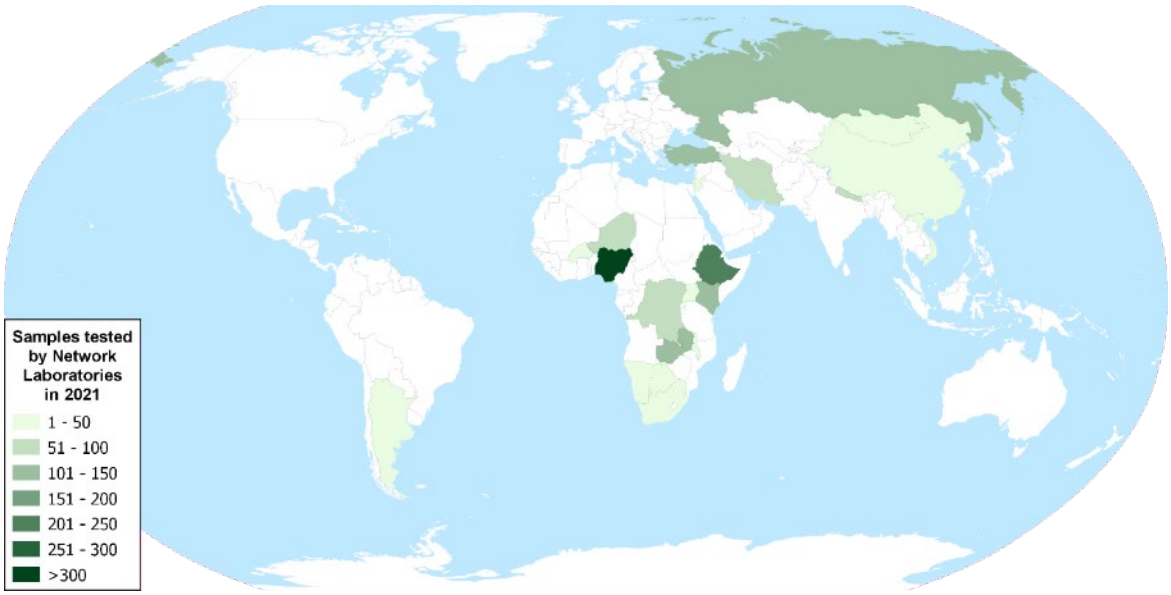


Figure 3: Samples received during 2021 from FMD outbreaks (routine surveillance that is undertaken in countries that are FMD-free without vaccination is not shown). Data from presentations given at the WOAH/FAO FMD reference laboratory network annual meeting (https://www.foot-and-mouth.org/Ref-Lab-Network/Network-Annual-Meeting). Source: WRLFMD. Map conforms to the United Nations World map, June 2020.

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 region (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 WOAH/FAO FMD reference laboratory network meeting in December 2021) 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	21.5							
O ME-SA Ind2001	40	86[1]	7	2				
O EA or O WA			3	55	55.5	65	16	
O EURO-SA								90
O CATHAY	10.5							
A ASIA Sea-97	18							
A ASIA Iran-05	0		32					
A ASIA G-VII		10	10					
A AFRICA				33	22	17		
A EURO-SA								10
Asia-1	0	4	12.5					
SAT 1				0	8	3	16	
SAT 2			0.5	10	14	15	52	
SAT 3					0.5		16	
C								

[1] includes cases due to the emerging O/ME-SA/SA-18 lineage that has been recently detected in Pool 2

A number of outbreaks have occurred where samples have not been sent to the WRLFMD or other laboratories in the WOAH/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-2021.

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 April to June 2022 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 April to June 2022.

WRLFMD Batch No.	Date received	Country	Total No. samples	Serotype	No. of samples	No. of sequences	Sequencing status
WRLFMD/2022/000008	06/05/2022	United Arab Emirates	15	O	7	7	Finished
				FMDV-GD	3		
				NVD	5		
WRLFMD/2022/000009	11/05/2022	Algeria	5	O	4	4	Finished
				FMDV-GD	1		

WRLFMD Batch No.	Date received	Country	Total No. samples	Serotype	No. of samples	No. of sequences	Sequencing status
WRLFMD/2022/000010	16/05/2022	Mongolia	17	Pending	17		Pending
WRLFMD/2022/000011	12/05/2022	Israel	10	O FMDV-GD	9 1	9	Finished
WRLFMD/2022/000012	18/05/2022	Ethiopia	48	Pending	48		Pending
WRLFMD/2022/000013	12/05/2022	Palestine	12	O	12	12	Finished
WRLFMD/2022/000015	18/06/2022	Indonesia	6	Pending	6		Pending
WRLFMD/2022/000016	06/05/2022	Thailand	16	Pending	16		Pending
Totals			**129**		**129**	**32**	

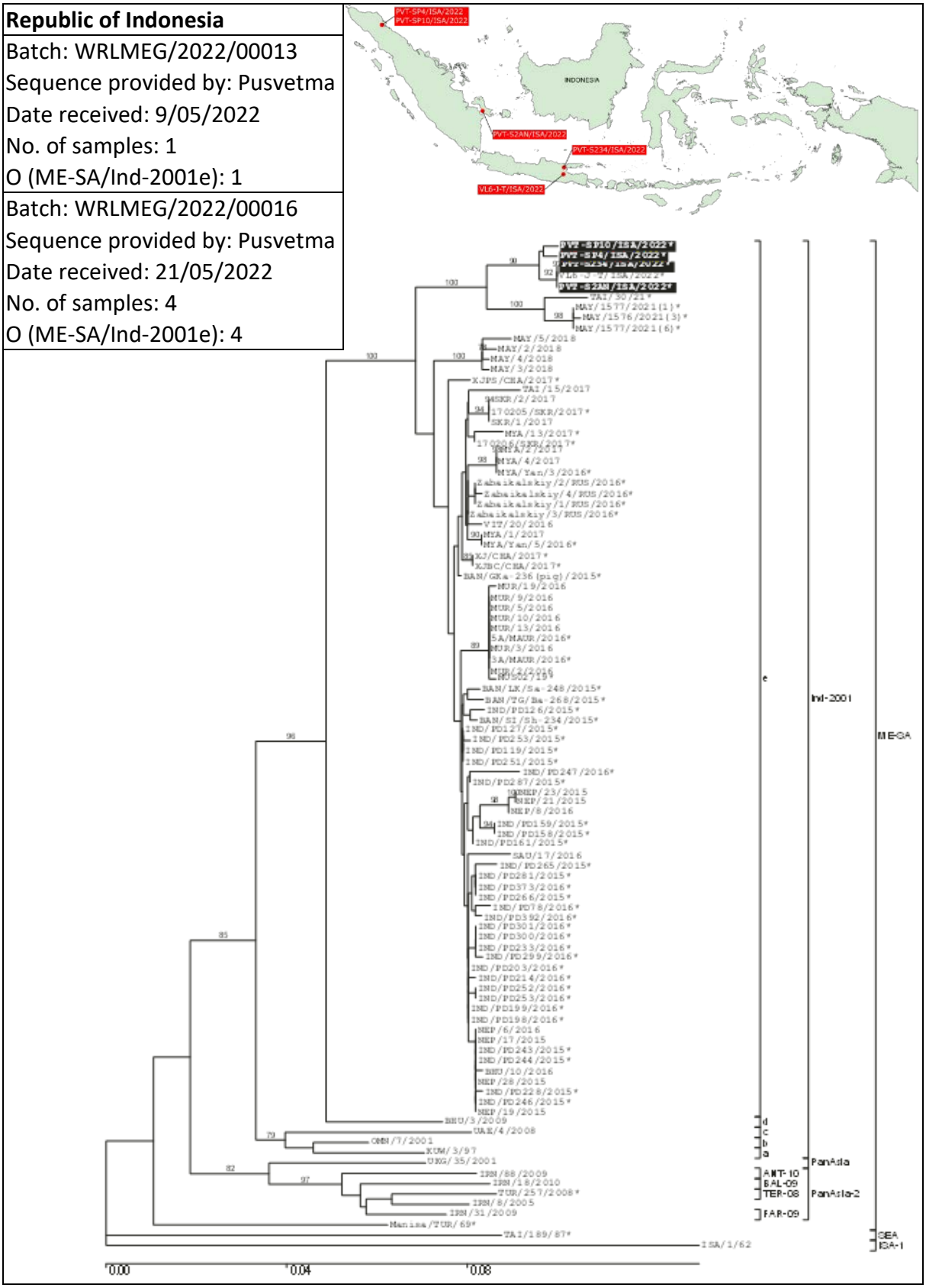
Table 3: VP1 sequences submitted by other FMD Network laboratories to the WRLFMD from April to June 2022.

WRLFMD Batch No.	Date received	Country	Serotype	Date Collected	No. of sequences	Submitting laboratory
WRLMEG/2022/00012	13/04/2022	Malawi	O	4 Feb 2022	1	BVI
WRLMEG/2022/00013	09/05/2022	Indonesia	O	2022	1	Pusvetma
WRLMEG/2022/00014	10/05/2022	Thailand	O A	2021 2021	8 12	Pakchong
WRLMEG/2022/00015	13/05/2022	Mali	SAT 2	14 Aug 2021	2	ANSES
WRLMEG/2022/00016	21/05/2022	Indonesia	O	2022	4	Pusvetma
WRLMEG/2022/00017	11/06/2022	Malaysia	O	Jan 2021-Mar 2022	14	MNFMDL
WRLMEG/2022/00021	29/06/2022	Mozambique	O	13 May 2022	1	BVI
				Total	**43**	

4. Detailed analysis

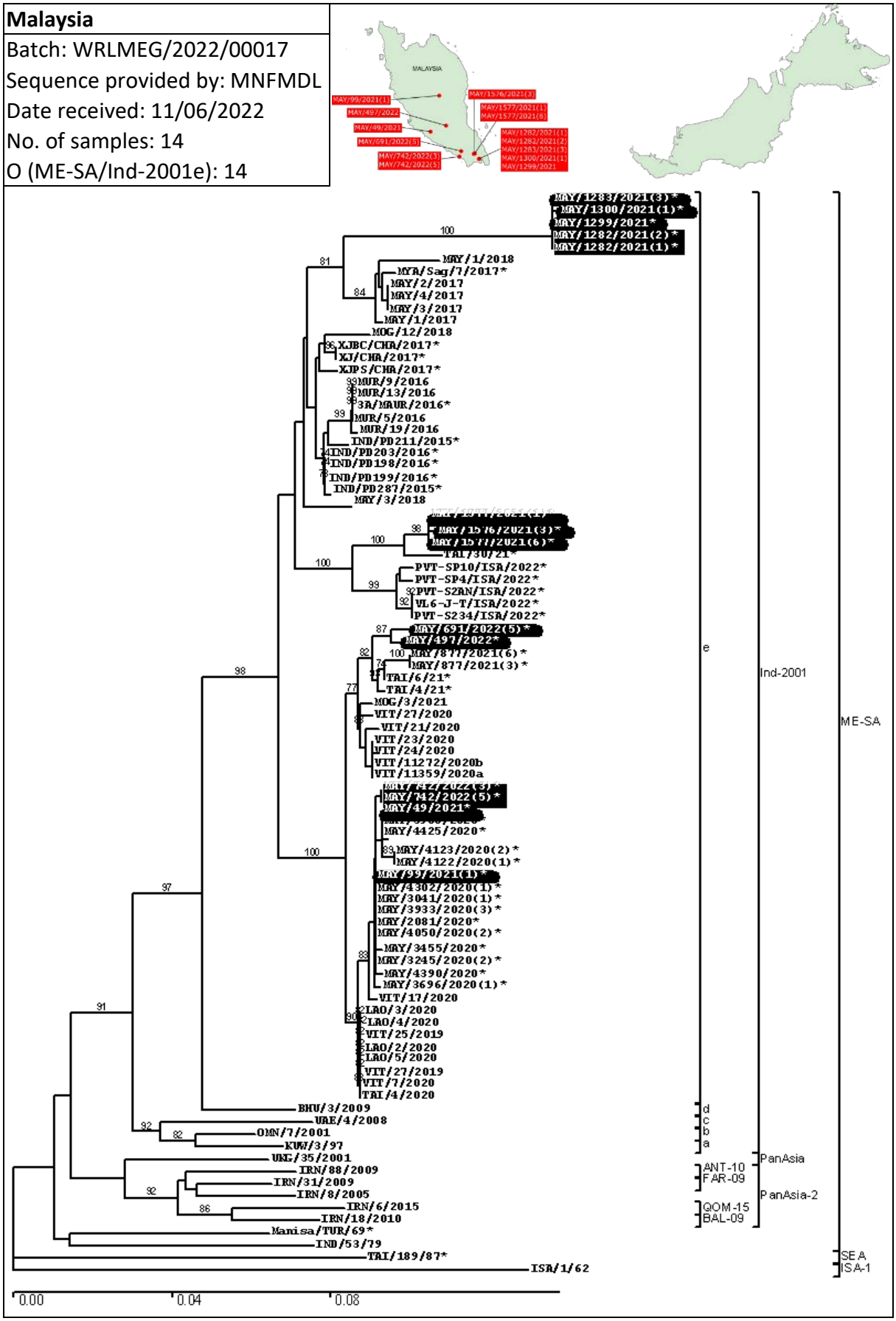
4.1. Pool 1 (Southeast Asia/Central Asia/East Asia)

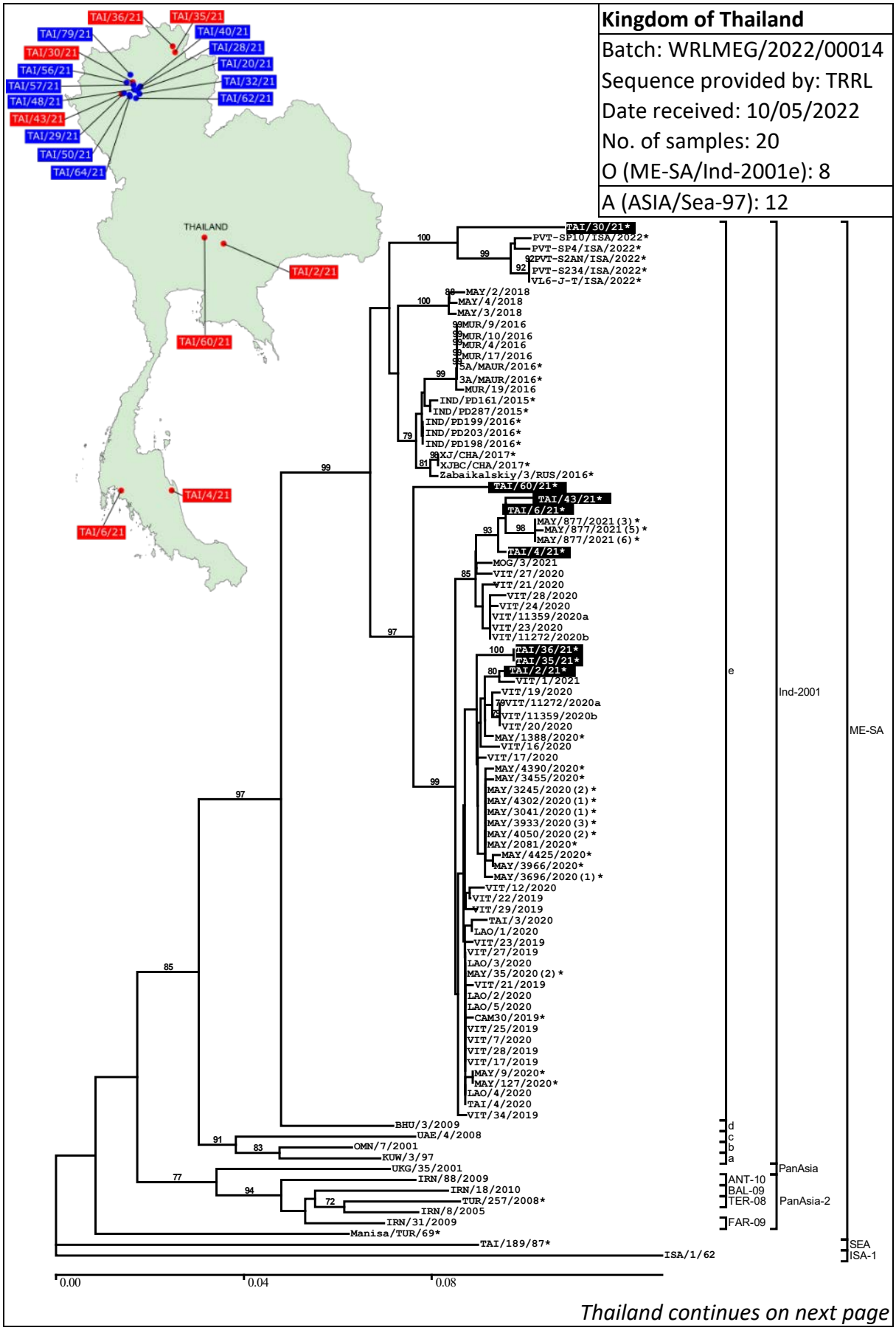
Republic of Indonesia
Batch: WRLMEG/2022/00013 Sequence provided by: Pusvetma Date received: 9/05/2022 No. of samples: 1 O (ME-SA/Ind-2001e): 1
Batch: WRLMEG/2022/00016 Sequence provided by: Pusvetma Date received: 21/05/2022 No. of samples: 4 O (ME-SA/Ind-2001e): 4



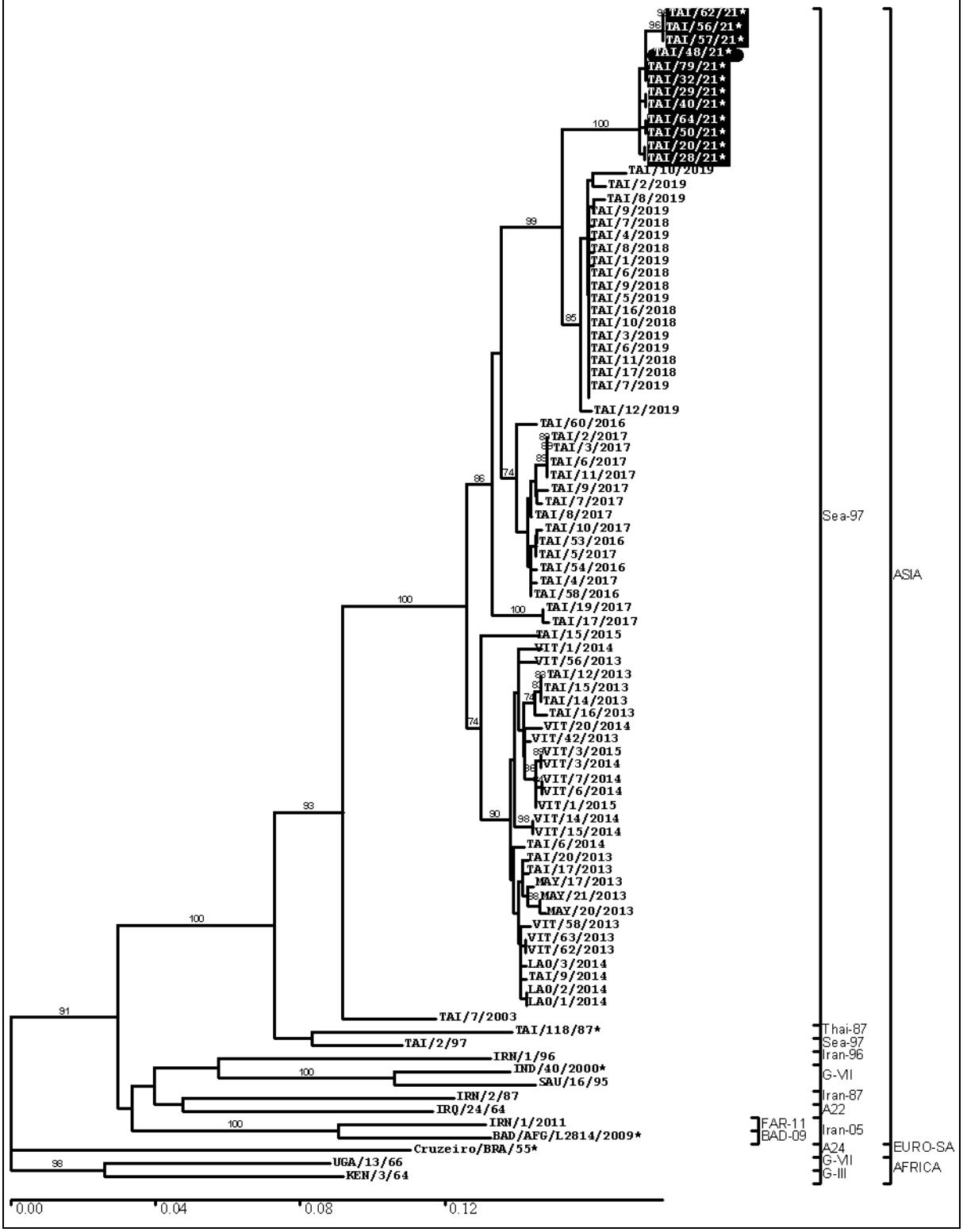
Malaysia

Batch: WRLMEG/2022/00017
Sequence provided by: MNFMDL
Date received: 11/06/2022
No. of samples: 14
O (ME-SA/Ind-2001e): 14




Kingdom of Thailand
Batch: WRLMEG/2022/00014
Sequence provided by: TRRL
Date received: 10/05/2022
No. of samples: 20
O (ME-SA/Ind-2001e): 8
A (ASIA/Sea-97): 12
THAILAND
TAI/36/21
TAI/35/21
TAI/79/21
TAI/40/21
TAI/30/21
TAI/28/21
TAI/56/21
TAI/20/21
TAI/57/21
TAI/32/21
TAI/48/21
TAI/62/21
TAI/43/21
TAI/29/21
TAI/50/21
TAI/64/21
TAI/2/21
TAI/60/21
TAI/4/21
TAI/6/21
TAI/30/21*
PVT-SP10/ISA/2022*
PVT-SP4/ISA/2022*
PVT-S2AN/ISA/2022*
PVT-S234/ISA/2022*
VL6-J-T/ISA/2022*
MAY/2/2018
MAY/4/2018
MAY/3/2018
MUR/9/2016
MUR/10/2016
MUR/4/2016
MUR/17/2016
5A/MAUR/2016*
3A/MAUR/2016*
MUR/19/2016
IND/PD161/2015*
IND/PD287/2015*
IND/PD199/2016*
IND/PD203/2016*
IND/PD198/2016*
XJ/CHA/2017*
XJBC/CHA/2017*
Zabaikalskiy/3/RUS/2016*
TAI/60/21*
TAI/43/21*
TAI/6/21*
MAY/877/2021(3)*
MAY/877/2021(5)*
MAY/877/2021(6)*
TAI/4/21*
MOG/3/2021
VIT/27/2020
VIT/21/2020
VIT/28/2020
VIT/24/2020
VIT/11359/2020a
VIT/23/2020
VIT/11272/2020b
TAI/36/21*
TAI/35/21*
TAI/2/21*
VIT/1/2021
VIT/19/2020
VIT/11272/2020a
VIT/11359/2020b
VIT/20/2020
MAY/1388/2020*
VIT/16/2020
VIT/17/2020
MAY/4390/2020*
MAY/3455/2020*
MAY/3245/2020(2)*
MAY/4302/2020(1)*
MAY/3041/2020(1)*
MAY/3933/2020(3)*
MAY/4050/2020(2)*
MAY/2081/2020*
MAY/4425/2020*
MAY/3966/2020*
MAY/3696/2020(1)*
VIT/12/2020
VIT/22/2019
VIT/29/2019
TAI/3/2020
LAO/1/2020
VIT/23/2019
VIT/27/2019
LAO/3/2020
MAY/35/2020(2)*
VIT/21/2019
LAO/2/2020
LAO/5/2020
CAM30/2019*
VIT/25/2019
VIT/7/2020
VIT/28/2019
VIT/17/2019
MAY/9/2020*
MAY/127/2020*
LAO/4/2020
TAI/4/2020
VIT/34/2019
BHU/3/2009
UAE/4/2008
OMN/7/2001
KUW/3/97
UKG/35/2001
IRN/88/2009
IRN/18/2010
TUR/257/2008*
IRN/8/2005
IRN/31/2009
Manisa/TUR/69*
TAI/189/87*
ISA/1/62
e
d
c
b
a
FAR-09
ANT-10
BAL-09
TER-08
Ind-2001
PanAsia
PanAsia-2
ME-SA
SEA
ISA-1
0.00
0.04
0.08
Thailand continues on next page

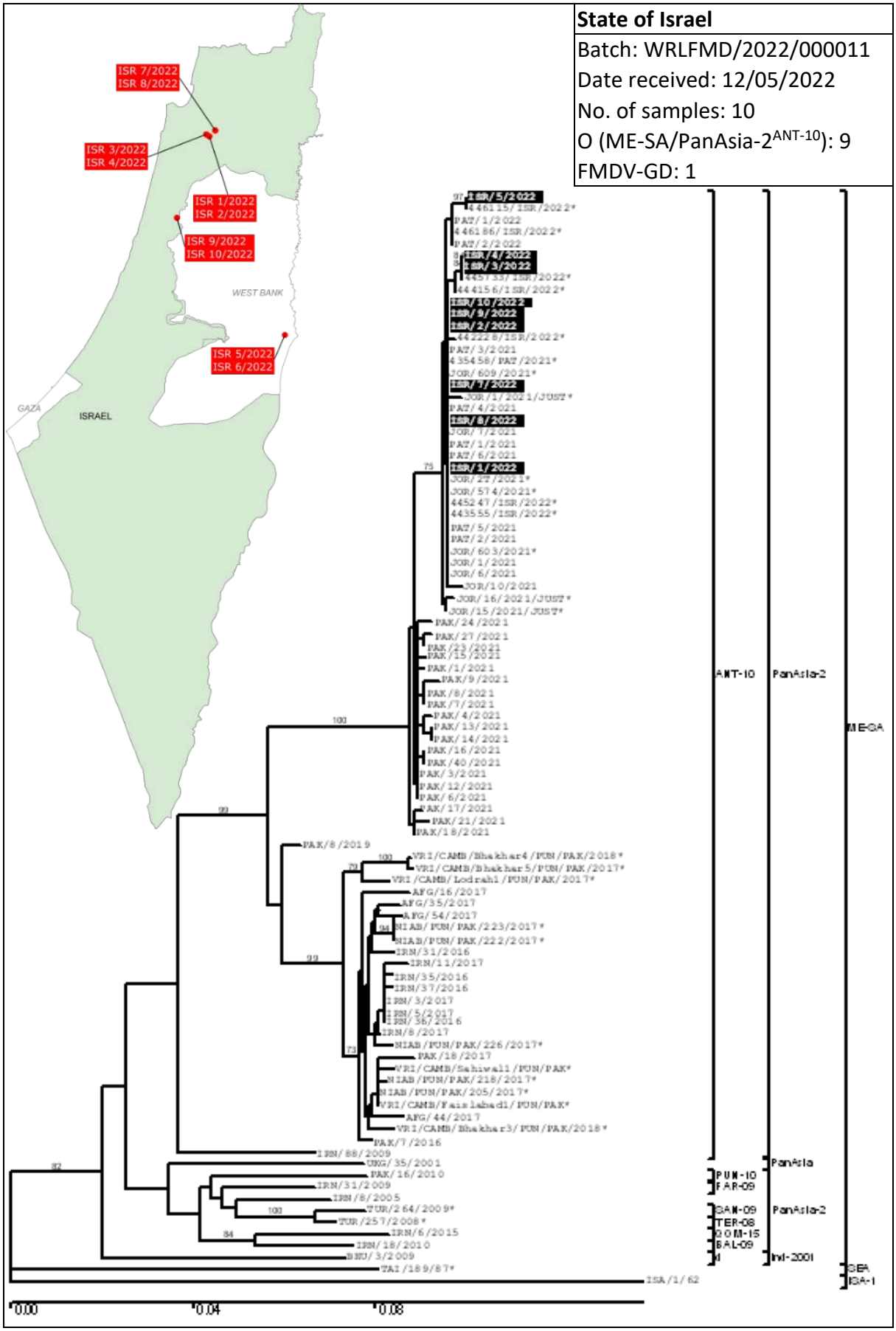
Thailand continued

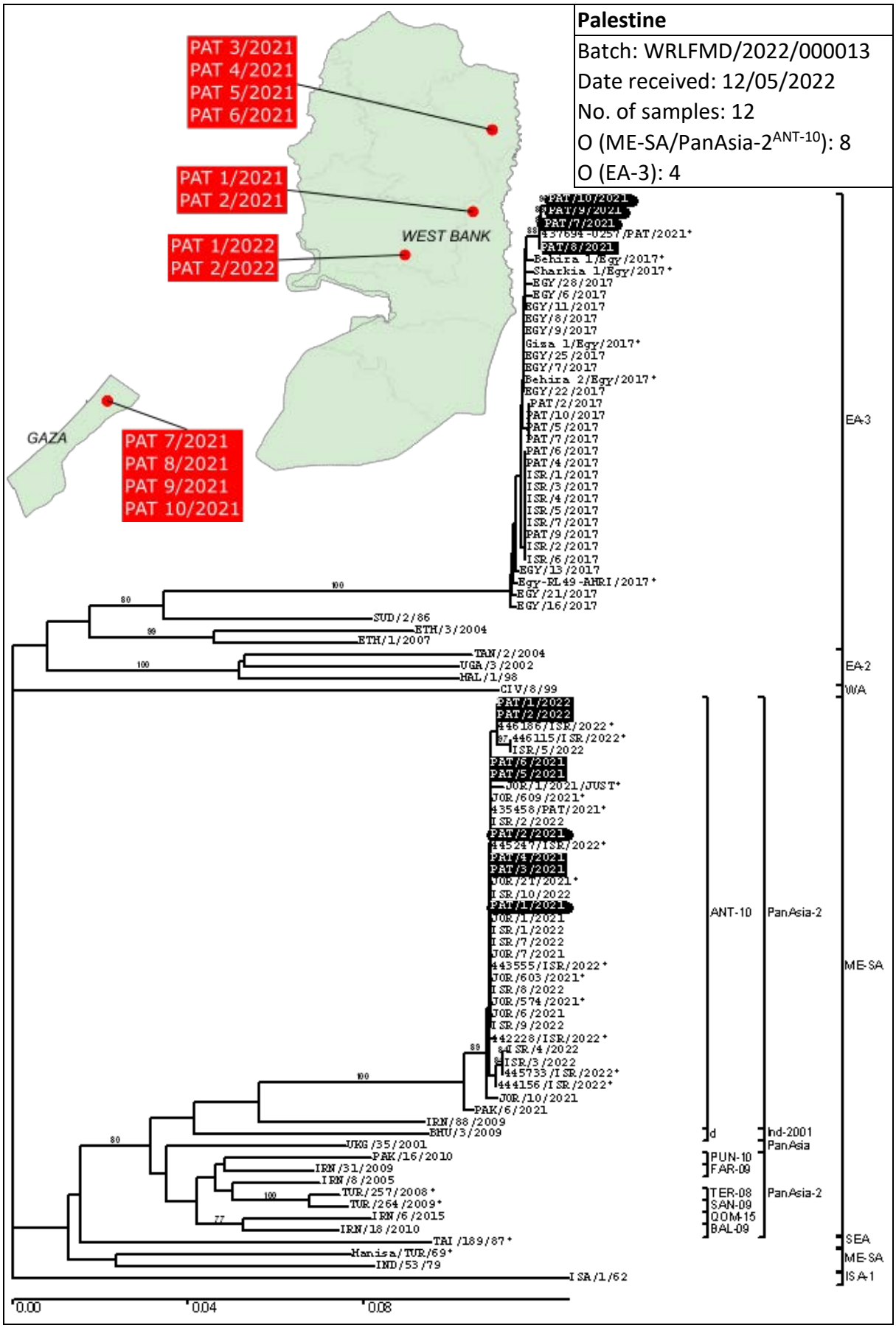


4.2. Pool 2 (South Asia)

No samples/sequences received.

4.3. Pool 3 (West Eurasia and Middle East)




Palestine
Batch: WRLFMD/2022/000013
Date received: 12/05/2022
No. of samples: 12
O (ME-SA/PanAsia-2ANT-10): 8
O (EA-3): 4
PAT 3/2021
PAT 4/2021
PAT 5/2021
PAT 6/2021
PAT 1/2021
PAT 2/2021
PAT 1/2022
PAT 2/2022
WEST BANK
GAZA
PAT 7/2021
PAT 8/2021
PAT 9/2021
PAT 10/2021
EA-3
EA-2
WA
ME-SA
SEA
ME-SA
ISA-1
ANT-10
PanAsia-2
Ind-2001
PanAsia
PUN-10
FAR-09
TER-08
SAN-09
QOM-15
BAL-09
PanAsia-2
0.00
0.04
0.08

United Arab Emirates

Batch: WRLFMD/2022/000008

Date received: 06/05/2022

No. of samples: 15

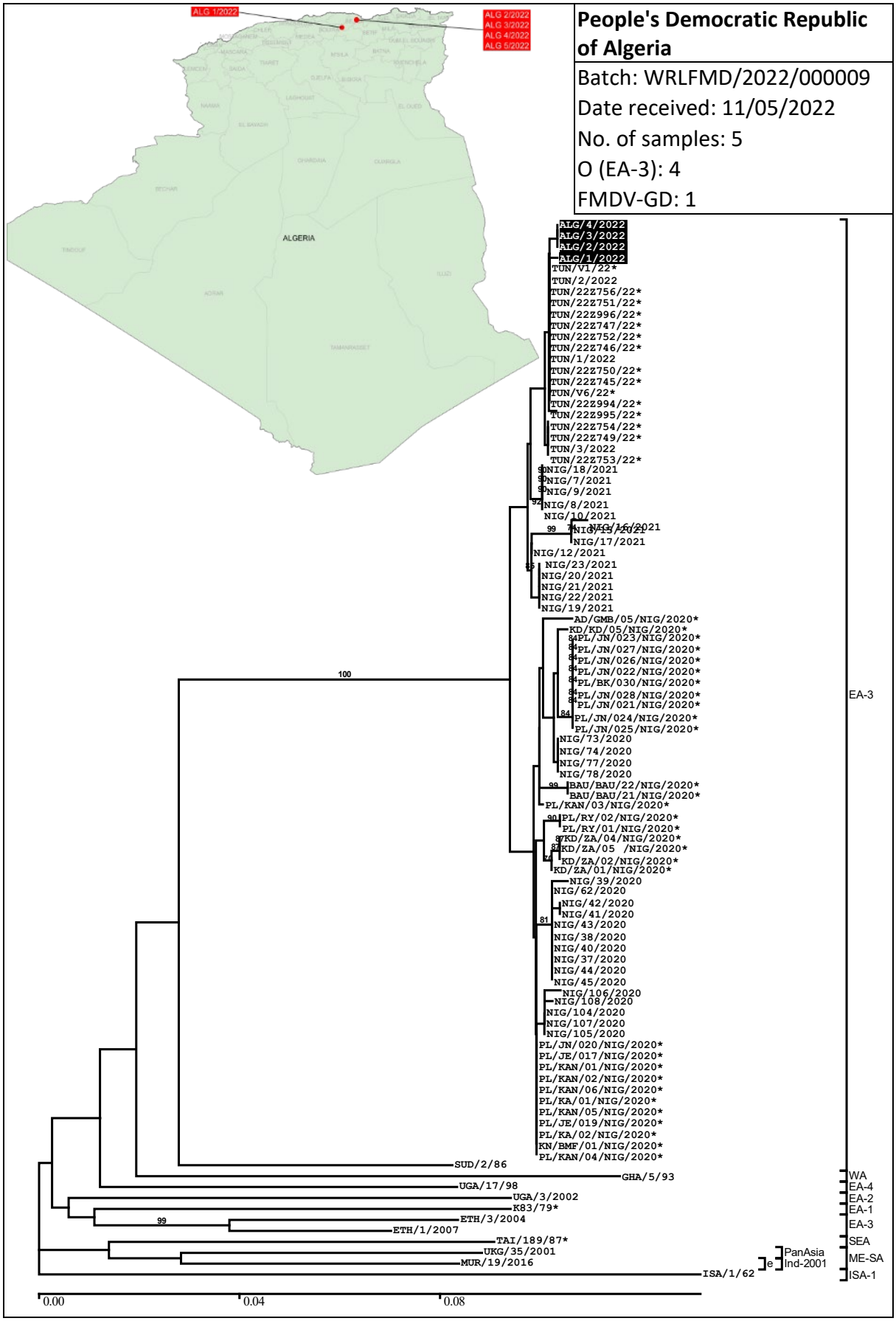
O (ME-SA/PanAsia-2^{ANT-10}): 2

O (ME-SA/SA-2018): 5

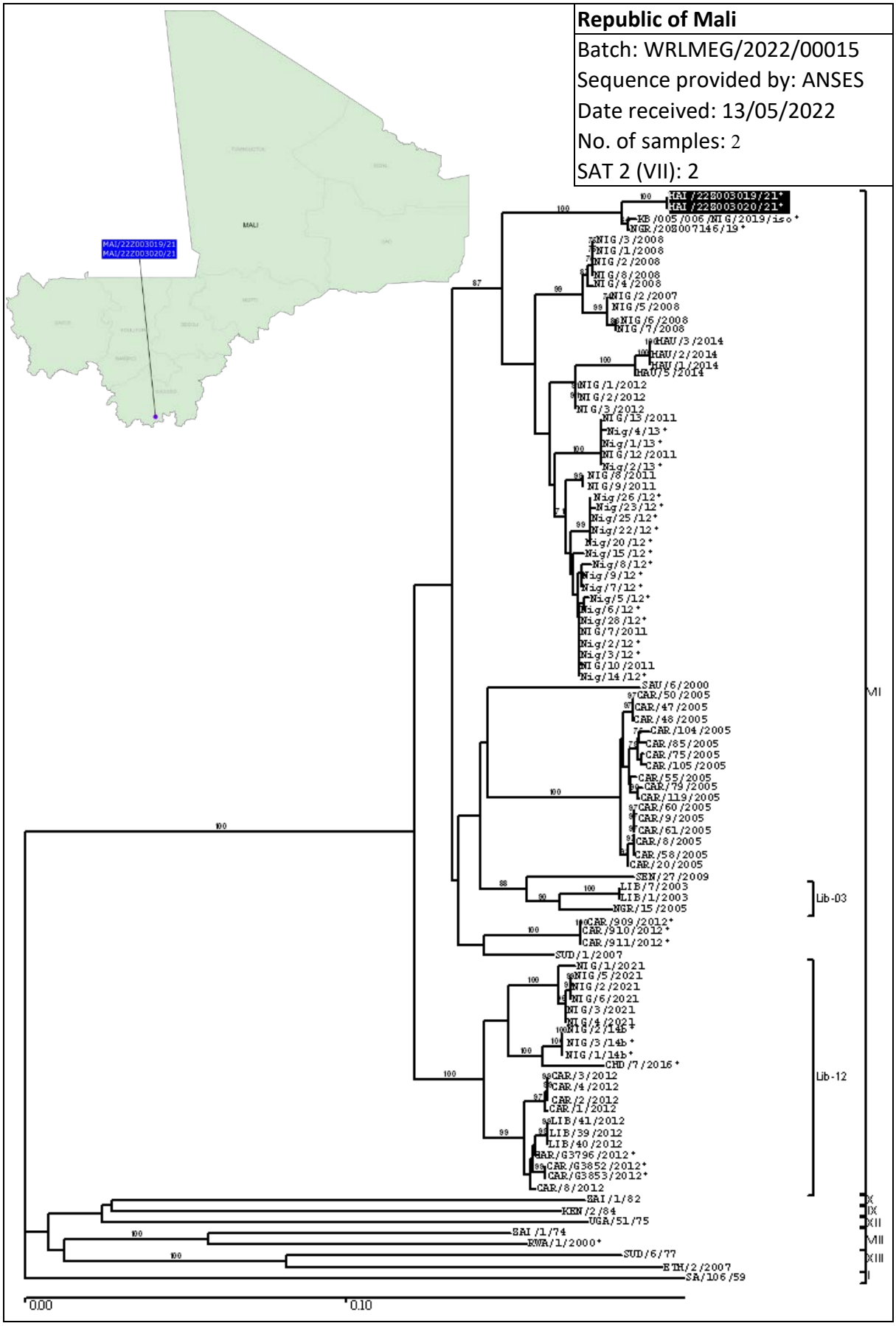
FMDV-GD: 3

NVD: 5

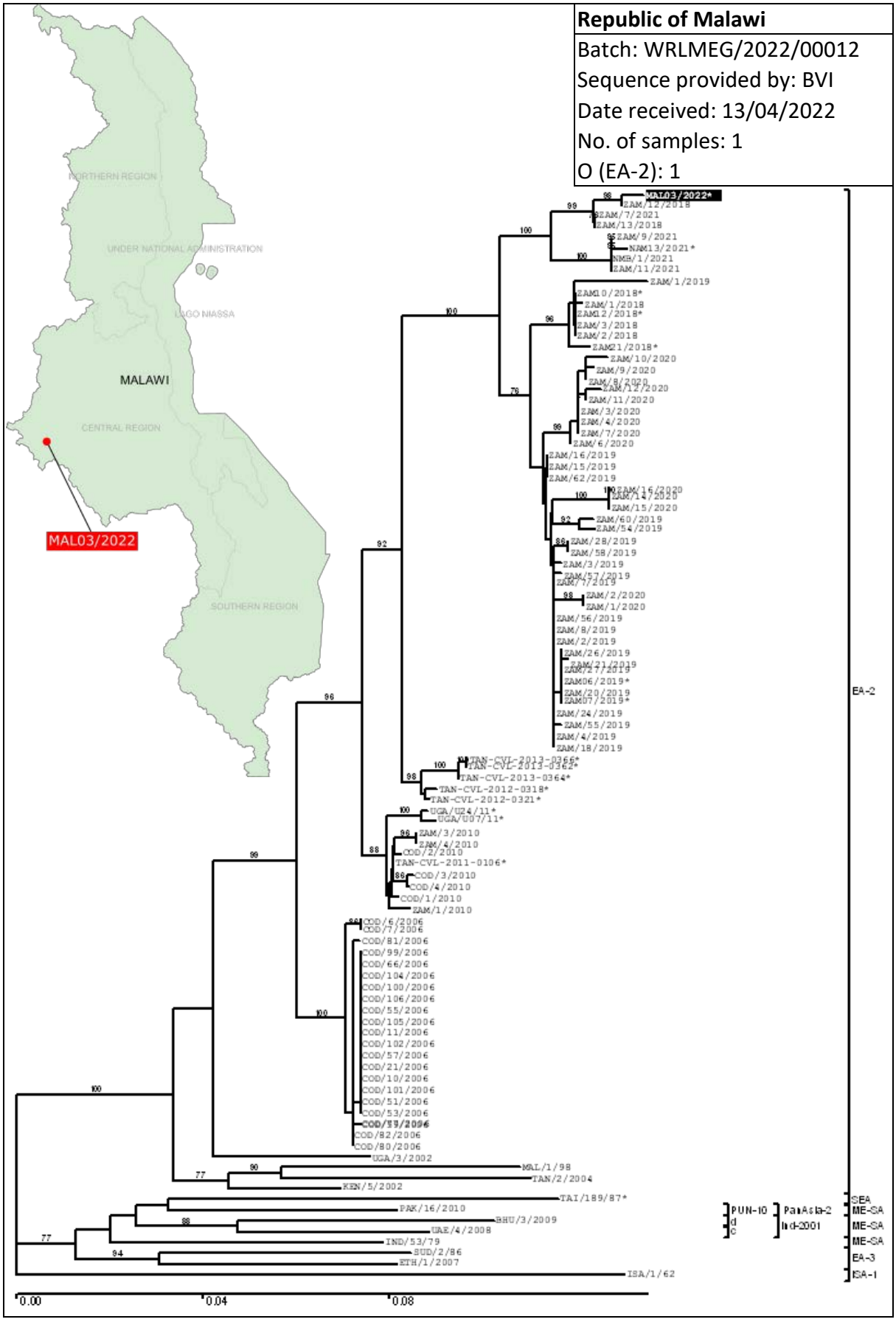
4.4. Pool 4 (North and East Africa)

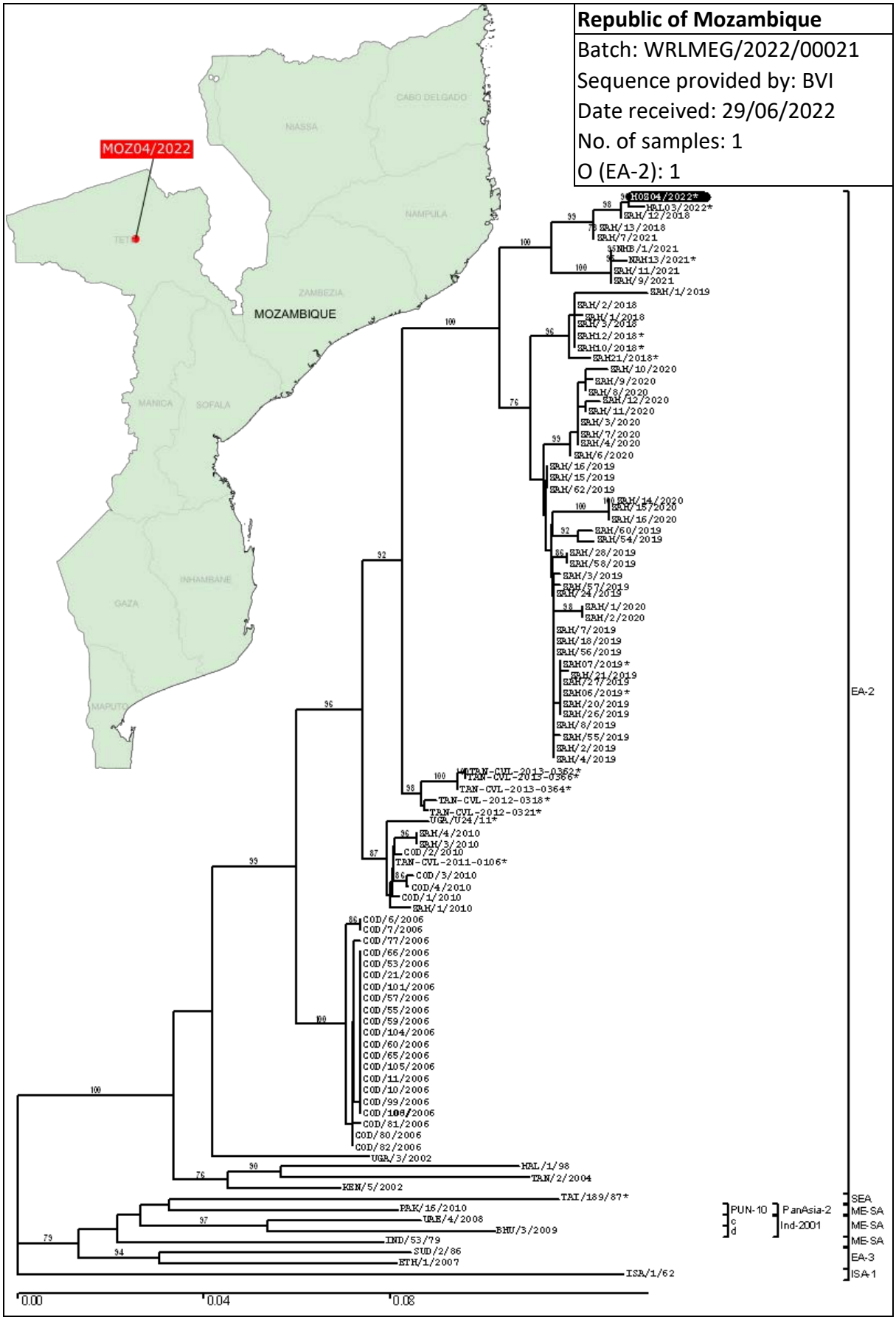


4.5. Pool 5 (West Africa)



4.6. Pool 6 (Southern Africa)




Republic of Mozambique
Batch: WRLMEG/2022/00021
Sequence provided by: BVI
Date received: 29/06/2022
No. of samples: 1
O (EA-2): 1
MOZ04/2022
MOZAMBIQUE
CABO DELGADO
NIASSA
NAMPULA
TETE
ZAMBEZIA
MANICA
SOFALA
INHAMBANE
GAZA
MAPUTO
EA-2
SEA
ME-SA
ME-SA
ME-SA
EA-3
ISA-1
PUN-10
c
d
PanAsia-2
Ind-2001
0.00
0.04
0.08

4.7. Pool 7 (South America)

No samples/sequences received.

4.8. Vaccine matching

Antigenic characterisation of FMD field isolates by matching with vaccine strains by 2dmVNT from April to June 2022.

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
Algeria	2	-	-	-	-	-	-
Namibia	1	-	-	-	-	1	-
Pakistan	2	2	-	2	-	-	-
Tunisia	2	-	-	-	-	-	-
Zambia	2	-	-	-	-	-	-
Total	**9**	**2**	**0**	**2**	**0**	**1**	**0**

Abbreviations used in tables

For each field isolate the r_1 value is shown followed by the heterologous neutralisation titre (r_1-value / titre). The r_1 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	**Vaccine Match** *r_1 = ≥ 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.*
N	**No Vaccine Match** *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.
NT	**Not tested against this vaccine**

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 $TCID_{50}$.

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 O FMDV

Isolate	Serotype O		O 3039 *Boehringer Ingelheim*		O Campos *Boehringer Ingelheim*		O_1 Campos *Biogénesis Bagó*		O Manisa *Boehringer Ingelheim*		PanAsia 2 *Boehringer Ingelheim*		O/TUR/5/09 *MSD*	
	Topotype	Lineage	r_1	*titre*	r_1	*titre*	r_1	*titre*	r_1	*titre*	r_1	*titre*	r_1	*titre*
NMB 01/2021	EA-2	-	0.49	*1.76*	NT	-	0.63	*2.71*	0.35	*2.03*	0.46	*2.23*	0.72	*2.26*
ZAM 12/2018	EA-2	-	0.98	*2.08*	NT	-	0.74	*2.76*	0.71	*2.22*	0.63	*2.34*	0.58	*2.27*
ZAM 13/2018	EA-2	-	1.00	*2.11*	NT	-	0.91	*2.85*	0.78	*2.26*	0.76	*2.42*	0.69	*2.35*
ALG 02/2022	EA-3	-	0.73	*2.09*	0.80	*2.48*	0.50	*2.58*	0.70	*2.39*	0.83	*2.51*	0.81	*2.30*
ALG 04/2022	EA-3	-	0.56	*1.97*	0.53	*2.29*	0.43	*2.52*	0.51	*2.25*	0.55	*2.33*	0.63	*2.19*
TUN 01/2022	EA-3	-	0.60	*1.92*	NT	-	0.56	*2.65*	0.71	*2.35*	0.46	*2.33*	0.91	*2.29*
TUN 03/2022	EA-3	-	0.65	*1.95*	NT	-	0.55	*2.64*	0.62	*2.29*	0.41	*2.28*	0.74	*2.20*
PAK 09/2021	ME-SA	PanAsia-2	0.45	*1.61*	0.15	*1.95*	0.47	*2.58*	0.19	*1.94*	0.32	*2.19*	0.30	*1.92*
PAK 12/2021	ME-SA	PanAsia-2	0.81	*1.87*	0.25	*1.72*	0.42	*2.53*	0.25	*2.06*	0.32	*2.19*	0.78	*2.34*

Table 6: Vaccine matching studies for A FMDV

Isolate	Serotype A		A22 Iraq *Boehringer Ingelheim*		A Iran 2005 *Boehringer Ingelheim*		A GVII 2015 *Boehringer Ingelheim*		A Malaysia 97 *Boehringer Ingelheim*		A/TUR/20/06 *MSD*	
	Topotype	Lineage	r_1	*titre*	r_1	*titre*	r_1	*titre*	r_1	*titre*	r_1	*titre*
PAK 28/2021	ASIA	Iran-05	0.20	*1.95*	0.31	*2.03*	0.61	*1.61*	0.20	*1.75*	0.20	*1.27*
PAK 29/2021	ASIA	Iran-05	0.14	*1.81*	0.35	*2.08*	0.51	*1.53*	0.16	*1.66*	0.21	*1.29*

Table 7: Vaccine matching studies for Asia-1 FMDV

Isolate	Serotype Asia-1		Asia 1 Shamir *Boehringer Ingelheim*	
	Topotype	Lineage	r_1	*titre*
PAK 31/2021	ASIA	Sindh-08	0.44	*2.15*
PAK 48/2021	ASIA	Sindh-08	0.38	*2.09*

Table 8: Vaccine matching studies for SAT 2 FMDV

Isolate	Serotype SAT 2		SAT2 Zim 83 *Boehringer Ingelheim*		SAT2 Eritrea 98 *Boehringer Ingelheim*	
	Topotype	Lineage	r_1	*titre*	r_1	*titre*
NMB 01/2020	III	-	0.09	*1.37*	0.10	*1.05*

Annex 1: Sample data

Summary of submissions

Table 9: Summary of samples collected and received to WRLFMD (April to June 2022)

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*
Algeria	5	4	-	-	-	-	-	-	1	5	-
Botswana	1	-	-	-	-	-	-	-	1	-	1
Israel	10	9	-	-	-	-	-	-	1	10	-
Malawi	2	-	-	-	-	-	-	-	2	2	-
Namibia	4	1	-	-	-	1	-	-	2	4	-
Palestinian, State of	12	12	-	-	-	-	-	-	-	12	-
Tunisia	3	3	-	-	-	-	-	-	-	3	-
United Arab Emirates	15	7	-	-	-	-	-	-	8	10	5
Zambia	3	2	-	-	1	-	1	-	-	3	-
TOTAL	55	38	0	0	1	1	1	0	15	49	6

Clinical samples

Table 10: Clinical sample diagnostics made by the WRLFMD April to June 2022

Country	Date		WRL for FMD Sample Identification	Animal	Date of Collection	Results		
	Received	Reported				VI/ELISA	RT-PCR	Final report
Algeria	11-May-22	31-May-22	ALG 1/2022	CATTLE	28-Mar-22	O	FMDV GD	O
			ALG 2/2022	CATTLE	31-Mar-22	O	FMDV GD	O
			ALG 3/2022	CATTLE	31-Mar-22	O	FMDV GD	O
			ALG 4/2022	CATTLE	31-Mar-22	O	FMDV GD	O
			ALG 5/2022	CATTLE	31-Mar-22	NVD	FMDV GD	FMDV GD
Botswana	28-Feb-22	04-Apr-22	BOT 1/2022	CATTLE	01-Jan-22	NVD	NGD	NVD
Israel	12-May-22	31-May-22	ISR 1/2022	CATTLE	10-Feb-22	O	FMDV GD	O
			ISR 2/2022	CATTLE	10-Feb-22	O	FMDV GD	O
			ISR 3/2022	CATTLE	08-Mar-22	O	FMDV GD	O
			ISR 4/2022	CATTLE	08-Mar-22	O	FMDV GD	O
			ISR 5/2022	CATTLE	09-Mar-22	O	FMDV GD	O
			ISR 6/2022	CATTLE	09-Mar-22	NVD	FMDV GD	FMDV GD

Country	Date		WRL for FMD Sample Identification	Animal	Date of Collection	Results		
	Received	Reported				VI/ELISA	RT-PCR	Final report
			ISR 7/2022	CATTLE	24-Mar-22	O	FMDV GD	O
			ISR 8/2022	CATTLE	24-Mar-22	O	FMDV GD	O
			ISR 9/2022	CATTLE	29-Mar-22	O	FMDV GD	O
			ISR 10/2022	CATTLE	29-Mar-22	O	FMDV GD	O
Malawi	28-Feb-22	04-Apr-22	MAL 1/2021	CATTLE	04-Jan-21	NVD	FMDV GD	FMDV GD
			MAL 2/2021	CATTLE	04-Jan-21	NVD	FMDV GD	FMDV GD
Namibia	28-Feb-22	04-Apr-22	NMB 1/2020	CATTLE	25-Sep-20	SAT 2	FMDV GD	SAT 2
			NMB 2/2020	CATTLE	25-Sep-20	NVD	FMDV GD	FMDV GD
			NMB 3/2020	CATTLE	28-Dec-20	NVD	FMDV GD	FMDV GD
			NMB 1/2021	CATTLE	06-Jan-21	O	FMDV GD	O
Palestine	12-May-22	31-May-22	PAT 1/2021	CATTLE	04-Dec-21	O	FMDV GD	O
			PAT 2/2021	CATTLE	04-Dec-21	O	FMDV GD	O
			PAT 3/2021	SHEEP	13-Dec-21	O	FMDV GD	O
			PAT 4/2021	SHEEP	13-Dec-21	O	FMDV GD	O
			PAT 5/2021	GOAT	13-Dec-21	O	FMDV GD	O
			PAT 6/2021	GOAT	13-Dec-21	O	FMDV GD	O
			PAT 7/2021	CATTLE	16-Dec-21	O	FMDV GD	O
			PAT 8/2021	CATTLE	16-Dec-21	O	FMDV GD	O
			PAT 9/2021	CATTLE	19-Dec-21	O	FMDV GD	O
			PAT 10/2021	CATTLE	19-Dec-21	O	FMDV GD	O
			PAT 1/2022	SHEEP	23-Mar-22	O	FMDV GD	O
			PAT 2/2022	SHEEP	23-Mar-22	O	FMDV GD	O
Tunisia	16-Mar-22	18-May-22	TUN 1/2022	CATTLE	04-Jan-22	O	FMDV GD	O
			TUN 2/2022	CATTLE	04-Jan-22	O	FMDV GD	O
			TUN 3/2022	CATTLE	05-Jan-22	O	FMDV GD	O
United Arab Emirates	06-May-22	23-Jun-22	UAE 1/2021	ORYX	09-Apr-21	O	FMDV GD	O
			UAE 2/2021	ORYX	09-Apr-21	O	FMDV GD	O
			UAE 3/2021	SHEEP	19-Jul-21	NVD	NGD	NVD
			UAE 4/2021	SHEEP	19-Jul-21	NVD	NGD	NVD
			UAE 5/2021	SHEEP	20-Jul-21	NVD	NGD	NVD
			UAE 6/2021	SHEEP	20-Jul-21	NVD	NGD	NVD
			UAE 7/2021	SHEEP	21-Jul-21	NVD	NGD	NVD
			UAE 8/2021	CATTLE	25-Oct-21	NVD	FMDV GD	FMDV GD
			UAE 9/2021	GOAT	07-Nov-21	O	FMDV GD	O
			UAE 10/2021	GOAT	07-Nov-21	O	FMDV GD	O
			UAE 11/2021	GOAT	07-Nov-21	O	FMDV GD	O
			UAE 12/2021	CATTLE	30-Nov-21	NVD	FMDV GD	FMDV GD
			UAE 13/2021	CATTLE	30-Nov-21	NVD	FMDV GD	FMDV GD
			UAE 14/2021	SHEEP	05-Dec-21	O	FMDV GD	O
			UAE 15/2021	SHEEP	05-Dec-21	O	FMDV GD	O

Country	Date		WRL for FMD Sample Identification	Animal	Date of Collection	Results		
	Received	Reported				VI/ELISA	RT-PCR	Final report
Zambia	28-Feb-22	04-Apr-22	ZAM 4/2015	CATTLE	10-Nov-15	SAT 1, SAT 3	FMDV GD	SAT 1, SAT 3
			ZAM 12/2018	CATTLE	23-Mar-18	O	FMDV GD	O
			ZAM 13/2018	CATTLE	23-Mar-18	O	FMDV GD	O
	TOTAL				**55**			

Annex 2: FMD publications

Recent FMD Publications (April to June 2022) cited by Web of Science.

(2022). Spatial risk factors influencing on the occurrence of foot-and-mouth disease outbreaks in Karnataka. *International Journal of Infectious Diseases,* 116**,** S64-S64**,** DOI: 10.1016/j.ijid.2021.12.151.

Ali, I., Rehman, A., Mushtaq, M. H., Ijaz, M., Khaliq, M. S., Khan, M. S. U., Khalid, S.*, et al.* 2022. Outbreak investigation and identification of risk factors associated with the occurrence of foot-and-mouth disease in Punjab, Pakistan. *Preventive Veterinary Medicine,* 202**,** 9**,** DOI: 10.1016/j.prevetmed.2022.105613.

Banda, F., Shilongo, A., Hikufe, E. H., Khaiseb, S., Kabajani, J., Shikongo, B., Set, P.*, et al.* The first detection of a serotype O *Foot-and-mouth disease virus* in Namibia. *Transboundary and Emerging Diseases***,** 7**,** DOI: 10.1111/tbed.14561.

Bertram, M., Stenfeldt, C., Holinka-Patterson, L., Fish, I., Farooq, U., Ahmed, Z., Hartwig, E. J.*, et al.* Multiple genome sequences of *Foot-and-mouth disease virus* Asia-1 lineage Sindh-08 from outbreaks in Pakistan, 2011 to 2012. *Microbiology Resource Announcements***,** 3**,** DOI: 10.1128/mra.00312-22.

Brown, E., Nelson, N., Gubbins, S. & Colenutt, C. 2022. Airborne transmission of *Foot-and-mouth disease virus*: a review of past and present perspectives. *Viruses-Basel,* 14**,** 14**,** DOI: 10.3390/v14051009.

Canini, L., Blaise-Boisseau, S., Di Nardo, A., Shaw, A. E., Romey, A., Relmy, A., Bernelin-Cottet, C.*, et al.* Identification of diffusion routes of O/EA-3 topotype of *Foot-and-mouth disease virus* in Africa and Western Asia between 1974 and 2019-a phylogeographic analysis. *Transboundary and Emerging Diseases***,** 10**,** DOI: 10.1111/tbed.14562.

Chanchaidechachai, T., Saatkamp, H., Inchaisri, C. & Hogeveen, H. 2022. Analysis of epidemiological and economic impact of foot-and-mouth disease outbreaks in four district areas in Thailand. *Frontiers in Veterinary Science,* 9**,** 8**,** DOI: 10.3389/fvets.2022.904630.

Childs, K., Ben, J., Harvey, Y. & Seago, J. 2022. Trans-encapsidation of *Foot-and-mouth disease virus* genomes facilitates escape from neutralizing antibodies. *Viruses-Basel,* 14**,** 10**,** DOI: 10.3390/v14061161.

Chimera, E. T., Fosgate, G. T., Etter, E. M. C., Jemberu, W. T., Kamwendo, G. & Njoka, P. 2022. Spatio-temporal patterns and risk factors of foot-and-mouth disease in Malawi between 1957 and 2019. *Preventive Veterinary Medicine,* 204**,** 8**,** DOI: 10.1016/j.prevetmed.2022.105639.

Compston, P., Limon, G. & Hasler, B. A systematic review of the methods used to analyze the economic impact of endemic foot-and-mouth disease. *Transboundary and Emerging Diseases***,** 12**,** DOI: 10.1111/tbed.14564.

Eckstein, S., Ehmann, R., Gritli, A., Ben Rhaiem, M., Ben Yahia, H., Diehl, M., Wolfel, R., Handrick, S., Ben Moussa, M. & Stoecker, K. 2022. Viral and bacterial zoonotic agents in dromedary camels from southern Tunisia: a seroprevalence study. *Microorganisms,* 10**,** 12**,** DOI: 10.3390/microorganisms10040727.

Edge, D., Mahapatra, M., Strachan, S., Turton, J., Waters, R., Benfield, C., Nazareth, N., Njeumi, F., Nazareth, N. & Parida, S. 2022. Development and evaluation of molecular

pen-side assays without prior RNA extraction for peste des petits ruminants (PPR) and foot-and-mouth disease (FMD). *Viruses-Basel,* 14**,** 17**,** DOI: 10.3390/v14040835.

Fish, I., Stenfeldt, C., Spinard, E., Medina, G. N., Azzinaro, P. A., Bertram, M. R., Holinka, L.*, et al.* 2022. *Foot-and-mouth disease virus* interserotypic recombination in superinfected carrier cattle. *Pathogens,* 11**,** 20**,** DOI: 10.3390/pathogens11060644.

Garcia, A. I. E., Lefebvre, D. J., Nyabongo, L., Haegeman, A., Nkundwanayo, C., De Vleeschauwer, A., Ntakirutimana, D.*, et al.* 2022. Outbreaks of foot-and-mouth disease in Burundi, East Africa, in 2016, caused by different serotypes. *Viruses-Basel,* 14**,** 15**,** DOI: 10.3390/v14051077.

Hassan, A. M., El-Mayet, F. S., El-Habbaa, A. S., Shahein, M. A., El Zowalaty, M. E. M., Hagag, N. M. & Sharawi, S. S. A. 2022. Molecular characterization of newly emerging *Foot-and-mouth disease virus* serotype SAT 2 of Lib-12 lineage isolated from Egypt. *Virus Research,* 311**,** 12**,** DOI: 10.1016/j.virusres.2021.198651.

Ide, Y., Kitab, B., Ito, N., Okamoto, R., Tamura, Y., Matsui, T., Sakoda, Y. & Tsukiyama-Kohara, K. 2022. Characterization of host factors associated with the internal ribosomal entry sites of foot-and-mouth disease and classical swine fever viruses. *Scientific Reports,* 12**,** 11**,** DOI: 10.1038/s41598-022-10437-z.

Ijaz, M., Ali, M. M., Awan, F., Ishaq, M. & Ahmad, A. 2022. FMD virus spillover from domestic livestock caused outbreak in captive wild ungulates: First report from Pakistan. *Acta Tropica,* 231**,** 7**,** DOI: 10.1016/j.actatropica.2022.106439.

Jain, B., Tewari, A., Prasad, M. & Kadian, S. K. 2022. A novel approach for estimation of anti-FMDV protective immunity generated in multiple vaccinated field animals. *Acta Virologica,* 66**,** 90-94**,** DOI: 10.4149/av_2022_110.

Keck, H., Hoffmann, B. & Eschbaumer, M. 2022. Proof of proficiency of decentralized *Foot-and-mouth disease virus* diagnostics in Germany. *Viruses-Basel,* 14**,** 10**,** DOI: 10.3390/v14051098.

Kim, A., Lee, G., Hwang, J. H., Park, J. H., Lee, M. J., Kim, B. & Kim, S. M. BacMam expressing highly glycosylated porcine interferon alpha induces robust antiviral and adjuvant effects against *Foot-and-mouth disease virus* in pigs. *Journal of Virology***,** 14**,** DOI: 10.1128/jvi.00528-22.

Kim, A. Y., Park, S. Y., Park, S. H., Kim, J. Y., Jin, J. S., Kim, E. S., Park, J. H. & Ko, Y. J. 2022. Comparison of high-performance liquid chromatography with sucrose density gradient ultracentrifugation for the quantification of foot-and-mouth disease vaccine antigens. *Vaccines,* 10**,** 17**,** DOI: 10.3390/vaccines10050667.

Kristensen, T., Normann, P. & Belsham, G. J. 2022. The N-terminal region (VP4) of the foot-and-mouth disease capsid precursor (P1-2A) is not required during its synthesis to allow subsequent processing by the 3C protease. *Virology,* 570**,** 29-34**,** DOI: 10.1016/j.virol.2022.03.006.

Lee, H. W., Jiang, Y. F., Chang, H. W. & Cheng, I. C. 2022a. *Foot-and-mouth disease virus* 3A hijacks Sar1 and Sec12 for ER remodeling in a COPII-independent manner. *Viruses-Basel,* 14**,** 19**,** DOI: 10.3390/v14040839.

Lee, M. J., Kim, H. M., Shin, S., Jo, H., Park, S. H., Kim, S. M. & Park, J. H. 2022b. The C3d-fused foot-and-mouth disease vaccine platform overcomes maternally-derived antibody interference by inducing a potent adaptive immunity. *NPJ Vaccines,* 7**,** 15**,** DOI: 10.1038/s41541-022-00496-8.

Lim, D. R., Ryoo, S., Kang, H., Oh, S. H., Jang, S. H., Kang, B., Park, H. J.*, et al.* Enhanced detection and serotyping of *Foot-and-mouth disease virus* serotype O, A, and Asia1 using a novel multiplex real-time RT-PCR. *Transboundary and Emerging Diseases*, 12, DOI: 10.1111/tbed.14603.

Lysholm, S., Lindahl, J. F., Munyeme, M., Misinzo, G., Mathew, C., Alvasen, K., Dautu, G.*, et al.* 2022. Crossing the line: seroprevalence and risk factors for transboundary animal diseases along the Tanzania-Zambia border. *Frontiers in Veterinary Science,* 9, 18, DOI: 10.3389/fvets.2022.809128.

Ma, X. S., Zhang, K. S., Luo, Z. K., Nian, X. F., Choudhury, S. K. M., Zhu, Z. X., Song, R.*, et al.* FMDV 3A antagonizes the effect of ANXA1 to positively modulate viral replication. *Journal of Virology*, 20, DOI: 10.1128/jvi.00317-22.

Manyweathers, J., Hayes, L., Xie, G., Gardner, H., Maru, Y., Woodgate, R. & Hernandez-Jover, M. 2022a. On-farm evaluation of a predictive model for Australian beef and sheep producers' vulnerability to an outbreak of foot-and-mouth disease. *Preventive Veterinary Medicine,* 204, 7, DOI: 10.1016/j.prevetmed.2022.105656.

Manyweathers, J., Maru, Y., Hayes, L., Loechel, B., Kelly, J., Felton, S., El Hassan, M., Kruger, H., Woodgate, R. & Hernandez-Jover, M. 2022b. Foot-and-mouth disease ready? How co-creation of and participation in knowledge development and sharing can transform relationships between livestock producers and other animal health stakeholders - an Australian case study. *Journal of Science Communication,* 21, 18, DOI: 10.22323/2.21020203.

Miller, R. S., Bevins, S. N., Cook, G., Free, R., Pepin, K. M., Gidlewski, T. & Brown, V. R. Adaptive risk-based targeted surveillance for foreign animal diseases at the wildlife-livestock interface. *Transboundary and Emerging Diseases*, 12, DOI: 10.1111/tbed.14576.

Moreno-Torres, K. I., Delgado, A. H., Branan, M. A., Yadav, S., Stenfeldt, C. & Arzt, J. 2022. Parameterization of the durations of phases of foot-and-mouth disease in pigs. *Preventive Veterinary Medicine,* 202, 13, DOI: 10.1016/j.prevetmed.2022.105615.

Munsey, A., Mwiine, F. N., Ochwo, S., Velazquez-Salinas, L., Ahmed, Z., Rodriguez, L. L., Rieder, E., Perez, A. & Vanderwaal, K. 2022. Ecological and anthropogenic spatial gradients shape patterns of dispersal of *Foot-and-mouth disease virus* in Uganda. *Pathogens,* 11, 11, DOI: 10.3390/pathogens11050524.

Palinski, R. M., Brito, B., Jaya, F. R., Sangula, A., Gakuya, F., Bertram, M. R., Pauszek, S. J.*, et al.* 2022. Viral population diversity during co-infection of *Foot-and-mouth disease virus* serotypes SAT 1 and SAT 2 in African buffalo in Kenya. *Viruses-Basel,* 14, 16, DOI: 10.3390/v14050897.

Pezzoni, G., Calzolari, M., Foglia, E. A., Bregoli, A., Nardo, A. D., Sghaier, S., Madani, H.*, et al.* Characterization of the O/ME-SA/Ind-2001d *Foot-and-mouth disease virus* epidemic recorded in the Maghreb during 2014-2015. *Transboundary and Emerging Diseases*, 12, DOI: 10.1111/tbed.14611.

Puckette, M., Primavera, V., Martel, E., Barrera, J., Hurtle, W., Clark, B., Kamicker, B., Zurita, M., Brake, D. & Neilan, J. 2022. Transiently transfected mammalian cell cultures: an adaptable and effective platform for virus-like particle-based vaccines against *Foot-and-mouth disease virus*. *Viruses-Basel,* 14, 11, DOI: 10.3390/v14050989.

Sareyyupoglu, B., Gulyaz, G., Sarac, F., Uzar, S., Kabakli, O., Cokcaliskan, C., Gunduzalp, C., Uzun, E. A. & Camli, O. 2022. Antibody response of sheep to simultaneous vaccination

of foot-and-mouth disease, peste des petits ruminants, sheep pox and goat pox, and bluetongue vaccines. *Tropical Biomedicine,* 39**,** 47-54**,** DOI: 10.47665/tb.39.1.002.

Shaw, A. E., Burman, A., Asfor, A., Brocchi, E., Grazioli, S., Browning, C., Ludi, A., Tuthill, T. J. & King, D. P. 2022. Avidity of polyclonal antibodies to *Foot-and-mouth disease virus* in bovine serum measured using bio-layer interferometry. *Viruses-Basel,* 14**,** 13**,** DOI: 10.3390/v14040714.

Shin, S., Park, S. H., Park, J. H., Kim, S. M. & Lee, M. J. 2022. Age-dependent dynamics of maternally derived antibodies (MDAS) and understanding MDA-mediated immune tolerance in foot-and-mouth disease-vaccinated pigs. *Vaccines,* 10**,** 16**,** DOI: 10.3390/vaccines10050677.

Siengsanan-Lamont, J., Theppangna, W., Phommachanh, P., Khounsy, S., Selleck, P. W., Matsumoto, N., Gleeson, L. J. & Blacksell, S. D. 2022. Abattoir-based serological surveillance and spatial risk analysis of foot-and-mouth disease, brucellosis, and Q fever in Lao PDR large ruminants. *Tropical Medicine and Infectious Disease,* 7**,** 16**,** DOI: 10.3390/tropicalmed7050078.

Soltan, M. A., Mahmoud, M. M., Hegazy, Y. & Abd-Eldiam, M. M. Emergence of *Foot-and-mouth disease virus*, serotype O, Europe-South America topotype in Egypt, 2022. *Transboundary and Emerging Diseases*, 3**,** DOI: 10.1111/tbed.14612.

Somagond, A., Patel, B. H. M., Pattanaik, A. K., Dutt, T., Sanyal, A., Sheshagiri, G., Bhanuprakash, V., Gaur, G. K., Singh, M. & Yadav, S. 2022. Economic evaluation of therapeutic diet formulated for Foot-and-mouth disease (FMD) infected crossbred calves. *Indian Journal of Animal Sciences,* 92**,** 545-548.

Stenfeldt, C., Bertram, M., Holinka-Patterson, L., Fish, I., Farooq, U., Ahmed, Z., Hartwig, E. J.*, et al.* Multiple genomes of *Foot-and-mouth disease virus* serotype Asia-1 obtained from subclinically infected Asian buffalo (*Bubalus bubalis*) in Pakistan. *Microbiology Resource Announcements*, 3**,** DOI: 10.1128/mra.00311-22.

Tuncer-Goktuna, P., Malal, M. E., Sareyyupogoglu, B., Cokcaliskan, C., Tascene, N., Uzun, E. A., Arslan, A.*, et al.* 2022. The effects of simultaneous foot-and-mouth disease and *Escherichia coli* vaccination on the immunity of pregnant cows and their calves. *Preventive Veterinary Medicine,* 204**,** 12**,** DOI: 10.1016/j.prevetmed.2022.105645.

Tyulegenov, S. B., Zhakupbayev, A., Berdikulov, M., Karibayev, T., Yessembekova, G. N., Sultanov, A. A., Perez, A. M. & Abdrakhmanov, S. K. Foot-and-mouth disease in Kazakhstan. *Transboundary and Emerging Diseases*, 3**,** DOI: 10.1111/tbed.14607.

Wu, R. S., Wang, H. C., Su, C. L., Wang, P. H. & Lin, E. C. 2022. Pedigree-based analyses of changes in genetic variability in three major swine breeds in Taiwan after a disease outbreak. *Translational Animal Science,* 6**,** 9**,** DOI: 10.1093/tas/txac043.

Yang, K., Song, H. T., Shi, X. N., Ru, J. X., Tan, S. Z., Teng, Z. D., Dong, H., Guo, H. C., Wei, F. H. & Sun, S. Q. 2022a. Preparation of a polysaccharide adjuvant and its application in the production of a *Foot-and-mouth disease virus*-like particles vaccine. *Biochemical Engineering Journal,* 184**,** 9**,** DOI: 10.1016/j.bej.2022.108479.

Yang, M., Zhmendak, D., Mioulet, V., King, D. P., Burman, A. & Nfon, C. K. 2022b. Combining a universal capture ligand and pan-serotype monoclonal antibody to develop a pan-serotype lateral flow strip test for *Foot-and-mouth disease virus* detection. *Viruses-Basel,* 14**,** 8**,** DOI: 10.3390/v14040785.

Yin, W. Z., Xuan, D. C., Wang, H. Y., Zhou, M. X., Deng, B. H., Ma, F., Lu, Y. & Zhang, J. Q.

2022. Biodegradable imiquimod-loaded *Mesoporous organosilica* as a nanocarrier and adjuvant for enhanced and prolonged immunity against *Foot-and-mouth disease virus* in mice. *ACS Applied Bio Materials,* 5**,** 3095-3106**,** DOI: 10.1021/acsabm.2c003823095.

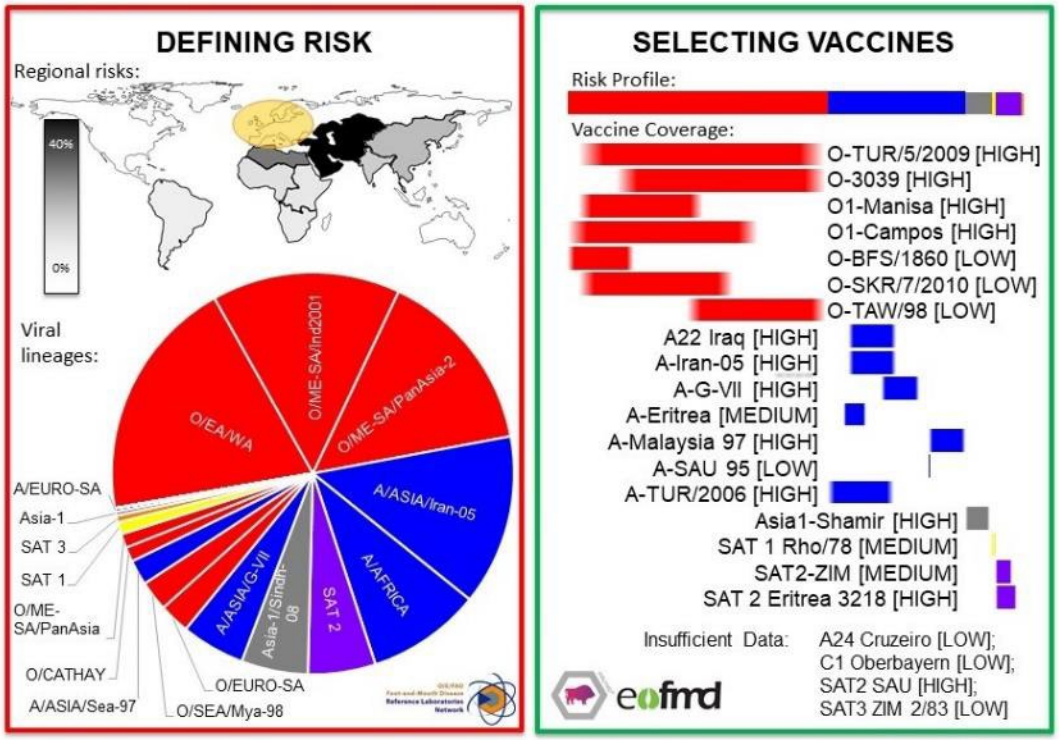
Zhang, T., Lu, B. Z., Yang, B., Zhang, D. J., Shi, X. J., Shen, C. C., Cui, H. M.*, et al.* 2022. Component identification and analysis of vesicular fluid from swine infected by *Foot-and-mouth disease virus*. *Frontiers in Veterinary Science,* 9**,** 8**,** DOI: 10.3389/fvets.2022.860978.

Zia, M. A., Dobson, S. J., Rowlands, D. J., Stonehouse, N. J., Shah, M. S. & Habib, M. 2022. Development of an ELISA to distinguish between *Foot-and-mouth disease virus* infected and vaccinated animals utilising the viral non-structural protein 3ABC. *Journal of Medical Microbiology,* 71**,** 12**,** DOI: 10.1099/jmm.0.001516.

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 WOAH/FAO FMD reference 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 prioritisation (for Europe): June 2022:



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's Open Access Courses provide convenient self-paced training which you may study anytime, anywhere, free of charge. There are currently eight courses in English and one in Arabic:
  - **Introduction to Foot-and-Mouth Disease** (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.
  - **Introduction to Rift Valley Fever** aims to build your understanding of Rift Valley fever diagnosis, surveillance, prevention and control.
  - **What is the Progressive Control Pathway** (available in English and, for anyone who is new to the PCP-FMD, a short e-learning module is also available in Arabic) 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.
  - **Introduction to the Risk-Based Strategic Plan** introducing the Risk-Based Strategic Plan (RBSP).
- **Public Private Partnerships in the Veterinary Domain** course, developed in partnership with the World Organisation for Animal Health (WOAH), applying public-private partnerships to the control of FMD and similar transboundary animal diseases.
- **Simulation Exercises for Animal Disease Emergencies** (available through FAO eLearning academy) aiming at building your understanding of simulation exercises and their value as part of the emergency preparedness cycle.
- A course on **Introduction to the FMD Minimum Biorisk Management Standards** is currently in development. The virtual course will be open access, will target National Competent Authorities, Institute directors for FMD facilities, biorisk managers and laboratory personnel in laboratories handling infectious FMD. The learning objectives will include introduce the importance, implications and responsibilities of implementing the FMD Minimum Biorisk Management Standards.
- **FMD Laboratory investigation training**, in partnership with The Pirbright Institute, is currently in preparation. The course will start in November 2022 and will cover selection of diagnostic tests to detect *Foot-and-mouth disease virus* and specific antibodies, interpretation of test results, outline of techniques for further characterization of FMD virus, basic principles of laboratory quality assurance, key principles of biosecurity, and biosafety measures. The course will be targeting laboratory professionals working in European, African and Asian countries. The course will be accessible on nominations, but a number of seats will be reserved to self-applications
- The next **WRLFMD residential training course on FMD diagnostic methods** is scheduled for May 2023.

Other resources

Podcasts (http://www.fao.org/eufmd/resources/podcasts/en/)

- We have a constantly updated series of short podcasts relating to the FAST world
- The EuFMD has opened an FMD Emergency Toolbox (EN, FR).
- A series of videos on foot-and-mouth disease in English, Bulgarian, Greek and Turkish (https://www.fao.org/eufmd/who-we-are/fr/)
- Leaflets on FMD in English, Turkish, Bulgarian and Greek, for the Thrace region (https://www.fao.org/publications/card/en/c/CB4903EN)
- Join our Telegram channel to receive EuFMD updates (https://t.me/eufmd)
- Find out who TOM is and why you need him (https://www.eufmd.info/tom-training)

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

- European Commission for the control Foot-and-mouth disease (EuFMD) Open Session 2022 will be held on 26th to 28th October 2022 in Marseille, France.
    - *Digitalization and innovation applied to the prevention and control of foot-and-mouth and similar transboundary animal diseases (FAST)* https://www.eufmd.info/os22

Proficiency test scheme organised by WRLFMD

Phase XXXIII of the WRLFMD proficiency testing scheme (PTS) has been concluded, and the participating laboratories should have received their feedback letters. The final report for this exercise will be distributed shortly.

Invitation letters for the next exercise (Phase XXXIV) planned for Autumn 2022 will be sent in the next weeks and any interested laboratories should contract the WRLFMD for further information. Progress of this PTS will be described in future quarterly reports.

EuFMD Committees

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

Hold-FAST tools

AESOP. Assured emergency supply options; **EuFMDiS**, FMD spread model; **GET PREPARED** toolbox. Emergency preparedness; **GVS**. Global Vaccine Security; **Online Simulation Exercises**; **Outbreak Investigation application**; **Pragmatist**. Prioritization of antigen management with international surveillance management tool; **PCP-FMD**. Progressive Control Pathway for foot-and-mouth disease; **PCP-Support Officers**; **SAT**. PCP Self-Assessment Tool; **RTT**. Real Time Training; **SMS Disease reporting**; **SQRA toolkit**. A method for spatial qualitative risk analysis applied to FMD; **Telegram**; **TOM**. EuFMD training management system; **Global Monthly reports**; **VADEMOS**. Vaccine Demand Estimation Model; **VLC**. Virtual Learning Center. **Microlearning**.

United Nations Sustainable Development Goals (UN-SDGs)

EuFMD's programme has a main focus on

Thinking of the environmental footprint

Together against wasting resources, think twice before printing.

Animal Production and Health Division, NSHA / European Commission for the Control of Foot-and-Mouth Disease (EuFMD)

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